Conducive Walking Environment in UTP

by

Ilya Izana bt Idrus

Dissertation submitted in partial fulfillment of
the requirement for the
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CERTIFICATION OF APPROVAL

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Civil Engineering Programme
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Approved by,

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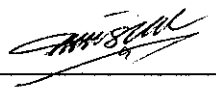
UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
June 2006

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



(ILYA IZANA BT IDRUS)

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ABSTRACT

Currently, the number of vehicles in UTP has been increasing year by year thus contributing to several issues such as traffic congestion and limited parking spaces. In order to reduce the problems, it is recommended that a walking network is established in UTP in order to provide more convenient walking environment to the students, thus making walking within the campus more attractive rather than riding vehicles. The project proposed a walking network in UTP as to promote students to walk within the campus in order to reduce the number of vehicles in UTP. If walking is made more attractive, more students will favour walking as the main mode of travel in the campus. This project provides proper and better pedestrian facilities in UTP besides promoting healthy lifestyle to UTP students and offer UTP students' safer and pleasurable pedestrian walkway. The main methodology is the travel demand modeling involving the usage of EMME2 software tool. The data was gained from the questionnaires which were distributed to the students. With the data as input, few scenarios were generated and compared for its effectiveness. Providing better pedestrian facilities and a more welcoming environment for pedestrians appears to increase the willingness to walk. Well designed facilities will attract students to walk since they feel safe and comfortable. The congestion in UTPs' route network will be minimized as more students will shifts from their current mode of transport to walking,

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND STUDY

Accepting the official invitation from the Government to set up a university, Universiti Teknologi PETRONAS (UTP) was established on 10 January 1997 by PETRONAS. As an institute of higher learning, UTP provides opportunities for the pursuit of knowledge and expertise as well as for the advancement of engineering, science and technology. It is aligned to PETRONAS' objective to produce well rounded graduates who are creative and innovative with the potential to become leaders of industry and the nation. Towards this end, it aims to nurture creativity and innovation as well as to upgrade the level of technology and education which would uplift the community's standard of living.

Conducive learning environment is an essential element for every university. Thus, one of the approaches in achieving the university's objective is to enhance the environment of study in UTP by offering up-to-date infrastructures and excellent facilities to the students so that the students can adapt to the surrounding and improve their achievement in academic and non-academic. As students need to travel almost everyday within the campus area, infrastructure in term of transportation is very significant to them and should be given some attention.

1.2 PROLEM STATEMENT

1.2.1 Problem Identification

The population growth of students at UTP has been increasing year by year, thus rapidly increase the number of students bringing their own vehicles to the university. This has increased the students' mobility but unfortunately, it contributes to traffic congestion, accidents, and parking problems, as well as air pollution in UTP.

At present, the students choose cars and motorcycle as their main mode of transport within the campus. For those who have their own transport, they can travel around UTP conveniently, but for those who do not have any transport, the only option they have to travel inside UTP is to walk. However, proper facilities are not provided. When walking within the campus, either to attend classes, going to the library or recreational activities, they are exposed to the surrounding elements. This is why students prefer to use vehicle rather than walking even though the level of traffic congestion increases.

1.2.2 Significant of the Project

Observing the circumstances, it is recommended that a walking network is established in UTP in order to provide more convenient walking environment to the students, thus making walking within the campus more attractive.

In few years time, when the university management would like to reduce the number of cars in the campus by limiting the vehicle ownership, walking in the campus is an option well worth considering as it is a type of exercise activity. Walking is a great way to stay healthy. Exercise at the start and end of the day will wake you up in the morning and relax at night. It is now well documented that walking is one of the best ways of improving health and fitness as well as reducing stress levels [1].

Walking is a preferable mode of travelling in most countries and universities overseas. In Oxford University, for instance, walking is being aggressively encouraged as a substitute to the car usage [1]. Ideal for short trips, walking is also inexpensive. If enough facilities are provided, walking will be more attractive and the most chosen mode of transport in UTP, like many universities overseas.

The project is a proposal to establish a walking network in UTP as to encourage students to walk within the campus in order to reduce the number of vehicles in UTP. If walking is made more attractive, more students will prefer walking as the main mode of travel in the campus. This project provides proper and better pedestrian facilities in UTP. Besides that, it promotes healthy lifestyle to UTP students and should offer UTP students safer and pleasurable pedestrian walkway.

1.3 OBJECTIVES AND SCOPE OF STUDY

1.3.1 Objectives

The main objective of the study is to propose a walking network in UTP that will provide better pedestrian facilities to the students, mainly. The walking network shall cover all possible zones and routes in the campus area.

1.3.2 Scope of Study

The scope of study for this project involves the following.

i. *Literature review*

- ★ As the basic for this study, literature reviews on the existing walking network and pedestrian facilities for local and overseas will be done.
- ★ The development plan of UTP is also vital as to know the planned development and progress of the development so far.

ii. *Data analysis and traffic modelling*

- ★ Questionnaires are to be distributed to the students as the main focus in this study, in order to know their origins and destinations. These inputs later will be used for the demand forecasting as the input. Besides that, the questionnaires will also include their mode of transport preferences if the facilities were upgraded and opinions on how the existing facilities can be improved to meet their expectation.
- ★ The traffic data shall be analyzed using the 'four-step processes', which is the approach for forecasting travel demand. The 'four-step processes' are:
    - trip generation
    - trip distribution
    - modal choice – car and pedestrian, and
    - traffic assignment
- ★ The usage of the traffic software, EMME/2 is suggested this traffic modelling purpose.

iii. *Design*

★ For this stage, a simple traffic site plan of walking facilities should be produced for the entire UTP; the hostel, recreational areas and campus zone. The walkways must be designed proficiently. The distance should be kept to minimum. Covered walkways are suggested considering the climate conditions. Benches should be provided at an appropriate distance for the convenience of users. Well designed walking facilities will encourage the students to use the walkways

CHAPTER 2

LITERATURE REVIEW

Walking has always been the most fundamental of all transportation modes. While it may not be the primary mode for all trips, walking is usually a part of every trip whether it is at the beginning, the end, or as connection between other modes.

Walking is also a mode of transportation that can occur anywhere – along roadsides, across parking lots, and on designated pedestrian facilities.

2.1 IDENTIFY THE NEEDS OF PEDESTRIANS

Before deciding on the appropriate extent and standard of pedestrian facilities, it is important to assess the potential demand. There are two steps in the process [2]:

1. obtaining reliable estimates of the existing demand, and
2. projecting this demand to a future design year. Most techniques are concerned with the first step.

Manual Counts

Manual counts are concerned with counting the flow of pedestrian through a junction, across a road or along the road section/footway. If manual counts are to be useful, they need to satisfy the following:

1. The time period(s) in the day over which the counts are undertaken must coincide with the peak times.
2. The survey locations need to be carefully selected in order to ensure that the total existing demand is observed.

Video Survey

Cameras are set up at the selected sites and video recordings taken of pedestrian movements, together with their interaction with vehicles where appropriate, during the selected observations period. Such survey produces a permanent record of pedestrian movement and their interaction with vehicles.

Attitude Survey

This required detailed questionnaires based on the attitude surveys, often directed at particular target groups. Attitudes survey enables complete information to be obtained on why existing trips are made by the current mode of travel but not others. They can also gather information on what new facilities or improvement to existing facilities, need to be provided to divert trips to cycling and increase the amount of current cycling activities.

2.2 PEDESTRIAN REQUIREMENTS

Based on international experience, it can be concluded that there are four main requirements that represent most wishes of pedestrians regarding the infrastructures. When planning and designing for pedestrians, these requirements must play an important role. The requirements are mentioned below [2]:

Safety

The route used by pedestrians must have low risk of traffic accidents. The minimum requirement is that walking is not more dangerous than other modes of transport. A second important safety aspect is personal safety against robbery and harassment, in particular after dark. Important factors that reduce the security risk are good visibility, street lights, a high pedestrian traffic volume, and community surveillance at critical points.

Coherent network of direct walk routes

The networks of pedestrian routes must have no gaps and must be linked to the main points where pedestrian begins or complete their trips. Directness means that the network provides pedestrians with a route which goes as direct as possible to their destination, without detours or long waiting times at crossing points.

Comfort

Comfortable pedestrian movement means: minimal hindrance by other pedestrians, i.e. a capacity large enough to avoid pedestrian congestion, a reasonably smooth and hard pavement, proper waiting areas at bus stops and road crossings.

Attractive walking environment

The environment surrounding the pedestrian route must be conducive to walking. Important factors are: trees that provide shade, clean routes (absence of solid waste or excrements), kiosks and shops along the route but not encroaching the walkway, small public parks along the route that can serve as resting place, no close exposure to traffic exhaust and noise.

2.3 BENEFITS OF WALKING

The positive consequences of walking as healthy modes of transportation, or as purely recreational activities, span across many aspects of our lives. They can be expressed in terms of the health of environment (and resulting health of all living things), as well as the health of individuals who are more physically active. A transportation system that is conducive to walking can reap many benefits in terms of reduced traffic congestion and improved quality of life. Economic rewards both to the individual and to society are also realized through reduced health care costs and reduced dependency on auto ownership (and the resulting insurance and maintenance costs). There are also other economic benefits of bicycling and walking that are more difficult to measure, such as the increased economic vitality of communities that have emphasized pedestrian mobility [3].

2.4 FORECASTING TRAVEL DEMAND

Travel demand is expressed as the number of persons or vehicles per unit time that can be expected to travel on a given segment of a transportation system under a set of given landuse, socio-economic and environmental conditions. The approach that is commonly used to forecast travel demand is the 'four-step processes' that are [4]:

1. Trip Generation and Attraction
    - The number of trips by persons and vehicles
2. Trip Distribution
    - The distribution of the trips throughout the area
3. Modal Choice
    - The type of mode, usually private or public, used for the trip
4. Traffic Assignment
    - The highway or transit route that the trips takes

Figure 2.1 illustrates the 'four-step processes'.

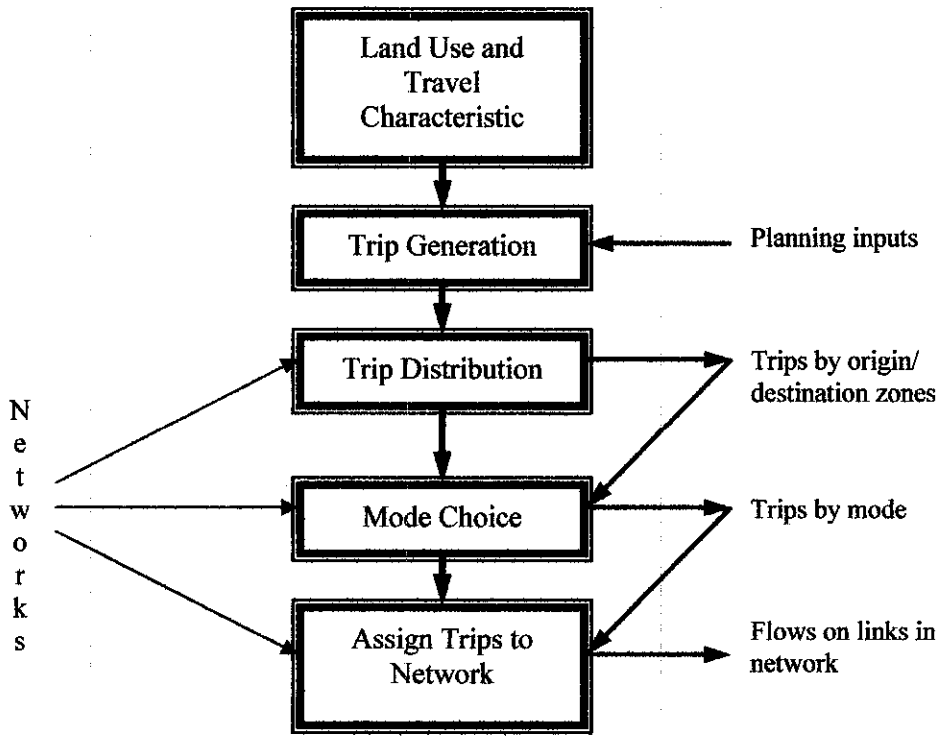

Figure 2-1: Schematic diagram of a conventional four–step urban transport model

2.5 PEDESTRIAN FACILITIES

Pedestrians are an integral part in transportation system. The importance of good design not only applies to development of new facilities, but also to improvement and retrofit of existing facilities for pedestrian use. When pedestrian access is expanded and existing conditions for pedestrians are improved, higher numbers of pedestrians

can be expected to use the system. Research has shown that well designed and maintained pedestrian facilities encourage walking and promote higher levels of pedestrian travel.

Pedestrians want facilities that are safe, attractive, convenient, and easy to use. If designed properly, the best public pedestrian facilities can also be the most durable and the easiest to maintain. Poor design of pedestrian facilities can lead to perpetual problems and can actually discourage use if pedestrians are made to feel unsafe, unprotected, or uncomfortable. Unattractive, inadequate, and poorly designed and maintained facilities can be an unfortunate waste of money and resources and a hindrance to community vitality.

Good design is an important factor in incorporating pedestrians into any local transportation system, but it cannot be expected to solve all pedestrian related problems.

Consistent with the Guide for the Development of Bicycle Facilities (AASHTO,1999), there are five general types of bicycle and pedestrian facilities [5]:

i **Shared used paths** are facilities physically separated from motorized vehicular traffic by an open space or barrier and are either within the highway right-of-way or within an independent right-of-way. Shared used paths may be used by bicyclists, pedestrians, skaters, wheelchair users, joggers and other non-motorized users.

ii **Bike lanes** are portions of roadways portions of roadways that have been designated by stripping, signing and pavement markings for the preferential or exclusive use of bicyclists.

iii **Signed shared roadways (bike routes)** are shared roadways that have been designated by signing as preferred routes for bicycle use.

iv **Shared roadways** are roadways that are open to both bicycle and motor vehicle travel. They may be existing roadways, streets with curb lanes, or road with paved shoulders.

v **Walkways** are pedestrian facilities that can be either separated from roadways, such as sidewalks and paths, or part of roadways, such as crosswalks or wide shoulder.

Plate 2.1 to *Plate 2.4* show the examples of pedestrian facilities.

Plate 2-1: Shared walkway and cycle track in Japan.

Plate 2-2: Sidewalk in Putrajaya.

Plate 2-3: Covered walkway

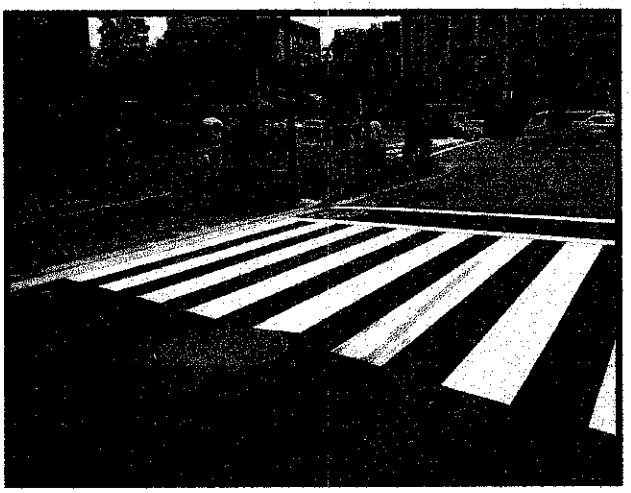

Plate 2-4: An example of friendly pedestrian facility. Kerbs dropped to assist crossing with pushchairs, wheel chairs & visual impaired.

Meanwhile, the 1994 *Washington State Policy Plan* recognizes that "pedestrian facilities" are far more extensive than the simple definition of a sidewalk as defined by Washington law. *Figure 2-2* compares the expanded definition of pedestrian facilities to the definition of a sidewalk [6].

Expanded Definition of Pedestrian Facilities

Pedestrian facilities include:

- Sidewalks and on-street facilities
- Walkways and trails
- Curb ramps
- Traffic calming and control devices
- Crosswalks
- Grade separations (such as underpasses and overpasses)
- Wide shoulders in rural areas
- Furnishings that create a pedestrian friendly atmosphere (such as benches and landscaping)
- Other technology, design features, and strategies intended to encourage pedestrian travel (such as traffic calming devices including traffic circles, speed humps), planting strips, shelters, public art, and lighting

Source: Washington State Policy Plan, 1994

Definition of sidewalk:

A sidewalk means property between the curb lines in the lateral line of a roadway and adjacent property, set aside and intended for the use of pedestrians or such portion of private property parallel and in proximity to public highway and dedicated to use by pedestrians.

Source: Revised Code of Washington (RCW) 46.04.540

Figure 2-2: Comparison between the expanded definition of pedestrian facilities and definition of a sidewalk

The capital facility development guidance is summarized and can be referred in *Appendix A*.

Typical concerns

Where no walkways are provided, or where walkways are in poor repair or broken, or where they have missing sections, the following conditions will likely result:

- People may be forced to walk in the roadway, resulting in increased pedestrian/motor vehicle collisions. About 8 percent of all pedestrian crashes involve people walking along the road. Having a sidewalk, walkway, or other suitable place to walk reduces the chance of a crash.

- Without a safe and durable place to walk, people are discouraged, and in extreme cases prevented, from walking. Children have a difficult time walking to school, seniors can't get to nearby shops, and transit users must bushwhack their way to transit stops.
- The absence of sidewalks can eliminate access to all destinations for some people with disabilities. Even short gaps where sidewalks do not exist make sections of sidewalks that do exist completely inaccessible to these individuals.
- Not providing a durable and safe place to walk ignores the needs of people who rely on walking as a mode of travel.

There is likely no community in the United States that does not have at least some gaps within its walkway system. Worse, many new residential areas have few or no sidewalks or paths. Ensuring continuity throughout the pedestrian infrastructure can improve pedestrian safety and increase the likelihood that more people will want and choose to walk more often.

Possible solutions

Obviously, the solution is to provide good facilities for people to walk. Establishing policies to ensure that safe places to walk will be developed is a good starting point in making a community more walkable. With these policies in effect, the development of pedestrian linkages becomes routine and a natural part of highway, road, and street planning; design; and construction processes. Such policies may be part of a local comprehensive plan, or they can be included in metropolitan or statewide long-range transportation plans. Some technical information on designing for sidewalks and walkways from Pedestrian Facilities Guideline prepared by Otak can be referred in *Appendix A*.

2.6 PEDESTRIANISATION

Certain areas, or particular lengths of road, experience high levels of pedestrian activity. Such places may be potential candidates for some form of pedestrianisation scheme. These schemes are most commonly introduced in shopping and market areas but they can also be beneficial in high intensity office areas or in conservation areas or other places where environmental conditions are highly valued.

Pedestrianisation allows the creation of an environment which respects a human rather than a vehicular scale [7]. However, to be successful, such schemes require satisfactory provision to be made for local and through traffic or public transport and parking including in particular the access needs of mobility handicapped people. Access for servicing of premises in the restricted area for emergency vehicles must be provided. Decisions on the most appropriate type of measure are therefore usually controlled by the existing characteristics of the street or area in question but there are varieties of options from which to choose depending upon the extent to which vehicles can or should be excluded. The options range from full pedestrianisation, with total vehicle exclusion, to partial or part-time pedestrianisation, with some or all vehicles excluded to differing degrees, at different times of day or on different days of week.

Full pedestrianisation

By excluding all vehicles (or all motor vehicles) for all of the time, with exemptions only for emergency and maintenance vehicles, full pedestrianisation usually allows the carriageway to be eliminated and enables the street to become a continuously paved area with consistent surface textures (see Plate 2.5).

Partial pedestrianisation

Local circumstances can make it impracticable to totally exclude all vehicles from an area all the time. Suitable exemptions (in addition to those from emergency services etc.) where vehicle encroachment is permanently limited, footways can often be widened and in these circumstances, provision for vehicles should be made to minimum standards consistent with safety. The overall aim should be to design for

people and not for vehicles and attention to detail is important if the maximum environmental benefit is to be achieved.

Signing

Signing is an important consideration in pedestrianisation schemes. For aesthetic reasons it should be kept to minimum consistent with legal requirements and driver comprehension. Sign clutter should be avoided.

Plate 2-5: Pedestrian prioritized area.

CHAPTER 3

METHODOLOGY

3.1 PROCEDURE IDENTIFICATION

3.1.1 Background Study

The task started with a background study on the situation currently faced in UTP. The problems and projects requirement that the project will be expected to solve, including the data or input the projects will work with, such as resource availability for the project, time constraints, equipments and computer facilities needed were identified. It aimed to gain the understanding of the flow of the projects operation and structure of the projects.

3.1.2 Literature Review

A thorough study on the related topics to the projects is done to collect relevant information. The project has been divided into small section to do the research and the understanding of the relationship or connection between the sections.

The literature review is discussed in Chapter 2.

3.1.3 Data Collection - Questionnaires

Review relevant documents and plans such as the development plan prepared for UTP, for current and future besides collecting existing data. At this stage, the origin and destination are identified. As the main method for data collection in this project, the questionnaires were distributed to the students to find out their feedbacks and opinions regarding the project. It is divided into 2 sections and will be distributed 40 sheets per block, which about 20% of the students' population.

The first section of the questionnaire asked about the trip information generated by the students per hour; including origin, destination, trip purpose and mode of transport, based on one of their typical day. While the second section will focus about

the student's opinions in choosing mode of travel in UTP and also to gather information on what new facilities or improvement to existing facilities can be done to make walking more attractive.

The full development plan of UTP is available in *Appendix B* while the example of questionnaire form can be referred in *Appendix C*.

3.1.4 Reconnaissance Survey

Reconnaissance survey is conducted to provide and assessment of the physical features in the study area. It is conducted in order to identify the best route location to be proposed, where the distance to travel must be kept to minimum. The survey was conducted within the hostels, new campus, USM building and sport complex. However, for the purpose of this project, it only covered the area around residential villages and campus area.

Apart from that, it is also conducted to assess the walking environment in UTP and to observe the existing pedestrian facilities. The problems with the existing facilities and what modification needs to be made are identified in order to improve the existing facilities.

3.1.5 Data Analysis

All the finding and data obtained from the questionnaires are analyzed to get the trip generated and attracted. From the questionnaire, the trip patterns can also be determined. Trip matrix is then derived for base year 2005. The trip matrix will be used as input for traffic assignment using EMME/2

3.1.6 Design

At the design stage, new pedestrian facilities to be proposed are to be determined. The shortest path must be considered in designing a pedestrian facility. From the survey conducted, few improvements were identified to be proposed. Since the environment

factor is the major problem, covered walkway is to be proposed from the residential village to the new campus. At certain points, crosswalks are to be proposed to ensure the safety of the pedestrian when crossing the streets.

3.1.7 Traffic Modelling

A traffic model is used for forecasting traffic flows on a transport network as outcomes of future development. Software package used is EMME2 traffic software. This software package is considered to be the most appropriate analytical tool because of its transparency, in that all the key functions and assumptions of the computer model are user friendly and readily audited and replicated.

The traffic models are developed essentially in two stages i.e. the base year traffic model and future year models. The base year traffic model incorporates both existing and newly collected data and is developed and adjusted to replicate existing traffic condition. The future year models incorporate assumptions regarding total population.

