A SPECIAL TRANSPORTATION MODELLING APPROACH FOR THE DISADVANTAGED GROUPS IN URBAN TRAFFIC

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August, 2000

A Special Transportation Modelling Approach for the Disadvantaged Groups in Urban Traffic

By

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A Dissertation Submitted to the
Graduate School in Partial Fulfilment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Department: City and Regional Planning
Major: City Planning

Izmir Institute of Technology
Izmir, Turkey

August, 2000

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ACKNOWLEDGEMENTS

I thank to my supervisor Prof. Dr. Akın SÜEL for his supervision and encouragement all throughout the study, and I must especially thank for his continued support enabling an excellent study environment, the research scholarship, and in providing the transport package for this kind of study that requires a concentrated devotion.

I must specially thank to Assoc. Prof. Dr. Güneş GÜR, co-advisor, who actually contributed the work in a team-work spirit and always stood by all through the study and controlled every stage of the work with his excellent guidance and corrections.

I also thank to Prof. Dr. Cemal ARKON, the Dean, and Assoc. Prof. Dr. Semahat ÖZDEMİR for their useful courses and criticisms that especially helped in the formation of the thesis structure and theoretical background.

I owe a great deal to Prof. Dr. Haluk GERÇEK, from the Department of Civil Engineering-Transportation at ITU, who willingly supervised at the modelling stage. I appreciate much of his invaluable comments, corrections and transmitting of transportation knowledge and experience.

I must thank the Municipality of Aydın, and especially to Dr. Hüseyin AKSU, the Mayor, for his support and permission in using the municipal resources, enabling the surveys and use of the GIS resources. I also thank to the personnel at the GIS Center, especially Sibel ERBAŞ and Seher GÖLHAN there.

I appreciate Prof. Dr. Halis PÜSKÜLCÜ's helping in the cluster analysis and other statistical methods. I must also thank to Dr. Mustafa NADAR, from the PENNSTATE helping in the statistical problems.

I thank to Dr. Ümit TATLICAN, from the Department of Sociology in the Adnan Menderes University, who joined the home interview surveys voluntarily.

Special thanks to Hakan BARIŞIK for he prepared an excellent C++ program for random sampling, and also for his inspiring discussions and encouragement about modelling.

Thanks to Koray VELİBEYOĞLU for his precious and time-saving helps in using Excell, and also for his voluntary help in the home interview surveys. I must also thank to Tankut GÖKÇEN, for helping in both home interviews and the screen line counts.

I also thank to other people joining the home interview surveys, from the University of Adnan Menderes, especially to Halil ACAR, and his friends without whom the interviews and the counts would not be completed.

Rıfat TÜRKKAN and Erhan ÖNCÜ provided their own reports and documents prepared for their transportation studies.

Thanks to Tan YİĞİTCANLAR for his helping in fixing the computer problems and setting up the programs.

Dr. İlkim KAYA, from DEU, provided valuable materials on the standards and studies about disabled. I also thank to the personnel in the (Başbakanlık Özürlüler İdaresi) for providing materials about the legal status of the disabled people in Turkey.

Throughout the study, I had very useful and inspiring interviews with those people:

- Prof. Dr. Ayhan İNAL, the Department of Civil Engineering, METU
- Prof. Dr. Ali TÜREL, the Department of City and Regional Planning, METU
- Berna IŞIKER, DIE (SIS)
- The President of Automobile Owners and Drivers, Aydın
- Assoc. Prof. Dr. Salih DİNLEYİCİ, The Department of Electronics, IYTE
- The Staff in the EGO, Ankara Municipality

And, finally, I appreciate my roommates in the faculty for their patience and the peaceful atmosphere for studying. I thank faculty members and other people from other public or private institutions that I could not mention their names here, who have contributions in this study.

I should express my deepest gratitute to my family, and specially my sister, Op. Dr. Mehtap YAZICIOĞLU, for their continued moral support.

ABSTRACT

It has been known that conventional transportation models and studies have been inadequate to solve the acute transportation problems in the urban areas to date that overwhelmingly those disadvantaged groups face. The major reason is probably that the qualitative and social parameters that could be the real factors in the explanation of the "disadvantagedness" have not been efficiently considered in the modelling because of the uncertainty, and non-normative nature of the models.

This thesis study as a normative one offers basically two methodological approach that can be integrated to the normal models: First, the clear-cut definition of so-called disadvantaged by the cluster analysis method, and second, application of the modelling procedures both for normal case and for the disadvantaged simulatenously by which the determination of policy packages (policy capturing) is probable on the basis of the differences between the two models. The improvement of disadvantaged means getting closer to the normality in transportation conditions. With this, it is meant that policy-making to improve the disadvantaged can even start from the modelling stages.

As an innovative approach, various correlated variables are grouped into "Major" variables in the form of function formulations, which are thought best represent the social/qualitative parameters.

In the model runs, latest version of TRANUS (6.0) was used to speed up the modelling process (especially the Trip Assignments). With TRANUS™, categorical handling is possible. It is found that there appears a remarkable discrepancy between the two models at the level of Trip Generations (productions), and some different variables could be used in the model for disadvantaged.

Finally, in the Correspondence Module (or, category analysis), as of the adopted equity principles, the association of those disadvantaged categories (as transportation categories) with the "disadvantagedness" levels is maintained. This matching process also provided a gauge with which the policies could be produced for the matching transportation (disadvantaged) categories. To see the effectiveness of the method, three simulations are run based on the three policy scenarios where any move towards betterment in the condition of disadvantaged is welcome.

As the result of this study, though less than expected, an improvement was observed in the travel conditions of the disadvantaged. It is observed not surprisingly that policy formulations playing around the income related and vehicle ownership variables can be more successful in obtaining better results. More frequent trials with better scenario formulations as well would have ended with better results.

Key Words: Transportation Planning, Equity, Transportation Disadvantaged, Cluster Analysis, Category (Correspondence) Analysis, Transportation Ethics, Modelling-, Fuzzy Sets Analysis, Sensitivity Analysis, Simulation-, Gini Index

ÖZ

Şimdiye kadar bilinen ulaşım planlama model ve çalışmalarının çoğunlukla kentsel yolculuklar açısından mağdur (dezavantajlı) durumda kalan gurupların ulaşım sorunlarına somut çözümler getiremediği artık kabul edilmektedir. Bu durum, dezavantajlılığın oluşmasında rol oynayan niteliksel ve sosyal parametrelerin belirsizlik nedeniyle modellemede yeterince ele alınamamasından, ve modellerin normatif olmamasından kaynaklanmıştır.

Normatif bir modelleme yaklaşımı getiren bu tez çalışması, temelde iki farklı metodolojik yaklaşım sunar: Birincisi, gruplandırma (clustering) analizi yolu ile tarafsız ve ön koşulsuz bir ayrım neticesinde "Mağdur" genel grubunun tanımlanması, ikincisi ise, modelleme işlemlerini her iki durum (normal ve mağdur) için uygulayıp, iki model arasındaki sonuç farklılıklarından yola çıkarak planlama politikalarının belirlenmesidir. Burada amaç, mağdurun yolculuk kalitesinin iyileştirilmesidir ve iyileştirmeden kasıt ise, pozisyonunun normalin değerlerine yaklaştırılmasıdır. Bir bakıma, mağdurun durumunun iyileştirilmesine yönelik politikalar tam da modelleme aşamalarından başlatılmıştır.

Diğer bir değişik ele alış, çok sayıda değişkenin fonksiyon tanımlamaları şeklinde "Büyük" (Major) değişkenlere dönüştürülmesi konusunda olmuştur. Böylece, normalde etkisiz ve belirsiz konumda kalabilecek "küçük" değişkenlerin etkililiği sağlanabilmiş ve az sayıda değişkene indirgenmiştir.

Model işletimlerinde, süreci hızlandırmak için (özellikle yolculuk atamaları konusunda) TRANUS paket programının en son versiyonu (6.0) kullanılmıştır. TRANUS, kategori bazında model işletimi yapabilmekte ve bu çalışmada da mağdur ayrımında model çıktıları üretebilmek için bu özelliği kullanılmıştır. Sonuçlara bakıldığında, belirgin farklılığın özellikle Yolculuk Üretimi aşamasında oluştuğu (hane halkının sosyo-ekonomik değerleri) ve bunda değişkenlerin mağdur modeli için farklı olabilmesinden kaynaklandığı gözlenmiştir.

