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The Traffic Assessment of the Adjacent Arterial Streets Close to Gates of the Main Campus of the University of Mosul, Iraq

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Abstract. Like many university campuses, University of Mosul Main Campus (UOMMC) a major activity center and focus of traffic generator. The UOMMC surrounded by segments of four major arterial streets that form the outer limits of the campus At segments close to the campus gates of these streets, many traffic problems and congestion conditions occur due to the significant traffic volumes and movements with high vehicles and pedestrians conflicts, frequent parking turnover, increasing passengers loading and unloading operations throughout the campus working days. The main objective of this study is to evaluate the current and future traffic congestion situation at the main campus gates and its effect on the multilane streets segments around the main campus, near its gates. The methods of data collection included site visits, personal observations, questionnaire survey, measurements, and imaging techniques. The current and future traffic operational state of these segments concerning the traffic stream characteristics or level of service is defined by three primary measures (according to HCM 2016): traffic flow rate, traffic speed, and traffic density. Finally, the study provided suggested and proper solutions for the existing and future traffic problems simulate the benefit of the campus community to provide the protection of life and property, optimum use of campus gates and, acceptable and safe traffic flow on the multilane streets around the main campus.

Key Words: Campus, Traffic Speed, Traffic Flow, Arterial Street, Level of Service, Questionnaire Survey

1. Introduction

Streets are the lifeblood of our communities and the foundation of our urban economies. They must be safe, sustainable, resilient, and economically beneficial, all while accommodating traffic. The vitality of urban life demands a design approach sensitive to the multifaceted role streets play in our cities [1,2]. Many studies asserted the importance of transportation on the life of urban and economic development performances, and investment especially urban expansion [3,4]. The nature of the engineering and traffic characteristics of the roads network inside the university with the surrounding streets are the mirror of civilization and modernity for this university and pride for its community and motivation for the continuation of the process of scientific and cultural progress and advancement. These streets play a vital role in the university community life. Universities with large numbers of academic staff, students, administrative personnel and many diversified activities (e.g., working, studying, and business) are comparable to small cities and therefore ensuring safety and comfort of pedestrians becomes key for everyone is a pedestrian at one point in time[5,6]. Most campus plans emphasize maintaining a high quality environment for its students and staff in order to be competitive with other local and international universities. Vehicular circulation has become a priority for many universities, sometimes
on the cost of pedestrian movement [7]. Meanwhile, other universities have emphasized the importance of pedestrian network in linking various university activities. Improved public transport to support pedestrian movement is the most sustainable solution for university campuses worldwide [8]. Traffic is a measure of the use of the road, and therefore provides important information about the needs of the road user. The basic parameters of traffic flow: flow rate, speed and, density is the basis for estimation of multilane streets level of service [9]. The University of Mosul is a public university located in Mosul-Iraq. The University was established in 1967. Like many universities across Iraq and elsewhere in the world, the University of Mosul seek to present their goals of a commitment to ethical and professional values, create a stimulating environment for learning and intellectual creativity, support the human rights, employ technology optimally, and pursue creative research that contributes to building a knowledge society. The activities of the University of Mosul community have had and will continue to have a significant impact on the aspects of city life. The university includes 24 colleges, 6 research centers, 7 consulting offices, 5 Hospitals & Clinics, few museums, a number of directorates, technical and administrative units distributed throughout three campuses. University of Mosul Main Campus (UOMMC) has the personality and significance of a large campus with a considerable university population. There are more than 51 thousand persons represent the UOMMC community, that classified into four groups: students, faculty members, staff, and other regular users of Mosul University(daily visitors, contracted, vendors, and any employee of an official or government agency located inside the campus) from the total University population of about 55 thousand persons. The area of the UOMMC is estimated at 200 hectares. In 1989 a study in the title "Recommended Traffic and Parking Program for UOMMC"[10] was carried out, with the objective of enhances traffic operation and to relieve parking problems, also improving the safety level for both vehicles and pedestrians. This program was developed to reflect the university requirements to meet the predicted traffic and parking needs and the campus in the year 2000. During the years 2000-2019, many studies, small projects, and unpublished research were conducted to address specific and temporary traffic and parking problems within the main campus resulting from multiple causes such as changes in the Campus master plan, security requirements, or emergency conditions in the movement of vehicles and pedestrians.

