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Application of Sustainable Transport Policies in Areas of High Frequent Density Campus of Jadiriya

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Abstract: ***This research investigates and discusses theimplementation ofthe master plan for transport and parking at the campus of University of Baghdad in 2017. Although the master plan emphasizes on economic benefits and revenue, it is benefit of environmental sustainability. Thus, there is a need to effectively implement the master plan and provide new proposals on sustainable transportation to reduce the number of private car parking spaces. The work began by analyzing the earlier designed general parking outline in university's master plan to determineif it meetsthe requirements of buildings after successive implementation. The success or failure of the master plan in relation to reduction in the demand for parking was also assessed. A statistical model was developed to represent the relationship between the area of roads required and the number of cars in parking, and the group of independent factors that are believed to have an impact on these numbers as well as to forecast future needs as regards parking spaces. The distribution of parking cars was found not be neither environmentally sustainable nor socially justifiable, given the clear variation in access time on foot from the nearest parking lot to the workplace. Nonetheless, the over 23% of non-users of vehicles on campus can contribute to the actualization of the concept of sustainable transport (walking). Therefore, this study recommends the preparation and implementation of detailed designs of sustainable transport and parking programs to reduce the planning, environmental, social and economic problems that exist in the master plan of the university campus.***

Keywords: Parking spaces; Jadiriyah; Car Sharing; Campus of Jadiriya; Biking; Green track.

I.INTRODUCTION

The creation of sustainable transportation measures in areas of high density such as market places, hospitals and schools are crucial to modern development. However, the construction of new buildings at the Baghdad University Campus is not accompanied by adequate and properly planned parking spaces. The area and number of parking cars generally depend on the number of future users of the buildings, especially the diverse functions of the buildings and the different institutional requirements such as development of new faculties or departments.

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The parking location at the university is not fully linked with land use and infrastructure of the master plan. Moreover, the location of the parking site did not rely on a sustainable environmental rationale [1].

Therefore, this research hypothesizes that the creation of parking spaces does not exclusivelydepend on economic benefits, but also in the achievement of sustainable environmental development. Part of the concept of sustainable transportation is to reduce parking spaces and make them economically viable. Therefore, this study is the first review of the concept of sustainable transportation and transport policies before analyzing Al Jadriyah Campus, Baghdad University as a case study. This research adopts afield survey to collect information through direct interviews, correspondence and questionnaires. Data is also collected from documents of the master plan from competent departments in the university. Then statistically analyze those data and evaluate them in order to obtain the spatial suitability required for parking.

II.THE CONCEPT OF SUSTAINABLE TRANSPORTATION

Sustainable transportation is also referred to as green transportation. It is a concept that refers to any means of transport with low impact on the environment, which includes non-motorized transport, walking, cycling, transit-oriented development, green vehicles and car-sharing. The building or protection of sustainable transport systems in urban areas can lead to fuel-efficient transportation, conservation of space, and promotion of healthy lifestyles. The term "sustainable transportation" stems from the concept of sustainable development. It has been used to describe the means of transportation, and planning and transport systems that are consistent with broader sustainability issues. There are many definitions of sustainable transport, or related terms by means of sustainable transport and mobility.

The European Union (EU) ministers for transport Council defines sustainable transport as the arrival and convergence of needs of individuals, companies and the community with safety and in a procedure that conforms to human health and environment and promotes equality within and between successive generations. It is cost effective, works equitably and efficiently, and supports the competitive economy andbalanced regional development. It also limits emissions and waste within the earth's absorption capacity.

Sustainable transport utilizes green or renewable resources generated at production rates, as well as non-renewable resources at rates lower than that of renewable energy while lessening the impact of exploitative land use and noise pollution [2].

Traffic jams incure some economic expenses that include wasting people's time and delaying the arrival of goods and services. The actual purpose of transportation is to enable access to work, education, goods and services, family and friends. Conventional transportation strategies aim to enhance movement, particularly for cars, but fail to cover the wider impact of transportation. In contrast, novel approaches to transportation aim to improve accessibility and reduce environmental and social impacts simultaneously, while managing traffic jams. Communities that effectively encourage the sustainability of their transport networks are part of a wider program to develop more sustainable and habitable cities [3].