Son aşamada, Tekabüliyet Modülü (Correspondence Module) diyebileceğimiz bir kategori analizi ile, çalışma kapsamında benimsen hakçalık (equity) ilkeleri gereği, çeşitli mağduriyet kategorilerinin hangi mağduriyet düzeylerine eriştikleri saptanmıştır. Bu çakıştırma işlemi sırasında, ayrıca ne tür politikaların hangi mağduriyet gurupları için üretilebileceğine dair bir ölçü sistemi de elde edilmiştir. Yöntemin etkililiğini ölçmek için ise, mağdurun durumunda herhangi bir iyileşmeyi getirebilecek üç değişik politika senaryosuna dayanan üç ayrı simulasyon üretilmiştir.

Sonuç olarak, beklenen ölçüde olmasa da, simulasyonlarda mağdurun durumunda belli bir iyileşme kaydedilebilmiştir. Burada, sürpriz olmayan bir bulgu da, en fazla iyileşmeyi sağlayacak politikaların ağırlıklı olarak gelirle ve araç sahipliliği ile ilgili parametreleri ele alan politikaların olduğu gözlenmiştir. Daha iyi düşünülmüş senaryo formülasyonları ile çok daha iyi sonuçlar alınabilmesi mümkün gözükmektedir.

Anahtar Sözcükler: Ulaşım Planlaması, Hakçalık, Ulaşım Mağduru, Guruplama Analizi, Kategory (Tekabüliyet) Analizi, Ulaşım Etiği, Modelleme, Belirsiz Set Analizi, Duyarlılık (Esneklik) Analizi, Simulasyon, Gini Endeksi

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Chapter 1

INTRODUCTION

1.1. The Purpose of the Thesis and Its Contribution to the Literature

The main purpose of this study is to determine the "needs" of people, via the modelling approach, in their travel activity. "How" to meet the need is also the concern of the thesis that is truly about the improvement of the conditions of those needy. By offering a new approach in transportation planning, it is intended to make it clear what demand levels the needy will present in different stages of the planning. The needy is presented here under the umbrella term "disadvantaged", who **primarily** needs the improvements in his/her travel conditions. With this urge, our secondary aim appears to be finding of the "type" and "size" of the improvements. In the following step, for this purpose, we need to answer the question: "Who" needs the improvement? Can we find it through the modelling approach?

Thus, the thesis study mainly will be about a new modelling approach, an experimental try, rather than building totally a new model. Therefore, what is called "ideal" model, here, will not, in fact, be a radical divergence from the conventional ones but a minor shift, one that seeks a social/ethical flavor among the modelling approaches developed by now. However, we will have to base our model validation on the simplest level of transportation planning for easy cognition of the model.

The existing models (from now on will be called 'conventional') have not effectively taken into account the participation parameters, the conditions and the opinions of citizens in the modelling process. The model approach in this study will *at least* take into account their situation and perceptions, qualitative parameters that measure the disadvantagedness, as will be revealed in the home interview surveys later, about the transportation services in terms of the "disadvantagedness" criteria.

Initially, it is searched on internet whether any identical thesis study recently having the same considerations in the literature existed. The worldwide sources were scanned through library and the internet systems (Bliss and Ulakbim Systems in Bilkent University) searches.

It might be appropriate, first, to review the latest studies in transportation which are close to the study of ours in the world in general. Although, many innovative studies and applications have been realized in an effort to provide improved and effective transportation to the disabled people, there were only few ad hoc modelling studies for especially the disabled and pedestrians. Mitsuyoshi and Kurose's (1987, p.1139-52) study was about the special model for pedestrians within a limited neighborhood (a shopping district). The study offered a spatial interaction that can replace the conventional trip distribution process for pedestrian movements, which have long been a neglected trip mode in the literature. According to that study, the flow of pedestrian movement comprises almost a 40 per cent of all daily trips. This phenomenon, of course, is an important aspect in pedestrian street planning and design. The study also emphasized the role of accidents the pedestrians exposed to in transportation planning. The facilities, shopping centers, etc. had to be located accordingly considering the pedestrian flow. In the distribution algorithm, also the probability parameters for second, third and other shopping trips were considered. Heavy traffic conditions were regarded as the distracting factors. Additionally, there are the pedestrian speed factors differing according to the conditions (eg, for children and old people). Finally, a conclusion was arrived at special parameter of the ratio of shopping population over the total population. This will probably resemble to the "disadvantagedness ratio" of our study to be tested yet. But, the mentioned model is unsuitable for the main streets.

Category analysis (which will be called 'Correspondence Module' in our study) of Rengaraju and Satyakumar (1994) offered a method to derive average trip rates for each cell. Analysis of Variance (with F-Test) is used for finding the meaningful stakeholder groups. The methods used gave some hints about the cluster analysis for the thesis study. Here, goals were associated to the identified groups and the stepwise multiple regression method was used to do that by valuing the goals on the basis of the individual characteristics. Another method is about the clustering technique assembling the groups with similar interests in the Levine and Underwood's similar study. Interestingly, the affiliations are made with no a priory groups definitions (ie, objective). K-Mean clustering based on seven goals facilitated a natural (self-organizing) clustering technique that left about four distinct clusters. This is a kind of multi-criteria clustering (which is a technique what we look for) considering the valuations from different perspectives (or, criteria). Levine and Underwood tried to find clusters of social groups responding the similar result to the transportation issues (Levine J. and Underwood 1996, pp.97-111). They used the AHP (Analytical Hierarch Process)- based analysis in their surveys which is simply asking the respondent a pairs of goals and pick the most important one for him/her. So, the persons, and the goals too, were ranked relatively. The process employs a metric gauging the distances between the responses. In the study, one of the objectives to be rated was specified as "increasing the mobility of the transportation disadvantaged"!

For theoretical search, ethics related studies were observed in the studies of Richard and Hosmer's (1996), Okun's (1975), Nader's (1965), and Nozick (1974) that basically draw attention to the equity issues. Harvey's (1973) and Howe's (1994) ethical guidelines are general for professionals' (especially planners) ethical responsibility. In the practice side of ethics, the Australia based studies of Newman *et al* (NHS 1992), Moriarty and Beed's (1991) and Blaser's (1996) concerns on disabled' situation, Wachs' (1982) and Webber's (1982) attention on social and equity issues in transportation planning are relatively the most profound and recent ones. Freund and Martin's (1993) book emphasizes on the role of automobile in creating social inequities.

Mandell (1991), in his study, criticized the ineffective handling of Gini index in the literature, which is almost the sole measure of equity using Lorenz curve and brought new contribution to the method claiming it to be more useful. The index is based on the transfers of resources from the best-off to worse-off groups. In simpler terms, the equity situations of the groups are relatively measured referencing their average deviations to a general mean.

Among the studies considering the situation of the "transportation disadvantaged", it is worth to mention particularly an Australian study that compiled some statistics about the different views of being disadvantaged in transportation on the basis of household level (The NHS 1992, p.30-62). According to this study, three types of disadvantaged appear to exist: Socially and demographically disadvantaged households, economically disadvantaged households, and accessibility disadvantaged households. Access difficulties are mostly based on the travel mode used. The findings will be referred in this study in the next chapters later on. As one of the most valuable studies, Brail et al (1976) probably formed the first inquiry about modelling and demand estimation for transportation disadvantaged. Yet, the disadvantaged is only composed of the elderly and disabled who need a special transportation facilities and design. It is mentioned that the traditional demand estimation techniques are useless for the disadvantaged populations since their transportation pattern and needs would quite diverge from the rest. In this study, the demand estimation technique is the driving of a "prevalence rates" representing latent demand of disadvantaged for travel based on the various data compilations about population (such as census data). It is also emphasized that home interview surveys could reveal this demand (1976, p.53). However, in the estimation of the rate, there is the difficulty of overlapping of categories.