2. Study Problems
The rapidly expanding urbanization around and within the UOMMC presents a common factor, which is the aggravation of traffic and parking problems. Through the coming years, without an accessible, holistic, sustainable and developable solution, the challenges carried by the main campus with the traffic problems placed upon their streets (around and inside) will multiply in quantity and quality. The majority of these streets have heavy traffic flow, vehicles and pedestrians movements, Commercial alleys, essential transit routes, frequent parking turnover, and noisily with their activities throughout the working day. Throughout the site visits and personal observations, the following notices and facts were recorded:
1. The city parts around the main campus location are becoming more popular places to live, and traffic designing for these areas presents significant challenges. The rapid and uncontrolled developments in these areas have made them a collection of residential, commercial, and commercial centers and have created an unacceptable level of variation in transportation demand and supply plan, causing many traffic problems.
2. Generally, Public transport at these streets is a mix between private taxi-car and minibus services, which usually operate without regular timetables and fixed paths. With high flexibility, they can simulate easily the actual demand. The minibuses operate like taxis, competing for loading and unloading the passengers close to the campus gates. Therefore, the regulation and control of these modes are difficult and result in inefficient use of street lanes and congestion in street segments near the gates.
3. Due to the security enforcements at the campus gates, the traffic flow and circulation for vehicles and pedestrians are suffering from the congestion and safety problems, which form long queues on the streets near these gates. The general disaffection of campus community, as motorists, passengers
or pedestrians, to the increase of their travel and waiting time near the campus gates during entering and exiting associated to the uncontrolled traffic congestion, poorly transit operating in quality or quantity, and lack of sufficient local traffic enforcement and management are indications of the urban abnormality for the university and city.

4. Over the last ten years, the percentage of private car usage has increased on the campus at a much greater rate than in Mosul's central business district. Because of the increase in car ownership as a result of the increase in the monthly income of the campus community on the one hand, and on the other hand, the luxury that a personal car provides today. It offers the greatest level of comfort and convenience, door-to-door service, and great flexibility and ability for changing travel plans. So, it has become an important component and mode of a campus transportation system,

3. **Objective**

   The main objective of this work is to provide components of goals which include:

   1. describe, analyze, and evaluate the existing traffic flow characteristics at the UOMMC gate areas.
   2. assess the current traffic flow elements and conditions on the multilane streets segments around the main campus, near its gates.
   3. develop a more suitable solution with recommendations according to the UOMMC community needs and aspirations, which will improve traffic safety and efficiency of mobility for all modes of surface transportation at the study areas.

3.1. **Study Area**

   The UOMMC surrounds by the segments of four major arterial streets, which are classified as divided multi-lane highways of 6-lane. These segments form the outer perimeter of the main campus and parallel of its outer boundaries. From the west, Street No. 1 (Culture Street), the segment of 2 Km long, from the South Street No. 2 (Al-Manassa Street) segment of 1.6 Km long, Street No. 3, the segment of 2.4 Km long (Al-Hadba Street) in the east, and from the North Street No. 4 (Al-Qusour Street), segment length of 1.9 Km. While each street has a total length of more than 10 Km. These streets meet with each other through three major interchanges around the campus location (as shown in Figure 1). Each of these streets is one of the most important arterial streets in the city's road network that links many parts and wide areas of different city directions and provides access to all residential neighborhoods that it passes through. streets are an economic asset as much as a functional and pivotal element. Streets No.2 and No.3 are designed with parallel frontage roads to provide direct access and parking to adjacent residential and business areas.

   Currently, 7 campus gates are using for entering and exiting vehicles and pedestrians, distributed as follows: Gate No. 1, 2 and 3 on Street No. 1, used for entry and exit of pedestrians only, Gate No. 4 on Street No. 2, while Gate No. 5 and 6 set on Street No. 3, and finally Gate No. 7 on Street No. 4 and all these four gates (4 to 7) are used to enter and exit vehicles and pedestrians. In general, each gate consists of a paved street, pedestrian sidewalks, information room, checkpoints, and security office.