III.THE PROGRAMS

Sustainable transport programs account for the most significant impact at the city level as a major issue in transport and land-use planning. The advent of legislative acts in several countries enforced sustainability guidelines on the impact of climate change on planning of transportation. Numerous cities have identified the need to connect sustainability to transport policies for environment protection, for example reducing the trips and redesigning parking location taking into consideration natural elements, increasing footpaths and bicycle lanes, increasing the aesthetic value and decreasing fuel consumption [4]. Main examples of sustainable transport policies include:

3.1 Car Sharing Program

Is a model of car rental where people rent cars for short periods of time, often by the hour. It differs from traditional car rental in that the owners of the cars are often private individuals themselves, and the car sharing facilitator is generally distinct from the car owner. Car sharing is part of a larger trend of shared mobility. Car sharing enables an occasional use of avehicle oraccess todifferent brands of vehicles. The renting organization may be a commercial business. Users can also organize as a company, public agency, cooperative, or ad hoc grouping [5].

3.2 Parking Cash-out Program

Parking cash out is a commuter benefit in which an employ-er offers employees the option to accept taxable cash income instead of a free or subsidized parking space at work. The idea behind parking cash out is simple: given a choice of cash or a parking space, many people would prefer to receive cash. This practice encourages employees to drive to work alone, thereby increasing traffic congestion and air pollution. Given the option to take cash instead of the parking space, many employees will take the cash and choose to carpool, take transit, or walk or bike to work. The benefits are substantial: employees receive broader and more equitable commuter benefits, traffic and emissions decrease, and the employer may be able to reduce parking costs [6].

3.3 Parking Permit Pricing Modifications

Free or low- cost parking does not motivate people to use environmentally friendly alternative modes of transportation. Parking Permits make users pay to use the campus parking that is provided. This helps to show that there is no such thing as "free parking". Although parking can be provided cost-free to the public, it always comes at the cost of the environment, the city, and taxpayers. The goal of this program is to set a price on parking and discourage faculty, staff and students from bringing their cars to campus [7].

3.4 Park & Ride Lot

Park and ride (or incentive parking) facilities are parking lots with public transport connections that allow commuters and other people heading to city centers to leave their vehicles and transfer to a bus, rail system (rapid transit, light rail, or commuter rail), or carpool for the remainder of the journey. The vehicle is left in the parking lot during the day and retrieved when the owner returns. Park and rides are generally located in the suburbs of metropolitan areas or on the outer edges of large cities. A park and ride that only offers parking for meeting a carpool and not connections to public transport may be called a park and pool [8].

3.5 Biking Promotion Programs/Facilities and Safety

Biking Promotion Programs encourage people to bike to their destination when possible instead of driving. They provide participants with incentives such as: short-term and long-term bicycle parking covered bicycle racks that protect against weather damage, shower facilities and commuter rewards [9]. One type of promotional bikeprogram is bike sharing. The college provides a number of bikes, which may be used by faculty, staff and students to run errands or for work-related issues. Bike Safety includes making 7 the campus and the surrounding areas bike friendly to encourage bike use and to prevent accidents.

3.6 Public transport

Public transport (also known as public transportation, public transit, or mass transit) is transport of passengers by group travel systems available for use by the general public, typically managed on a schedule, operated on established routes, and that charge a posted fee for each trip. Examples of public transport include city buses, trolleybuses, trams (or light rail) and passenger trains, rapid transit (metro/subway/underground, etc.) and ferries [10].Most public transport systems run along fixed routes with set embarkation/disembarkation points to a prearranged timetable, with the most frequent services running to a headway (e.g.: "every 15 minutes" as opposed to being scheduled for any specific time of the day). However, most public transport trips include other modes of travel, such as passengers walking or catching bus services to access train stations [11].

IV.CASE STUDY: AL JADRIYAH CAMPUS, BAGHDAD UNIVERSITY

The study area is the campus of University of Baghdad that covers approximately 1300 acres, where the colleges, service buildings and infrastructure are distributed. Implementation of parking location in master plan followed by the signing of random parking randomly around the buildings on the road, as well as lack of presence in the center of the campus. There are previous attempts to solve the environmental problems associated with improper parking spaces by the decision-makers, but these solutions were isolated, periodic, unable to address the environmental and economic problems, and not specifically developed as planning solutions to transport and parking distribution.

Examples of these attempts included the encouragement of walk-by-walk walking, plantinglarge areas of the site, and creating parking lots around the site; however, these solutions are not environmentally and economically viable.