It is observed from the literature that such a definition problem (ie, eliciting the 'disadvantaged' out) is still less considered and would fairly be unique and, thus, can safely be worked on in this study here: The thesis proposal seems to present an innovative modelling approach and the testing of the concept on a case study will also claim to be unique. The accompanying model proposed here largely feeds not on the compilation of theoretical knowledge of transportation planning but rather on the premises of basic human rights and ethics.

For the evaluation techniques, the studies of Elker's, Nijkamp and Blaas' and Richardson *et al* were found practically useful. Saaty's (1980b), Levine and Underwood's on multi-attribute analysis techniques gave especially valuable insights on the evaluation and clustering techniques for the various transportation categories. Ma and Goulias' (1997) recent article carrying a new methodology approach about revealing the behavioral tendencies also used the cluster analysis technique to define types of persons having these different tendencies. Four clusters are found. In this study, it is also testified whether the person-based data or household-based data is more reliable. It concludes that temporal dependencies appear to be stronger in the household-based than the person-based. Cluster analysis is done on the basis of "distance between two clusters". The clustering technique is used personal/household, short-term/long term, temporal and activity segregation. Household-based patterns are found more stable. That can be evaluated as the methodological innovation among transportation planning techniques (Ma and Goulias 1997, p.309-331).

There are also some innovative studies to improve the travel conditions of disabled. These are mostly specific models for the operational systems (on-call services, pick up and delivery problem with time windows, etc.) to transport the disabled persons and utilize optimization type algorithms. A recent work of Toth and Vigo's can be a good example to that (1997, pp.60-71). Interestingly, different parameters were used for different sorts of disabilities and the operational transportation system is set accordingly. However, these studies do not directly match with our considerations since they are operational models and follow after different purposes.

1.2. The Thesis, Assumptions and Limitations

The purpose of this section is to establish the guidelines and construct the methodology content of the Ph.D. thesis proposal. For each corresponding section, there will be the definition of research process and the method analysis describing the appropriate techniques.

The new modelling approach put here, first, needs its premises be tested whether it can run validly to some extent and then whether is a useful tool for improving the targeted groups, who are called "disadvantaged". Thus, such a model is expected to contribute much to the theoretical literature. Since the ethics is equity based, in general, and it is about to protect the natural rights of individuals, a special place on equity principles will be cited in both the theoretical part and the last chapter (Chapter

5) of the thesis. In the model building and testing, the primary concern will be whether such "ethical parameters" could feasibly be built into the conventional models on the basis of equity principles. Therefore, in the latest test, we will try to see whether the model (as verified logically) promises a tangible solution to the problems of disadvantaged and whether shows the ways and practical planning tools in order to heighten their position.

Shortly, such a model should still base on the conventional TPMs (Transportation Planning Models) and conform to their structure, for still we appreciate their "tangy" usefulness. When examined through, it can be observed that they are for overall improvement of transport but not for a targeted group. Yet, although our model will focus on those disadvantaged, in fact, without depriving the Bentham's general goodness. That simply resembles to Pareto Optimality principle; when a group's position is heightened, the other group should not be worsened off. But, in this study, a group is expected, *at least*, to equalize to the overall average (we mean not to the "advantaged"). Equalization, on the other hand, to the advantaged would have caused another imbalance (inequity) in the general view. Equalization process in the model is the most crucial part to pay attention simply because of the difficulty to find the means of equalization. That will necessitate running a simulation module to see the hypothetical effects of policies. Such simulation-based models hopefully exist.

It should urgently be noted that the model is not for the aim of producing data but to prove its usefulness. Therefore, there is no room for undergoing a devoted transportation planning effort with a model yet to prove its usefulness for the local area. Any data could be used to see whether the model runs properly. Nevertheless, we have discovered that the existing data of the various studies in Turkey were not suitable to the modelling purposes presented here. Therefore, it is decided to test the model in wholly a new area. In this sense, the model will be a deductive one evolving from theory to model that is to be verified on the basis of new data (ie, real data).

1.2.1. The Body of Thesis

This way of handling takes a high place in theoretical discourse and the methodology of convincing on its dialectic. Yet, it is not intended to navigate around philosophical metaphors in-depth. We will only cite such viewpoints from the arguments already acknowledged in the literature that such a study is necessary and has its backlash. For the first time, the ethical considerations will require building of a new methodology to be verified first. Hence, it is advised that it be an ad hoc divergence from the other known models that have got less concern for ethics.

At this point, it may be helpful to elaborate little on the meaning of the terms advantaged and disadvantaged: Being advantaged means the state of being superior in conditions of one aspect of travel relatively to other(s). Being disadvantaged similarly is the state of being worse in conditions of the aspect relatively to other(s).

The thesis will base on three main hypotheses: 1) The existing transportation has left such disadvantaged groups markedly off the system benefits, and the "disadvantagedness" is being increased in quality and quantity 2) The conventional Transportation Models have not brought the necessary cure addressing to this specific situation of those groups but maintained the status-quo, and, 3) It can be possible to help improve their situation through a normative modelling approach.

These hypotheses are to be firmly tested and verified. While the first one is to be proven on the basis of some techniques and strong arguments from literature, the second could only be verified by citing from the literature, which will take place in the Chapter 2. After the Hypotheses (1 and 2) are proven, the purpose of the thesis will be to verify its main promise: Creating a new method of modelling to accomplish the third hypothesis as stated above. The very summarizing statement of the thesis can be put in words as:

> "In such an assumptive context, the thesis will come forward with such a statement: "The disadvantageous position of some urban travellers requires some policies in order to improve their conditions. We take it granted that this could be done safely, and this can be done through the

> modelling steps. Thus, it requires the search for a model to validate their situation and also construct a model of solution (ie, a normative modelling)."

1.2.2. The nature of the study

The thesis work is heavily experimental work rather than the theoretical and literature search. But, this does not necessitate skipping the conceptual work that is preliminary to the study explaining the rationale of the study behind.

Since the study (and the model) is a heavily constrained type and limited by many assumptions and restrictions, it is ad hoc, serving only to limited number of aims set but not to what an exactly comprehensive, a "perfect" planning study requires. The target test area is basically narrowed down to Home-Based Work trips including here also the school trips. Therefore, we could only observe the so-called "regular" trips of the citizens that are basically the work and school trips in our case study.

Again, since the purpose is the testing of the model, we could comfortably take a limited number of traffic assignment zones: 12, enough for a small city. We will go into detail about zoning and sampling considerations in the Chapter 3: The Case Study and Data Manipulation.

Here, in this section, we will list the ambient (general) assumptions and constraints as to define the content of the thesis.

1.2.3. Assumptions

Basic assumptions and the restrictions of the "ideal" modelling approach will be:

1. The aim is only to test the model; thus, forecasting of future demand is not certainly intended at this level but only for the base-year for comparison reasons.

2. Calibration is necessary but the accuracy of calibration is not the primary concern, since our aim is not certainly to reach the true knowledge at this level. We are not seriously involved in the transportation planning of a town.
3. We will run a simple sequential (Four-step) transportation planning model, which constitutes the basis of all models. Yet, we may not take trip attractions or traffic assignment steps interchangeably (simply because these steps contribute less to the testing of the model, and, also they are the most difficult parts of the modeling in especially collecting the required data).
4. Since the model is established on the O-D estimates, and the calibration is needed, the Gravity Model will be a doubly-constrained one.
5. Aggregation levels will mostly be on the basis of zones. That is also to say, the model will be zone-based model, where values are aggregated from the person-based data. One of the major reasons in applying zone-based aggregation is that the package (TRANUS) used in the model runs is zone based. Therefore, the positions of disadvantaged/advantaged will be determined accordingly at the level of zone aggregation. But, sometimes we may also use person-based aggregations, or even household-based aggregations when it is necessary. But, aggregations can be done from bottom (individual) to the top (zones).
6. Weekend trips possibly need not be taken into consideration for testing aims of the model, which may otherwise cause noise. Weekend trips are more irregular and pose different characteristics than week trips. We want to have a simplified view.
7. To simplify the model and for clarity, we will only consider:
    - "general" trips (or, "average") and frequently done "everyday" trips (we call "regular" trips)
    - vehicular trips are our focus since they are more observable (not including bicycling)
    - trips of those 6 yearsold and above are taken.
    - The model applied to disadvantaged and disabled will be the same in principle with the conventional one. Both will be run with the same software package.
8. TAZ (Traffic Assignment Zones) boundaries will probably coincide with that of the district (mahalle) zones for simplicity but in some cases may not; the zones will have

centroids determined heuristically (simply because the aim is here just to test the model) as the gravity center in relation to the places of the household samples drawn.