EMME2 will run the analysis for two modes of transport, car and pedestrian each for two time horizons which is 2005 (base year) and 2010 (fully developed).

The trip matrixes were split into car and pedestrian trips. EMME2 software was used to assign travel demand (trip matrix) onto the transport network. The traffic assignments results from the EMME2 model runs were analysed to determine the performance of various links.

Basically, the software will run for two (2) time horizons under three (3) conditions which are:

1. 2005 base year
    - UTP is not yet fully developed
    - Pedestrian facilities are not 100% provided
    - Scenario 1: Car matrix = 2005 base year matrix
    - Scenario 2: Pedestrian matrix = 2005 base year matrix.

2. 2010 do nothing (no changes done to the facilities)
    - UTP is assumed to be fully developed
    - Pedestrian facilities are not 100% provided
    - Scenario 3: Car matrix = 2010 matrix
    - Scenario 4: Pedestrian matrix = 2010 matrix.

3. 2010 do something (improved pedestrian facilities)
    - UTP is assumed to be fully developed
    - Well-designed pedestrian facilities are provided
    - Scenario 5: Car matrix = 2010 car matrix - additional shift (car-to-walk)
    - Scenario 6: Pedestrian matrix = 2010 pedestrian matrix + additional shift (car-to-walk)

Figure 3-1 shows the flow of the process.

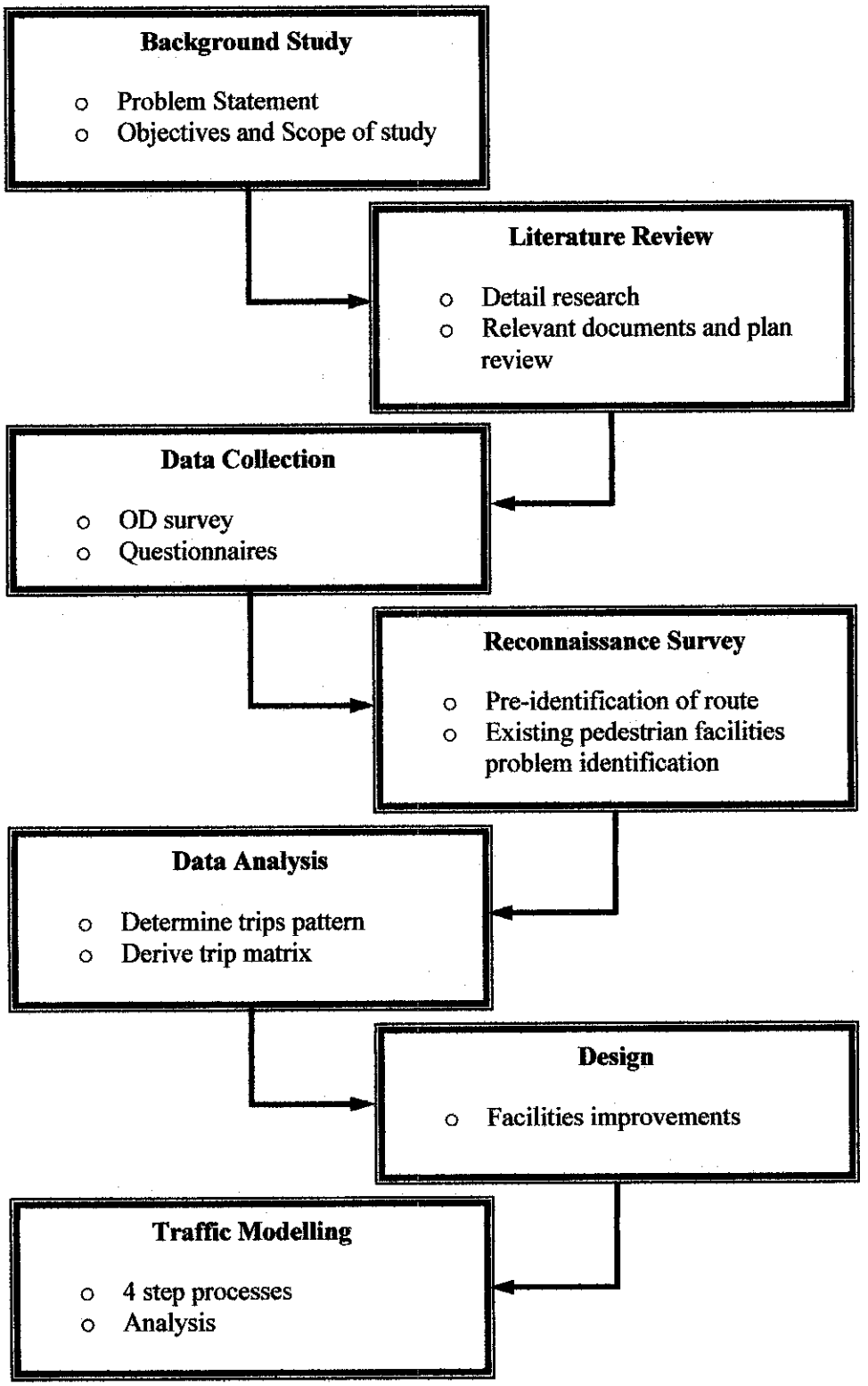

Figure 3-1: Flowchart of methodology

CHAPTER 4

RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Travel Demand

Travel demand is expressed as the number of persons or vehicles per unit time that can be expected to travel on a given segment of a transportation system under a set of given landuse, socio-economic and environmental conditions.

The total population of UTP students in 2005 base year is 4400 students and for 2010, which is by then UTP is fully developed is estimated to be 6600 students. Thus, the growth factor of the population is 1.5 which means there is 50% student population increase within 5 years. Based on the survey, the total trips generated and attracted by all means of transport mode in year 2005 is 22000 person-trips per day, equivalent to 5 trips per person per day.

The standard 'four-step process' travel demand:

1. *Trip Generation*
   The number of trips by persons and vehicles. The trips were obtained from the traffic survey based on the student's most typical daily trips. Findings about this process can be referred in section 4.1.2.

2. *Trip Distribution*
   The distribution of the trips throughout the area. More details on trip distribution is discussed in section 4.1.3.

3. *Modal Choice*
   The type of mode, usually private or public, used for the trip. Under this study, the trip matrices were split into two; car and walking trips. Refer section 4.1.4 for results from questionnaire.

4. *Traffic Assignment*

The highway or transit route that the trips takes. EMME/2 traffic software is used in order to determine the trips assigned. The output of traffic assigned for each mode of transport can be referred in section 4.1.5.

4.1.2 Trip Generation and Trip Distribution

4.1.2.1 Questionnaires

The questionnaire was divided into 2 sections. The first section of the questionnaires is asking about the students' trip information per hour based on one of their typical day. Meanwhile, the second section focused on the students' opinions in choosing mode of travel in UTP and also to gather information on what new facilities or improvement to existing facilities can make walking in UTP more attractive.

The estimated population of UTP students for year 2005 is 4400. 1000 copies (20% of total population) of questionnaires were distributed to all villages. The questionnaires were distributed 40 sheets per block. Listed below are the numbers of block for each village:

1. Village 1 : 4 blocks
2. Village 2 : 6 blocks
3. Village 3 : 5 blocks
4. Village 4 : 5 blocks
5. Village 5 : 6 blocks

However, out of 1000 copies distributed, only 50% of the questionnaires distributed were successfully retrieved back. It now can be roughly estimated that the questionnaires collected only cover 10% of the total population.

4.1.2.2 Origin-Destination (OD) survey

The purpose of this survey is to know the number of trips generated and attracted respectively by each traffic zones. The trips were made from 6 am until 7 pm on weekdays based on the student's typical day. The study area was divided into 14 zones, which are:

1. Zone 1 : Village 1
2. Zone 2 : Village 2
3. Zone 3 : Village 3
4. Zone 4 : Village 4
5. Zone 5 : Village 5
6. Zone 11 : Chancellor Complex
7. Zone 13 : Pocket C
8. Zone 12 : Pocket D
9. Zone 14 : USM Building
10. Zone 19 : Pocket A and B (Future)
11. Zone 21 : Sport Complex
12. Zone 22 : Mosque
13. Zone 23 : V4 Field
14. Zone 31 : Outside UTP

Figure 4.1 shows the sketch of the divided zones.

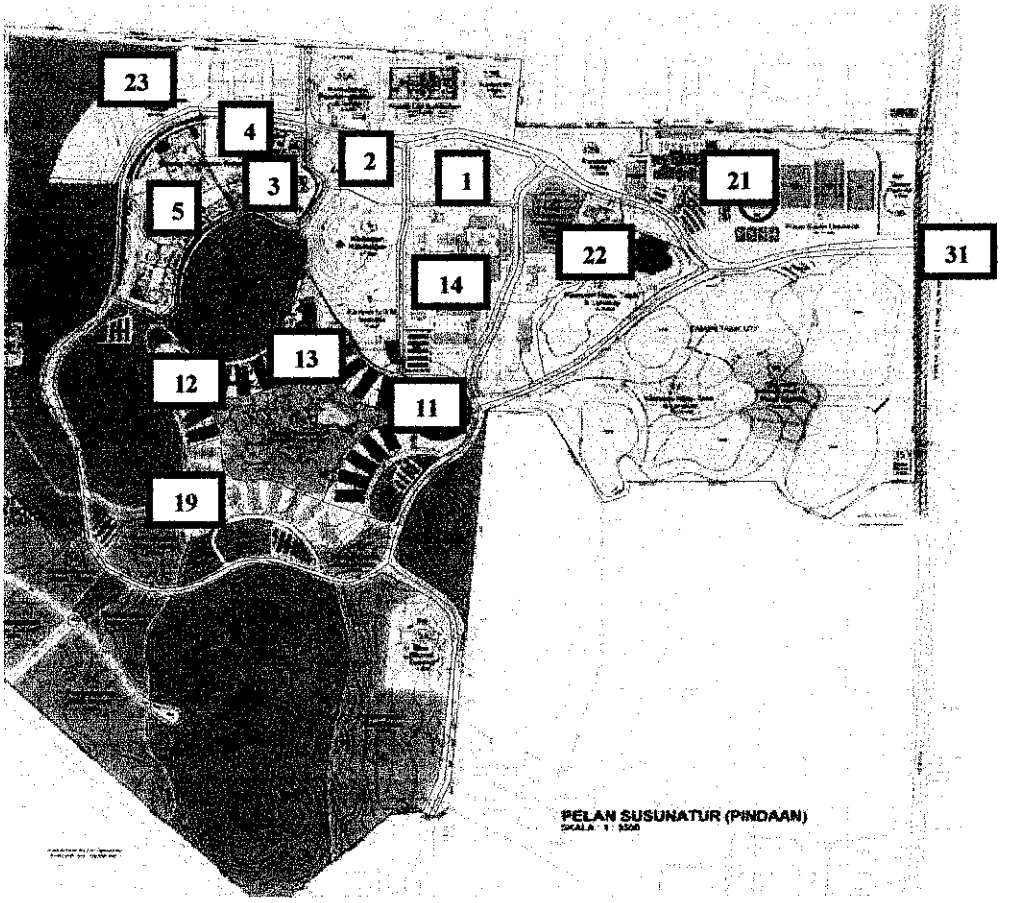

Figure 4-1: The UTP zoning for the OD survey

Table 4.1 shows the total of trip distribution and trip generation for each zone. From the table, most of the trip generation was made from zone 2 and zone 5 because most of the questionnaires successfully collected were from these two zones. Thus, for trip generation the data is unreliable. But, the pattern for trip attraction can be taken into consideration because from the observation done during weekdays, most of the students went to academic buildings rather to go outside.

As shown in *Figure 4-2*, the highest generated is from Village 3 with a total of 3295 trips which most of the trip is made by walk (1926 trips). This is followed by the trips from Village 4 (3097 trips) and Village 5 (2813 trips). While in *Figure 4-4*, Village 3 is also identified as where the most trips attracted with a total of 3189 trips. Also, for this destination trips, walking is the highest mode which is 2292 trips (see *Figure 4-5)*.

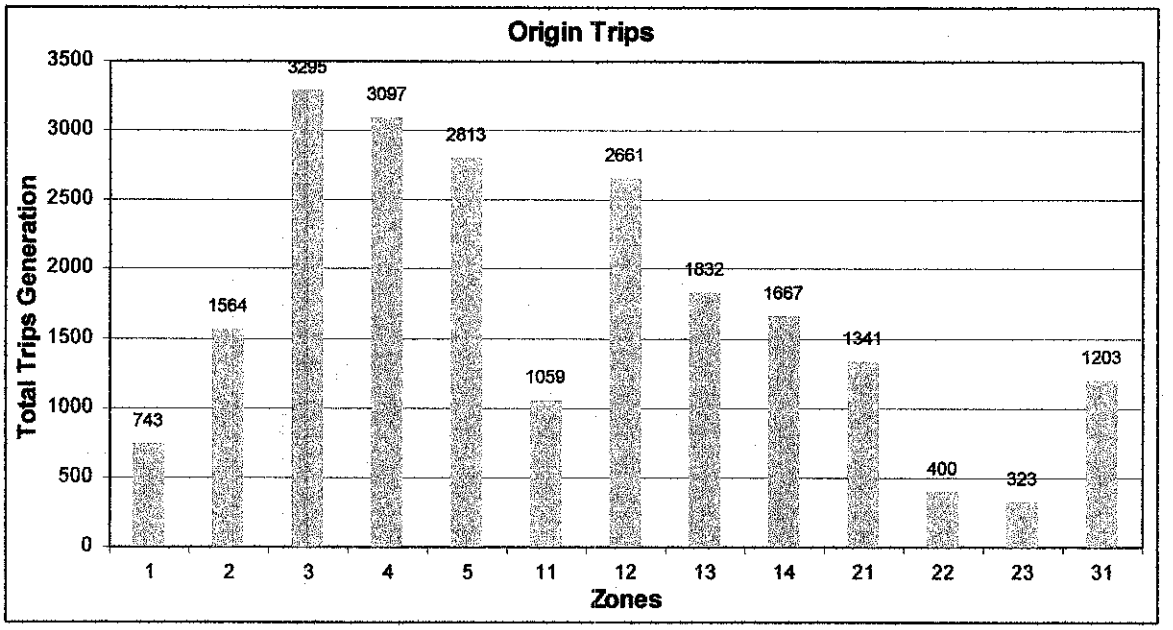

Figure 4-2: The total of trip generations for each origin zones

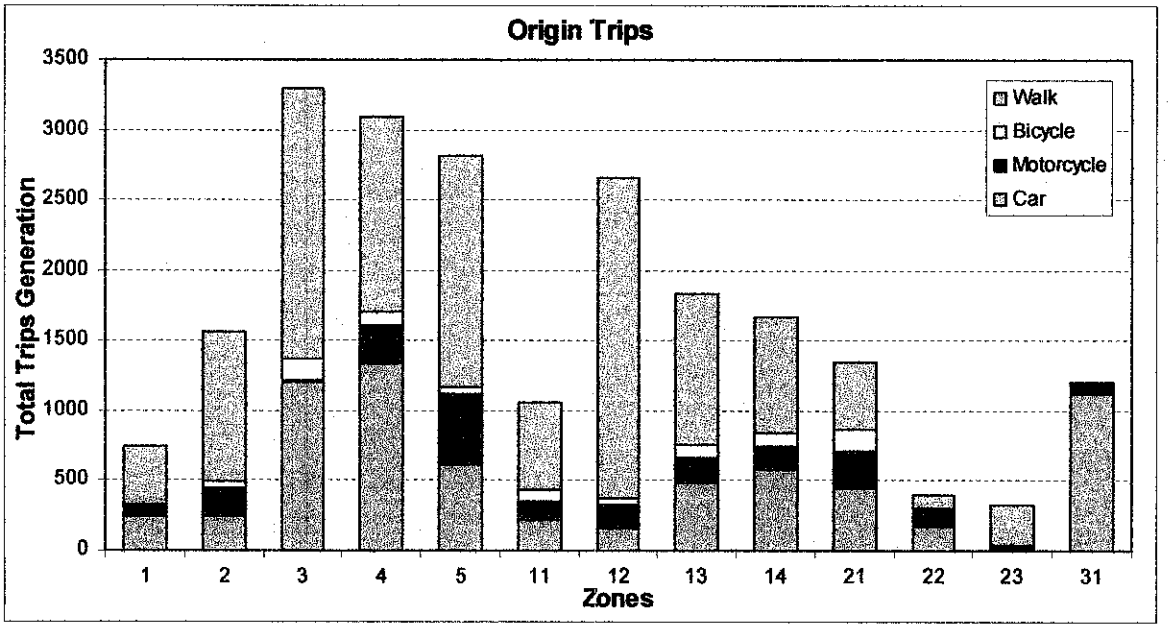

Figure 4-3: The trip generations from the origin zones according to mode of transport

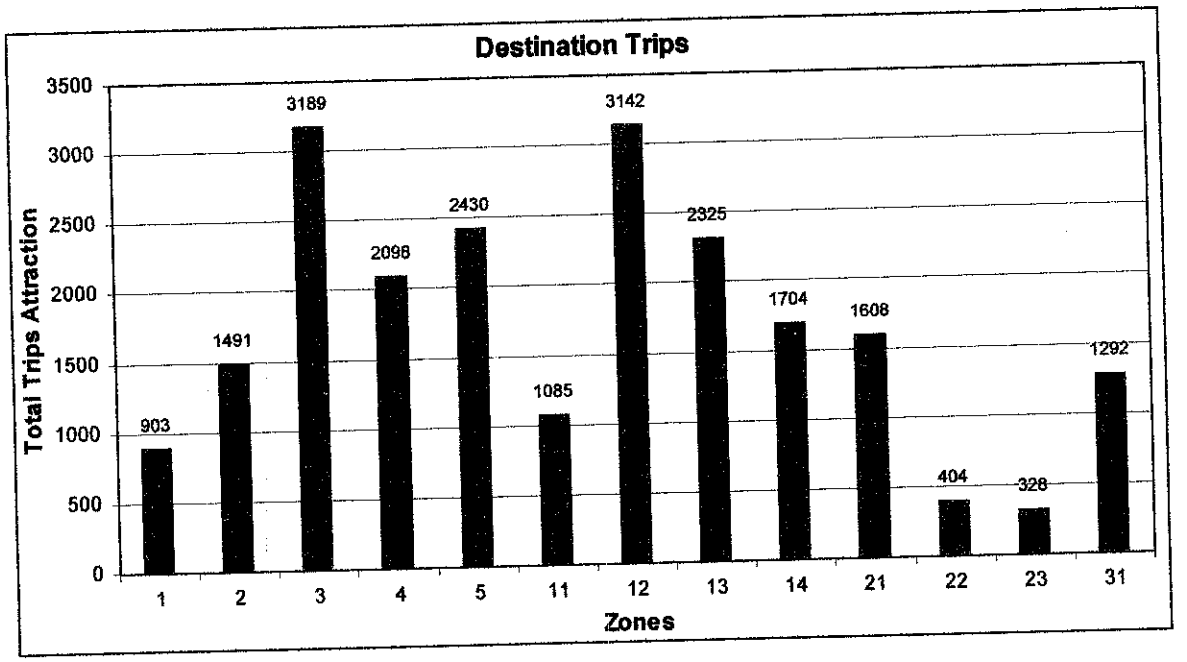

Figure 4-4: The trip attractions for each destination zones

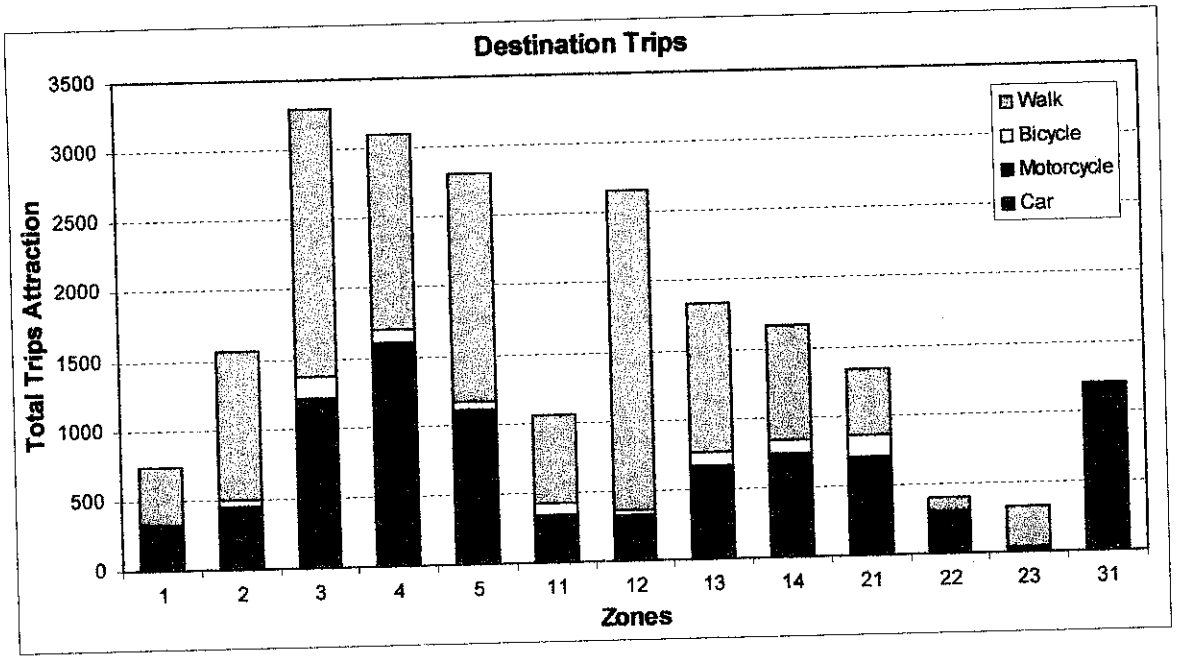

Figure 4-5: The trip attractions to the destination zones to mode of transport

4.1.2.3 Matrix In-filling and Data Expansion

Trip values equal to zero is not logic because rationally from one zone to one zone, there must be at least one trip generated. It would have required a significant number of extra samples resulting in much additional cost and time to observe all movement on the ground. Therefore, the zero cells must be filled with some value.

The in-filling is defined as below:

$$\text{Samples in-filling} = 0.45 \times \frac{\text{Zonal trips value}}{\text{Total trips}}$$

Factor of 0.45 was selected because when the zero trips value multiplies with 0.45, the answer will still be zero. Another reason was when the 0.45 value is rounded to an even number, the value will still be zero. Thus, 0.45 is the best option.

It is necessary to expand the data after cleaning and transposing them in order to make up the total number of trips as per the collected traffic counts. In order to build up a full complete through picture that is representative of all students' population, the questionnaire sample was expanded to full volume counts. This is achieved by computing sample expansion factors for each origin and destination by their respective residence.