3.2. **Data Collection**

   To achieve the objectives of this study, several methods were used to collect the required information included site visits, personal observations, measurements, imaging techniques, and questionnaire survey. "The data collection also includes a review of available data and documents at the relevant university departments as the study required. Strong data collection technologies and analytical methods can allow better and more timely performance monitoring" [11]. The manual observation (manual count data collection in the field or from video) was used in this work. The method of periodic monitoring of the video camera was used for collecting the necessary traffic data.
The data collection sites included two area types: The first is the area used for entry and exit at each gate, which consisted of 7 sites. The second is an area of the arterial street segment affected by the traffic flow and movement close to each campus gate, which consists of 4 sites. All traffic flow measurements were made on times that represent normal daily conditions at the study area locations and under the normal traffic operational conditions, avoiding the unusual occurrences. Data about the number and movement of vehicles and pedestrians at selected points within the area of each gate at the main campus are conducted for periods of 12 hours (7:00 a.m. to 7:00 p.m.) of a normal weekday using digital camera imaging techniques from a vantage point. The principal measurements of traffic movement: traffic volume, speed, and density are used to provide a good indication for the effectiveness measure of these streets. Proper vantage points were decided to install the camera and traffic data where was recorded at each site at the four streets at regular intervals of 5 minutes for 10 hours (7:00 a.m.- 5:00 p.m.). A longitudinal section of 100 m length was made on the selected sections at the four streets for speed measurements. The time and distance measurement method were used to collecting traffic speed information during off-peak hours of a weekday. It involves measurement of the time required for a vehicle, a random sample of 100 vehicles, to traverse a measured section length of 100 meters. The periodic monitoring technique of the camera was applied to collect these data Questionnaire survey was conducted for the main campus community to obtain the traffic and pedestrian data necessary to establish the basic characteristics of vehicular and pedestrian movement at the study area near campus gates. Data regarding the necessities and priorities of the persons using these streets have been gathered through a questionnaire survey. The questionnaire form was designed with direct and general questions with multi choices or with short answers. These answers according to the campus community groups gave indications and data on:

1. Trip origin  
2. Occupation and gender  
3. Type of vehicle and class (having campus permit or badge to enter the campus)  
4. Mode of travel  
5. Daily entering and exiting campus gate  
6. The preferable campus gate for entering and exiting  
7. Suggestions and remarks.

![Figure 1. Study Area Map](image-url)
Sample size must depend upon the errors in the data collection process and in the subsequent trip prediction process, where approximate estimates of travel requirements are necessary. As stated by Traffic Engineering Studies ITE Manual [11], The following equation is used to find the necessary sample size:

$$n = \left( \frac{S \ast K}{E} \right)^2$$

Where $n$ is the minimum sample size, $K$ is the constant based on the desired confidence level ($K= 1.96$ for 95% confidences level, $S$ is the estimated sample standard deviation or coefficient of variation ($S≈ 10-30 \%$), and $E$ is the permitted error (in this work $E= 1\%$). The study decided to use $S= 20\%$ then $n= 1537$.

3.3. Data Analysis

The analysis of traffic flow is based on three fundamental elements of the traffic flow relationships: flow, speed, and density. Comprehension of each of the characteristics and the relationships between one element and the other two provides the ability to assess the current traffic situations or predict future conditions [11]. Traffic density (traffic volume as the rate of flow divided by traffic speed) at multilane streets is a major factor in the analysis of traffic congestion and in evaluating the effectiveness of these streets. According to Highway Capacity Manual (HCM) 2016[12], the peak and off-peak hours traffic flow and speed data were later calculated to find the measure of effectiveness (traffic density), then the level of service was recorded. The analysis of existing traffic flow conditions included an assessment of streets and operating conditions, and pedestrian movement conditions provided a basic data of the study to project future traffic growth and operating conditions that could be expected to result from campus growth for the next ten years. Depending on the general policy setup by the University administration, the recent rate of faculty members to the students should be not more than 1:12 and for future years would be 1:10. While the rate of staff number to the faculty members plus student numbers is 1:10. Therefore, the study considered that the predicted number of students is the basis for the estimation of the campus community size in 2030. Figure 2 illustrates the numbers of Campus community groups during the last ten years. In 2020 the total number of the Campus population is 51176 persons include: 3799 faculty members, 4276 staff, 40996 students and 2105 other users, where the number of the other users' group represents the average daily number. The study test two methods to estimate the growth rate of the students:

![Figure 2. Numbers of Main Campus Community Groups During the Years of 2010 to 2020](image-url)
a. Assuming a linear equation of the growth rate using the Least Squares Method to the past trend of the students' numbers for the last ten years, as shown in Figure 2. The resulting equation is found the predicted number of the students in 2030 is 51126 persons.

b. Based on the estimates and expectations of the United Nations Development Program and data in World Bank Report 2020[13], the annual population growth rate in Iraq for the years between 2020-2030 is 2.3 percent. The study considered this growth rate as the yearly projected increase in the campus student population for the years between 2019 and 2030, then found the predicted the number of the students at 2030 is 51470 persons (approximately the same result of the first method). The study decided to apply this annual growth rate of 2.3% to estimate the future number of students and traffic volumes at the study sites.