9. Whatever the interviewee' statement is, true or lie, will be regarded as the true statement.
10. Little trips (that can be covered under "social" trips) are not concerned but major ones (school, work, shopping, etc.) as expressed in the 5th item. Likely, pedestrian trips are out the concern; yet, they need to be calculated for exclusion. Therefore, they will take place in the model accounts and results.
11. The link capacity calculations may not be so elaborate. The calculations are not for each direction but, after the total is calculated for the road, the average is assigned to the directions.
12. The "Equalization" part of the Model (last phase), which is about the policies to improve the travel conditions of disadvantaged, may not adapt to the cost considerations in terms of system efficiency; the model described here is free of many monetary shortcomings that, in fact, really exist in the real life. Our model is not an optimization one and does not promise to solve cost-related or system efficiency related (profit maximization) problems here. To see whether the model works or not in terms of providing the "equality", what we look for, we will ignore cost-related criteria. Yet, the cost consideration from the point of user is within the concern of the study.
13. Similarly, whether the transportation system operator (municipality) can supply the technologies for this improvement is not our concern. It is assumed that the municipality is able to supply everything (even if not so in reality) and it has got to supply every resource needed.
14. The subject (case) city of modelling need to be medium-sized (Aydın is quite suitable) posing not many complexities, and it has the clear/definable boundaries for the modeling assuming that there is no external trips coming from outside and going outwards and by-passing. All freight and other components of traffic will be out of concern, and therefore will be extracted in the calculations. Those commuting from outside the boundaries of concern area, and outer districts, (which is probably the contiguous settlements of Aydın) are also assumed to be

external, and not taken into the concern. Thus, we need not have to conduct (external) cordon traffic counts.

15. As related to the 13th assumption, the expressway newly constructed is not accepted as one of the intra-urban traffic distributors but of the external traffic, therefore, is not taken into consideration.
16. We expect (or, assume) all trips originating from home will end at home again within a day. Or, in other words, we focus solely on the Home Based trips (for work and school trips). Though, Non-home Based trips are out of the concern, they are assumed to be internalized in the home-based trips. But, separate handling of Non-Home Based trips are difficult and requires some further surveying techniques.
17. Additionally, since every trip ends at home, total trip production must equate to the total attractions.
18. Although essential, we will not consider here land use interaction, because of the complexities it may create, as the component of the modelling since our concern is basically with the social one (therefore, the most important parts of the model automatically becomes Trip generation and Modal Split stages).
19. The transportation network is basically composed of the currently used main arteries and district distributors. New streets and boulevards under construction, or that are incomplete yet, or are not thoroughly used, are not accepted since they are not currently available.
20. The interview form should not only be regarded as a typical form for transportation planning but also for measuring the disadvantagedness levels of the citizens.
21. "Disadvantagedness" will be considered for only the urban users of the system but not for the operator/government, non-users (or, external users) or other indirectly impacted groups. As mentioned earlier, the costs and benefits of the system operator, or of other parts are not within our concern, here.
22. Statistically, all data is assumed to be Normally Distributed, even if they may not be.

1.2.4. Terminology Used in the Study Context

The terms listed below are mostly the ones used according to what is meant shortly by the use of the term conformingly within the context of this study. Some of them may grammatically be wrong that here serves to shorten the long phrasing of words instead. Some short-cut terms, such as 'ideal model' may also serve to recall a concept without introducing long explanations every time.

"IDEAL" MODEL: The modelling approach offered in this thesis work by handling the population as divided into two categories as disadvantaged and relatively advantaged. Since the promise is normative and has the idealism to maintain equity, it is called "ideal".

ABLED: all people who are not involved in any category of disabled

ADVANTAGED (see also disadvantaged, and Normality): all people that are not classified in the category of disadvantaged. Mathematically, subtraction of disadvantaged from all (Normal) people leaves out the advantaged automatically.

AGGREGATION: converting person or household-based data to the zone based data by simply taking the arithmetic mean. The aggregation should be tested that it be representing the real collected data.

AIR-DISTANCE: distances measured on the map

AMELIORATING-VALUE (see also WORSENING-VALUE): data (variable) value scaled so that when increasing it informs the situation of the person (household or zone) gets better such as the value 4 is better than the value 2 (used in Standardization Process of data).

BASE-YEAR (PLANNING): The modelling and the model run for the current situation with no policy consideration and simulations. Simulation results are to be compared to Base-year (no policy) situation.

CAPTIVE GROUPS: Especially among the transport disadvantaged, those who have no choice other than one travel behavior (such as peak travellers who only travel at peak hours, a transit captive who has no alternative other than transit for travelling)

CONVENTIONAL (MODEL): Typical four-step modelling approach applying the most basically known processes. Conventional model, within the context of the study, meant the model run for Normality.

COUNT VALUES (see also model values): the traffic counts from the streets where screen line counts are made for the peak hours, which are to be compared with the model values for calibration.

DISADVANTAGED (see also advantaged, and normality): those who are relatively less benefiting, or usually suffering, from the existing transportation system, or, are frequently in disadvantageous position due to their personal reasons. This class is determined objectively as the outcome of the clustering technique.

"DISADVANTAGEDNESS": Here, it is intentionally emphasized on the relativity of the term, which differs from case to case, from one person to another, due to the different conditions. Note that the word is grammatically wrong. It replaces the phrase "disadvantageous position".

DISABLED: those who are frail and handicapped, having (an) organ(s) malfunctioning, of whose movement ability is usually constrained. It is expected that disabled suffer more from the disadvantageous positions.

EQUALIZATION: is any effort in attempt to equate the disadvantaged to the Normality, which is to be proposed as the final conclusion by the study.

EXTERNAL TRIPS: Trips by-passing or ending (originating or destined) beyond the city limits defined in this study

FOUR-STEP TRANSPORTATION PLANNING (see also CONVENTIONAL MODEL): the planning approach following up consecutively the four basic steps of the conventional transportation planning: Trip Generation, Trip Distribution, Mode Split and Traffic Assignment.

HOME-BASED NON-WORK TRIPS: Trips other than work purpose either ending or beginning at home

HOME-BASED WORK TRIPS: Trips with work purpose either ending and beginning at home

LAND USE INTEGRATED (OR, INTERACTION): usually refers to the models with the land use variables.

(the) MAIN AXIS: We mean the Adnan Menderes Boulevard, which makes the commercial center of the city and where almost all public transportation routes overlap.

MODEL (or, MODELLED) VALUES (see also count values): The output values from the TRANUS software, that are to compare with the count values for calibration.

"NATURAL" CLUSTERING: this clustering technique is literally called SOFM (Self-Organizing Feature Map) with which the data are clustered automatically with no specified criteria but given the set of rules or dimensions. For easy understanding, here, we call it 'Natural'.

"NORMAL", or NORMALITY (see also advantaged, and disadvantaged): all population of concern. Mathematically, summation of advantaged and disadvantaged. It also represents the standards and local values for all area.

PRIVATE TRAVEL/ TRIP: Trips realized by private modes, most usually by automobile. Private trips are usually meant comfort and convenience, thus, associated with advantaged.

PUBLIC TRAVEL/ TRIP: Trips realized by public modes, most usually by "dolmuş" (called "dernek") in Aydın case. Public trips usually recall the disadvanatgedness.

REGULAR (TRIPS): Trips realized for the purposes of work and school. Routinely done social/recreational or shopping trips can also be this kind. These trips are also associated with peak hour trips

ROUTE: set of links on which a transit operator operates its transit vehicles

SEGMENT: link between two nodes.

SINGLY CONSTRAINED MODEL: Trip Distribution model approach using only A_i calibration values in the case non-availability of the information of attractions but only productions from which, in another iteration, Bj calibration values can be found.

SOCIAL TRIPS: Trips with the purpose other than work or school, such as recreational, sports, visits, shopping, religious, etc.. Social trips are usually irregular, and thus, hard to estimate in models.