The factor is defined as below:

$$\text{Samples expansion factor} = \frac{\text{Total of students' population}}{\text{Survey samples}}$$

4.1.3 Modal Choice

The current population of students in UTP is estimated around 4400 people. However, for the purpose of this study; the questionnaires were distributed to 20% of the student's population which are from Village 1, Village 2, Village 3, Village 4 and Village 5. Since the Old Village 5 will not be included in the future development of UTP, the population there is excluded for this study. Out of all the questionnaires distributed, only 42% of the questionnaires were retrieved back.

When asked on their most preferable mode of transport, most of the students choose walking with 35.5%, 32.2% choose riding motorcycle, 29.6% choose riding a car and the rest 2.6% choose riding bicycle. The result is tabulated in Table 4-2.

Table 4-2: Most preferred mode of transport for UTP students

Mode of Transport	Percentage
Walk	35.5%
Car	32.2%
Motorcycle	29.6%
Bicycle	2.6%

4.1.4 Traffic Assignment

The purpose of running EMME2 software is to determine the trips assigned for each trip generated. EMME2 will automatically determine the route that the trips will take by considering some of the input parameters.

The input parameters are:

i. Distance
ii. Road hierarchy
iii. Number of lane
iv. Volume delay functions (Vdf)

The EMME2 software will forecast the travel demand for two mode of transport, which is car and walking for 2 times horizon; 2005 and 2010. The reason is to get the pattern of travel demand in year 2005 and 2010 and do the comparison between 2010 do nothing (existing condition) and 2010 do something (provided well designed pedestrian facilities).

The parameters of each scenario are:

1. **2005 base year**
    - UTP is not yet fully developed
    - Pedestrian facilities are not 100% provided
    - Pedestrian matrix = 2005 base year matrix.
    - Car matrix = 2005 base year matrix

2. **2010 do nothing (no changes done to facilities)**
    - UTP is assumed to be fully developed
    - Pedestrian facilities are not 100% provided
    - Pedestrian matrix = 2010 matrix.
    - Car matrix = 2010 matrix

3. **2010 do something (improved pedestrian facilities)**
    - UTP is assumed to be fully developed
    - Well-designed pedestrian facilities are provided
    - Pedestrian matrix = 2010 pedestrian matrix + additional shift (car-to-walk)
    - Car matrix = 2010 car matrix - additional shift (car-to-walk)

The increase of walking demand in year 2010 do something will be based on the questionnaires analysis of how many students are willing to change their mode of transport from either car, motorcycle or bicycle to walking if enough and improved pedestrian facilities are provided. Due to the shift, the increase in walking demand will reduce the demand for travelling with vehicle in UTP.

From the survey, total number of students willing to change their mode of transport if well designed pedestrian facilities are provided is 72.6% while the remaining students who do not want to change is 27.3%.

The EMME2 outputs of each scenario for two (2) mode of transport are shown in *Figure 4.5* to *Figure 4.16* whereas more detail outputs can be referred in *Appendix E*.

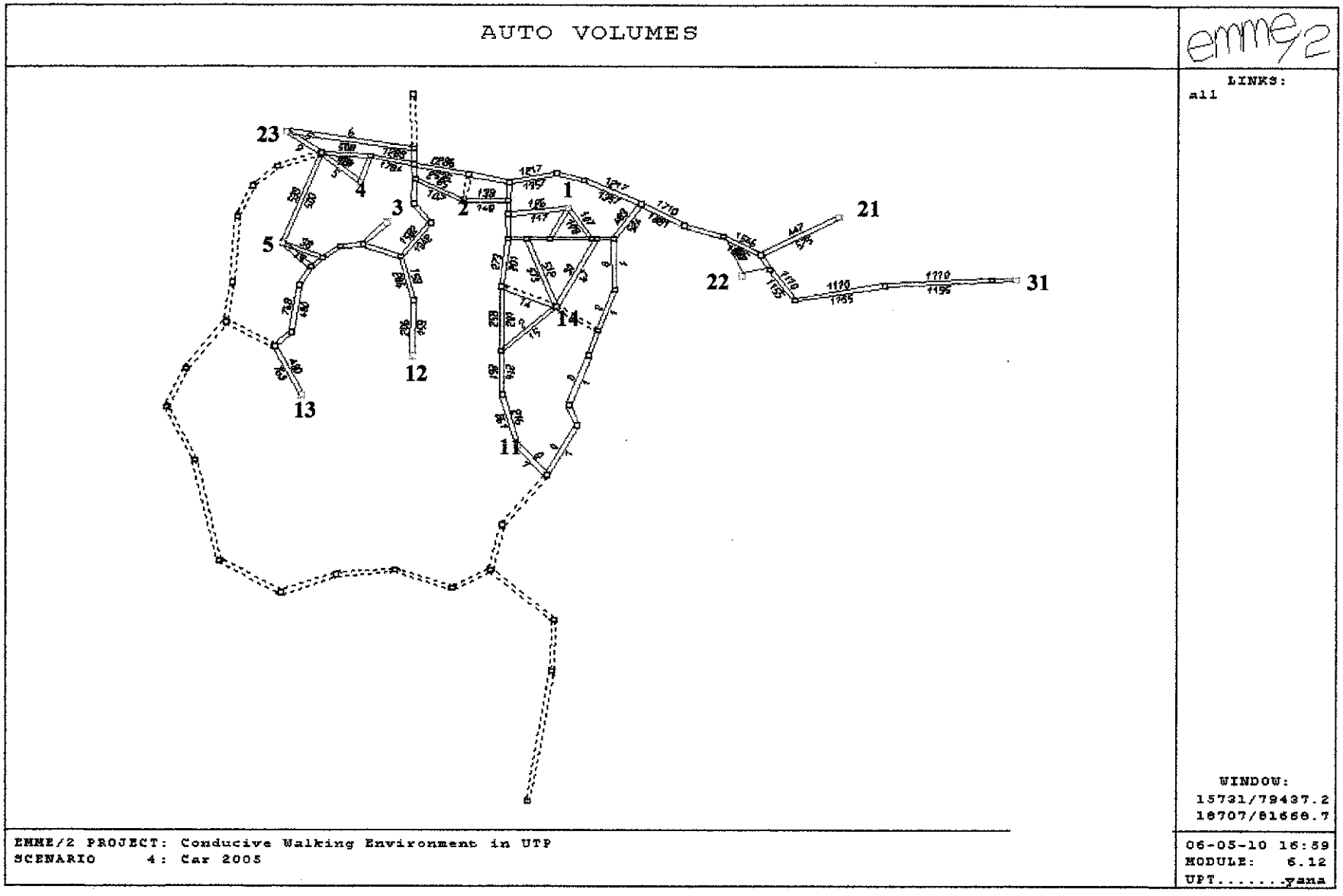

Figure 4-6: Scenario 1 - Car 2005 (base year)

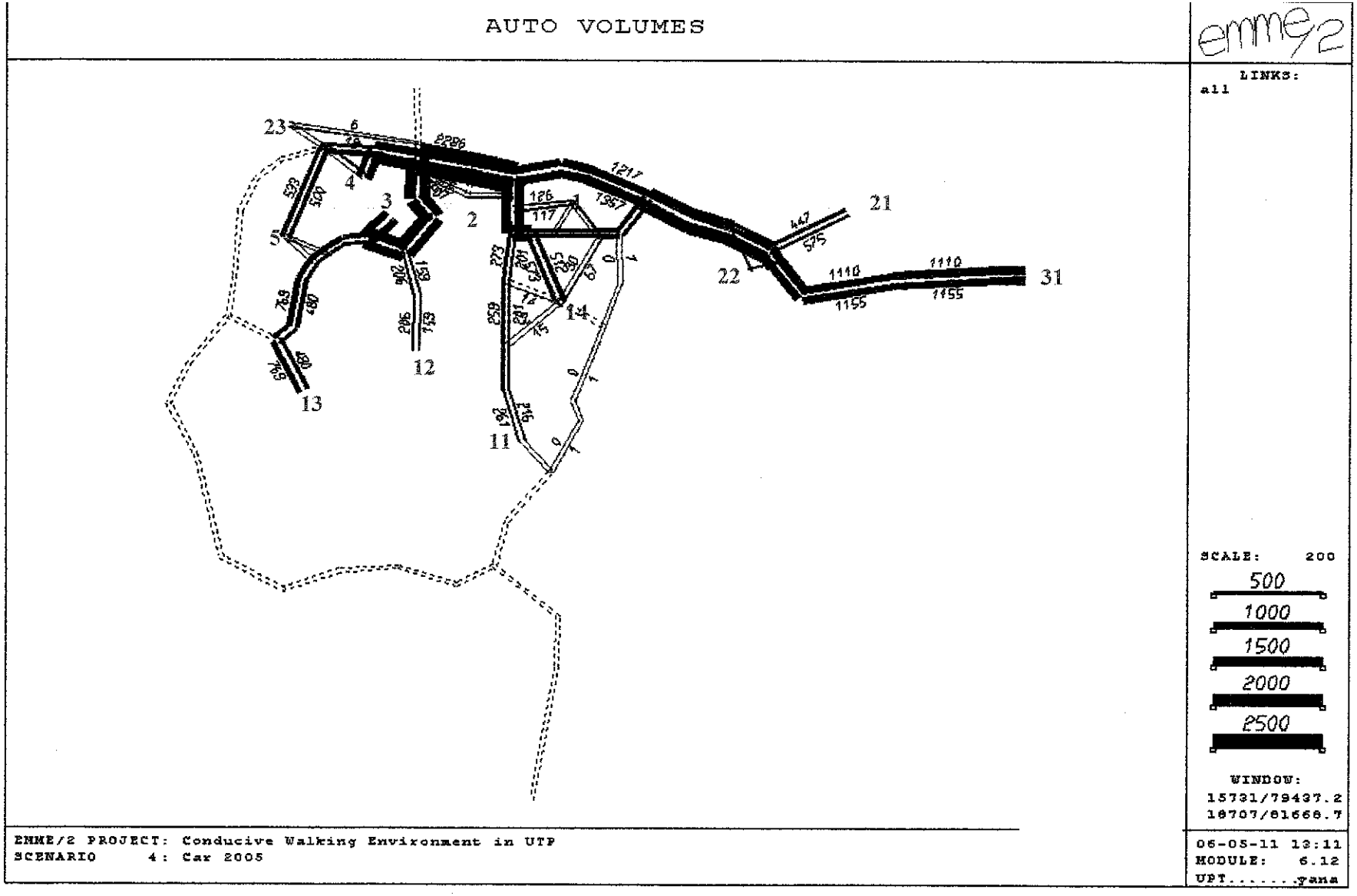

Figure 4-7: Scenario 1 - Car 2005 (base year)

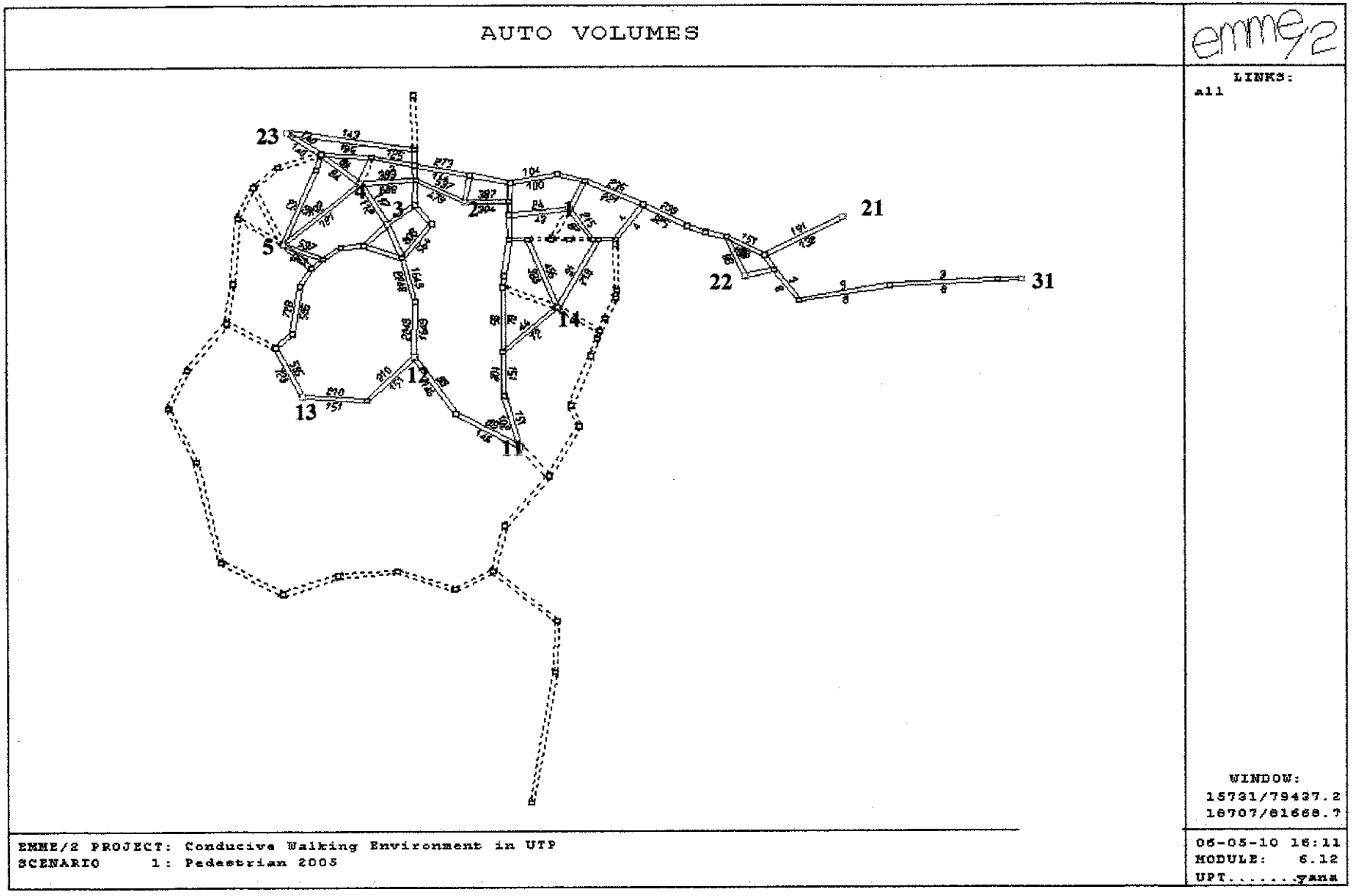

Figure 4-8: Scenario 2 - Pedestrian 2005 (base year)

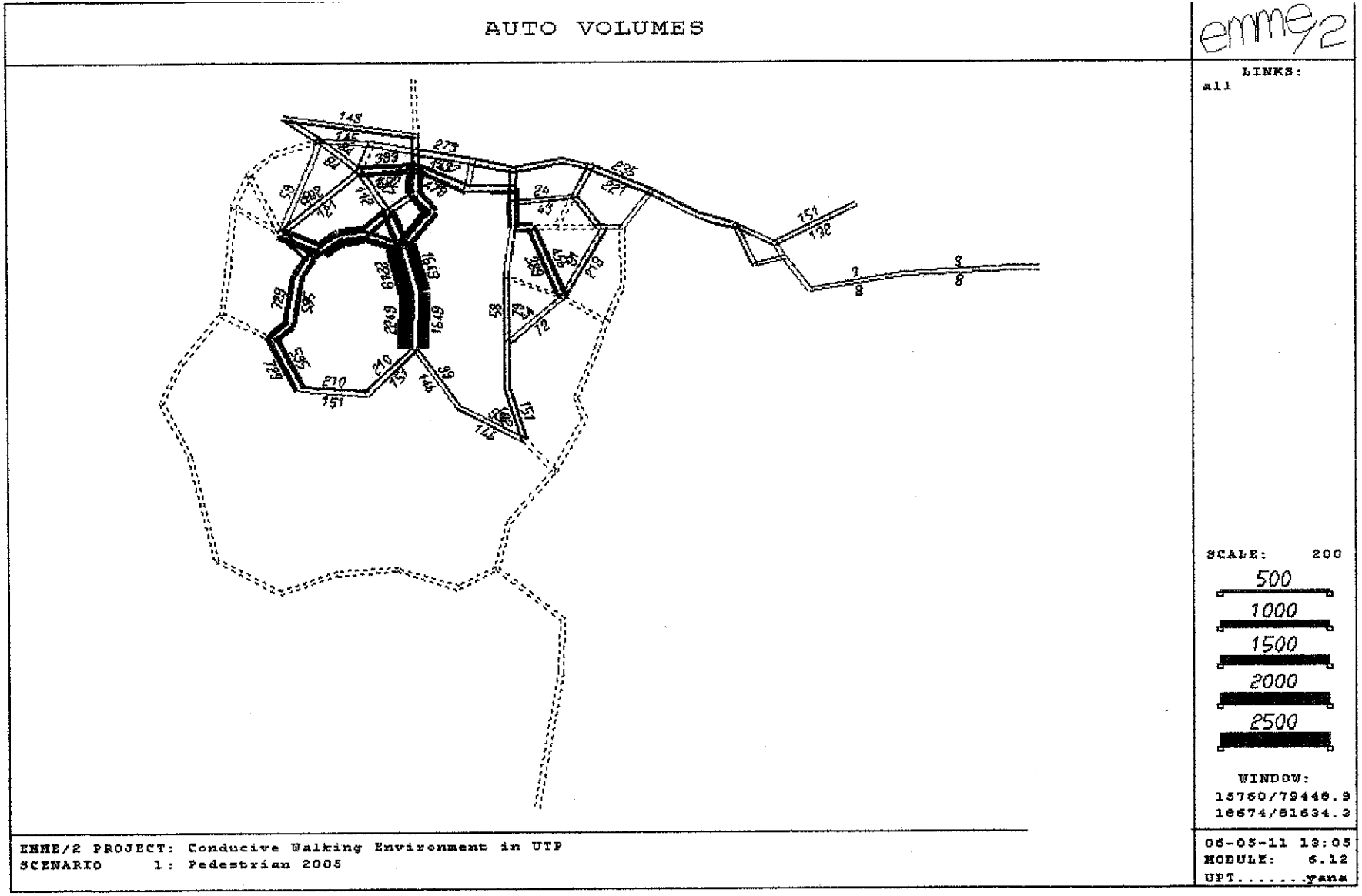

Figure 4-9: Scenario 2 - Pedestrian 2005 (base year)