The total number of questionnaire forms given to the campus community is 5300 forms (60% given to male and 40% to females), distributed as 500, 500, 4000, 100, and 200 forms for faculty members, staff, undergraduate students, postgraduate students, and other users group respectively. While the total number of returned forms, filled completely and correctly, is 2614 forms. The response of the campus community to fill the forms is about 49.3%, distributed as 63.4% (317 forms), 55.6% (278 forms), 44.8% (1793 forms), 81.0% (81 forms), and 71.5% (143 forms) for faculty members, staff, undergraduate students, postgraduate students, and other users group respectively. For the results that required achieved the required sample size with normal and real distribution of the campus population, only 1700 forms were selected randomly and used. These selected forms divided as 136, 153, 1300, 34, and 68 forms for faculty members, staff, undergraduate students, postgraduate students, and other users group respectively.

4. Results and Discussion
A. The results of the traffic flow measurements and questionnaire survey at the 7 sites of the Campus gates show the followings:

1. The car ownership percent for each faculty member and staff group was calculated as the ratio of the number of the permit vehicles of each group that duly registered with the Follow-up Department, which is responsible for managing and controlling traffic inside the campus to their total number. Because of the university enforce strict rules that prohibit students and other users groups from entering their cars to the campus, the car ownership percent for these groups considered in this work as the average car ownership percent for Mosul city population according to the same gender and age (annual growth rate of 2.3%) . Figure 3 indicates the percent of the past, current, and future car ownership of the campus community groups.

![Figure 3. Car Ownership percent of Main Campus Community Groups During the Years of 2010 to 2020 and predicted for 2030.](image-url)
2. Respectively, Tables 1 and 2 illustrate the distributions of travel mode of arriving and entering trips to the UOMMC based on the questionnaire survey, classified according to trip maker occupation and gender. It is noticed that the largest percentage of faculty members and staff use their vehicles as a motorist, especially males with more than 64% for faculty and 55% for staff. The dominant mode of travel for the female faculty members and staff is passengers (Auto and transit) with 60.25% and 82.1% respectively. While, walking is the mode most used by students to enter the university by up to 63% (83% of total male students and 34% for female students), but the means of the passenger (auto and public transit) is the most hired mode to their trips from the origin point to the campus by more than 79% (66% of total male students and 97.5% for female students).

3. The great variation in the using percentages of students of the different modes of travel in the Tables 2 and 3, is due to the forcing by the campus administration to grant a small number of students permission to enter the campus and prevent the largest number of them. This reason led to either stopping their vehicles at their own risk outside the campus, along the streets near the campus gates, or using public transportation, then entering through the campus gates as pedestrians. Thus, pedestrian flows increased, creating crowded conditions along sidewalks and forcing them into vehicle traffic lanes.

**Table 1. Distribution of travel mode of arriving trips to the Campus based on the Questionnaire Survey in the study area, classified according to trip maker Occupation and gender.**

| Mode of travel | Person trips % (out of 1700 respondents) |
|----------------|----------------------------------------|
|                | Faculty | Male | Female | Staffs | Male | Female | Students | Male | Female | Other users | Male | Female | Total | Male | Female |
| Motorist       | 39.00   | 15.35| 32.50  | 7.25   | 18.55| 0.35   | 10.70    | 3.25 | 21.15 | 2.30       |
| Auto-passenger | 10.90   | 13.35| 9.10   | 20.80  | 14.00| 21.00  | 13.00    | 15.75| 13.20 | 20.15      |
| Transit        | 9.35    | 11.30| 13.75  | 14.55  | 25.25| 19.50  | 37.75    | 19.00| 23.40 | 18.35      |
| Walking        | 0.75    | 0.00 | 1.65   | 0.40   | 1.30 | 0.25   | 0.55     | 0.00 | 1.25 | 0.20       |
| All modes      | 60.00   | 40.00| 57.00  | 43.00  | 59.00| 41.00  | 62.00    | 38.00| 59.00 | 41.00      |