V.PROBLEM OF CAMPUS

The problems were related to the movement and parking location in the campus. To properly identify these problems, questionnaires were distributed to students and professors, with general opinions collected through direct interviews, as well as the studies presented to the Construction and Projects Department by investors. First problem, the walking distance exceeded 200 meters for majority of lecturers and students, particularly students living in dormitories and university housing or people working on campus in buildings far from the daily bus route. These distances appear relatively lengthy due to the warm desert environment, the presence of dust storms in summer, and rain and cold weather in winter. The second problem in the distribution of parking sites on the campus is not equal and does not suit the occupants of buildings of staff and students, Increasing the walking distance to more than 200 meters to reach the buildings.

Finally, parking accounts represent 4.9% of the total area of the site, which is not distributed by building capacity or user density. Therefore, there is a significant variation in access time from the main gate to buildings, which results in economical fuel losses, vehicle disruptions and potential accidents due to the speed of vehicles exceeding 80Km / hour and congestion as well as environmental pollution due to emissions, noting that some parking lots are not enough for the number of vehicles required, while other parking spaces are almost empty even during peak hours.

5.1 The potential implementation of sustainable transport at the site

There exist sufficient spaces on campus for use as new parking spaces or new roads and paths and parking bikes and roads, particularly between the buildings and colleges. The existence of spaces in each faculty will ensure social justice in movement across the campus. There are large green gardens and green paths with large areas. In addition, the campus has a ring road in which the transportation system can be controlled. Providing new spaces within the university can reduce the incidence of roads and unused parking. However, the cost of establishing a sustainable transport system is relatively high. Nonetheless, the application of sustainable transport programs can easily be controlled using modern means of communication and the Internet. Sustainable transport systems can easily be promoted within the university through media activities, seminars, conferences and external screens on campus. The university can exploit the experiences of staff in the field of transport planning, sustainable transportation, and engineering techniques for the operation of clean-fuel transport such as electric buses and others.

5.2 Master plan

There exist sufficient spaces on campus for use as new parking spaces or new roads and paths and parking bikes and roads, particularly between the buildings and colleges. The existence of spaces in each faculty will ensure social justice in movement across the campus. There are large green gardens and green paths with large areas. In addition, the campus has a ring road in which the transportation system can be controlled. Providing new spaces within the university can reduce the incidence of roads and unused parking. However, the cost of establishing a sustainable transport system is relatively high. Nonetheless, the application of sustainable transport programs can easily be controlled using modern means of communication and the Internet. Sustainable transport systems can easily be promoted within the university through media activities, seminars, conferences and external screens on campus. The university can exploit the experiences of staff in the field of transport planning, sustainable transportation, and engineering techniques for the operation of clean-fuel transport such as electric buses and others.

Table. 1 Building areas and coverage rates at theUniversity of Baghdad

No	Land use	Plot area m2		Usage ratio %
1	Buildings and their accessories	1061656	31	1
2	Parking	169600	4.9	2
3	Roads	165240	4.8	3
4	Parks, squares and walks	662734	19.5	4
5	public services	72200	2.1	5
6	Free spaces	1118570	37.7	6
7	Total	3250000	100	7

Source: Researcher based on the field survey

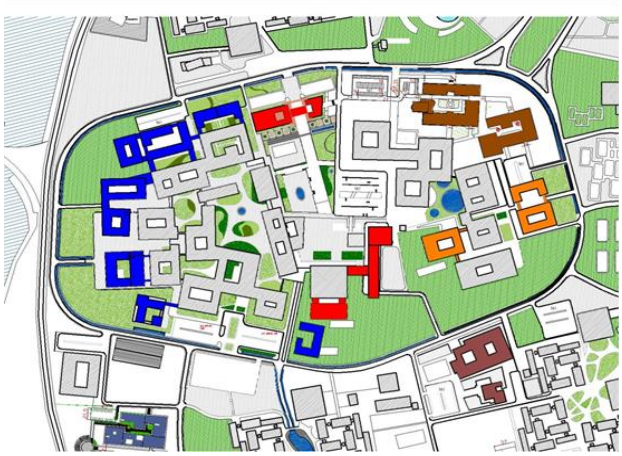

Fig. 1 Master plan of Baghdad University in Jadiriyah

The number of buildings is 146, except for residential houses and student apartments, which vary in their area and use, but the largest proportion is for the use of students. The survey included the distribution of questionnaire forms to a sample of users as well as the data collected about each building. These data included parking that servingthe building and its surroundings; distance from building to nearest car park; vehicle ownership; vehicle capacity, bike use, and commuting cost.