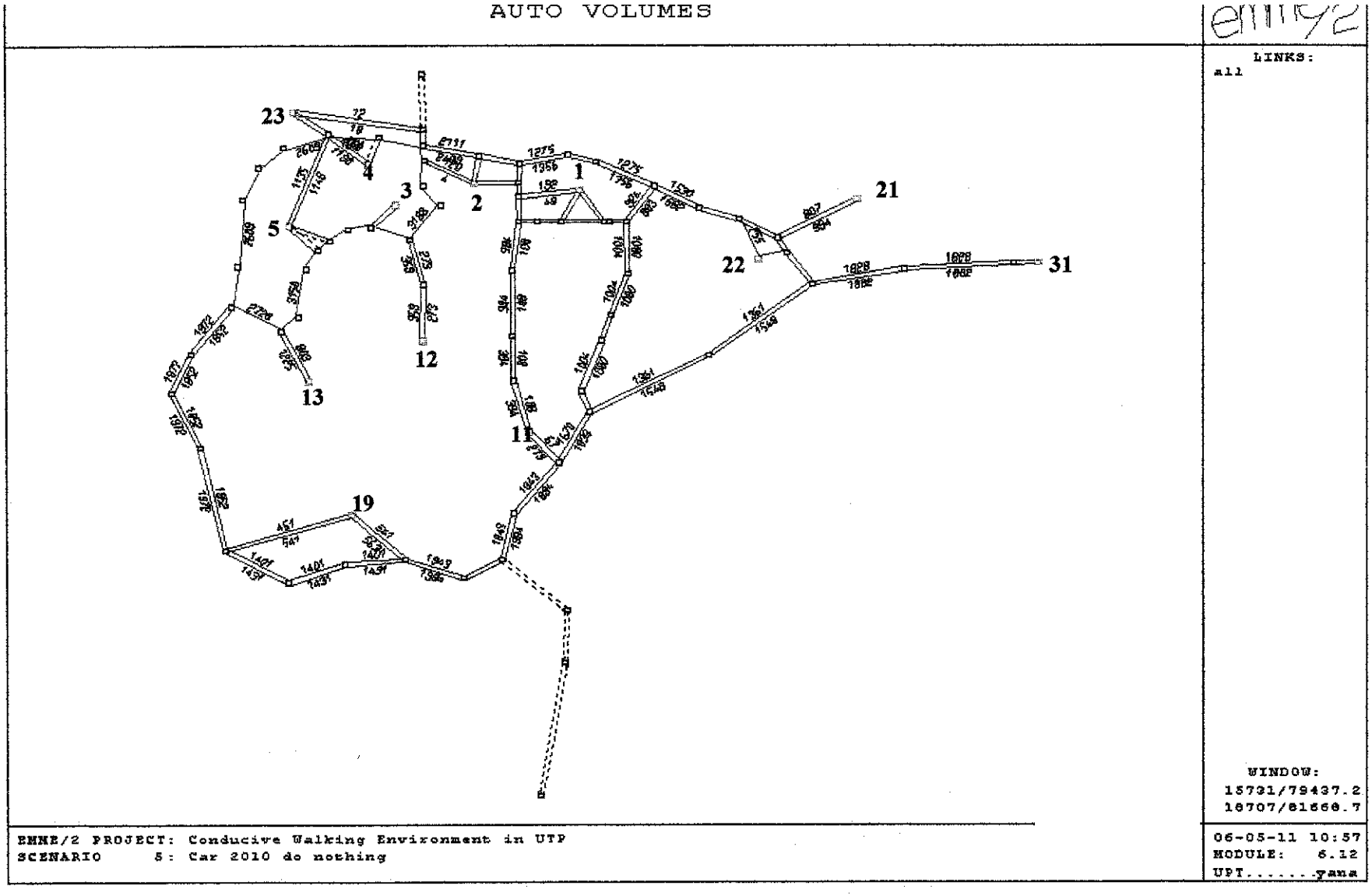

Figure 4-10: Scenario 3 - Car 2010 Do Nothing

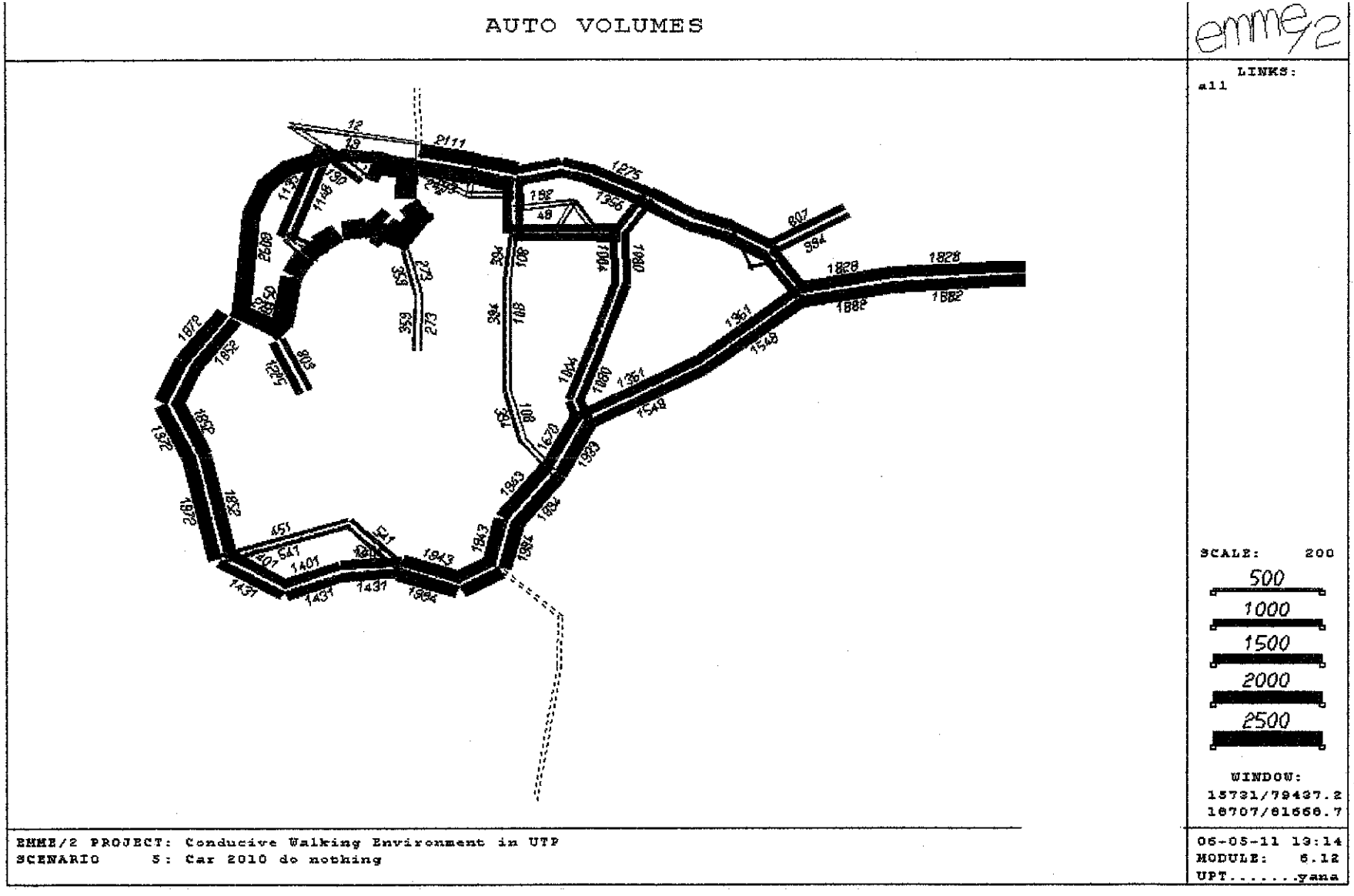

Figure 4-11: Scenario 3 - Car 2010 Do Nothing

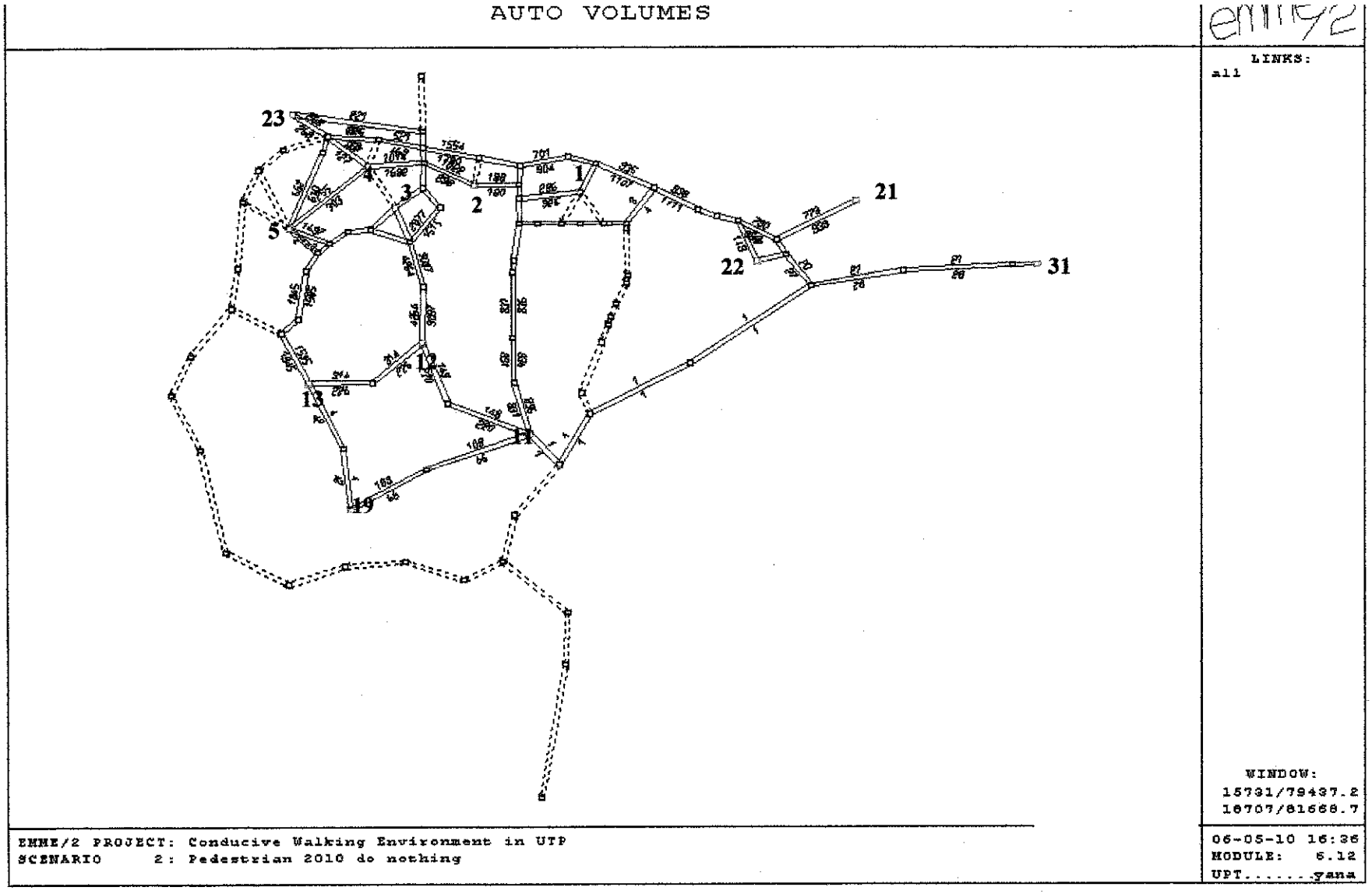

Figure 4-12: Scenario 3 - Pedestrian 2010 Do Nothing

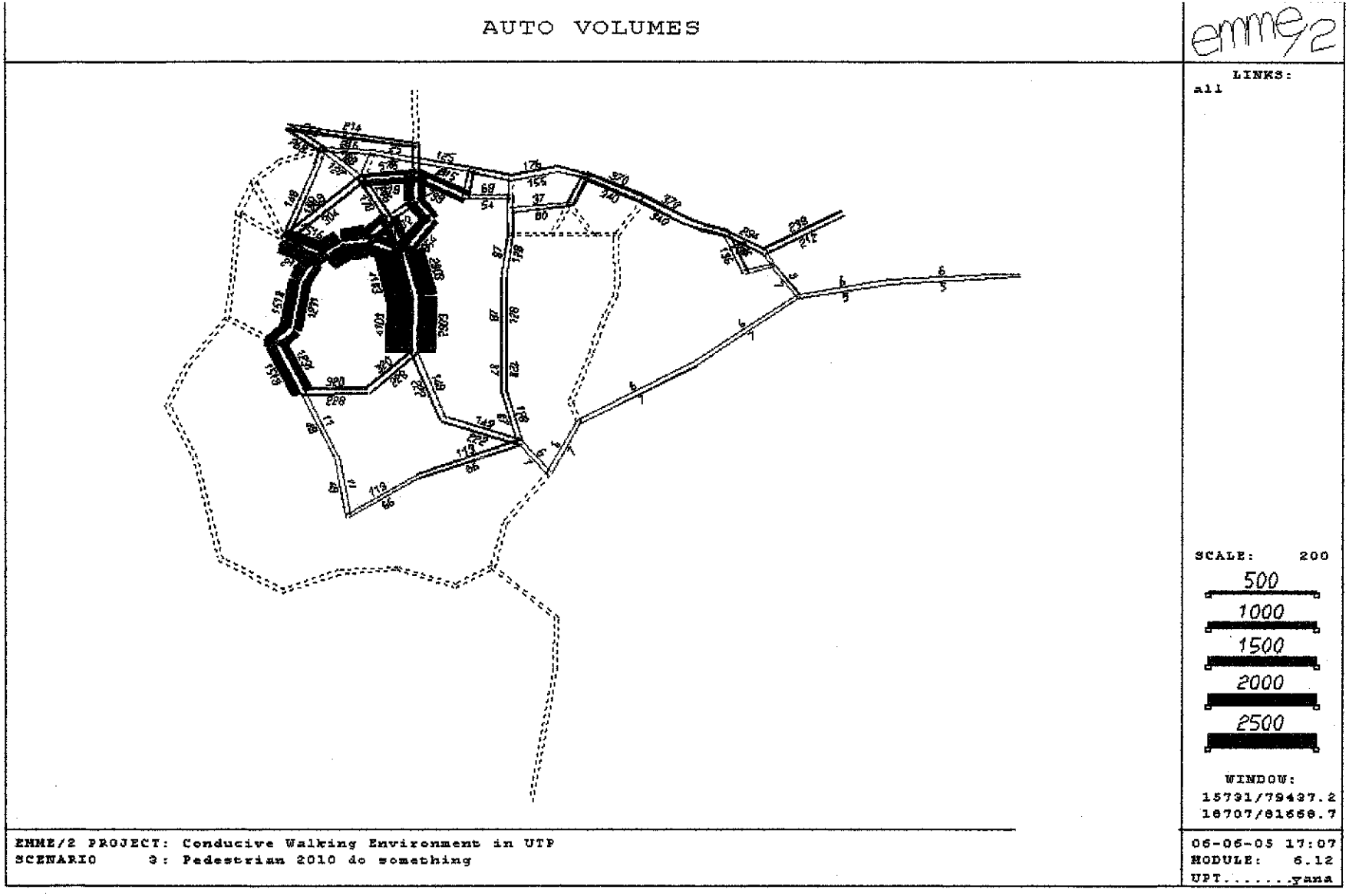

Figure 4-13: Scenario 4 - Pedestrian 2010 Do Nothing

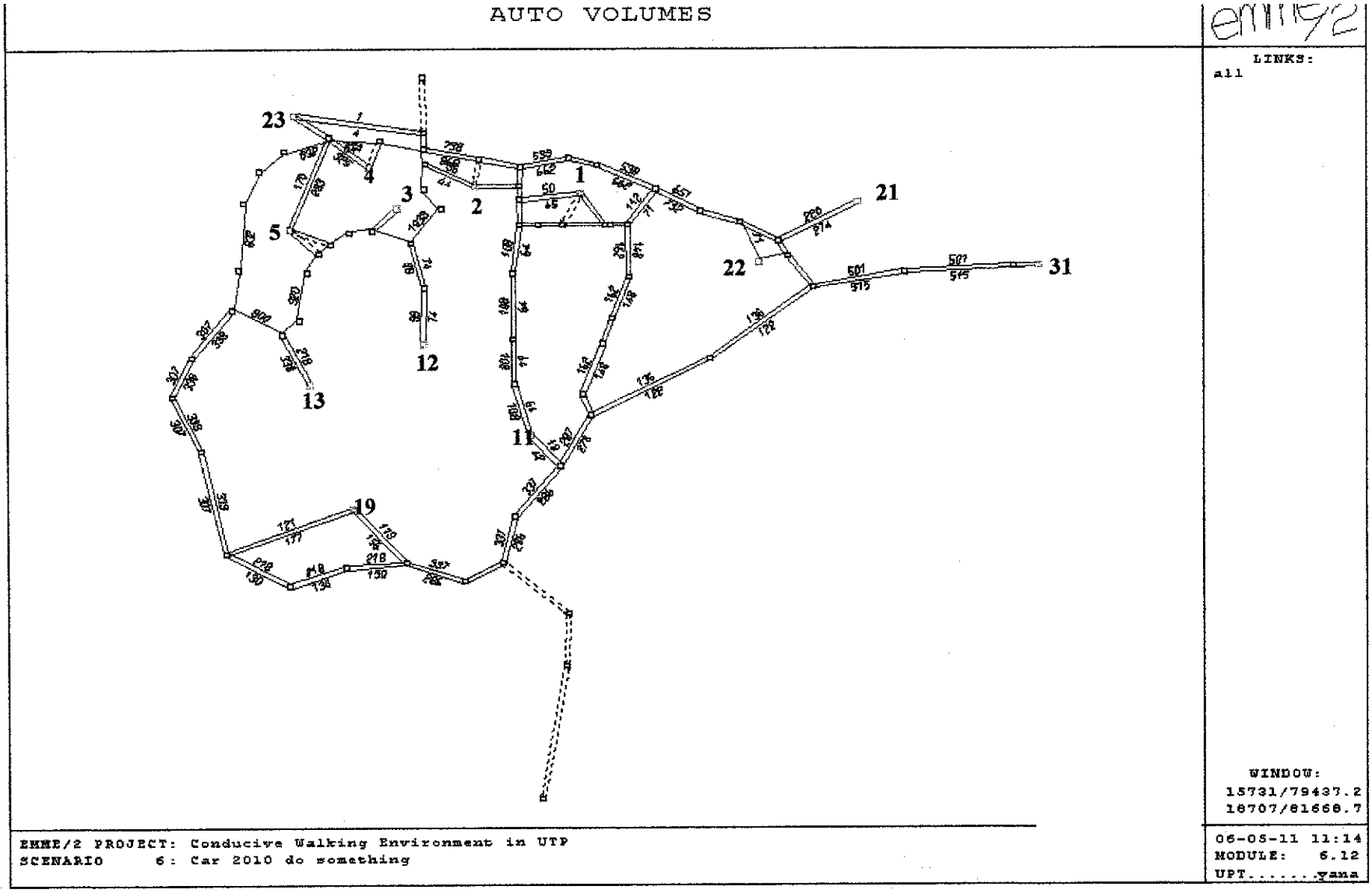

Figure 4-14: Scenario 5 - Car 2010 Do Something

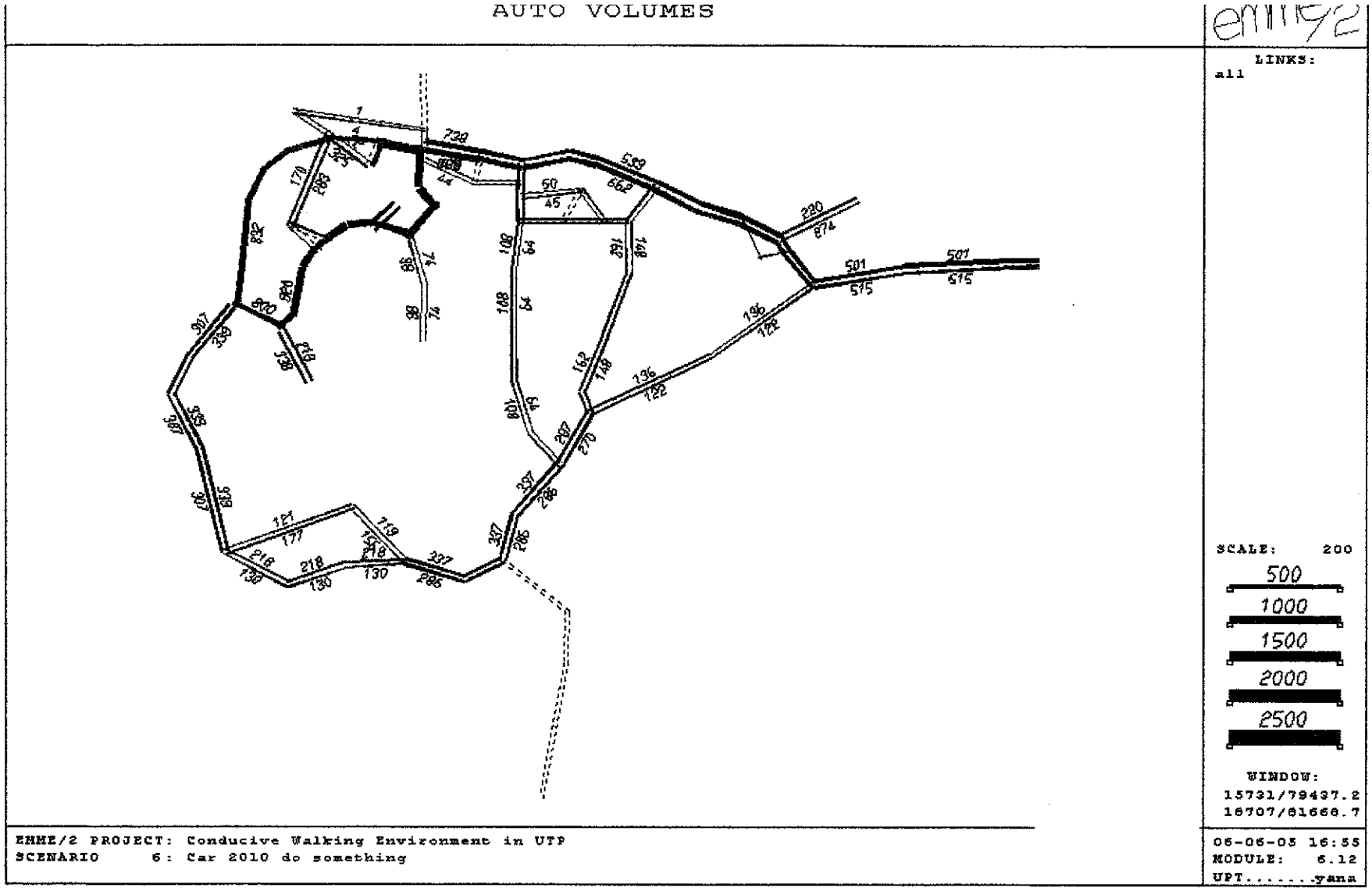

Figure 4-15: Scenario 5 - Car 2010 Do Something

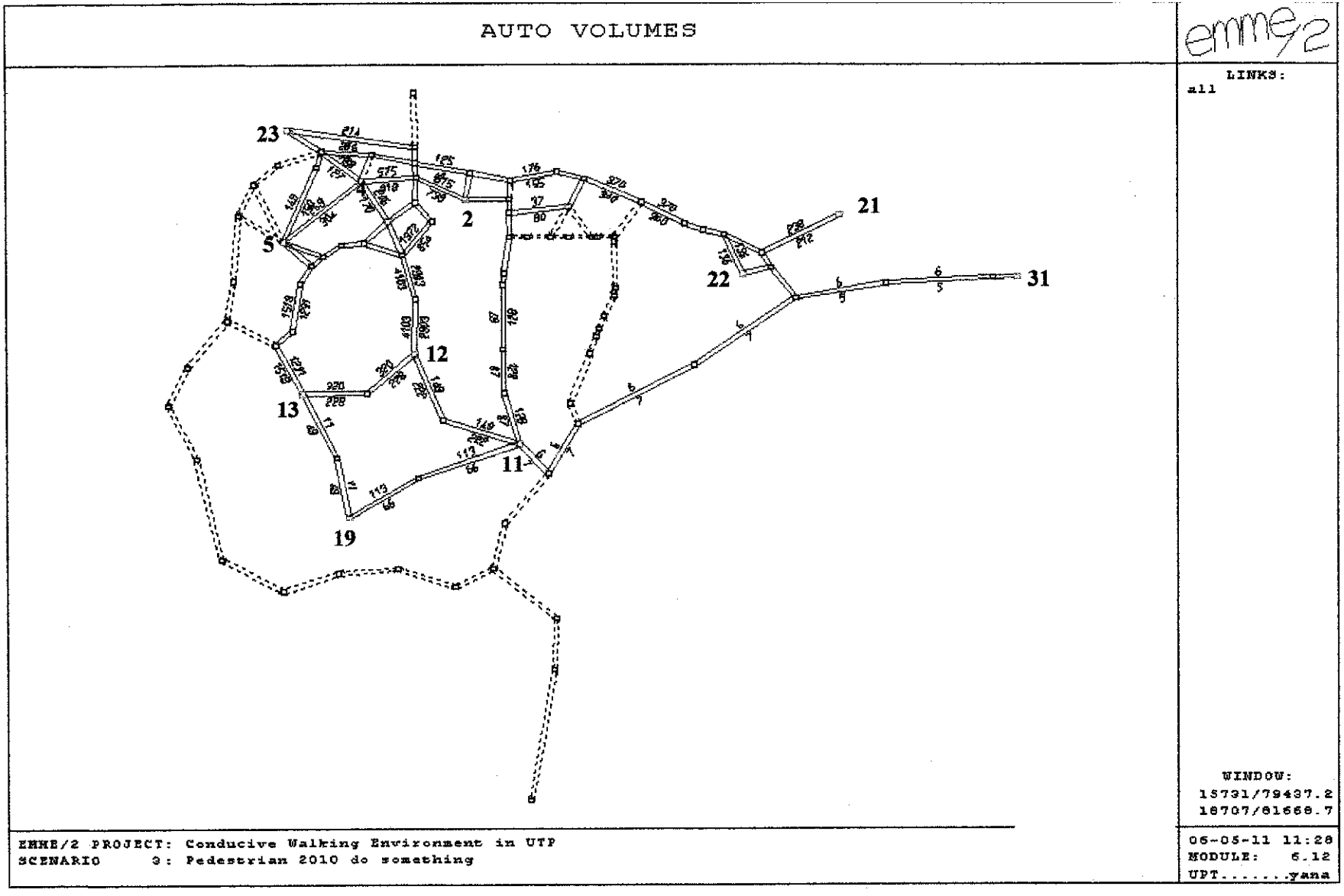

Figure 4-16: Scenario 6 - Pedestrian 2010 Do Something

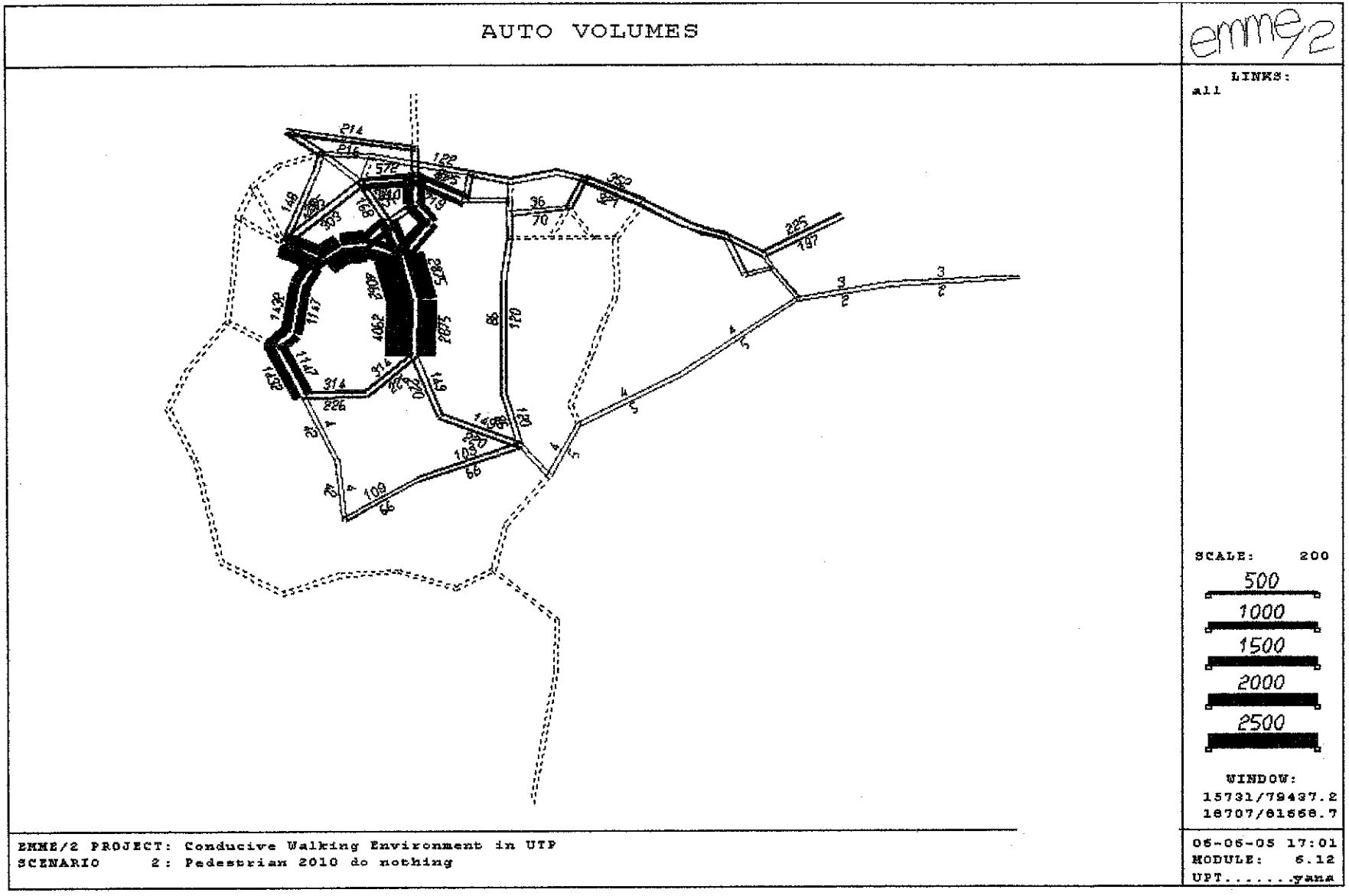

Figure 4-17: Scenario 6 - Pedestrian 2010 Do Something

4.1.5 Scenario Comparison

In base year 2005, which is the current scenario where the pedestrian is available but does not covers all of the area, it is observed from *Figure 4-6* that on typical day; most of the main roads are congested with cars (Zones 31, 1, 2, 3 and 4). While most walking activities occurs from the residential village (Zone 3, 4 and 5) to the Pocket D located at the new campus, Zone 13 (see *Figure 4-17*).

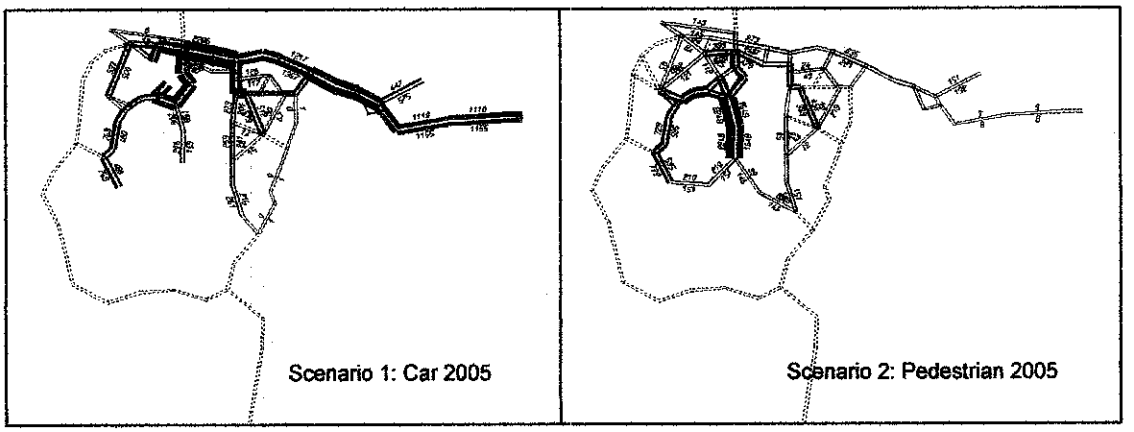

Figure 4-18: Scenario comparison between Car 2005 and Pedestrian 2005

However, in year 2010 when UTP is fully developed and the student population increased with a growth factor 1.5 from 4400 to 6600 but no changes done to the facilities, the volume of cars are very congested mostly at all main roads (*Figure 4-18*). As for pedestrian, the most congested area is between the residential village (Zone 3, 4 and 5) to the new campus as in *Figure 4-13*. In year 2010, the old USM campus (Zone 14) will no longer be used for having classes but the classes is relocated to the new pockets, Pocket A and B (Zone 19).

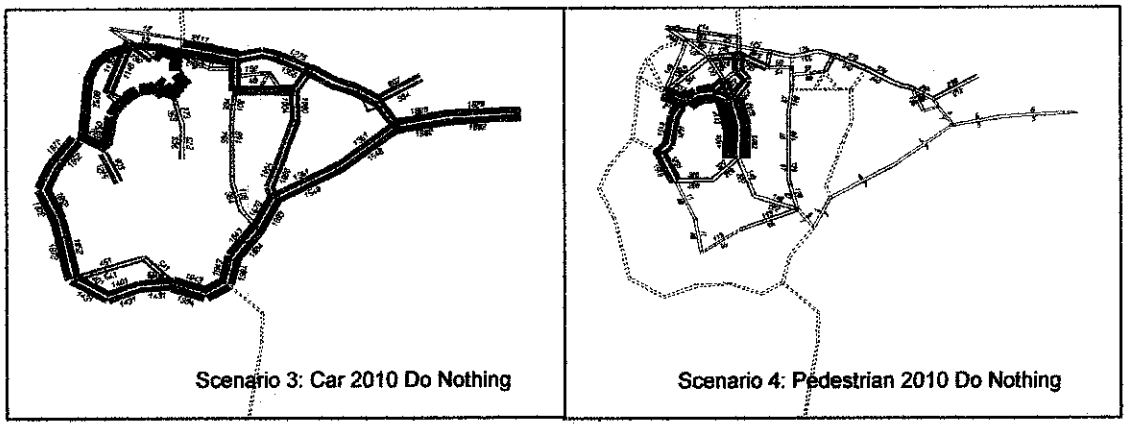

Figure 4-19: Scenario comparison between Car 2010 Do Nothing and Pedestrian 2010 Do Nothing

In contrast, if some improvements done to the facilities, there will be an estimated shift of 72.6% from other mode of transport to walking. 27.4% of the students choose to remain with their current mode of transport. Thus, it can be seen that the overall car network is less congested in *Figure 4-14* compared to the car network in *Figure 4-13*. While *Figure 4-15* shows an increase in pedestrian volume. This justifies that the congestion problem can be solved by making some improvement to the existing facilities in order to attract more students to walk within the campus (see *Figure 4-19*).

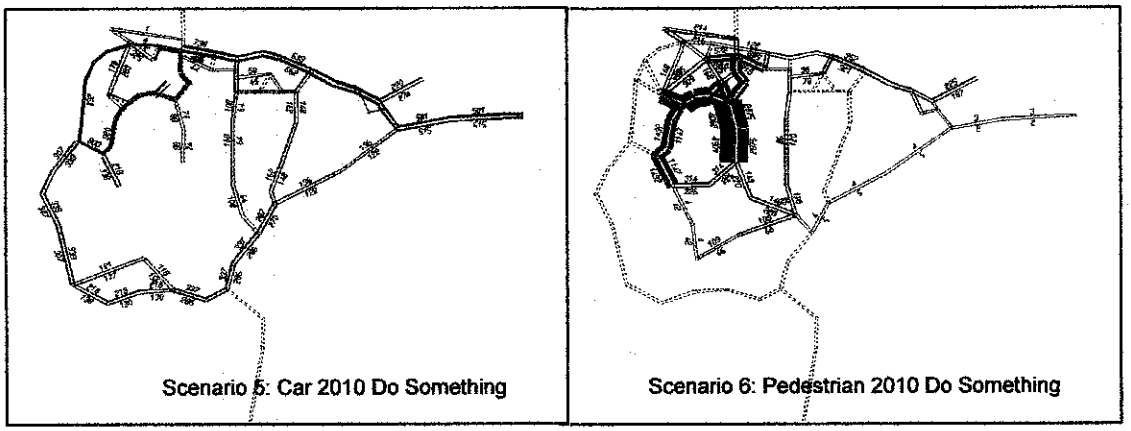

Figure 4-20: Scenario comparison between Car 2010 Do Something and Pedestrian 2010 Do Something

4.2 DISCUSSION

4.2.1 Problems and Issues

4.2.1.1 Existing pedestrian facilities in UTP

During the reconnaissance survey, few problems have been identified on the existing pedestrian facilities. For instance, the walkway near Village 3 (*Plate 4.1*) is currently damaged. The surface is aesthetically nice, however when it rains, the water will fill the void between the surface blocks.

Below are some of the problems identified:

i. Improper surface (*Plate 4-1* and *Plate 4-2*)
ii. Improper sidewalk provision (*Plate 4-3*)
iii. Discontinuity in walking route (*Plate 4-4* and *Plate 4-5*)

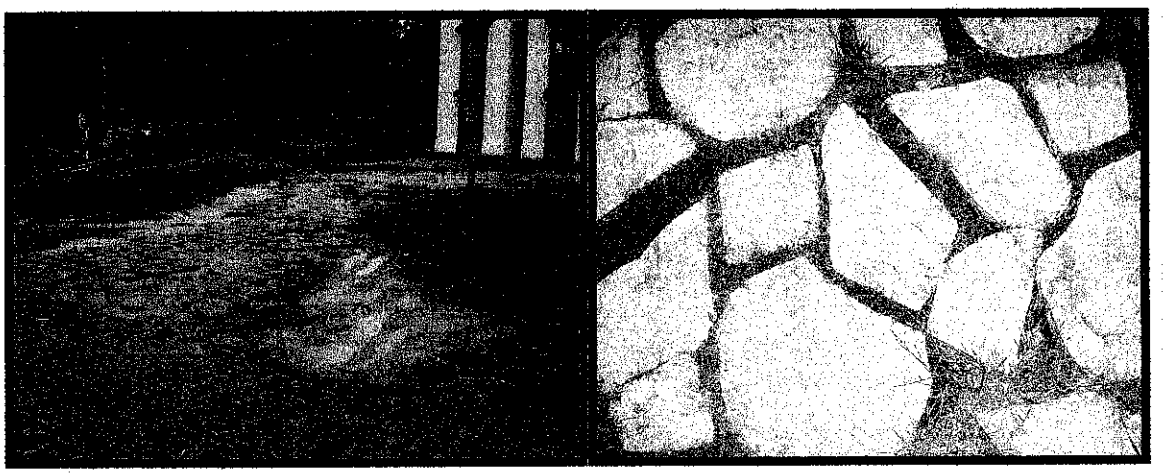

Plate 4-1: Improper surface for pedestrian near Village 3

Plate 4-2: Improper surface at the New Campus blocks

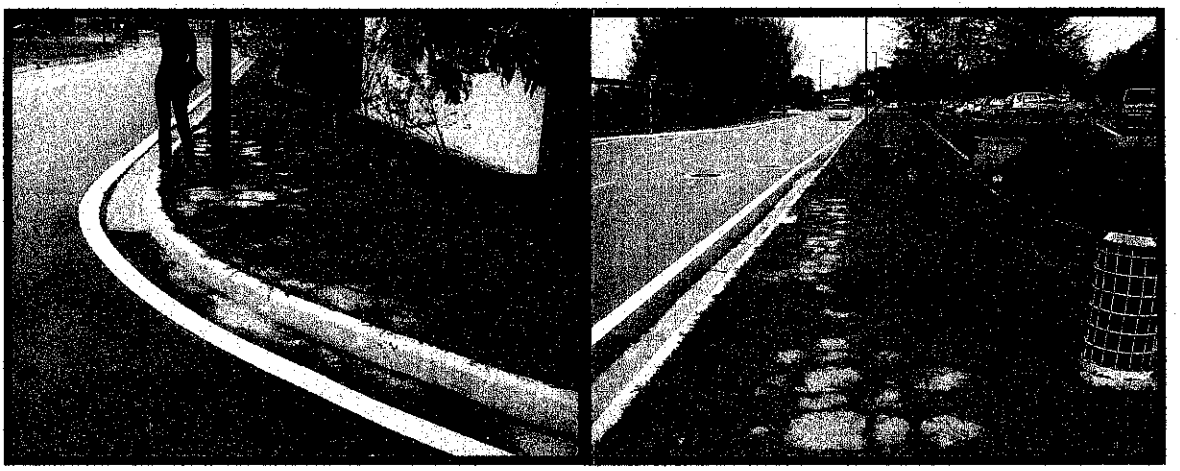

Plate 4-3: Sidewalk along the road from Village 2 to Village 4 which is not properly provided.

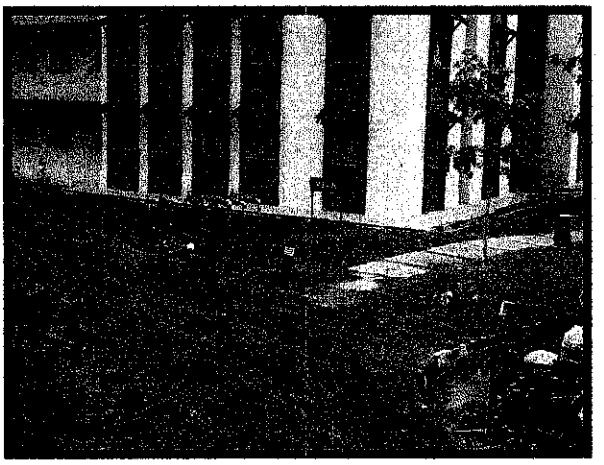

Plate 4-4: Discontinuity of walkway near Village 3.

Plate 4-5: Discontinuity of pedestrian route at the New Campus blocks.

4.2.1.2 Environmental Factor

Apart from the problems with existing facilities, environmental factor also contributes to students' modal choice. For example, when they walk to class at the new campus, they need to face hot sun. Plate 4-6 justified the problem where there is some students use their book as protection against the hot sun.

Plate 4-6: Environmental factor also contributes to modal choice

On top of that, during heavy rains there is no covered walkway to protect them.

4.2.2 Modal Choice

Plate 4-7: Some students still prefer to walk rather than riding vehicles

From the questionnaire, the students gave many reasons on their choice of preferred mode of transport. The reasons why they prefer to ride a vehicle than walking are summarized as follows:

i. It is more comfortable
ii. It saves time
iii. Hot weather in UTP
iv. The distance of one place to another is rather far
v. Car can accommodate many people (4-5 persons per car)
vi. It is more convenient during bad weather
vii. They might get tired and sweating if walking

