Conceptual intelligent travel demand modelling framework for universities - Case study: King Abdulaziz University

Alaa Sindi*
1 Department of Civil and Environmental Engineering, Jeddah, Kingdom of Saudi Arabia

Abstract. King Abdulaziz University provides its educational services to over 180 thousand students. The number of vehicles entering and existing the university’s reached 350 thousand vehicles per day; Based on that, the transportation network within and around the campus experiences high vehicles delay. The first step to deal with the issue is by developing a conceptual travel demand modelling framework, which set the map for developing the travel demand models. This research presents a conceptual travel demand modelling framework, which is divided into four stages: define the evaluation time period (short, mid, long time span), establish a data collection program, prioritize transportation issues at campus, and model the transportation issues and propose solutions. The university has various departments. Each one contributes to the transportation movement by one way or the other. The framework incorporates these departments in the modelling framework with the aid of technology with the aim of relieving the pressure on the university’s transportation network in a timely manner and with minimum cost. Implementation of this modelling framework showed that management strategies supported with specialized transportation studies will accomplish that aim, while in the same time, it will ensure a sustainable transportation system, and improve the quality of life.

1 Introduction

King Abdulaziz University is one of the main universities in the Kingdom of Saudi Arabia. It is in the western region of the country in the heart of the city of Jeddah and lies on 560 hectares. It was established in 1967 as a private university that held 100 students. Since its establishment, the university has seen significant growth in terms of student population (now over 180,000), educational facilities, offices and clinics, and importantly, the university’s surrounding area has developed rapidly as well. Students, residents of Jeddah and visitors to the city benefit from the university’s facilities and services, and as a result, over 350,000 thousand vehicles are entering and exiting the university’s main branch, Al-

* Corresponding author: alaasindi@gmail.com

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Sulaymaniyah, daily. These details about the university’s original profile and what it has become today are important in understanding the footprint of the university and its surrounding areas.

Based on student population and services offered to the community and subsequent traffic generation, the university is the major trip generator for the city. This high demand impacts the transportation network of the university and its surrounding areas, resulting in serious traffic issues. In addition, travel demand is expected to increase in the coming years due to upcoming travel generator developments within the university and its surrounding areas. The high rate of trip generation of the university has attracted residents and business establishments to relocate to this area. Regional railway stations, shopping malls, hospitals and residential areas have been constructed or are in the process of being constructed around the university. This will result in further traffic related issues in the area. Therefore, there is a need for a tool that can predict travel demand accurately and test several alternatives to make effective decisions regarding the university’s infrastructure plans. The outputs of this tool are expected to help in relieving pressure on the university’s transportation network, improve mobility, ensure sustainability of the current transportation network and to help guide decision making regarding the university’s continued planning for facilities and services.

The most widely used method in modelling and predicting travel demand for cities is the traditional four-stage sequential model developed by Mayor and Miller [1, 2, 3]. It starts by collecting information about the transportation network, land use information, residential socioeconomics and trip information. Then, this method utilizes this information to model residents’ trip generation, trip distribution, model split and traffic assignment. This model can be calibrated and validated against current conditions to be able to predict future travel demand. However, it is important to acknowledge that students’ travel behaviour is different from that of regular residents of a city, and this requires a special travel demand model to account for these differences [4].

Travel demand at universities varies from day to day, term to term and year to year. Consequently, each time frame needs specific data and a tailored approach to handle transportation issues. Examples of incidents that occur on a daily basis are car accidents, closure of a gate(s) and change of routes for maintenance or construction, which could be managed through a smart transportation system. Travel demand at universities depends on students’ and faculty members’ schedules, which arise from constraints and requirements for use of and access to university facilities. Based on these variables, students’ schedules vary from term to term and will result in changes to travel demand. Looking forward, the trend is for universities to expand and build new educational facilities to accommodate increases in numbers of students, faculty and staff, which in turn changes the profile of travel demand at universities. Various treatments could be applied to smooth mobility on campus for each time period with minimal costs. Major transportation infrastructure can be an adequate solution for long-term transportation issues. However, it is expensive and takes substantial time to construct. On the other hand, transportation management strategies are not as costly and are easier to implement within a shorter period of time, which makes it more appropriate for short and mid-term transportation issues.

2 Literature review

Studies have shown that travel demand frameworks for universities are different from those that are used for cities. Students’ lives incorporate elements of daily life, their studies, as well as work, and this results in a unique quality and quantity of activities on and off campus. Students’ walking distances and shared modes of transportation also distinguishes their travel behaviour from that of residents. However, both frameworks use the traditional
four-stage travel demand model with some differences in the modelling framework to suit the uniqueness of the university context. Additionally, there is limited research in existing literature regarding students’ travel behaviour [5, 6].