STRUCTURAL DIFFERENCE: Global (or, overall) difference in the final results of a model stage (for example, Trip Distribution's) between that of Normality and that of disadvantaged.

TPM: Transportation Planning models, usually used in the sense to represent first generation four-step models

TRAFFIC ASSIGNMENT ZONES (TAZ): Zones designated for the purpose of transportation planning. Centroids represent the zones and conceived that trips are originated and destined to.

TRIP ATTRACTION: Trips that are attracted by the zone

TRIP: was defined as any movement from origin to destination for the distances more than 300 meters for a given purpose (Ortuzar and Willumsen, 1994, 79). Yet we can assume for more than 500 m for vehicular trips, but no distance criterion for the pedestrian trips. As written on our survey forms, trip is described as the travel by a vehicle or walking and by purpose from one point to another in the urban area with no break in the movement.

WORSENING-VALUE (see also AMELIORATING-VALUE): data (variable) value scaled so that when increasing it informs the situation of the person (household or zone) gets worse such as the value 2 is better than the value 4 (used in Standardization Process of data).

1.3. The Overall Methodology of Search and the Organization of Thought

Briefly, the research methodology is comprised of those steps:

- Literature survey
- Problem definition
- Pilot study area
- Conducting the surveys (data gathering)
- Model runs (as four-step planning) for two categories for the model validation
- The simulations to measure the effectiveness of the policies taken

Huge number of parameters (ie, data), most of which are qualitative, is to be reduced to few major (function) variables. They require being scaled (between 0 and 100 points) and comparable. Comparability is also necessary for the clustering process.

The usefulness of the method described is important here from the city planner viewpoint. The model should be a tool in producing policies to help improve the conditions of the disadvantaged in transportation. The captured policies derived from the differences between the two model runs, one for normal and one for the disadvantaged, are to be tested through three simulations. Thus, the very clear-cut definition of the disadvantaged plays the key role in this study. For this, self-organized multi-variate clustering technique will be utilized.

After verified, this study with the set of methods is expected to provide an initiation and secure path for further researches, as an integration effort to conventional models, that can be followed in similar ethics-based studies.

Chapter 2

CONCEPTUAL FRAMEWORK

In the first part, ethical confrontations (mostly equity related) in the existing transportation system will be discussed. Besides, how automobile and highway-based transportation has affected modelling approaches and, vice versa, will be emphasized and exemplified (Banister 1994; Barry and Simpson 1994; Bly and Webster, 1984). Then, there will be the discussion of the deterministic features of the conventional models (which are already been examined) and their positivistic basis that preserves the status quo transportation view. All the properties of some important models as belonged to different categories in terms of the four basic modelling approaches are categorically examined to see their misfits or shortcomings. Thus, it is intended to cite a detailed explanation of a conventional model in which both city planner and engineering perspective are going to be united.

In the second part, the Turkish experience and modelling efforts will be briefly overviewed relating to the transportation investments after 1963. This will give an idea to verify the disadvantageous position of groups in terms of the modes they use. Finally, the method of clustering that might be used to define the disadvantaged will be introduced. Correspondingly, the general transportation system and access related standards in the determination of threshold values for identifying the sub-categories of disadvantaged (explained in Chapter 5) will be reviewed briefly. Especially the standards for disabled are of prime importance.

2.1. The Existing Structure of Transportation

2.1.1. Ethical Considerations and Problems

Though the resources are scarce on transportation-related ethical issues, in the literature, Okun's (1975) and Nader's (1965) works provide some thoughtful insights based on the equity and efficiency struggles that will be useful to apply to daily transportation conflicts conformingly. Such studies do essentially feed on the equity concerns. By this virtue, it is emphasized in this study that transportation, as a routine daily urban activity, has also a "social" component: The transportation applications cause inevitable inequities: The applications, in the long run, distribute benefits to some and costs to some others. In the short run, travels may be more efficient and comfortable to some and inefficient, uncomfortable and more costly to others. Therefore, it must contain a progressive handling from especially social point of view. In this study, only the short run (ie, daily travels) inequities and impacts will handled.

According to the NPTS 1990 reports (quoted in OHIM, 1994), the emerging issues in the West has been lately on the travel equity with ethnic/gender issues such as the distribution of innovation in car technology, the women's place in travel activities and the rate of use of private vehicles by elderly. Car ownership significantly increases among elderly: walking and transit declines. However, This may be the result of car-oriented city and, even for those elderly, owning a car may be compulsory for their accessibility needs. Urban poor is also observed to have minimum trip rates compared to the better off. Yet, urban poor has slightly more trip rate than the households without vehicles who live in suburbs in a typical day: The question is, then, on whether this situation arises due to the choice or lack of transportation vehicle (OHIM, 1994).

For women, for example, automobile provides flexibility, security and trip chaining, which saves time for especially working mothers. 37% more than men, women are likely to have work-related chain trips, and 15%, non-work trips. A working mother without a car would be one of the most suffering people among the disadvantaged (OHIM, 1994).

Apparently, the ethical (and equity) issues are quite different in the Western developed societies than in developing countries as Turkey. While having one car is certainly not an advantage for a family in the developed societies, it may make an important indication of being advantaged, for example in Turkey, compared to non-owners at all. Blacks are seen as the disadvantaged since the majority of them could afford to buy only older cars while whites consider for second or third cars with technological innovations on them. In Turkey, there is no such a racial issue for equity consideration.

Another ethical issue in this context arises from the fact that the world increasingly becomes disabled. The exclusion of disabled or mobility-impaired from the city amenities is a nightmare for those people. The death rates have been reduced but the associated result is the increase in the rate of handicapped and old people who need more attention, in regard to the developments in medicine and insurance amenities (Blaser, 1996; Brail et al, 1976). The world is getting increasingly old, too. Yet, the car ownership and mobility of the elderly has also increased in the developed world (Banister 1994, pp.165-7).

It is the similar trend for Turkey: while the proportion of old was 6,88% in 1990, it is expected to be 7,85% in 2005 (Kaya 1994, p.5). Thus, transportation service and facilities require some modifications for those people. Especially, those handicapped have many difficulties in travelling in the urban environments of Turkey.

> " A society that does not value people with disabilities tends not to value anyone." (Blaser 1996)

Yet, the ethical surge by now has still not fully matured level even in the developed countries. There is still not a methodological handling of the issue, not specific measures and emphasis in the literature. Hosmer (1996) have lately announced the significant place of the transportation ethics but only drawing the guidelines that refer to ten basic (historical) ethical principles. Hosmer's warning in his article (1996) was for the transportation planners' negligence towards creating a systematic research field for ethical problems that people have been facing almost everyday. He first urges the essential place of transportation in our very vital activities: health care, education, employment, recreation, social and cultural, etc. "Changes in transportation system do influence the quality of people's lives". But, he accepts that even the various ethical principles are in conflict among themselves. Then, he immediately warns that Bentham's Utilitarianism should not be the sole determinant of choice because of its undemocratic nature. If not all, we should at least try to prevent the damages that might come to either rights or as outcome to financial, physical, social or individual domains. Because, in the social contract, we did not agree to help each other but agreed not to harm others in pursuit of their right to self-development.

The other issue is the post-modernist situation of the models. From the professional viewpoint of ethics, the scientists and planners should be doing something concrete with the models, also attaining social objectives to overcome (or reflecting among the solutions) such ethical issues in their studies: Models are too away from realities. Garrett and Wachs in their recent study pointed just on the ethical responsibility of modelling studies (quoted in Sheck 1997, p.133): "The issue of precision in the modelling process has been brought to a new level of questioning". That also means not only the precision of the studies is the matter but, maybe, also the decisiveness and accomplishment of the task (mostly social objectives) they promise. Batty blames the models to be self-reflective but not working for outer realities:

> "Modeling has been acquired a life of its own.. retreated from volatility of public policy -making into its cocoon (world).. and not responded to the challenge of social change.." (Batty, cited in Banister, 1994)

The problem of mathematical irresponsiveness should let us handle models a little free from its deterministic nature in order to get rid of the inaptness to represent the qualitative factors in transportation reality. Yet, such a modelling approach would be very utopian, too: therefore, the mathematical relations will still form the basis of such models as accompanied by the set of assumptions. However, complex mathematical models are inhospitable among planners leading only engineers handle the issue who, in turn, ignore social/ethical or qualitative aspects of planning (Elker 1981, p.39, Ülengin and Topçu 1997, p.1067). Decisiveness of the model, here, is one of the most important measures for achieving a perfect modelling.