However, even though most of them prefer to ride vehicle for travelling in UTP, there are still students who preferred walking as the most (*Plate 4-7*). Their reasons are:

i. Walking is very cheap and saves a lot of money, besides promoting a healthy lifestyle.
ii. It is easier and more convenient to travel by walk than other mode of transport as they do not need to worry about the parking.
iii. Poorly located parking lots discouraged them to bring their vehicles.
iv. They do not own a vehicle.
v. Most of the places are in walking distance, as UTP is not that very big

vi. Low maintenance

vii. They enjoy the environment

viii. Insufficient budget

ix. Cars is not allowed in new campus for students

4.2.3 Solution

4.2.3.1 Pedestrianisation

In order to increase the level of walking in UTP, a pedestrianisation can also be implemented in UTP. For example, the usage of cars are only limited until the Main Hall and then from there, they will need to ride a bus to the residential village or to the new campus. With such implementation, the number of vehicles in UTP can also be controlled. Details on pedestrianisation can be found in section 2.6.

4.2.3.2 Improved Pedestrian Facilities

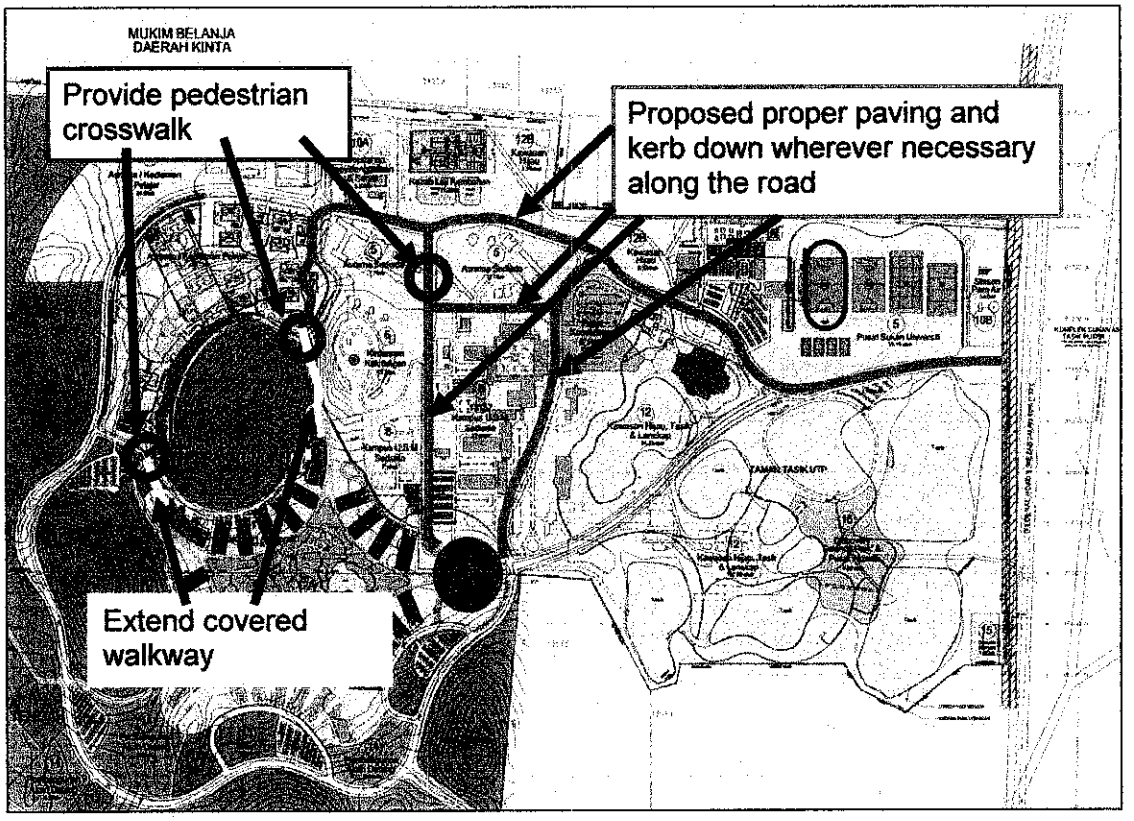

Figure 4-21: Proposed improvements on existing pedestrian facilities

As shown in *Figure 4-20*, few improvements were proposed to be made to the existing pedestrian facilities. Three (3) pedestrian crosswalks are proposed at three (3) different locations that are from Village 1 to Village 2, from Village 3 to Pocket D and from the end of the crosswalk at Village 5 to Pocket C. Meanwhile, covered walkways are proposed from the residential area to the New Campus. The proposed covered walkway is located from Village 3 to Pocket D and the existing covered walkway at Village 5 is extended to Pocket C. Finally, proper paving and kerb down are proposed wherever necessary along the entire road network.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Providing better pedestrian facilities and a more welcoming environment for pedestrians appears to increase the willingness to walk. If improvements made to current existing facilities, more students will shift their current mode of transport to walking.

From the questionnaire, it was found out that students preferred to walk as the most. However, due to some limitations such as lack of pedestrian facilities, they prefer to ride vehicles to travel within UTP. Well designed facilities will attract students to walk since they feel safe. With the shifts of students from motorized vehicle to walking, the congestion in UTPs' route will be minimized.

In addition, no students' vehicles are allowed in the New Campus. Thus, by providing proper and better pedestrian facilities from their residential village to the New Campus, they will be protected from the environmental factor especially from the hot sun and rain.

5.2 RECOMMENDATIONS

5.2.1 Level of Service

The Level of Service (LOS) of pedestrian is not covered in this study. Thus, if further study were to conduct, it should also expand the study on LOS of pedestrian in UTP. In addition, Pedestrian Safety Index (PSI) which provides a measure of the pedestrian's perceived level of comfort and safety on a particular road link [14].

The PSI is based purely on mathematical formula that takes into account various aspects of the pedestrian environment and adjacent road characteristics. The PSI formula is as follows:

$$PSI = -1.2021\ ln(W_t + f_p\%OSP + f_b w_b + f_{sw} W_{sw}) + 0.23\ ln(V_{15}/L) + 0.0005V^2 + 5.3876$$

Where:

W_b, W_t, W_{sw}	=	width of buffer, total road and sidewalk
V_{15}	=	peak 15 minute traffic volume
f_b, f_p, f_{sw}	=	buffer area, parking and sidewalk
%OSP	=	percent on-street parking
V	=	average running speed of vehicles
L	=	total number of through lanes

The pedestrian level of service model is used, without modification, to measure the perceived comfort and safety of current conditions, with or without existing sidewalk facilities. The significant advantage of PSI formulation is that it provides a purely quantitative means of comparing roadways for pedestrian comfort and safety, and prioritizing pedestrian improvements.

Calculated PSI values range from 1 to 5.5 and are reported on Level of Service basis (A through F), as shown in Table 5.1.

Table 5-1: Level of Service Scale for PSI

Level of Service	Calculated PSI Value
A	≤ 1.5
B	> 15.and ≤ 2.5
C	>2.5 and ≤ 3.5
D	>3.5 and ≤ 4.5
E	>4.5 and ≤ 5.5
F	>5.5

5.2.2 Detail Design

The detail design of the pedestrian facilities can also be covered for further studies on this project. More research can be done on the facilities design such as the material to be used for the pavement, the type of trees to be planted to shade the users and also the street furniture.