VI.RESULTS

The buildings were divided into ten categories based on the number of users and their data obtained from questionnaires, personal interviews and the site inventory of the number of vehicles in each parking lot for five days. An upper limit of the number of cars was adopted because it represents the actual number of building users. The residential complex and the internal sections represent a private internal movement. Walking was found to constitute 96% of the mode of transport. It is included in Table 2 as building users in categories: 5, 6, 7, 8, 9, 10.

The survey also included the number of vehicles entering the campus, which is the mostimportant indicatorof the extent of environmental pollution; and parking areas. The results of the survey shown in Table (3) represents the requirements for the distribution of parking spaces and their spaces in a manner that does not exceed five minutes as the average time to reach the building on foot to justify the use of sustainable transport modes such as a bicycle or electric train (clean fuel) on campus, which is the main objective of the general recommendations.

Table. 2 Building Categories by capacity and access time from parking

No.	Category / number of users in the building	Number of buildings within category	Time required to reach the parking		
			5min.	10 min.	11+
1	1-100	٣١			٠٢
2	101-200	٨			٢٢
3	201-300	٩			٧٢
4	301-400	٥			١٢
5	401-500	٥			٧٣
6	501-600	٦			٣٤
7	601-700	٤			١٤
8	701-800	٢			٣٦
9	801-900	٢			٤٦
10	900+	٢			٠٦

Source: Researcher based on the field survey

Table. 3 Ownership of Vehicles according to Vehicle categories and numbers daily

Category number	Vehicle category/ Passenger	Number of vehicles	The required space [15]	Average: passengers per vehicle	Ownership of the vehicle		No.of private vehicles
First	1-4	٠٦٩١	٠٠٠٩٤	٢	٧٣	٣٦	٠٥٤١
Second	5-11	٨٥٤	٠٤٧٣١	٨	٢	٨٩	٨١
Third	12-27	٧٢	٢٧٩	١٢	-	٠٠١	-
Fourth	40-45	٩	٤٦٨	٥٤	-	٠٠١	-
	Total	٤٥٤٢	٦٧٥٤٦				٨٦٤١

Source: Researcher based on the field survey

Table. 4 Private Transport vehicles, their categories and preparation to the University

No.	Vehicle category/ Passenger	No. of car	Average number of passengers per vehicle	Total passengers	Average cost person / day	Total cost ID (22 days)
1	1-4	٠٦٩١	٢	٠٢٩٣	٠٠٠٣	٠٠٠٠٢٧٨٥٢
2	5-11	٦١٩	٩	٤٤٢٨	٠٠٠٢	٠٠٠٦٣٧٢٦٣
3	12-27	٧٢	١٢	٤٣١١	٠٠٥١	٠٠٠٢٢٤٧٣
4	40-45	٨١	٥٤	٠١٨	٠٠٠١	٠٠٠٠٢٨٧١
	Total	٨٤٩٢		٤١٠٩		٠٠٠٨٩٦٦٧٦

Source: Researcher based on the field survey

6.1 Implement sustainable transport program

Programs are implemented to achieve the university's goals of sustainable development, and reduction of the cost and problems of transportation. These goals can be attained by emphasizing on: reducing access time (five minutes) of walking on campus; adapting to the current stateof the buildings and not designing for the vacant areas at this stage; appropriately reducing parking spaces to satisfy the needs of buildings only and ensuring vehicles from outside the university (temporary) do not exceed 10%; re-distributing land uses around the buildings and developing bicycle paths, parks (Figure 6) and green belt around the buildings; deploying schematic, environmental and economic treatments that promote walking and cycling; achieving the concept of social equity in time of arrival, cost of travel, health and traffic safety, and develop a green transport system (electric bus).

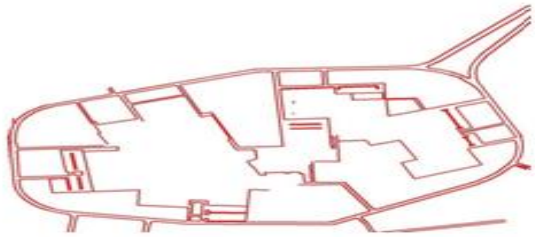

Fig. 2 Road network of campus; Source: researcher

6.2 Statistical model

A statistical model was developed to represent the relationship between the area of roads required and the number of parking spaces, and the group of independent factors that are believed to have an impact on these numbers. The linear regression model, which assumes a linear relationship between the ranges of variables affecting the number of parking spaces as an independent variable, is based on a linear relationship that can be standardized for the purpose of determining the direction and quantity of movement in the university.