The general steps for solving transportation problems are: identifying the problem and its constraints; collecting data; developing and calibrating the model; validating the model; testing alternative solutions while also summarizing the performance of each alternative based on measures of effectiveness; and selecting the solution that satisfies the constraints and performs well. Smart cities use technology and applications for intelligent transportation systems in many parts of the previous steps with the aim of solving transportation problems in an efficient way [7, 8, 9, 10, 11]. For illustration, there are several approaches (including manual and with the aid of technology) used to identify problems in transportation networks, such as: transportation system users’ comments and concerns; collection of video surveillance; live monitoring of cellphone data for incidents or traffic problems; as well as prediction of future traffic issues. The municipality of the city of Jeddah developed a cellphone application to report residents’ concerns such as problems with the condition of streets. The app allows residents to attach a picture of the damage, the location and a description of the situation. The city can then fix the issue, communicate with the resident who reported the problem to ensure that the complaint has been received and to confirm that the repair service has been completed.

There are various means that can be used to collect transportation data. For example, video cameras supported with software can process video data to count traffic, determine turning movements and detect accidents. These data can be inputted directly to simulation software to analyze current situations or predict traffic scenarios after an accident takes place and to also propose solutions to mitigate the effect of accidents [12, 13]. Cellphones and apps such as Google Maps also can be used to collect detailed information about individuals’ movements such as trip start time, location, mode of transportation and travel time [14]. However, the collection of this type of data is contingent on individuals allowing the sharing of their personal data to app developers so that transportation agencies can retrieve comprehensive travel information necessary for evaluating, planning and designing the transportation network. These data could be simulated or visualized and analyzed to identify possible parking problems, vehicle incidents, congestion and issues related to public transit. The collected data from various sources such as loop detectors, video surveillance cameras, cellphones, household travel surveys, land use as well as transportation system information are cleaned and merged in a unified form that enables the analyst to manipulate and analyze the data to develop transportation models [14, 15, 16, 13].

Advanced tools that can analyze and predict travel data are micro and macrosimulation software. Microsimulation is usually used to analyze fewer numbers of intersections at a microscopic level. The modeller needs to use simulation software to evaluate traffic conditions or test several alternatives and recommend the optimal solution(s) given the problem’s specific constraints [17]. The macroscopic software could be used to model a city or a university campus. The macro-simulation software could be used to predict future demand, identify future traffic issues, test alternative solutions and also propose optimal solution(s). In addition, simulation software can be fed with real time data to predict the immediate effect of an accident and propose possible corrective actions [12].

Transportation management solutions are efficient ways to deal with transportation issues in a timely manner. For example, promoting public transit or shuttle services supported with advanced intelligent transportation system technology could shift many users from using their private vehicle to using public transit and subsequently relieve pressure on the road network [18, 19]. Cellphones are used around the globe to plan for travel using various modes of transportation such as buses, metros and ride sharing. The
fact that users of public transit can track and plan their trips using apps enhances customer confidence of the given service and improves travel experiences that can maintain customers and increase ridership. Managing and coordinating traffic lights using transportation control centers enforced with specialized algorithms that monitor the traffic around the city or use smart traffic signals are proven to improve the efficiency of an intersection [20, 21].

3 Context of the study

King Abdulaziz University annually collects traffic counts using loop detectors during the first month of the year. However, travel behaviour varies significantly from day to day, from month to month and also from term to term. The university holds national exams where residents of Jeddah visit the university to take these exams. In addition, the university holds many events, and the times and dates differ from term to term and result in an increase in travel demand at different points in time. The traffic volume at the first of the month of each term is different from the rest of the term. Students register in many courses and drop some after a month of attending, which results in a drop in travel demand. In addition, when midterms start, some students stay home to study and miss some classes, which also results in a reduction in travel demand. Based on the variety of behaviours, there is a need for an automated system to collect 24-hour traffic data, land use and students’ travel patterns to establish a transportation library to be able to model travel demand and propose solutions to transportation issues. Technology as presented above can help achieving these objectives.