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10. *"Pedestrian Facility Design Guide"*, The National Center for Bicycling & Walking (NCBW) available at http://www.bikewalk.org/walking/pedestrian_design_guide_intro.htm
11. http://www.inro.ca/en/products/emme2/e2fea.pdf
12. *Highway Capacity Manual 2000*, Transportation Research Board, National Research Council, Washington D.C

13. *Pn. Norma Nun*, Transport Modeller, Road and Highway Department; Jurutera Perunding Zaaba Sdn. Bhd., nunnorma@yahoo.co.uk
14. "Kamloops Pedestrian Master Plan", 2002, ICBC

Appendix A:

Sidewalks and Walkways Design Guideline

Summary Capital Facility Development Guidance

NOTE - For more detail, including design and safety specifications, the following two documents are excellent resources and are recommended for site-specific facility location planning and specific design applications:

- *The Guide for the Development of Bicycle Facilities* (AASHTO, 1999) and
- *Pedestrian Facilities Guidebook* (Washington State Department of Transportation, 1997)

The cities, towns, counties and other jurisdictions within the central Puget Sound Region should refer to the following guidelines when planning new bicycle and pedestrian infrastructure and programs. Doing so would ensure that an integrated, seamless regional bicycle and pedestrian system is created that serves the needs of the greatest number of people and facilitates the greatest possible growth in biking and walking in the future.

Types of Bicycle and Pedestrian Facilities

Consistent with the above noted *Guide for the Development of Bicycle Facilities* (AASHTO, 1999), there are five general types of bicycle and pedestrian transportation facilities, each with varying character and/or levels of separation from adjacent roadways:

- **Shared use paths** are facilities physically separated from motorized vehicular traffic by an open space or barrier and are either within the highway right-of-way or within an independent right-of-way. Shared use paths may be used by bicyclists, pedestrians, skaters, wheelchair users, joggers and other non-motorized users.
- **Bike lanes** are portions of roadways that have been designated by striping, signing and pavement markings for the preferential or exclusive use of bicyclists.
- **Signed shared roadways (bike routes)** are shared roadways that have been designated by signing as preferred routes for bicycle use.
- **Shared roadways** are roadways that are open to both bicycle and motor vehicle travel. They may be existing roadways, streets with wide curb lanes, or roads with paved shoulders.
- **Walkways** are pedestrian facilities that can be either separated from roadways, such as sidewalks and paths, or part of roadways, such as crosswalks or wide shoulders.

In addition to the above types of on and off-street linear transportation facilities, a broad variety of complementary facilities exist that further support effective and convenient pedestrian and bicycle travel. These include but are not limited to: bike lockers, bike racks, showers/dressing rooms, bike/pedestrian bridges, lighting, landscaping, curbcuts, medians, pedestrian refuge islands, curb ramps, benches, drinking fountains, restrooms and signage.

Choosing what type of facility to put where depends on a multitude of factors and considerations, including the destination to be served, existing infrastructure, right-of-way issues, and many more. This document gives summary guidance to assist in getting started in planning for the general locations and types of bicycle and pedestrian facilities that might be desired for inclusion in a community or jurisdiction's transportation plan element. For more specific details about locating a given type of facility, including design and safety specifications, *The Guide for the Development of Bicycle Facilities* (AASHTO, 1999) and the *Pedestrian Facilities Guidebook* (Washington State Department of Transportation, 1997) should be used for reference.

Type of Place--Geographic Classifications

For regional planning purposes, categories of types of places in the region were defined. These classifications are referenced in this Implementation Strategy, *Destination 2030,* and other local planning documents. Our region includes the following categories of places:

Designated Urban Centers. The central Puget Sound Region has 21 formally designated urban centers. Urban centers are places that contain a mix of business, commercial, residential and cultural activity within a compact area. VISION 2020, *Destination 2030,* and the region's local growth management plans envision urban centers in revitalized downtown districts, as well as in emerging suburban hubs. These are places where walking, bicycling and transit use, as well as automobile access, are viable transportation options

Activity Areas. There are hundreds of activity areas around the region. These are places that, although they are not classified as an urban center, have higher than average levels of density. Activity areas are characterized by a nucleus of commercial, retail, recreational and residential uses and often are the commercial core for the surrounding community.

Regional Transit Stations. A regional transit station can be a rail station (light rail, commuter rail or passenger rail), a ferry terminal, or a bus transit center where a variety of

regional bus routes converge. The area around regional transit stations is often targeted for high levels of mixed-use development that includes both commercial and residential uses. Such developments are called "transit-oriented developments" or TODs.

Park-and-Rides. These are parking lots where several regional bus routes converge. They are usually located in suburban locations. They provide parking so that people can drive in, park their car, and transfer to the bus. They often contain amenities such as rider services and information, sheltered areas and restrooms. A regionally significant park-and-ride is defined as having at least 250 spaces.

Transit Routes. A transit route is any street that accommodates fixed-route bus service.

Facility Development Guidance

Shared use Paths, Bike Lanes and Bike Routes. An interconnected system of bike lanes, shared use paths and bike routes is an integral piece of our region's transportation network. Paths, bike lanes and bike routes should be built in the following areas first to achieve maximum use:

- On all new or reconstructed roadways and bridges, except where prohibited by law
- Within designated urban centers, activity areas and regional transit station areas
- Within a two-mile radius (a ten-minute bike ride) of urban centers, activity areas, regional transit stations, regional park-and-rides, large parks and other recreational destinations, and colleges and universities. Paths, lanes and routes should be linked into a network and directly connect to the destination they are intended to serve.

Sidewalks and Walkways. A recent study completed by the University of Washington confirmed that higher numbers of pedestrians are found in areas where more complete and continuous sidewalks, walkways, crossings and other facilities exist. Sidewalks vary in width. In general, the width of a sidewalk or walkway needs to comfortably accommodate the volume of pedestrians normally using it. The *Pedestrian Facilities Guidebook* (WSDOT, 1997) should be referenced for design guidance on this issue. Sidewalks and/or walkways should be located in the following areas:

- All new or rehabilitated roadways and bridges, except where prohibited by law

- Both sides of the street within urban centers and activity areas
- Both sides of the street within a half-mile radius (ten-minute walk) of urban centers, activity areas, regional transit stations, regional park-and-rides, major parks and other recreational destinations, and colleges and universities
- Both sides of arterial roads with transit routes
- Both sides of all streets within a quarter-mile radius (five-minute walk) of bus stops
- Both sides of streets within a quarter-mile radius of elementary, middle and high schools
- All areas of new development and redevelopment

Crosswalks and Crossing Signals. A healthy walking environment includes many more features besides just sidewalks and walkways. Studies show that pedestrians will not travel more than roughly two minutes out of their way in order to cross the street. If forced to do so, they will likely abandon the walking trip all together the next time. Consequently, ample opportunities to safely cross the street should be provided at the following locations:

- Every major intersection and/or every two blocks within urban centers and activity areas
- Every major intersection and/or every two blocks within a ½ mile radius of urban centers, activity areas, regional transit stations, regional park-and-rides, major parks and other recreational destinations, and colleges and universities
- At every major intersection and/or every two blocks within a ¼ mile radius of transit routes
- At every major intersection and/or every two blocks within a ¼ mile radius of elementary, middle and high schools

Bike Parking and Storage. Secure bike parking and storage are necessary to accommodate bicycle travel. If there is the risk of one's bike being stolen or damaged, many cyclists will simply choose not to ride. Bike racks should be provided in the following locations:

- Every block within urban centers and activity areas.
- At every regional transit station and park-and-ride
- At all schools, colleges and universities
- At large retail stores and malls

At regional transit stations, people often leave their bikes unattended for many hours at a time, including overnight. Because of this, it is recommended that bicycle lockers be provided at all regional transit stations in addition to regular bike racks. When bicycle racks are

provided at regional transit stations in lieu of lockers, they should be covered or sheltered from inclement weather. It is also desirable to supply bike lockers at other locations with high demand, such as regionally significant park-and-rides, regional shopping centers, and colleges and universities.

Street Furniture and Support Facilities. Facilities such as benches, water fountains, restrooms and garbage receptacles should be provided in ample supply where there are high levels of pedestrians and bicyclists. In addition to parks and public plazas, street furniture should be provided within urban centers, regional transit station areas, activity areas, major park-and-rides, and at bus stops. Good lighting should be provided at every transit stop, within urban centers, at regional transit stations, park-and-rides, commercial districts and common attractions. Transit stops on arterials, major bus routes or at busy intersections should also include shelters and benches in addition to lighting, offering riders a safe, comfortable and protected place to wait for the bus. Shelters and benches should be provided at as many transit stops as possible. Street furniture, lighting and other amenities should not be overlooked. They are great enhancers to the pedestrian environment and can encourage more walking trips in the future.

Traffic Calming. Fast vehicle speeds are one of the biggest deterrents to cycling and walking. They compromise neighborhood livability by creating noise, air, and water pollution, and jeopardize the safety of pedestrians and cyclists. Traffic calming reduces and manages traffic speeds and volumes on streets to make them safer for pedestrians and bicyclists, and is one of the most effective ways to create pedestrian and bicycle-friendly streets. Traffic calming techniques should be considered in the following locations, especially if current vehicle speeds are incompatible with travel:

- On streets with high levels of biking and walking in urban centers, regional transit station areas and activity areas
- Around schools and bus stops
- Along transit routes
- In the immediate vicinity of parks and other recreational facilities
- On residential streets where speeding is a problem
- Other areas where pedestrian activity is being promoted

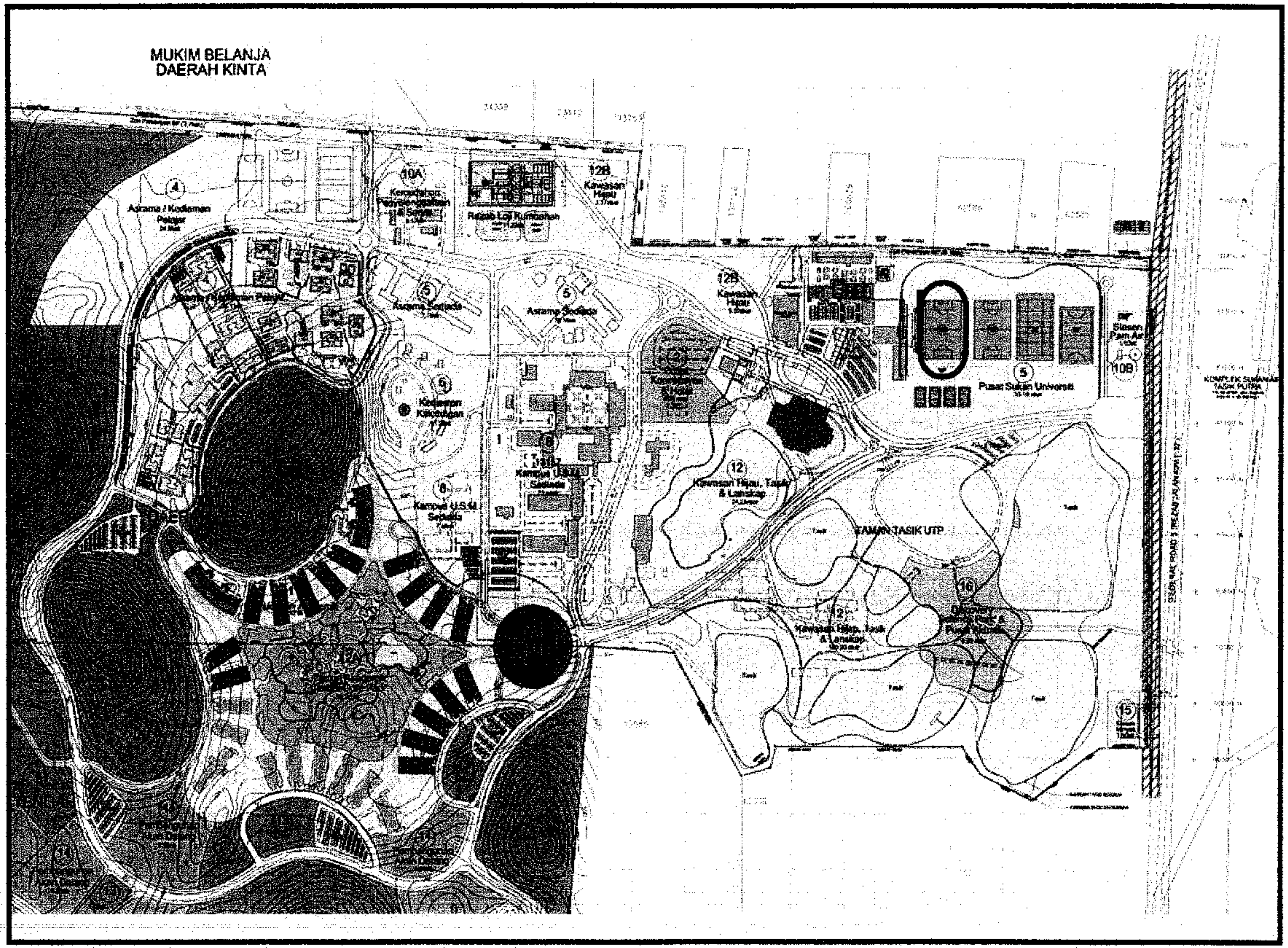
Some commonly used traffic calming methods include: medians, pedestrian refuge islands, narrow streets, curb bulb-outs, chicanes, landscaping, raised intersections and crosswalks,

speed bumps, traffic circles, roundabouts, and striped outside lanes for auto parking or designated bicycle use. There's an abundance of reference material on the topic, but two good sources to start with are *A Guidebook for Residential Traffic Management* available through the Washington State Department of Transportation and the City of Portland's Traffic Calming website at www.trans.ci.portland.or.us/Trafficcalming/.

Wayfinding and Signage. Signs, route markers and maps are important to guide pedestrians and cyclists to common destinations and safe routes. Countries around the world with the largest bicycle and pedestrian populations, such as The Netherlands and Belgium, regularly employ this technique with great success. In the Puget Sound region, designated bike and walking routes should be signed, making them easily recognizable. Common destinations such as tourist attractions, universities and colleges, and retail districts should also be signed to guide pedestrians and bicyclists. In addition, maps depicting bicycle and pedestrian routes should be produced, regularly updated, and provided to the public

Appendix B:

UTP Development Plan


MUKIM BELANJA
DAERAH KINTA
Asrama / Kediaman Pelajar
10A
12B
Kawasan Hijau
Rawatan Loji Kumbahan
Asrama Sedia Ada
Kampus U.S.M. Sedia Ada
12
Kawasan Hijau, Tasik & Lanskap
TAMAN TASIK UTP
16
Pusat Sukan Universiti
Stesen Pam Air
10B
15

Appendix C:

Questionnaire Form

UTP Traffic Circulation Study (FOR FYP)

Year: **Block:**

Fill in the survey table based on your typical day for all purposes (e.g.: to class, to meal, to sport, to bank)

Note:
1. Please fill in the table according to your normal routine, **neglect the Ramadhan.**
2. If you went to the sport complex in the evening or going out for supper at night, please note too.

Time		Purpose	Origin (from where)	Destination	Mode of Transport (eg: walk,car,bicycle)
from	to				
0600	0700				
0700	0800				
0800	0900				
0900	1000				
1000	1100				
1100	1200				
1200	1300				
1300	1400				
1400	1500				
1500	1600				
1600	1700				
1700	1800				
1800	1900				
1900	2000				
2000	2100				
2100	2200				
2200	2300				
2300	2400				
2400	0100				
0100	0200				
0200	0300				

*For origin and destination, state the area nearby

Village 1

Village 2

Village 3

Village 4

Village 5

USM Building

Sport Complex

Chansellor Complex

Pocket C

Pocket D

Outside UTP

1. What is your most preferable mode of transport to travel in UTP? (eg. attending classes, leisure etc.)
    - Car
    - Motorcycle
    - Bicycle
    - Walking

Why?

_____

_____

2. Do you own a vehicle?
    - Yes
    - No

State what type:_____

3. If you do not own any vehicle, how do you travel in UTP?
    - Walk
    - Carpool
    - Others : _____

4. In a week, which place is the most often place you walked to from your resident?
    - New Campus: _____ (State which building)
    - Sport Complex
    - Old USM Building
    - Others: _____

5. Do you feel safe walking within UTP?
    - Yes
    - No

6. How far do you willing to walk?
    - <200m
    - 200m-300m
    - >400m
    - Others

7. What are the reasons that you prefer riding a vehicle rather than walking?

_____

_____

_____

8. How do you rate the present pedestrian facilities in UTP?
    - Very poor
    - Poor
    - Moderate
    - Good
    - Very good

9. Additional comment on current pedestrian facilities:

_____

_____

_____

10. If the pedestrian facilities in UTP are upgraded with well-designed facilities (eg. covered walkways etc.), would you consider walking as your main mode of transport in UTP?
    - Yes
    - No

11. Please give your suggestion(s) to improve the pedestrian facilities in UTP:

_____

_____

_____

Appendix D:

EMME2 Inputs

t nodes init

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a*	4	16637.5	81328.6
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a*	2	16900.8	81276.8
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a*	11	17038.9	80560.8
a*	12	16771.3	80823.9
a*	13	16486.5	80707.4
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a	102	17968.9	81029.7
a	103	17739.8	80986.6
a	104	17675.9	81076.6
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a	106	17557.6	81170.4
a	107	17503.7	81185.9
a	108	17459.4	81204.1
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a	112	17015.7	81330.2
a	113	16914.3	81354.6
a	114	16774.7	81382.7
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a	117	16523	81369
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t links
init

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```
t functions init
a fd1 = length * 60 / ((volau .le. put(lanes * 500)) * (20 + ((15 - 20)
      * (volau / get(1)))) + (volau .gt. put(lanes * 1000)) * 10 / (1
     + (10 * (volau - get(2)) / (8 * length * get(2)))) + (volau .gt.
      get(1) .and. volau .lt. get(2)) * (15 + (10 - 15) * (volau -
      get(1)) / (lanes * (1000 - 500))))