6.3 Model Input

The independent variable was determined based on the extent of its impact on the capacity of parking spaces as follows:

I: Number of students of preliminary studies (X1); II: Number of Postgraduate Students (X2); III: Number of staff (X3); IV: Number of Employees (X4); V: The number of vehicles entering the campus (X5); VI: Number of bicycles (X6); VII: Access Time (X7); IIX: Cost of Access (X8); IX: Number of trees (X9); Dependent variable (Y): Number of required parking

A model for the number of parking required is designed for the following reasons:

The development of the study area by adding tunnels or bridges connecting parts of the transport network, and routing routes through the provision of alternative transport models such as walking, cycling and electric bus along with their efficiency to relieve pressure on the requirements of the vehicle [16], The adoption of four time periods.

Table. 5 Model input

Y	X1	X2	X3	X4	X5	X6	X7	X8	X9
2015	13902	614	1966	2188	2396	0	14	75	17950
2016	13928	705	1980	2203	2410	0	13	72	18200
2017	13935	748	2000	2225	2454	0	11	70	18655
2018	14000	800	2000	2500	2000	1000	5	50	20000

Table. 6 Model outputs

a0	a1	a2	a3	a4	a5	a6	a7	a8	a9
49.817	0.517	0.517	0.517	0.517	2.35	-0.032	-0.0012	0.71	-0.14

6.4 Model form

To express the relationship in a regression analysis and multiple linear correlations, the data for independent variables were entered in to model using the SPSS program. Where it gave the following results.Which expresses the relationship?

$Y= a_0+ (a_1 x)_1+ (a_2 x)_2+\cdots+ (a_9 x)_9$

a0 = 49.817
a1, a2 , a3 , a4 = - 0.517
a5 = 2.35
a6 = -0.032
a7 = -0.0012
a8 = 0.71
a9 = -0.14
Y (2017) = 11414.638
Y (2018) = 10118.21

6.5 Test of model

From the model outputs in Table (1), Annex (1), which shows:

- R2 Test: The r2 value of is 0.95, which means that 95% of the changes in the required area are considered by the nine independent variables, so the estimated linear regression equation is significant.
- Test F (calculated): Table (1) shows the calculated value of F (4182.69) and in comparison, to the table F, which is equal to 2.96 at the probability level of 5% and 4.69 at the probability level of 1%. It is noted that the calculated F is larger than the scale, that is, the estimated equation is significant at the level of two probabilities.
- The model can be used for future prediction and can be adopted for any future time period.

VII.DISCUSSION

The parking area is 169600 m2, denoting 4.9% of the site, which is enough to accommodate 131% of the cars entering the university. However, the parking area is distributed over horizontal parking spaces only, as well as semi parking spaces during the week, without serving any building. The highest number of vehicles that enter the university is 2454, with small cars making up 80%. Only 18.6% of the vehicles have the capacity for 9 people, 1% can convey 22 passengers and 0.4% are large buses. The total requirements of vehicle parking areas amounted to 64576 m2, representing 76% of the existing situation, distributed based on the categories of vehicles. The extra area of parking can be utilized for other purposes. The number of privately-owned cars is 1468, requiring an area of 36700 m2, which is the actual area of constructed parking spaces on campus (special parking for each college), representing no more than 22% of the parking area and caters for 16% of users.

The distribution of parking spaces is not socially justifiable, given the clear variation in access time on foot from the nearest parking lot to the workplace. The highest access time was 11 minutes for 41% of respondents, 6 - 10minutes for 36%, while the comfortablepercentage was only 23%. The rate of bike use is zero (0) %. Nonetheless, the biking culture has begun to spread, although it is limited to only males. The use of bicycles is important since it is one of the most important means of sustainable transport and most economically viable after walking. The total cost paid to the employees of the university exceeds 676 million dinars per month, including the amounts collected from car parks, which constitutes 33% of the cost of transport, at a rate of 56 thousand dinars per month per person. The total cost of constructing parking spaces and roads within the campus, covering 9.7% of the area, according to the prevailing price per square meter is approximately 5 billion dinars. 50% of the roads are not used by the vehicles and the surplus parking spaces. These spaces have not achieved any concept of sustainable transport or economic feasibility given the relatively high costs of construction and maintenance compared to their financial returns. The proportion of non-users of vehicles on campus is over 23% of building users, comprising students of the internal departments and residents of campus housing and neighboring areas, which is a good proportionthat can contribute to the actualization of the concept of sustainable transport (walking). Although the 11 minutes access time on foot from the nearest parking lot to the workplace is uncomfortable, about 45% of those walk paths are roofed with large planting areas around them.