While there is a King Abdulaziz University simulation-based travel demand model, it was developed in 2010. There are new factors that need to be considered, including the construction of several new buildings, shuttle services and planning that is intended to create a walkable environment for students. Moreover, regional rail stations, hospitals, shopping malls, hotels and residential areas were developed around the university, which are not accounted for in the 2010 model. The university’s and city’s strategic plans and policies for the coming years should be a central basis for long-term travel demand planning. In addition, the university has various departments that contribute in one way or another to the travel of students and visitors to and from campus. These details are also absent in the 2010 model, so there is a need to understand the impact that each department has on the transportation system to have better models and to manage traffic. Thus, there is a need for updating this model and a robust evaluation tool to assess travel demand during different times of the year.

4 Conceptual travel demand modelling framework for King Abdulaziz University

Every sector of the university makes different contributions to transportation management and travel demand at the university. While the contributions vary, the sectors are interrelated and will have an impact on one another. For instance, the vice president’s office for projects develops the university’s master plan. The plans result in the construction of transportation networks and university buildings, and the plans also intend to transform the university into becoming a smart campus. The university’s security department regulates traffic on campus and issues parking permits to faculty members and visitors. The students’ deanship is responsible for managing and operating the shuttle buses. Admissions offices admit students to programmes and distributes them across various faculties. Faculties assign students and faculty member schedules based on the number of
instructors, students and available facilities, and these schedules subsequently inform travel demand. Travel demand tends to be fixed for university employees based on their work schedules, but again, this demand is determined by managerial requirements as set out by the employee relations deanship.

This paper proposes a conceptual travel demand modelling framework that considers the above-mentioned sectors of the university to manage transportation issues in an efficient way. Upon completion of all steps and models of the conceptual modelling framework, the framework will be able to evaluate travel demand at various time periods and propose efficient solutions to transportation problems. The conceptual framework is divided into four stages: 1-Defining the evaluation time period. 2-Establishing a data collection program. 3-Modelling travel demand. 4-Prioritizing transportation solutions.

4.1 First stage: Defining the evaluation time period

The first stage defines the analysis timeframe based on the time or the occasion of the occurrence of a transportation problem. Transportation issues at the university will be categorized as short, mid and long-term time periods and described in further detail below. A short-term time period is any time during a given day when transportation issues occur, such as peak hours traffic, traffic accidents and changes in routes for maintenance, special events. Travel demand at King Abdulaziz University varies on a daily, weekly and monthly basis, and therefore these variances need to be accounted for. At the university, the highest travel demand is during the first month of each term when students are visiting administration offices for beginning of term services, and when students are registering in and dropping courses to finalize their timetables. In addition, travel demand on Sundays (which is the first day of the week) and Tuesdays are higher than the rest of the week as most classes take place on these days.

Mid-term time periods are related to transportation issues that are occurring on a term by term basis. Travel demand during each term differs based on the number of students who pass and fail courses, and the new number of students that are accepted into or are graduated from a program. These combinations together with the availability of faculty members, classes and labs at a specific time of a day shape students’ schedules, and consequently, students’ and instructors’ travel demand (where we will see differences from term to term). Although students’ schedules affect daily traffic conditions, they are assigned on a term basis and the resulting traffic issues are categorized as a mid-term time period. For illustration, parking lots are usually full at a specific time on Sunday and Tuesday mornings due to how classes are scheduled, which drives the movement of students during these specific time periods.

Long-term time periods are concerned with future years where the university will do further facility expansions to accommodate increases in the number of students, faculty members and employees. This will result in an increase in travel demand and this creates a need for new transportation infrastructure. As noted above, the university’s surrounding areas are developing and create an increase in travel demand, which affects the university’s transportation system users. Thus, there is a need to include the university’s surrounding areas in the modeling framework.

4.2 Second stage: Establishing a data collection program

To follow the previous section, below will be further information on the specific data that each time period needs for modelling and analysis. The data needed for the short-term time period are real time occurrences such as traffic, pedestrian counts, turning movements, incident locations, shuttle bus information and the condition of the transportation network.
This information could be collected using various means such as surveillance cameras supported with analytical software that can measure traffic volume and detect accidents. This methodology can track vehicles by plate number and thus identify the origins and destinations of the university’s visitors, students and faculty members (this would, however, require that plate numbers are registered with the university’s security department). The university’s security department would automatically (through software applications) give registered vehicles the ability to enter parking lots that have cameras and this would allow the department to easily detect any violations.