a fd2 = length / (((volau .le. put(lanes * 1200/60))) * 200) +
       (((volau .gt. put(lanes * 1600/60))) * 100) +
       ((volau .gt. get(1) .and. volau .lt. get(2)) *150)
a fd3  = length / (( volau .le. put(lanes * 10)) * 81.6) +
       ((volau .gt. put((lanes * 30)) * 41.4) +
       ((volau .gt. get(1) .and. volau .lt.get(2)) * 70.1))
```

Appendix E:

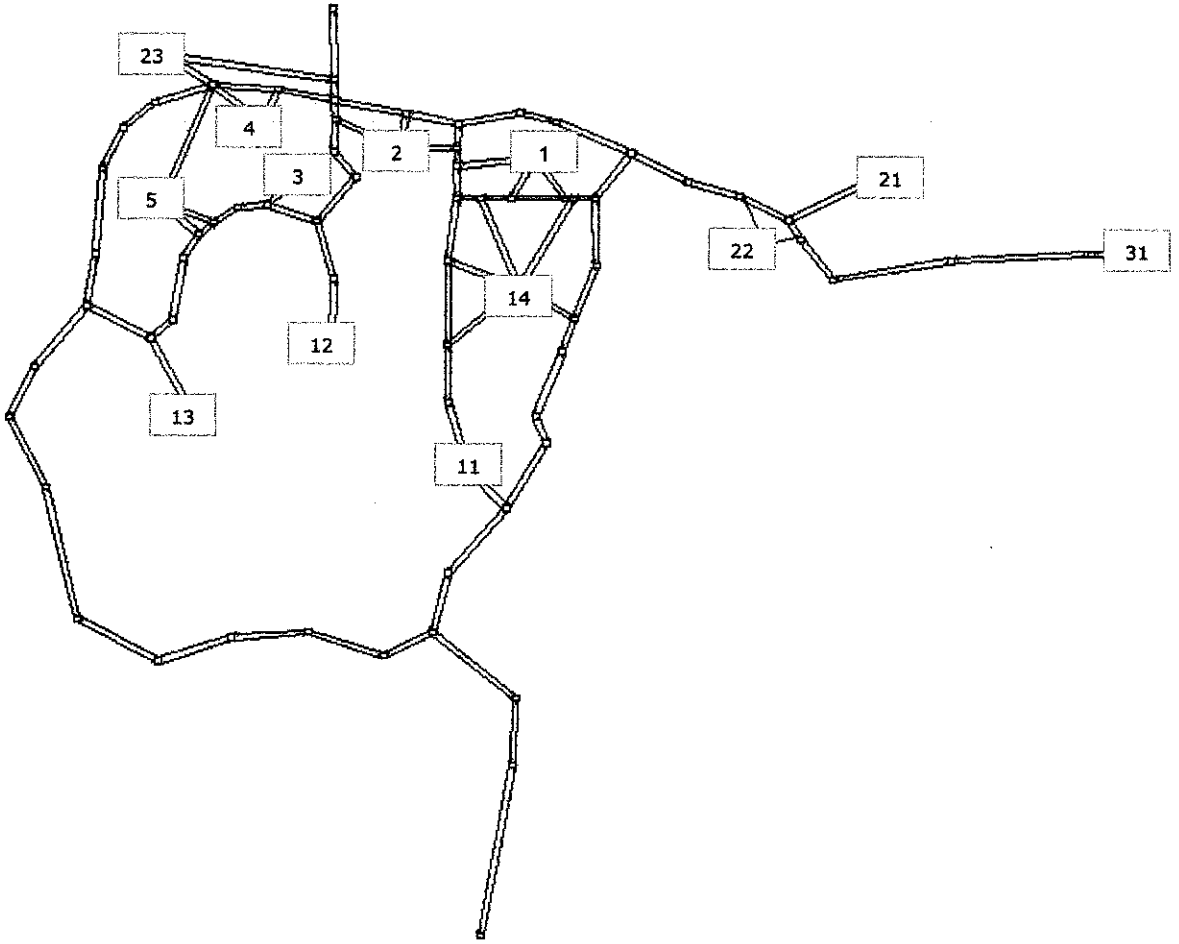
EMME2 Outputs

SCENARIO 1 -

Car 2005

BASE NETWORK

emme/2



LINKS:
all

WINDOW:
15791/79437.2
18707/81666.7

EMME/2 PROJECT: Conducive Walking Environment in UTP
SCENARIO 4: Car 2005

06-05-11 11:43
MODULE: 2.13
UPT.....yana

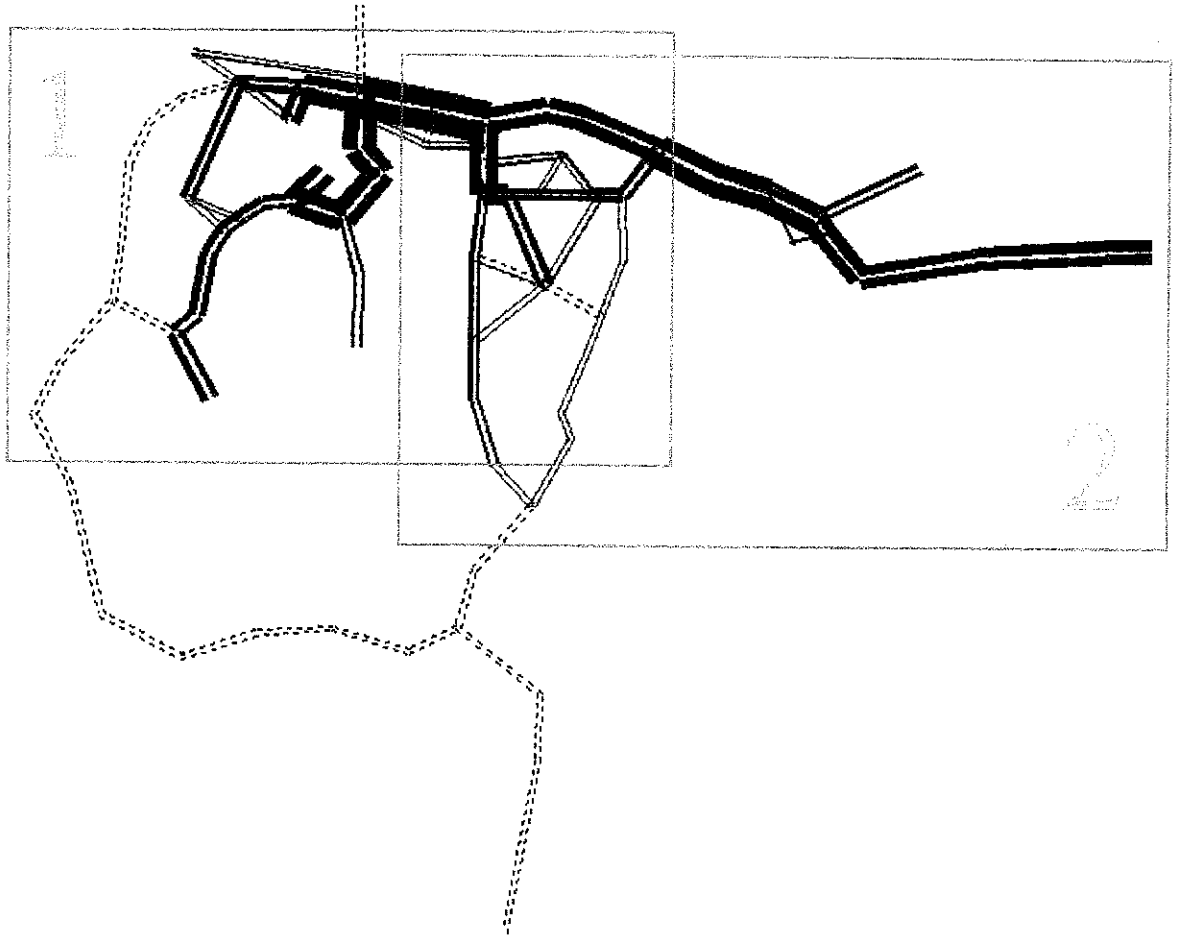
EMME/2 Module: 3.12 Date: 06-05-11 11:43 User: EB17/UPT.....yana
Project: Conducive Walking Environment in UTP
Matrix mf01:

origin	dest:	value	dest:	value	dest:	value	dest:	value	dest:	value
1	1:	0	2:	2	3:	3	4:	3	5:	2
1	11:	2	12:	69	13:	45	14:	18	21:	10
1	22:	1	23:	1	31:	79				
2	1:	1	2:	0	3:	2	4:	7	5:	1
2	11:	1	12:	25	13:	50	14:	74	21:	35
2	22:	20	23:	0	31:	17				
3	1:	3	2:	22	3:	0	4:	4	5:	3
3	11:	17	12:	34	13:	170	14:	169	21:	236
3	22:	51	23:	2	31:	489				
4	1:	5	2:	19	3:	6	4:	0	5:	29
4	11:	140	12:	4	13:	365	14:	169	21:	141
4	22:	84	23:	4	31:	365				
5	1:	2	2:	1	3:	3	4:	3	5:	0
5	11:	70	12:	42	13:	71	14:	133	21:	133
5	22:	2	23:	1	31:	155				
11	1:	29	2:	1	3:	2	4:	84	5:	63
11	11:	0	12:	1	13:	16	14:	15	21:	2
11	22:	1	23:	0	31:	3				
12	1:	35	2:	25	3:	7	4:	3	5:	35
12	11:	8	12:	0	13:	18	14:	18	21:	1
12	22:	1	23:	0	31:	8				
13	1:	44	2:	40	3:	152	4:	117	5:	78
13	11:	15	12:	0	13:	18	14:	23	21:	2
13	22:	1	23:	0	31:	8				
14	1:	35	2:	59	3:	202	4:	62	5:	140
14	11:	2	12:	25	13:	23	14:	0	21:	9
14	22:	1	23:	1	31:	22				
21	1:	9	2:	35	3:	202	4:	57	5:	133
21	11:	1	12:	1	13:	3	14:	2	21:	0
21	22:	1	23:	0	31:	3				
22	1:	1	2:	20	3:	51	4:	84	5:	2
22	11:	1	12:	1	13:	2	14:	2	21:	1
22	22:	0	23:	0	31:	3				
23	1:	1	2:	0	3:	2	4:	2	5:	1
23	11:	1	12:	1	13:	2	14:	1	21:	1
23	22:	0	23:	0	31:	3				
31	1:	62	2:	22	3:	472	4:	365	5:	162
31	11:	3	12:	3	13:	4	14:	8	21:	4
31	22:	3	23:	2	31:	0				

-->

AUTO VOLUMES

emme/2



LINKS:
all

SCALE: 200
500
1000
1500
2000
2500

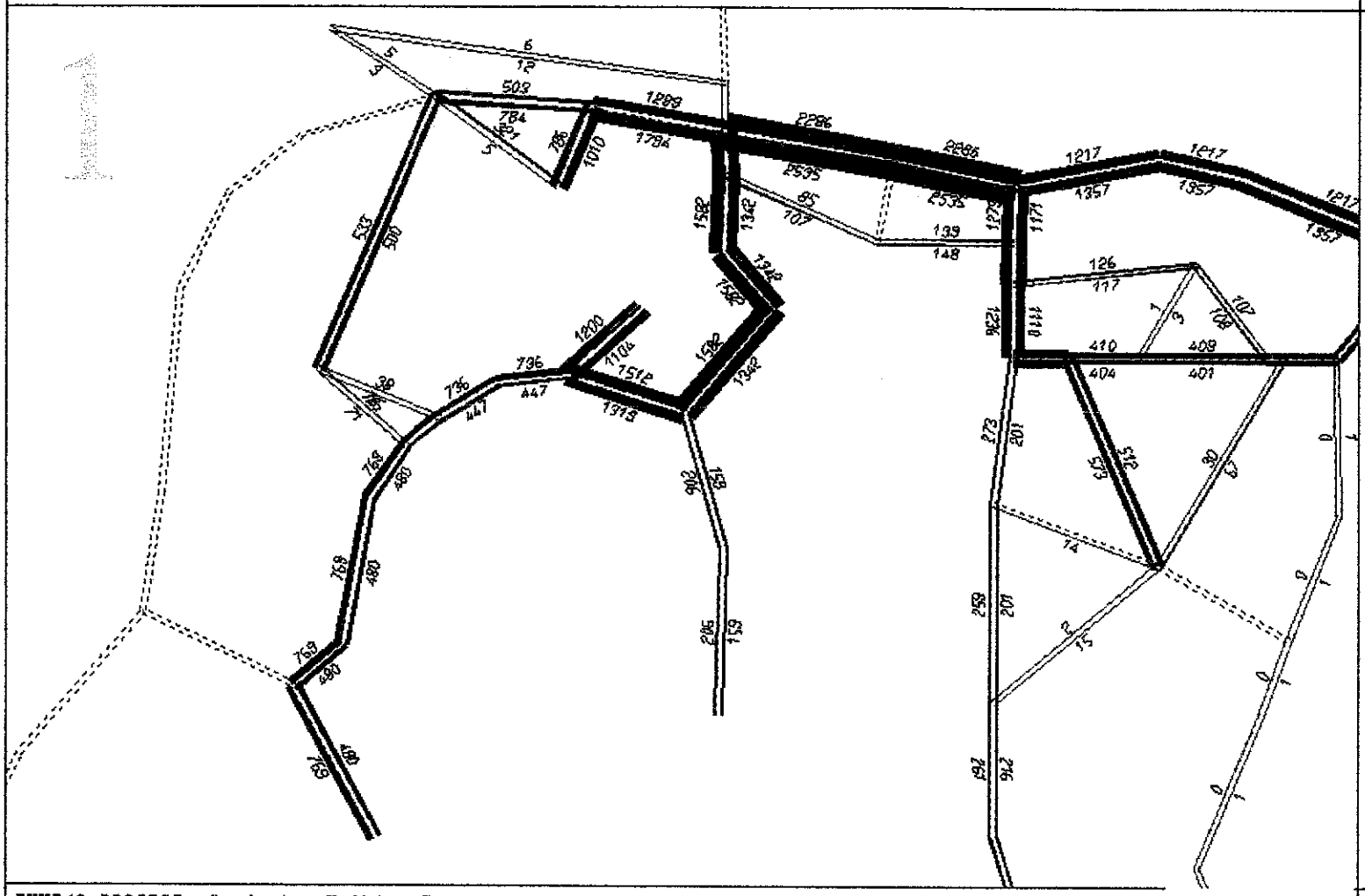
WINDOW:
15731/79437.2
16707/81668.7

EMME/2 PROJECT: Conducive Walking Environment in UTP
SCENARIO 4: Car 2005

06-05-11 14:59
MODULE: 6.12
UPT.....yana

AUTO VOLUMES

emme/2



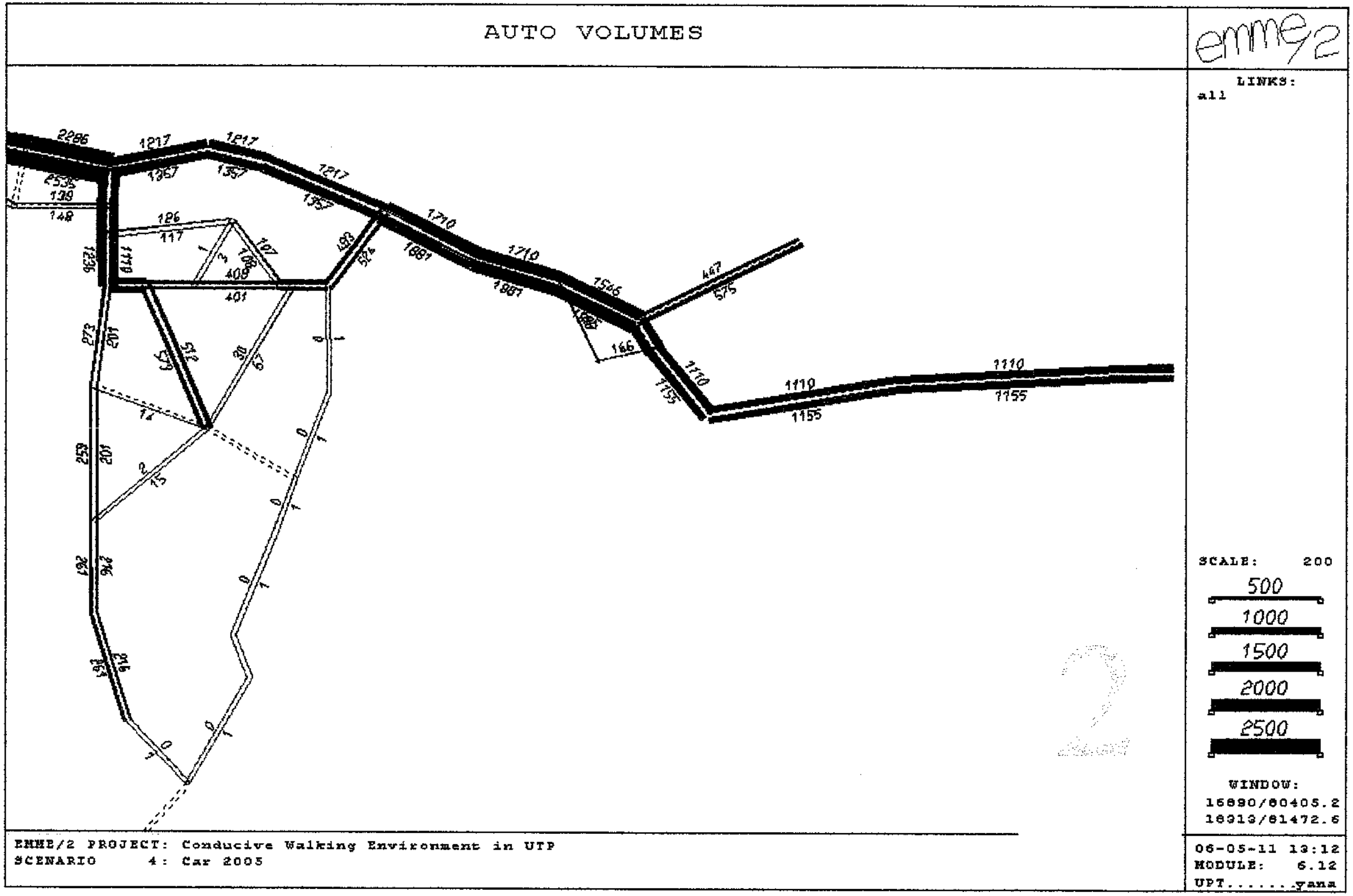
LINKS:
all

SCALE: 200
500
1000
1500
2000
2500

WINDOW:
16178/80660.4
17298/81500.1

ENME/2 PROJECT: Conducive Walking Environment in UTP
SCENARIO 4: Car 2005

06-05-11 13:12
MODULE: 6.12
UPT.....yana

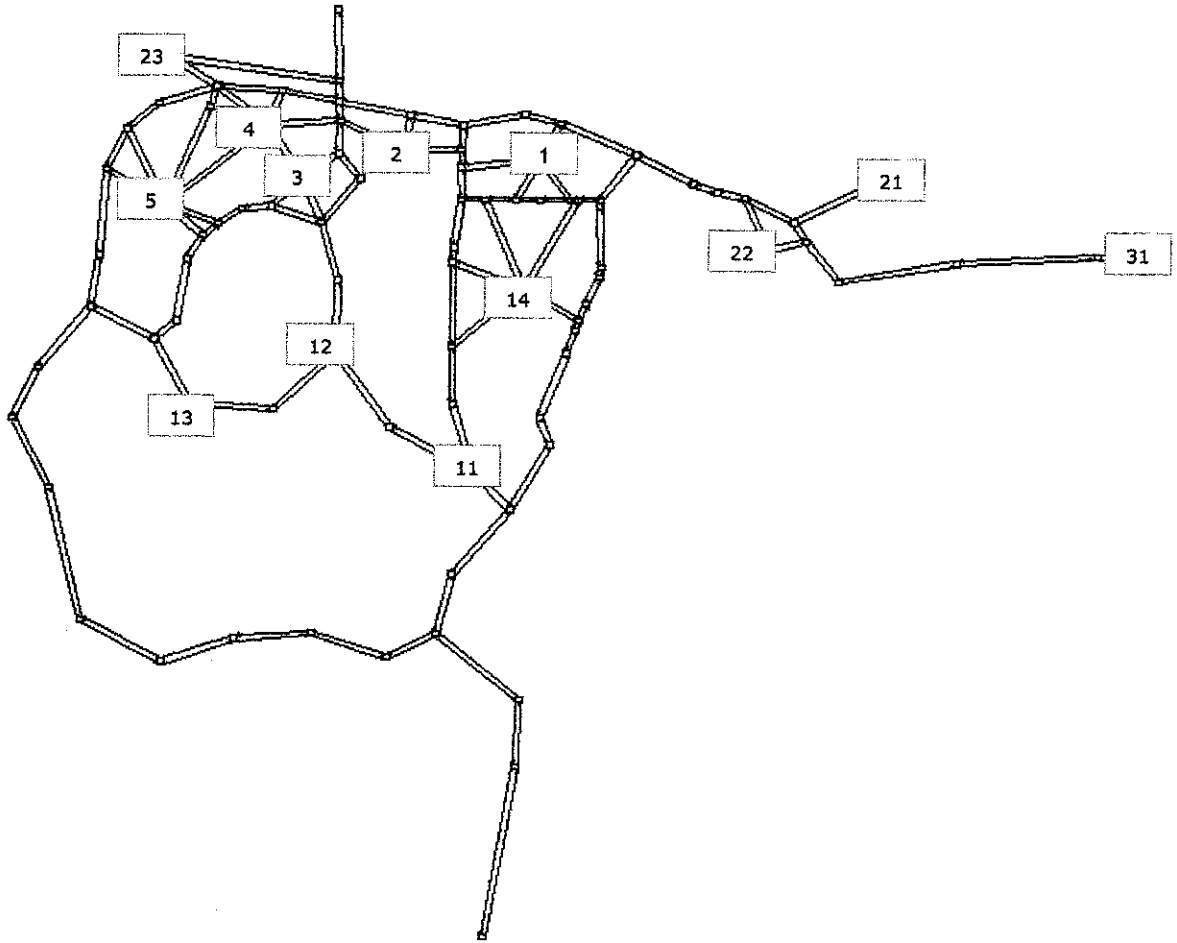

AUTO VOLUMES
emme/2
LINKS:
all
SCALE: 200
500
1000
1500
2000
2500
WINDOW:
16890/80405.2
18313/81472.6
EMME/2 PROJECT: Conducive Walking Environment in UTP
SCENARIO 4: Car 2005
06-05-11 13:12
MODULE: 6.12
UPT.......yana

SCENARIO 2 -

Pedestrian 2005

BASE NETWORK

emme/2



LINKS:
all

WINDOW:
15721/79437.2
18707/81668.7

EMME/2 PROJECT: Conducive Walking Environment in UTP
SCENARIO 1: Pedestrian 2005

06-05-10 16:13
MODULE: 2.13
UPT.....yana