Fortunately, user friendly transportation planning softwares help breaking this rigidity of mathematics with the interface attributes enabling designer to proceed planning procedures without entering complex algorithms. Yet, first, the models created in these softwares are not specific to the local needs but ready "packages". They can hardly be customized to the local conditions. Second, the designer still has to know, at least, of basics of mathematical planning procedures and the theories used.

A model should, at least, contain measurable or comparable parameters and numeric values, or logical sets, to be readable. Thus, a new model having qualitative and ethical dimensions should somehow attain a success of measurability. That means the model should lead to the application of a set of criteria based on the accepted standards or ideal values to be defined as policy goals that will be used to measure and quantify the qualitative values or aspects.

Transportation design, in general view, requires a state-of-the-art organization to provide both access and mobility to all users equitably. Some users, on the other hand, have superiorities, or advantages, in conditions of access or mobility. Some have automobiles that provide quick and door-to-door access; speed, comfort and reliability as well. Some have less costing travels relatively. Some wait longer in bus stops while some never. As there might be "natural born" inequities for some, some are advantaged or disadvantaged due to the transportation system capabilities. A transportation system, or traffic design, should be so well designed that it be producing equitably well benefits and be costing to users at minimum as well.

Thus, before the project or policy application process, a designer must:

1) Know basics of equity and efficiency well
2) Know "how" to reflect this equity, without damaging the efficiency side
3) Monitor and record short run and long run impacts and changes that resulted from the project or policy applied
4) Develop ways to redistribute or avoid the benefit and cost impacts resulted from the policy application for equity

Although a transportation system might be supposed to serve efficiently, it is also expected to serve equitably, when considering the users might be relatively disadvantaged due to the system inefficiencies, that forms the basis for ethical side of the service provision. To form this basis, usually priority concept is employed in various ways. Priority is a strong tool in the application of equity in favor of disadvantaged in general view of traffic. At first glance, primary subject to priority, for example, would be that vehicles should be forced to give priority to pedestrians (Diandas, 1984, p.208). Or, private car can be charged of full costs it causes on resources, congestion, space, pollution and accidents. That reliance on car travel should be reduced to assist the transport disadvantaged is over-emphasized many times by authors (Moriarty and Beed 1991, p.141)

In Turkey, the so-called "traffic service" was determined in the new Traffic Law 4199 (of 1996) as "to maintain safety of life and property on highways (..) to reduce the transport cost and to provide the comfort.." and, in order to maintain these objectives "..the effective organization and monitoring of traffic, the education, health care of users , administrative, jurisdictional and technical services has to be provided.". From this passage, the constitution pre-empts the safety concern on the roads. That is, it should serve humans and efficient movement of goods.

From the point of social progress of individuals, Engwicht (1991) summarized the role of accessibility as (quoted in NHS, 1992, p.63):

> "The city provides a context in which people can share their common resources in a common life in order to build an environment in which, through mutual support, each individual can reach their highest potential: socially, culturally, physically, spiritually, intellectually and emotionally. An urban transport system is the means by which this mutually supportive community exchanges the resources and gains access to the commonly owned resources in order to enable each individual to reach their fullest potential."

From the social point, he adds, then, consequently that, "by building our cities around car (..) we diminish accidental interaction (and access)". He elaborates on these interactions that may have positive implications on communal life.

In an overall rating of importance of issues in the study of Levine and Underwood's (1996, p.106), the necessity of increase in the mobility of transportation disadvantaged is heavily emphasized. That shows that the access and mobility impairment, although ignored, has been a mantling problem to date.

Although being one of the most important objectives of transportation planning, it is not likely that the need for ethical consideration has arisen now but rather it has been ignored to date. Ethical consideration bases on the equity principle (will be examined largely in the Chapter 5: Equalization Process) that should be sought among those users, providers and those impacted from the transportation projects and applications. The subject groups are basically the two groups: those who are the system users and directly impacted from the policies and applications, and, those who are not the system users but somehow are impacted by the negative or positive outcomes of the applications or policies.

Equity problems mostly appear in intangible, or externalities side, of the impacts. If there are external benefits for some groups, they are not taxed. Likely, if there are some disadvantaged groups who are exposed to the harmful or undesired effects of the transportation activity, they are not compensated for this impact. Projects and policies are implemented with no adequate public participation asking each interest group that can take share from the outcomes of the projects. In the study of Levine and Underwood (1996), the method for multi-attribute analysis of different interest groups to influence the planning goals, with a mindful ethical consideration, was offered and tested for some stakeholder groups. It showed that, although there are objectives that all groups come into agreement but also the objectives they conflict.

Another issue is the preserving of the rights of disabled ("natural born" disadvantaged), older, young and those somehow disadvantaged in the system. Ethically, first, their conditions need to be improved to benefit from the system as much easily and effectively as those who can. Second, they need to be protected from the harmful effects of the system if others are not similarly so. And, third, they should not be discriminated or eliminated in the activity itself solely on the basis of their disadvantageous position. From the principle of equity, rather they deserve much better conditions even than the others! According to the ADA (Americans with Disabilities Act) of 1990, everybody including the people with disabilities has the right of mobility. Thus, efficient public transit means are required to provide for those people who especially need flexible paratransit services adapting to their special conditions[1].

Ethical consideration that planners should be armed with can be examined in terms of responsibilities or duties of the person coming from his representativeness of

1 Mini-White House Conference on Mobility and Transportation for Seniors, APTA, 1995.

institutions: The rules of ethics tell us what we ought to do with regard to our profession (Howe, 1994, 3-19). But, we also have our human values telling us what we should do in our actions towards others personally (ie, normative guide). The planner's role was examined precisely in the studies of Elizabeth Howe (1994, ch:6 and 7) who especially put the importance of the ethical/deontological education of the planner to recognize their crucial role in affecting lives. Yet, she had not placed any specific attention for the transportation case.

Among the ten basic ethical principles, the most relevant principle to transportation business seems to be the Rawlsian Distibutive Justice that has also the space dimension in itself (Hosmer, 1996). Its "distribution" attribute also correlates to the distribution due of transportation activity. But, in fact, all have the share of relevance to every ethical subject.

For a careful ethical examination, the first requirement is that city and transportation planners, engineers and other transport executers seriously require to be armed with philosophical and deontological education before they take decisions. Because, as mentioned above, they are not just applying their projects and not only providing a service but they do interfere with quality of lives; they can even make someone rich and some other poor (as in the pedestrianization projects).

2.1.2. The Automobile Factor

It is intended, in this section, to briefly discuss how automobile has contributed to the inequity between the transport advantaged and disadvantaged. It is, indeed, seen as the core of the problems in transportation by many authors.

As one of the most influential mode of transportation, the invaluable place of automobile can not be denied for especially individualistic purposes when demanded as a necessity. This study is not to develop a counter argument blaming automobile for its harmful consequences but rather to figure the relevance of its chaotic effects as far as relevant within the context of this study. It is acknowledged that automobile is unsuitable way of mass transportation in urban areas and that the "auto-dependence" and automobile-oriented planning can cause many unethical consequences and inequities. Yet, for an elaborate work on those problems that "auto-dependence" might create, there is not much room to go into the details in the thesis framework. Instead, within the very limited scope of the thesis study, we will associate automobile's effects and contribution to creating the disparity (inequality) between the mentioned groups.

First of all, automobile is a wealth indicator and escalator; expensive commodity to own and thus an effective reagent to stress the owner's status and power. It becomes the attraction for people to own, and, therefore, an adherence to the power notion. It escalates the owner's accessibility and mobility compared to the non-owners, and produce advantages. Thus, the people who have cars rise automatically to an upper (advantageous) position while reducing the general well-being of the society and of their transportation situation. The inequity that automobile caused would be more apparent especially in car-based societies such as the U.S.