Colleges admit students to classes based on the number of students enrolled, the capacity of classes, and required facilities. Changes in schedules and class allocations from term to term change travel behaviour. Given this information, the data needed for the mid-term time period is the number of enrolled students in every term for each faculty, which is based on the faculty’s resources and capacity that could be obtained from the dean of administration’s office. In addition, information about students’ schedules at the beginning of the term and after students drop courses (which can be obtained from each faculty of the university) are needed. Inputting these schedules to travel demand models would help in presenting students’ travel demand. However, these schedules are not issued early before the term starts and thus, there might be not enough time for transportation modellers to identify the transportation issues as well as propose solutions. Therefore, the transportation modeller can use the default undergraduate students’ study plan as preliminary data.

The data needed for the long-term time period are future plans for the university and its surrounding area. There are various models that could be used to predict the expected number of enrolled students in a future year. However, the university’s policy toward university expansion plays an important role, and King Abdelaziz University is a public university. If the university became a private university or endorsed executive programmes, the number of student applications and enrollments would be impacted. The university then needs to expand its facilities or build new facilities to account for the increase in the number of students, faculty members and visitors. The size and location of these facilities play a major role in defining the futuristic travel demand. For illustration, large free parking facilities within a walking distance from students’ classes are expected to attract many students. The long-term policy for the university should be identified, such as promoting more parking facilities to accommodate the increase in travel demand, or an increased focus on shuttle or electric scooters services to better utilize existing parking facilities. It is important to keep in mind that non-educational facilities are significant for the university as well, as the university has built two driving schools and COVID-19 vaccination centre, which attract the residents of Jeddah throughout the year, and add to regular university students’ travel demand. The city’s master plan is also needed for the long-term analysis period. Since the last travel demand model of the university was in 2010, the university’s surrounding area has developed rapidly, which now includes new residential, commercial and hospital facilities. Additionally, parts of the regional rail system were opened recently and these rail systems are close to the university. Based on the city’s master plan, future travel demand for the university’s surrounding area could be identified and modeled to evaluate traffic movement around campus so that solutions to future traffic issues can be proposed.

4.3 Third stage: Modelling transportation issues and proposing solutions

There is various simulation software that can be used to predict futuristic travel demand and to analyze it during the three time periods that have been established for this study. VISSIM and VISUM will be used as an illustrative example. VISUM is a macroscopic simulation software that can be used to analyze current conditions and would accordingly predict
future traffic conditions for the university. Firstly, transportation system and traffic data need to be collected. For the short-term time period traffic issues, surveillance cameras supported with vehicle detection software can be used to count vehicles’ turning movements and to calculate an average vehicle delay. The second step is developing the model and ensuring that its outputs mimic real life conditions through calibration and validation stages. Finally, the last step would be to propose solutions to transportation issues, as well as record the benefits and costs of each alternative solution. In addition, management strategies such as opening and closing some gates at the university for maintenance purposes could be evaluated and a proposal of the best practice(s) of managing the gates could be predicted. The transportation network and traffic data from the previous step could be used to develop the microsimulation model and ensure the accuracy of the model by comparing its output with current conditions. Then, the model is ready to test various changes in the transportation network such as widening a street, restricting turns and so forth. The simulation modelling framework proposed at this stage forms the foundation for modelling and analyzing traffic at various analysis time periods. Other methods and examples of treating transportation issues during the three time periods are discussed below.

The occurrence of car accidents need an immediate reaction to mitigate its effects on the transportation network. The university’s road users could use an app to send the location of the accident and some details such as the severity and if it needs medical attention. The accident’s location could be entered into Google Maps to inform road users and advise them to take an alternate route. In addition, the university’s surveillance cameras can detect these accidents and send them directly to the security department so that they can work to clear the accident. In addition, traffic data and accident data could be entered directly to microsimulation software to propose several management strategies to reduce the negative impact of the accident until it is cleared out. Various scenarios could be tested before their occurrence, such as developing an optimal set of operations in the event that the university is holding a national test, or if an emergency occurs and an evacuation plan is required. These plans then could be distributed to users through text messages or the university’s app to ensure distribution of information. The availability of virtual tours and a 3D map to the university’s facilities on the user cell phone could help users to navigate campus during regular days as well as less frequent occurrences such as special events.

For mid-term time period traffic issues, students’ schedules could be inputted to VISUM as origin and destination at specific time periods of the day to model travel demand within the university’s transportation network. Changes in the number of students accepted to each college and various scenarios of their schedules based on the college’s constraints could be evaluated to reach the best practice(s) that reduces the negative impact on the transportation network. Transportation issues would be identifiable from VISUM software and analyzed in VISSIM software to propose solutions to the transportation network. The positive and negative impacts of each scenario would then be evaluated and summarized. Cellphone detection software could be used to monitor students’ movements at every time of the day and during various terms to locate the most appropriate shuttle bus stop locations and to better design the service. The university is recently developed an app to monitor shuttle buses and electric scooters on cell phones and to structure services to reduce dependence on private vehicles when students are moving from building to building.