**Table 2. Distribution of travel mode of entering trips to the Campus based on the Questionnaire Survey in the study area, classified according to trip maker Occupation and gender.**

| Mode of travel | Person trips % (out of 1700 respondents) |
|----------------|----------------------------------------|
|                | Faculty | Male | Female | Staffs | Male | Female | Students | Male | Female | Other users | Total | Male | Female |
| Motorist       | 38.25   | 15.35| 31.50  | 6.60   | 1.10 | 0.30   | 9.00     | 3.25 | 7.25 | 2.90       |
| Auto-passenger | 10.50   | 12.65| 8.70   | 20.50  | 3.30 | 12.65  | 11.25    | 14.15| 4.70 | 13.40      |
| Transit        | 8.25    | 10.65| 12.75  | 14.55  | 5.40 | 13.75  | 36.15    | 18.45| 7.35 | 13.10      |
| Walking        | 3.00    | 1.35 | 4.05   | 1.35   | 49.20| 14.30  | 5.60     | 2.15 | 39.70| 11.60      |
| All modes      | 60.00   | 40.00| 57.00  | 43.00  | 59.00| 41.00  | 62.00    | 38.00| 59.00| 41.00      |

4. Figures 4 and 5 present the hourly variation of the traffic movements for vehicles and pedestrians respectively. From 7:00 a.m. to 7:00 p.m. at the campus gates, the numbers of the vehicles and persons that enter, leave, or still inside the main campus are shown. The accumulation number represents the cumulative differences between the entering and exiting numbers of vehicles or pedestrians for each hour. The maximum number of entering vehicles of 2768 occurs at 8:00-9:00 a.m., and exiting vehicles of 2058 at 2:00-3:00 p.m., while the maximum accumulation of 4667 vehicles at 1:00-2:00 p.m. The maximum number of entering pedestrians of 4405 persons occurs at 8:00-9:00 a.m., and exiting pedestrians of 4456 at 2:00-3:00 p.m., while the maximum accumulation of 10502 persons at 12:00-1:00 p.m. The distributions of the total number of entering and leaving vehicles and pedestrians at each gate are shown in Figures 6 and 7 respectively, where Gate No. 6 shows a maximum number of 3295 entering vehicles and Gate No.7 of 2738 exiting
vehicles. While Gate No.3 shows a maximum number of 4750 entering persons and Gate No.1 of 4445 exiting persons. Knowing that heavy vehicles constitute 3.2% of the total number of vehicles.

Figure 4. Hourly Variation of Vehicles Movements at Main Campus Gates from 7:00 a.m. to 7:00 p.m.

Figure 5. Hourly Variation of Pedestrians Movements at Main Campus Gates from 7:00 a.m. to 7:00 p.m.

B. By the methods set out in the Highway Capacity Manual, the analysis of the existing traffic stream conditions at the four arterial streets segments adjacent to gates of the UOMMC shows the following findings:

1. Traffic flows on each street are not fixed but vary from hour to hour throughout the day according to the variations in traffic directional distributions, speeds, and streams
2. compositions. For each segment, Table 3 illustrates the traffic speed parameter: time mean speed (TMS), space mean speed (SMS), and 85 percentile speed (SP_{85}), and traffic flow rate parameters: peak hour factor (PHF), peak and off-peak hourly volume (V), and percent of traffic compositions: passenger cars (P%), trucks (T%), Buses(B%), and recreational vehicles (RV's%). Other characteristics are defined as follows: an extended general segment of level terrain, 6-lane divided highway, lane width=3.6 meters, and weekday commuter traffic, and total lateral clearance= 1.2 meters.

3. The current traffic conditions signify that all these street segments operate at an unacceptable level of high congestion in the morning or evening peak hour, where they suffer from double parking, loading and unloading conflicts, dense turning movements, and insufficient spaces for pedestrians flows. Meanwhile, as shown in Table 3, the level of service (LOS) during peak hours for the present situation is D, and the LOS for the future scenario (in 10 years) is E due to the increase in density.
These streets have been designed for a 15-minute peak period and operate significantly below capacity at other times of the day.