According to Webber (1982, p.60), there is one single equity problem between the car owners and people without car: "[A]s persons with cars (...) and suburban houses have become better-off, those without have become worse." And he puts the inequity adding: "..it is because some people are better off that others are worse off.". He especially relates the rise of social inequity to particularly the rise of automobilization trend. According to him, almost all advantaged are those with automobiles and almost half the nation (The U.S.) is affected from this inequity: "..those who are old, young, poor, and handicapped." (Webber 1982, p.61, Wachs 1982, p.53). Those who do not own automobile are even deprived of the access to economic and social life of the city (Wachs 1982, p.53). And, those who do not have the random-access are assumed to be disadvantaged. He sees the ultimate solution to equate the disadvantaged to the advantaged in creating a transportation system equivalent of automobile in quality and performance for people without car (1982, p.61). This is typically the PRT (Personal Rapid Transit) system. If this is not possible, even "direct cash payments to poor in the form of transportation vouchers" may be considered.

From the point of social inequities, it was emphasized, first, that automobile based transportation was undemocratic because elderly, young, disabled, women and poor are, in a great extent, excluded from the rights that automobile distributed over, which comprised almost 40% of the population: ".. that the transportation right is unequal distribution on the basis of race, sex, income level and other social differences." (1993, p.74). Second, this system also attacks on the existing rights (such as spatial) of all those groups. For example, disabled, elderly and young as pedestrians can not move freely in such a hostile environment. (1993, pp.84-87). And, this view is much more chronic and the effects are denser on these groups in the developing societies where the inherent system is usually not even automobile based and, thus, there appear many infrastructure inefficiencies. The problem is that multi-dimensional costs automobile causes over society are not tangible and easily recognizable, and that its costs are usually incurred upon non-users, and on the society in general, in the form of external effects.

Yet, within the limited scope of this research, the vast area of automobile's impacts can not be held largely. Rather, it can be possible to mention the everyday facts automobile has caused: even-worsening traffic congestion, over-crowded transit buses, spaces occupied by parked cars everywhere on the curbs, speed causing traffic accidents and fatalities are few examples. Pedestrians are confined to the margins of space left from the automobile's notorious occupation. Priority is given to the flow of the traffic rather than the flow of pedestrians. The automobile has irrevertible impacts on the city structure, especially the historic parts that should be preserved from the impacts of exhaust of vehicles. It deformed the walkable city structure into car-based cities. Thomson puts this fact as: " The basic form of our cities, towns and even villages is unsuited to the general use of cars."(1973, p.149).

Likely, the deterioration effects of the automobile use on the public modes were put in a manner of vicious cycle as in the Figure 1 (Bly and Webster 1984, p.148). According to that figure, which is peculiar to Western societies, automobile causes reductions in demand for transit use. Thus, the conditions and patronage of transit gets poorer. The users of transit, then, become disadvantaged from the worsening system of transit. Auto has also the final effects on the land use patterns from which disadvantaged are further displaced.

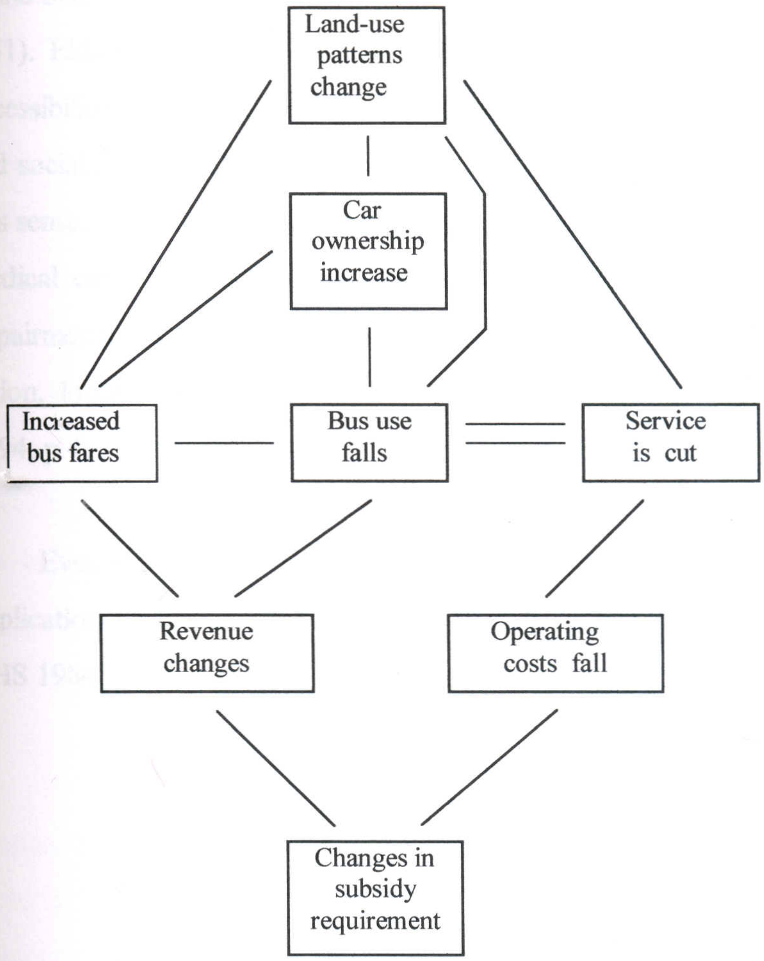

Figure 1. The Vicious Cycle of Automobile's Impacts on Transit Service Provision (Source: Bly and Webster 1984, p.148)

In the U.S. case, population groups without cars are found to be especially women who are retired and in the non-employed situation. From the point of where they live, those vehicle-less mostly resided in the central city (60%), who are mostly comprised of the poor and renters (Pisarski 1996, p.34-5). In the same study, it was found that vehicular trip-making habit of the aging population tends to decrease (1996, p.51). Elderly in Turkey similarly would like to be closer to the city amenities for accessibility reasons: shopping centers, religious facilities, health facilities, green areas and social activities (including relatives and neighbors), etc. (Kaya 1994, p.136-7). In this sense, transporting of old people gains importance because of their worries: crime, medical care, loneliness, lack of attendance, etc.. Old people also have functional impairments that probably cause exclusion from the trip making: reduced hearing and vision, locomotive difficulties, balancing disorders, anxiety, depression, etc. (Kaya 1994, p.4).

Even the increase in the number of cars at large could cause such an inequity implication on the society and urban pattern as Schaffer and Sclar put it (quoted in NHS 1984, p.62):

> "The automobile has given improved mobility to the middle class, middle aged. But, these owner drivers have not merely gained new mobility through the car; they have also re-arranged the physical location patterns of society to suit their own private needs, and unwittingly in the process destroyed and limited the mobility and access of all others'."

2.2. A Review of Transportation Planning Models

2.2.1. What Models Promise in General

The criticisms to transportation models are initially related to the mathematical ones and the positivist science, which had its origins in the late 19th century with the foundation of new revolutionary paradigms in physics such as Heisenberg's Indeterminism, Planck's Quantum Theory in 1900 and Einstein's Theory of Relativity in 1905 against the Newtonian paradigm.

Initially being the deterministic approach, transportation models were criticized still to be positivist and thus, being heavily mathematical representations, unrealistic because of the failure in representing the uncertainty in transportation. Yet, the practicality and explanatory power of mathematics (that represents positivism, here) was also acknowledged among many authors.

Due to the theoretical weakness of the transportation modelling, the general failure of the transportation models was related to its complete dependence on the mathematical representation that was deemed to be unsuccessful in adapting the changing conditions and needs, and uncertainty as well. Thus, the generic models and their derivatives, too, could not successfully transform the realities of past into the future realities. The first generation models were just to estimate the future needs for transportation facilities. But, it was later understood that this approach had no strategic (long-term) notion and would not follow the goals aimed. Therefore, the land use and policy attainment were traced down to those TPM models, which were acknowledged as the basis of all. Especially, the ILUTM and Lowry models have gained a reputed success in this integration.