For the long-term time period, the university and its surrounding areas’ strategic and master plans are needed so that it is possible to predict increases in travel demand and to quantify the impact on the current transportation network using VISUM. If we consider the example of accessing master plans for future facility construction, the model can actually quantify the effect of the planned facility’s location on the transportation network. It then
proposes a new location for the facility as well as changes in land use or changes in the transportation infrastructure. Finally, the university could suggest possible treatments.

4.4 Fourth Stage: Prioritizing transportation issues on campus

During each time period, there are a set of transportation problems that have various solutions. Solving a transportation issue at one part of the transportation network can have either a positive, negative or null effect on other parts of the network. Given this context, selecting the best alternative solution for all parts of the university’s transportation network from the previous stage for a specific time period might not lead to the best operational solution for the entire network. In addition, solving all of the university’s transportation network problems at a specific time period simultaneously is difficult and might be not efficient in terms of reaching an optimal solution. This research proposes prioritizing transportation problems based on average vehicle delays and the number of affected individuals. The section of the campus that experiences the highest vehicle delays and has the highest number of affected individuals is ranked as the highest priority location. In addition, if traffic problems occurring in one location are extended to other locations, the total vehicle delay of the other locations are added to the main location as a subsequent effect. The solution for the first priority location should be applied first as it is expected to impact the main travel time, which in turn helps in saving time and improving movement to and from campus. The solution for the second and the lowest priorities should not negatively affect the first priority solution. Any alternative solutions for the lowest priorities that negatively affects the highest priorities’ alternative solutions should be excluded from alternative solution options. With this type of organization and process of elimination, traffic problems would be prioritized and solved accordingly.

5 Implementation of the intelligent conceptual travel demand modelling framework

Using the proposed conceptual framework, the smart city center of the university identified the highest priority locations in a macroscopic level, which are the main gates of the university (gate 1 and the 50-years roundabout) and gate 16 (the freshman year women’s college). It was quantified that the number of vehicles entering gate 1 is 35,000 vehicles daily. The travel time to enter through the gate and reach to the 50-years roundabout reached up to 50 minutes during the morning peak period. Figure 1 shows the length of the queue in a blue line entering gate 1 from the 50-years roundabout inside the university to the shopping mall off campus.

![Fig. 1. The queue length of vehicles entering KAU campus through gate 1.](image-url)
Gate 16 is located at the southern side of gate 1. 43,000 vehicles enter gate 16 and leave the campus from gate 7 with a vehicle travel time of 45 minutes. Figure 2 shows the queue length of vehicles in a red line at this location of campus and the layout of the area.

Fig. 2. The length of vehicles queue inside and outside of the university’s campus.

It was found that traffic issues at gate 16 negatively impacts traffic conditions at gate 1, and we can therefore establish the highest priority section as gate 16 (the freshman women’s college area). Now we can apply the conceptual intelligent travel demand modelling framework as such:

**Stage 1:** The analysis period is the mid-term time period, as analysis requires changes in students’ schedules, coordination with the city of Jeddah traffic officers, modelling and testing various traffic scenarios at a complex area. **Stage 2:** Based on a field visit and complaints received from the transportation network users, drivers visiting the college create traffic violations. The traffic light at exit gate (gate 7) is causing traffic jam. The number of drop-off areas are limited. Vehicles entering the area from the north side are visiting the drop-off area even if they do not need to. Vehicle count is measured using loop detectors and video cameras installed at the first month of the first term in 2019. Vehicle travel time is measured using test vehicles that run several times in this section during the peak morning hour period. Students’ schedules and arrival rates are collected from the freshman year females’ college. Transportation network characteristics and operational plans are collected from the vice president’s office for projects and as well as the university’s security department.