```
EMME/2 Module:  3.12        Date: 06-05-10 16:13        User: EB17/UPT......yana
Project:        Conducive Walking Environment in UTP
Matrix    mf03:
```

origin	dest:	value	dest:	value	dest:	value	dest:	value	dest:	value
1	1:	0	2:	1	3:	11	4:	11	5:	2
1	11:	23	12:	124	13:	24	14:	87	21:	49
1	22:	86	23:	1	31:	1				
2	1:	1	2:	0	3:	12	4:	85	5:	1
2	11:	35	12:	440	13:	89	14:	268	21:	79
2	22:	1	23:	54	31:	5				
3	1:	6	2:	31	3:	0	4:	137	5:	198
3	11:	125	12:	658	13:	394	14:	35	21:	253
3	22:	2	23:	84	31:	2				
4	1:	13	2:	130	3:	112	4:	0	5:	102
4	11:	57	12:	464	13:	204	14:	85	21:	141
4	22:	4	23:	84	31:	4				
5	1:	2	2:	1	3:	170	4:	121	5:	0
5	11:	126	12:	683	13:	335	14:	98	21:	57
5	22:	1	23:	56	31:	1				
11	1:	35	2:	44	3:	152	4:	57	5:	147
11	11:	0	12:	99	13:	19	14:	72	21:	2
11	22:	1	23:	1	31:	1				
12	1:	139	2:	264	3:	686	4:	297	5:	399
12	11:	146	12:	0	13:	210	14:	139	21:	3
12	22:	3	23:	3	31:	2				
13	1:	18	2:	117	3:	342	4:	57	5:	253
13	11:	101	12:	151	13:	0	14:	28	21:	2
13	22:	1	23:	2	31:	1				
14	1:	215	2:	263	3:	70	4:	122	5:	36
14	11:	44	12:	73	13:	2	14:	0	21:	2
14	22:	1	23:	1	31:	1				
21	1:	69	2:	78	3:	236	4:	29	5:	56
21	11:	1	12:	4	13:	2	14:	2	21:	0
21	22:	1	23:	1	31:	1				
22	1:	86	2:	1	3:	2	4:	3	5:	1
22	11:	1	12:	4	13:	2	14:	1	21:	1
22	22:	0	23:	1	31:	0				
23	1:	1	2:	54	3:	85	4:	84	5:	56
23	11:	1	12:	4	13:	2	14:	1	21:	1
23	22:	1	23:	0	31:	0				
31	1:	1	2:	0	3:	2	4:	2	5:	1
31	11:	1	12:	4	13:	2	14:	1	21:	1
31	22:	0	23:	0	31:	0				

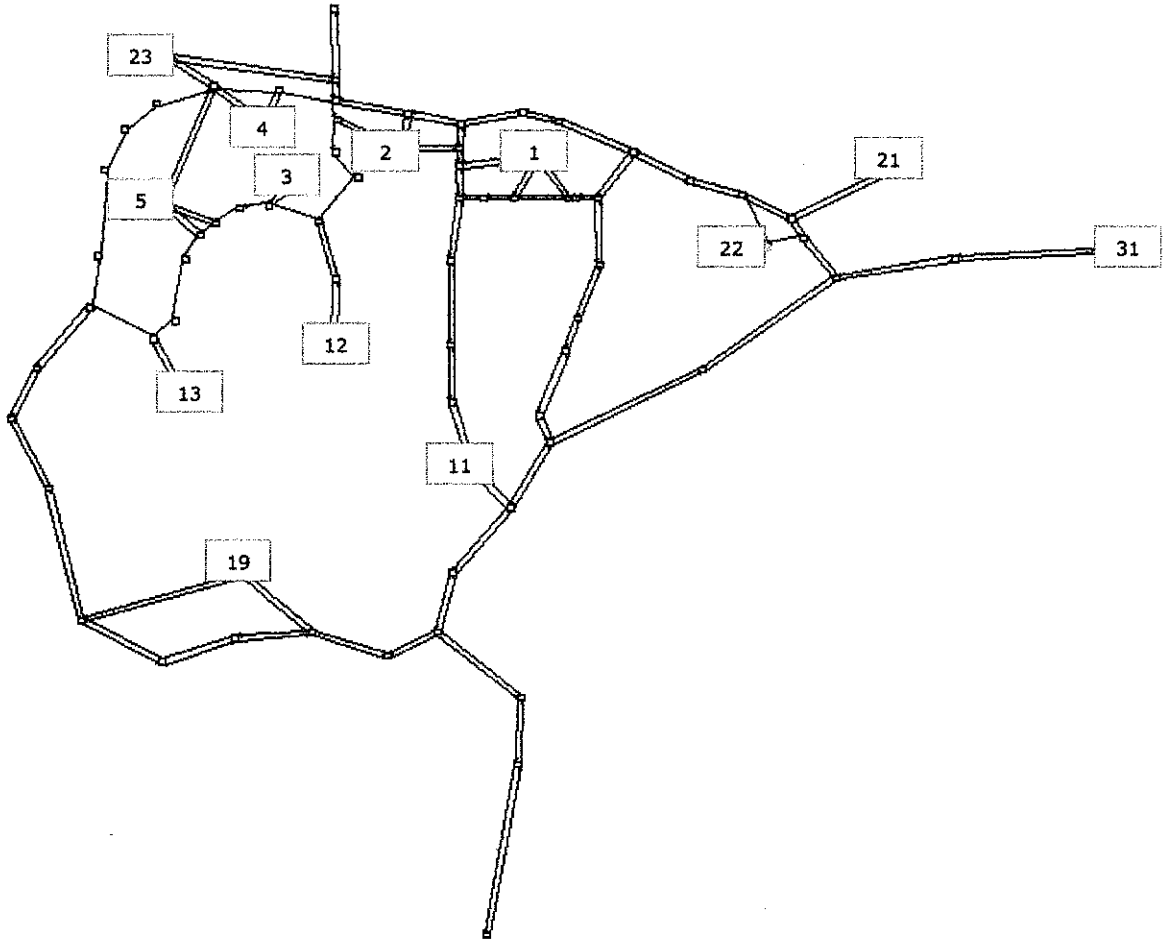
```
-->
```

SCENARIO 3 -

Car 2010 Do Nothing

BASE NETWORK

emme/2



LINKS:
all

WINDOW:
15731/79437.2
18707/81668.7

EMME/2 PROJECT: Conducive Walking Environment in UTP
SCENARIO 5: Car 2010 do nothing

06-05-11 11:08
MODULE: 2.13
UPT.....yana

EMME/2 Module: 3.12 Date: 06-05-11 11:08 User: EB17/UPT.....yana
Project: Conducive Walking Environment in UTP
Matrix mf08:

origin	dest:	value	dest:	value	dest:	value	dest:	value	dest:	value
1	1:	0	2:	2	3:	4	4:	5	5:	5
1	11:	2	12:	103	13:	67	19:	27	21:	14
1	22:	2	23:	2	31:	119				
2	1:	2	2:	0	3:	3	4:	11	5:	3
2	11:	2	12:	37	13:	75	19:	111	21:	52
2	22:	30	23:	1	31:	26				
3	1:	4	2:	32	3:	0	4:	6	5:	7
3	11:	26	12:	51	13:	254	19:	253	21:	354
3	22:	76	23:	3	31:	733				
4	1:	7	2:	28	3:	9	4:	0	5:	72
4	11:	210	12:	7	13:	547	19:	253	21:	211
4	22:	126	23:	6	31:	548				
5	1:	4	2:	3	3:	6	4:	8	5:	0
5	11:	176	12:	106	13:	179	19:	334	21:	334
5	22:	6	23:	2	31:	390				
11	1:	43	2:	1	3:	3	4:	126	5:	158
11	11:	0	12:	1	13:	24	19:	23	21:	2
11	22:	1	23:	1	31:	4				
12	1:	52	2:	37	3:	10	4:	4	5:	88
12	11:	12	12:	0	13:	28	19:	27	21:	2
12	22:	1	23:	1	31:	11				
13	1:	66	2:	60	3:	228	4:	176	5:	195
13	11:	23	12:	9	13:	0	19:	34	21:	3
13	22:	2	23:	2	31:	5				
19	1:	53	2:	89	3:	304	4:	92	5:	352
19	11:	2	12:	37	13:	35	19:	0	21:	13
19	22:	2	23:	2	31:	33				
21	1:	14	2:	52	3:	303	4:	85	5:	334
21	11:	2	12:	2	13:	4	19:	3	21:	0
21	22:	2	23:	1	31:	5				
22	1:	2	2:	90	3:	76	4:	126	5:	6
22	11:	1	12:	1	13:	3	19:	3	21:	2
22	22:	0	23:	1	31:	4				
23	1:	1	2:	1	3:	3	4:	3	5:	2
23	11:	1	12:	1	13:	3	19:	2	21:	2
23	22:	1	23:	0	31:	4				
31	1:	93	2:	33	3:	708	4:	548	5:	407
31	11:	4	12:	4	13:	6	19:	12	21:	5
31	22:	4	23:	4	31:	0				

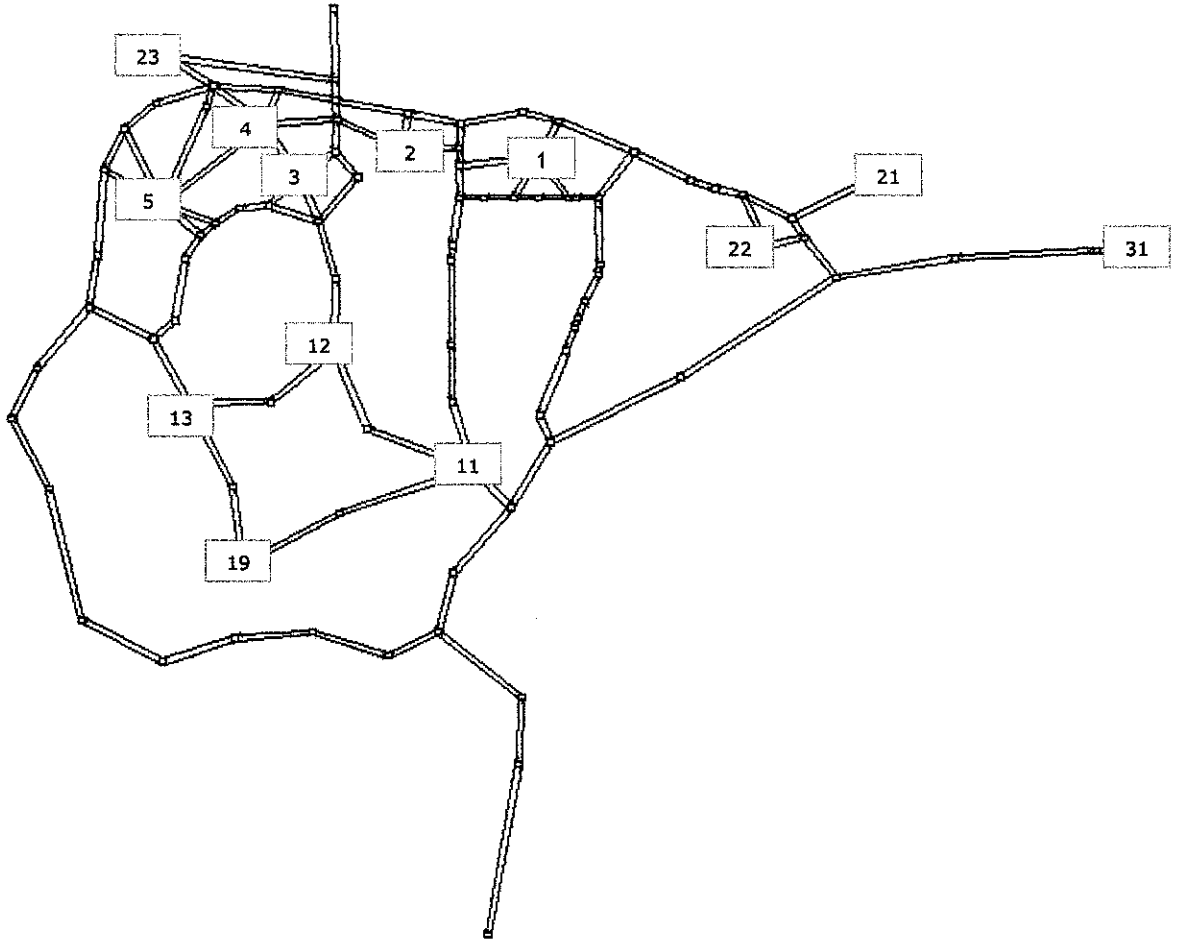
-->

SCENARIO 4 -

Pedestrian 2010 Do Nothing

BASE NETWORK

emme/2



LINKS:
all

WINDOW:
15731/79437.2
16707/81668.7

EMME/2 PROJECT: Conducive Walking Environment in UTP
SCENARIO 2: Pedestrian 2010 do nothing

06-05-10 16:40
MODULE: 2.13
UPT.....yana

```
EMME/2 Module:  3.12        Date: 06-05-10 16:40        User: EB17/UPT......yana
Project:        Conducive Walking Environment in UTP
Matrix   mf06:
```

origin	dest:	value	dest:	value	dest:	value	dest:	value	dest:	value
1	1:	0	2:	2	3:	16	4:	16	5:	4
1	11:	34	12:	186	13:	36	19:	131	21:	73
1	22:	129	23:	2	31:	1				
2	1:	2	2:	0	3:	18	4:	127	5:	3
2	11:	52	12:	660	13:	133	19:	402	21:	118
2	22:	1	23:	81	31:	7				
3	1:	9	2:	47	3:	0	4:	205	5:	496
3	11:	188	12:	987	13:	591	19:	52	21:	379
3	22:	3	23:	127	31:	3				
4	1:	19	2:	195	3:	168	4:	0	5:	255
4	11:	85	12:	696	13:	306	19:	127	21:	211
4	22:	6	23:	127	31:	6				
5	1:	4	2:	3	3:	427	4:	303	5:	0
5	11:	316	12:	1713	13:	841	19:	247	21:	142
5	22:	2	23:	141	31:	2				
11	1:	53	2:	67	3:	228	4:	85	5:	369
11	11:	0	12:	149	13:	28	19:	109	21:	3
11	22:	1	23:	2	31:	1				
12	1:	209	2:	396	3:	1029	4:	445	5:	1001
12	11:	220	12:	0	13:	314	19:	208	21:	5
12	22:	4	23:	4	31:	4				
13	1:	27	2:	176	3:	512	4:	85	5:	635
13	11:	151	12:	226	13:	0	19:	42	21:	3
13	22:	2	23:	2	31:	2				
19	1:	322	2:	394	3:	105	4:	183	5:	90
19	11:	66	12:	110	13:	4	19:	0	21:	3
19	22:	2	23:	2	31:	1				
21	1:	104	2:	117	3:	354	4:	43	5:	141
21	11:	2	12:	6	13:	3	19:	2	21:	0
21	22:	1	23:	1	31:	1				
22	1:	129	2:	1	3:	3	4:	4	5:	2
22	11:	1	12:	5	13:	2	19:	2	21:	2
22	22:	0	23:	1	31:	0				
23	1:	2	2:	81	3:	127	4:	127	5:	141
23	11:	2	12:	6	13:	3	19:	2	21:	2
23	22:	1	23:	0	31:	1				
31	1:	1	2:	1	3:	3	4:	4	5:	2
31	11:	1	12:	5	13:	2	19:	2	21:	1
31	22:	0	23:	1	31:	0				

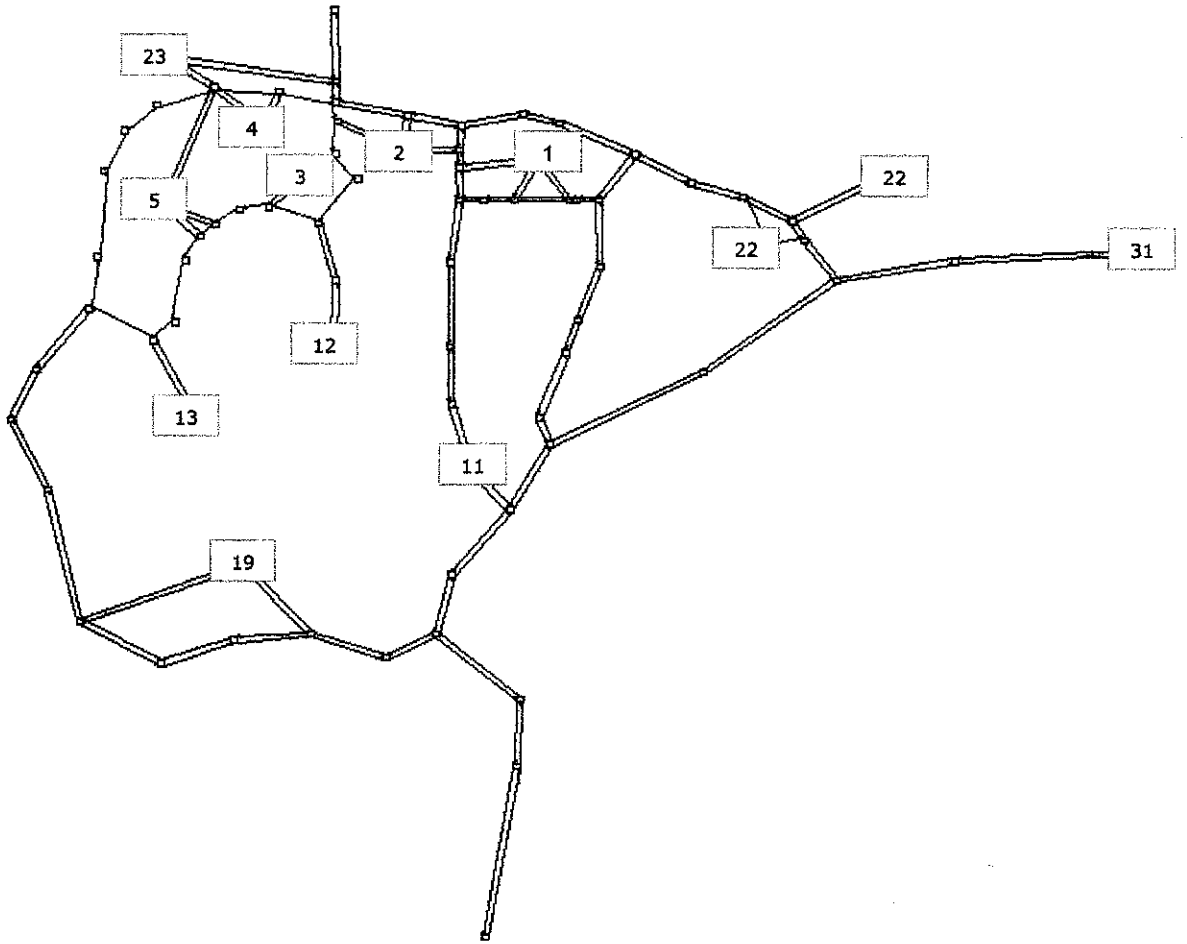
```
-->
```

SCENARIO 5

Car 2010 Do Something

BASE NETWORK

emme/2



LINKS:
all

WINDOW:
15731/79437.2
10707/81668.7

EMME/2 PROJECT: Conducive Walking Environment in UTP
SCENARIO 6: Car 2010 do something

06-05-11 11:10
MODULE: 2.10
UPT.....yana

```
EMME/2 Module:  3.12        Date: 06-05-11 11:19        User: EB17/UPT......yana
Project:        Conducive Walking Environment in UTP
Matrix   mf10:
```

origin	dest:	value	dest:	value	dest:	value	dest:	value	dest:	value
1	1:	0	2:	1	3:	1	4:	1	5:	1
1	11:	1	12:	28	13:	18	19:	8	21:	4
1	22:	1	23:	0	31:	33				
2	1:	1	2:	0	3:	1	4:	3	5:	1
2	11:	0	12:	10	13:	21	19:	30	21:	14
2	22:	8	23:	0	31:	7				
3	1:	1	2:	9	3:	0	4:	2	5:	2
3	11:	7	12:	14	13:	70	19:	69	21:	97
3	22:	21	23:	1	31:	201				
4	1:	2	2:	8	3:	2	4:	0	5:	20
4	11:	58	12:	2	13:	150	19:	69	21:	58
4	22:	35	23:	2	31:	150				
5	1:	1	2:	1	3:	2	4:	1	5:	0
5	11:	48	12:	29	13:	49	19:	92	21:	92
5	22:	2	23:	0	31:	107				
11	1:	12	2:	0	3:	1	4:	35	5:	43
11	11:	0	12:	0	13:	7	19:	6	21:	1
11	22:	0	23:	0	31:	1				
12	1:	14	2:	10	3:	3	4:	1	5:	24
12	11:	3	12:	0	13:	8	19:	7	21:	1
12	22:	0	23:	0	31:	3				
13	1:	18	2:	16	3:	62	4:	48	5:	53
13	11:	6	12:	3	13:	0	19:	9	21:	1
13	22:	1	23:	0	31:	1				
19	1:	14	2:	24	3:	83	4:	25	5:	96
19	11:	1	12:	10	13:	10	19:	0	21:	4
19	22:	1	23:	0	31:	9				
21	1:	4	2:	14	3:	83	4:	23	5:	91
21	11:	1	12:	1	13:	1	19:	1	21:	0
21	22:	0	23:	0	31:	1				
22	1:	1	2:	8	3:	21	4:	35	5:	2
22	11:	0	12:	0	13:	1	19:	1	21:	1
22	22:	0	23:	0	31:	1				
23	1:	0	2:	0	3:	1	4:	1	5:	1
23	11:	0	12:	0	13:	1	19:	1	21:	0
23	22:	0	23:	0	31:	1				
31	1:	26	2:	9	3:	194	4:	150	5:	112
31	11:	1	12:	1	13:	2	19:	3	21:	1
31	22:	1	23:	1	31:	0				

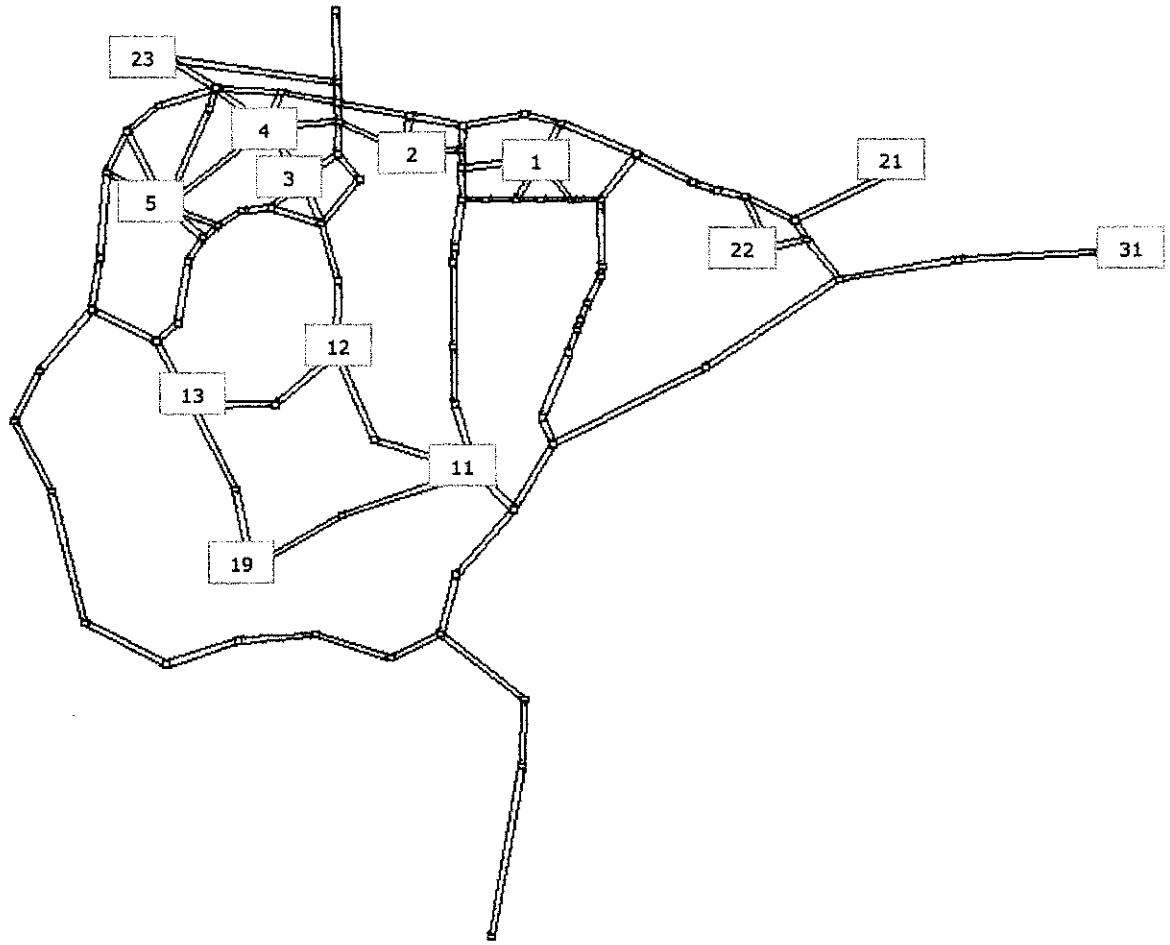
-->

SCENARIO 6

Pedestrian 2010 do something

BASE NETWORK

emme/2



LINKS:
all

WINDOW:
15731/79437.2
18707/81668.7

EMME/2 PROJECT: Conducive Walking Environment in UTP
SCENARIO 3: Pedestrian 2010 do something

06-05-11 11:32
MODULE: 2.13
UPT.....yana

EMME/2 Module: 3.12 Date: 06-05-11 11:32 User: EB17/UPT.....yana
Project: Conducive Walking Environment in UTP
Matrix mf07:

origin	dest:	value	dest:	value	dest:	value	dest:	value	dest:	value
1	1:	0	2:	2	3:	17	4:	17	5:	5
1	11:	35	12:	207	13:	49	19:	136	21:	76
1	22:	129	23:	2	31:	25				
2	1:	2	2:	0	3:	18	4:	129	5:	3
2	11:	52	12:	668	13:	148	19:	424	21:	128
2	22:	7	23:	81	31:	12				
3	1:	10	2:	53	3:	0	4:	206	5:	498
3	11:	193	12:	997	13:	642	19:	102	21:	450
3	22:	18	23:	127	31:	149				
4	1:	20	2:	201	3:	170	4:	0	5:	269
4	11:	127	12:	698	13:	414	19:	178	21:	253
4	22:	31	23:	128	31:	115				
5	1:	5	2:	4	3:	428	4:	304	5:	0
5	11:	351	12:	1734	13:	877	19:	313	21:	209
5	22:	3	23:	141	31:	80				
11	1:	61	2:	67	3:	229	4:	110	5:	400
11	11:	0	12:	149	13:	33	19:	113	21:	3
11	22:	2	23:	2	31:	2				
12	1:	219	2:	404	3:	1031	4:	446	5:	1018
12	11:	222	12:	0	13:	320	19:	214	21:	6
12	22:	4	23:	4	31:	6				
13	1:	40	2:	188	3:	558	4:	121	5:	673
13	11:	156	12:	228	13:	0	19:	49	21:	4
13	22:	2	23:	3	31:	3				
19	1:	333	2:	412	3:	165	4:	202	5:	160
19	11:	66	12:	118	13:	11	19:	0	21:	6
19	22:	2	23:	2	31:	8				
21	1:	106	2:	128	3:	414	4:	60	5:	207
21	11:	2	12:	7	13:	4	19:	3	21:	0
21	22:	1	23:	2	31:	2				
22	1:	129	2:	7	3:	18	4:	29	5:	3
22	11:	2	12:	6	13:	3	19:	2	21:	2
22	22:	0	23:	1	31:	1				
23	1:	2	2:	81	3:	127	4:	127	5:	141
23	11:	2	12:	6	13:	4	19:	3	21:	3
23	22:	1	23:	0	31:	1				
31	1:	20	2:	7	3:	144	4:	113	5:	83
31	11:	2	12:	6	13:	4	19:	4	21:	3
31	22:	1	23:	1	31:	0				

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