VIII.CONCLUSION

The research represents an attempt to implement sustainable transport programs in high frequent areas and select the campus in Jadiriyah as case study. It is highlighted that the environment of the study area will be improved through the multiplicity of models of transport, bicycle, walking and spatial suitability of parking location and spaces, thus encouraging the development of the environmental economy. The main conclusions of the research are:

i. **The specifications and access to the variables**

The results were consistent with expectations as the integration of the economy and the environment wasa goal of systematic analysis involving spatial relevance, rather than statistical data only. In this paper, nine independent variables (staff, students (under and postgraduate), employees, vehicle, bicycles, time commuting, cost commuting and trees) which allow for a more complete interpretation of suitable location and space for parking and the possibility of operating sustainable transport models.

ii. The importance of the impact of variables on the campus of Jadiriya

The multi-linear regression model is a guide to understanding the value of sustainable transport. Modeling results can be used to make decisions on green areas conservation and distribution so as not to interfere with sustainable transport programs and redistribute parking lots. For example, the positive impact of the number of users, the number of vehicles entering the campus, commuting cost, the negative impact of biking, access times and green spaces on the parking location that users are appreciating green spaces that are accessible with sustainable transport models.

The modeling results provide information on the factors driving multiple transport models, which can motivate the population to contribute to the achievement of goals that are lost when green areas fade. In addition, awareness and expected results will help motivate developers to contribute to sustainable transport projects.

Using the model can help Identification of parking locations. Moreover, the negative impact of some variables in the model means that a spatial balance should be achieved, so it is proposed to reduce parking spaces with an increase in landscape. All of this would contribute to the reorientation of decisions towards the preservation of land and environment.

Since the estimated coefficients of the 9 variables were all in line with expected values, the present study has some limitations that deserve further consideration:

i. Small sample size led to relatively lower R2 value.
ii. Public awareness of sustainable transport may be linked to both psychological and economic factors. For example, the difficulty of using a bike especially by females is higher than environmental factors.

IX.RECOMMENDATION

Based on the results and discussions, the following recommendations are given:

i. Preparing the detailed designs of the internal transport system based on the application of sustainable transport programs, which aims to reduce the environmental and economic problems in the campus (Figure 3)
ii. Implementation of the development of the transport system and parking achieved the concept of sustainability in transport and emphasize the development of clean transport such as electric train.
iii. Design two tracks for the electric train, taking into account the duration of the train traffic with the operation of at least three trains in each track to ensure that there is a train in each station for a period not exceeding five minutes.
iv. Access to the main center through the two tracks according to the frequency of temporary visitors, while permanent users by workplace.
v. Prepare a typical detailed design for a 7 / ha area (2.5% of the site), based on the outputs of the statistical model, where buildings, parking lots, proposed bicycle positions, electric train tracks, original vehicle road, Cars and bicycles (Figure 4).
vi. Focus on green areas with trees of different heights according to the environmental orientation, taking into account the green path of the train (Figure 5)
vii. Design more than one level at the intersection points between the roads and the electric train path (bridge or tunnel) to prevent accidents and maintain the usual speed.
viii. Adopt a modern technique in the design of bicycle positions with the installation of a device to monitor the movement of bicycles on the campus (Figure 5).

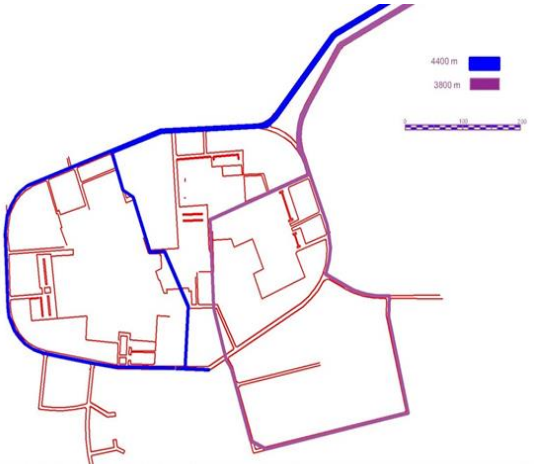

Fig. 3 Typical abstract design for the distribution of buildings, parking and paths; Source: researcher

Fig. 4 Suggested two tracks for the electric train

Fig. 5 Typical green track (right).typical bike parking (left)

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