### Table 3. Analysis Results of Traffic Flow Parameters and Level of Service of Study Streets Segments, and Number of Parked Vehicles Near to Gates of Main Campus.

| Street No. | Traffic Speed km/h | PHF | Off-peak hour | Peak hour |
|------------|---------------------|-----|---------------|-----------|
| TMS        | SMS                 | SP  | Time a.m.     | V veh/h   | T+B %  | RV's % | Time a.m. | V veh/h   | T+B %  | RV's % |
| 1          | 53                  | 44  | 76            | 0.88      | 9:45-10:45 | 2083  | 3.1       | 1.6       | 8:10-9:10 | 4179  | 4.2   | 2.0   |
| 2          | 64                  | 58  | 84            | 0.90      | 10:15-11:15 | 1525  | 4.4       | 1.2       | 8:05-9:05 | 3626  | 6.5   | 2.0   |
| 3          | 65                  | 59  | 83            | 0.86      | 10:00-11:00 | 1758  | 5.3       | 1.5       | 7:55-8:55 | 3710  | 7.9   | 3.3   |
| 4          | 69                  | 63  | 90            | 0.93      | 10:00-11:00 | 1047  | 6.0       | 1.2       | 8:15-9:15 | 2881  | 11.3  | 2.9   |

| Street No. | Students Parking |
|------------|------------------|
| On-Street (Spaces) | Off-Street (Spaces) | Density pc/km/lane | LOS |
| 1          | ---      | 227      | 14.90 | C |
| 2          | 62       | 21       | 10.75 | B |
| 3          | 119      | 65       | 11.15 | C |
| 4          | 18       | ---      | 9.55  | B |

| Street No. | Expected |
|------------|----------|
| Density pc/km/lane | LOS |
| 1          | 27.4     | E |
| 2          | 24.1     | E |
| 3          | 23.8     | E |
| 4          | 20.0     | D |

4. As previously mentioned, the university enforces strict rules that prohibit students from entering their cars to the campus. Nevertheless, more than 1,500 vehicles belonging to the students are permitted to enter the campus under specific conditions. Other students have to park their vehicles at their own risk outside the campus, along the streets near the campus gates. As shown in Table 3, during morning peak hour the study record the number of these parked vehicles as on-street or at available surface lots parking near the campus gates. Up to 2000 students travel to parked inside the local streets of the residential areas surrounding the campus.

5. Conclusions and Recommendations

The study sites were observed and reviewed to investigate the traffic and parking operation, traffic flow conflicts, safety, and comfort for vehicle motorists, passengers, pedestrians, and other street users on campus gates. From this standpoint, the study suggests the following points as one of the most appropriate solutions to the traffic problems in the study area:

1. The concept of ‘living streets’ can be applied for these segments, living streets are made according to the interaction between living locations around the campus and campus community. As an essential component of the street environment, sidewalks should be provided on all streets with width not less than 5 meters near the campus gates to serve and promote safety of pedestrian movement and access. Speed control mechanisms like speed humps and tables should be provided to slow down and control the vehicles speed.

2. Reducing the number of campus gates to four gates, two main gates on both Street No. 1 and 3 of a similar structural and traffic designs with a width of not less than 100 meters. And two secondary gates on each of Street No. 2 and 4 have one design with a width of not less than 30 meters. The design of each gate includes a one-way service road with one entrance and one exit, which is used only for loading and unloading passengers.

3. To avoid the parking on the street sides near the gates, off-street parking must be established with a capacity of more than 500 spaces near each main gate and 200 spaces for each secondary gate. Then, a comfortable, easy, and safe public transit path should be created around the campus that connects the campus gates to facilitate pedestrian transportation between them. Enforcement measures should be put in place to reduce conflicts with the entering and exiting.
vehicles to and from the main campus near their gates. To ensure smooth interconnected
between the campus and all locations of the city, the university authority must be working
with the local authority of the Mosul city to plan and design the street networks on and
around the main campus. The University of Mosul must be have sought to propose strong traffic
and parking plans to support the aims of safety and sustainability at the whole location of the
main campus. Further studies are needed to develop a convenient traffic and environment
system that will evaluate the conditions of the existing streets and produce suggestions for
improvement. Research on pedestrian flow improvement at and near the gates of the main
campus is a prerequisite and essentially recommended.

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