**Stage 3:** Gate 16 is modelled, calibrated and validated using VISSIM simulation software. Then, various solutions were examined given construction, implementation and regulation constraints. **Stage 4:** At the microscopic level and based on field visits, various locations are identified that result in transportation problems that needed to be treated. These locations are prioritized based on average vehicle delays and the number of impacted vehicles. The top priority location at the women’s section is the exit gate (gate 7). It has a traffic light that stays in green phase to the vehicles exiting the campus for 2.5 seconds and in red phase for 2 minutes. The vehicles’ queue is extended from the traffic light to the two entrances at the women’s section adding additional delays to vehicles entering this section and affect the negatively the traffic at the 50-years roundabout. Based on these factors, the exit at gate 7 was categorized as top priority. With the help of the city’s traffic department, the traffic light was cancelled, and all vehicles are directed to leave the university using the service lane, which ensures a continuous service rate for vehicles exiting campus. This resulted in a reduction in vehicle queue length as it no longer reached the entrances of this section. The second priority are vehicles entering through gate 16. It was found that the three drop-off lanes are not adequate for the 15,000 students and faculty members accessing this area. Thus, an additional 8 lanes were added on both sides of the existing drop-off area to distribute vehicle load on the transportation network. The lowest priority is the entrance from the north side. The vehicles exiting from gate 7 used to extend to the entrance from the north side of this section and negatively affected the operation of the 50-years
roundabout. Thus, the entrance from the north section was rerouted to join the main drop-off area of the women’s section. As a result, the travel time of vehicles entering from the north side of this section reaching gate 7 took 40 minutes. The cancelation of the traffic light and the subsequent reduction in the queue length made it possible to permit movement of traffic from the north entrance to gate 7, which takes 4 minutes of travel time. In addition, after discussions with women’s college officials and the necessary administrative offices, students’ schedules were modified. Thus, the students arrive at three different time periods of the day rather than in one hour. All of these strategies helped in revealing the pressure on the transportation network (see Figure 3).

![Fig. 3. The queue length in a red line after implementing the solutions based on the conceptual framework stages.](image)

Application of long-term planning was carried out partially and is still under development as follows: There is a need to quantify the effect of upcoming projects constructed by the university on the transportation network. Many projects are completed, while others are still under construction. Traffic in the university is increasing rapidly and parking lots are filling up in a faster rate than previous years specially after allowing female to drive (Stage 1). Transportation network, traffic count, parking, and building (already built and upcoming) information for the campus are collected (Stage 2). VISUM model was built, calibrated and validated for the university using traffic counts collected by loop detectors in 2019 (Stage 3). The university’s parking locations and information were identified and collected to be the basis for a zoning system on campus. The model predicted traffic counts on each road and then compared real data for validation. In this scenario, the highest priority areas are parking lots. Students spend a significant amount of time searching for parking spots and sometimes miss their classes while doing so (Stage 4).

Based on some analysis, most of the parking spots are well utilized around academic buildings. However, there are 4,000 parking lots, which are utilized by only 30% of their capacity. The smart city center at the university (with the help of the students’ deanship and the university’s security department) added a new shuttle and scooters service that transports students from parking lots to the academic square, where the majority of their classes are. In addition, they directed students to parking lots using a QR code developed by the smart city center that uses Google Maps to navigate students through campus to the parking lot where the shuttle service is waiting for them. The smart city center designed the shuttle stations to be a maximum of 250 meters away from the farthest class in the academic square. In addition, the center is developing an app to track and to request shuttles and electric scooters to efficiently use this service and to avoid running an empty bus as travel demand varies from term to term and day to day.

6 Conclusion

The rapid development of cities results in increases in population and increases demand on educational institutes such as universities, resulting in increases in travel demand on
associated transportation systems, which can serious traffic issues. King Abdulaziz University attracts over 350,000 thousand vehicles daily, and consequently, the university is the main trip generator for the city. This high demand causes high vehicle delays and other transportation problems. Most research focuses on cities’ traffic problems, and limited research focuses on transportation problems that are specific to universities. To manage transportation issues at the university, there is a need for a multi-step plan that incorporates several factors, including variation in student travel behaviour; how different areas of the university contribute to travel demand; fluctuating peak times throughout different time periods; as well as ongoing developments on campus and in adjacent areas to the university.

This paper proposes a conceptual intelligent travel demand modelling framework that considers various sectors of the university to manage traffic at the university in various time periods (short, mid, and long) with the aid of technology. The framework is divided into four stages, which are: 1- Defining the evaluation time period (short, mid, or long-term span). 2- Establishing a data collection program for each time period. 3- Modelling travel demand and proposing solutions using macro- and micro-simulation software. 4- Prioritizing transportation issues on campus. This framework fills the gap of the limited effort put toward modelling travel demand at universities. The applications of this framework present a fast and efficient way to deal with transportation issues. The framework advises using technology in solving transportation problems in an efficient way, which includes smartphone applications, video surveillance cameras and simulation software. It resulted in a significant reduction in vehicle delays, better management of parking facilities, saving students’ time and improving quality of life.

References