In the realistic and pessimistic atmosphere of the 70's, with the influence of the economic restructuring, the models were found to be the legitimacy tools for engineers to realize their projects. The models were found to be fairly mechanical among the aggregate approaches. Disaggregate (behavioral) models, on the other hand, tried to satisfy the need for human factor and put the behavioral variables, for persons' enigmatic behaviors into it, which were much easier to handle by computer techniques in simulation processes coming to the 90's. At the same time, the policy oriented package models (UTPS) started to gain popularity, taking the development or technological change ingredient (like growth factors) into the accounts, which are now at infancy level to develop.

2.2.2. The TPM Models

There has been so progressive evolution in the transportation modelling relating much successfully to urban planning from the very infancy level of the sixties to the more complex and elaborate level today. However, as commonly agreed upon, there has been little progress in establishing a perfect model gaining a firm and sound theoretical ground.

The first generation models have poorly contained planning goals and land use policies. One of the first classic aggregate studies was said to be Chicago Area Transportation Study (1960), that first considered a comprehensive planning approach with the passenger and vehicle estimations. The other forms of models have evolved from this basis (Banister 1994, p.21-2). Thomson defined the first conventional TPM (Transportation Planning Model) steps in 1974 as:

. Trip Generation
. Trip Distribution
. Modal Split
. Traffic Assignment

With the 70's, transport studies were felt almost useless: models were inflexible and not responsive to the real changes. Lee (1973, cited in Banister, 1994) stated the necessity to insert the goals into the models for large-scale projects. Actually the same techniques of the 60's were being used under the planning context all through the 70's. Land use models borrowed from the 60's also gained more importance. However, in almost every study, there was the problem of insufficient data. Only the Lowry's model (1964) made a breakthrough simulating an urban environment based on the spatial distributions of employment and the cost of travel.

Coming to the end of the 70's, there was the proliferation of models with stronger theoretical emphasis which are mostly the gravity type allocation models adopting mechanisms of change (Banister 1994, p.48). Meanwhile, there had been many objections to the systems approach that grew in the last decade in the transportation studies. With the 80's, some more strategic planning approaches became popular: For example, the disaggregate type models first to understand behaviors (or, patterns) and then solve the problems (like traffic congestion) aggregately with the aid of high technology (computer handling capacity), IT and intelligent transportation technologies (ITS). In the following course, so-to-speak, the mid-80's witnessed the demise of conventional TPMs. Towards the 90's, the governments played fewer roles but the market forces. The promise was to solve the problems caused by the private car use. Lately, package programs called UTPS in the U.S. were available in the market. However, forecasting was still insisting to be futile with higher inaccuracy to all the elaborateness of model designs. Development scenario building and simulating the effects of the "scenario" development is another important modification in the late GIS-based models (especially TransCAD and the EMME/2 versions). Especially, the planning approaches integrating the sustainability concept are at the agenda.

As of the further developments, even lawsuits were filed lately against such capacity-increasing and status quo retaining models that are rather expected to comply with the regional planning objectives (Sheck 1997, pp.131-3). For example, MTC (Metropolitan Transportation Commission) in Bay Area was found inadequate to comply with the CAA (Clean Air Act Amendments), first, failing to reduce the private trips and, second, to reduce the pollution. In fact, the model had resulted in more trips and traffic growth. Thus, the modellers are asked to re-model and comply with the environmental amendments.

The remaining criticism has been over the TPM's emphasis on automobile and highway based transportation (Freund and Martin 1993, p.20). And, this is called "institutional blindness" by the author: "this approach sets barriers before the realistic and solution- oriented planning approaches that are genuinely to solve real problems in transportation ahead." Though marvellous access controlled and speed freeways are constructed all around the U.S., the travel time still remains the same since the Second World War (1993, p.23).

2.2.3. What is Missing in Conventional Transportation Models

The conventional TPMs, first of all, were not theoretically sound enough and they tended to preserve the status quo trends, promoting more travel and mobility, and resisting to change factor. The constants in the models are stable, and therefore, TDMs pre-determine the future demand that might probably be otherwise different. There is no room for radical policy making and innovative urges (like technology impact). They are, thus, not suitable for planning aims in the strategic sense but rather to serve the "trend" arisen for current demand (Banister, 1994, p.131).

Second, qualitative and social aspects were less considered. Ethical evaluation in TPMs was not among the priorities. The Initial TPMs were criticized to have little concern with the "transportation needs of the community at large" and that they had inadequate level of public involvement (Bruton 1975, p.21). Models by now have generally evaluated too few alternative plans or policies.

TPM models are calibrated for the existing situation and time they are held but not for the future, which is contradictory to their futuristic promises. Some other minor shortcomings can be:

- assuming that human is rational is <u>not</u> always true
- each four step is independent, which, in fact, should be all correlated tightly and affect each other in loop cycles
- especially, it is narrow thinking that modal split is only between car and bus in most of the models, walk, bicycle or other transit modes are ignored
- all sorts of travel patterns are oversimplified, standardized and reduced into work trips, which, in fact, only one third of trips are work trips
- computations are generally erratic
- behavioral change is basically cost based and related to income levels only
- more focus on demand and less attention is paid to supplier side (operators, police, etc.) of the transportation process.

Disaggregate (Behavioral) Models lack the general theory of travel behavior. Statistical explanation is also weak. Diary studies are quite subjective. On the other hand, individuals one-by-one can not form an aggregate view of the system from which a neat conclusion or resolution can be derived. They only help the understanding of the behavioral aspects of the travelling. Behavioral models are of two types:

- one that uses utility (maximization) theory and is based on the rationality of behavior,
- the other uses Psychological Choice Theory, which is based on randomness

Yet, uncertainty in behavior and the continuous change in the state of mind (in decision making) take place at the margin, thus, is ignored in calculations. Only way to derive travel demand characteristics is to apply the stated preferences, or derived demand techniques.

Probabilistic disaggregate models need lots of data at hand and many random samplings. However, it is the best way to establish accurate data for policy planning. Utility function for each mode (alternatives) for each trip is a convenience for model building. Because the uncertainty, complexity and flexibility have now increased greatly, the modelling bussiness is open to the new methods to be developed for the appearing needs (Banister 1994, p.145).

In Land-use Type Models, the model building becomes more complicated because of the sole complexity of the land development process (Banister 1994, p.138).

Integrated transportation studies have always tried to include vision, financial constraints and potential transportation problems. Yet, poor empirical data has always been the weakest point of these models leading to the inaccuracy. Qualitative aspects can hardly be turned into quantitative expressions. It was seen that models are impractical and the results are unreal when population gets larger (Barra 1989, pp.65-7). On the other hand, since the social and economic differentiation is huge, the criteria to define the groups have never fully become satisfactory. Additionally, since utility concept is subjective in real life, it cannot be aggregate, yet, we cannot keep account of every individual (and make sense of it).

Another question is that the aggregate approaches standardize all tendencies and, thus, lead to determinism (Then, should politicization of the models be allowed?).

The ideal is that transportation models should be robust and adaptable to changes happening in real life. Yet, there occur many errors in modelling process with the complexity increased. Error types are many in modelling (Ortuzar and Willumsen 1994, p.67-9):

. human errors
. statistical errors
. modelling errors
. prediction errors
. external factors
. social factors
. misplacement of tests

As a result, every year approximately a +, - 20 per cent of error range occurs, which is acceptable after all.

2.2.4. The Rationale Behind New Modelling (Necessity for a new Modelling)

Taking all these considerations mentioned above into account, the model that will be proposed here should be addressing to some of these inefficiencies or misfits in the conventional ones. First of all, it is necessary that, for complete interdisciplinary cooperation, the models be traceable also by the planners but not only the engineers. Yet, we know that mathematical models are not well adapted to the policy-driven models well and also the qualitative aspects of transportation. Therefore, there needs to be a common ground where both approaches meet (mathematics and qualitative aspects).

The Land-use integrated models, on the other hand, have not brought actually much novelty to the classical approaches but even complexity. Yet, this complexity can be overcome through computer-aided models. They are much useful in many aspects especially in <u>simulating</u> environmental/economic impacts but not in solving the main dilemmas including the ethical problems.

There arises a necessity for a normative type of modelling that has been missing in the conventional ones. There also needs a modelling that includes qualitative parameters. A modelling effort that also clearly defines the benefit groups and takes the related ethical/social parameters derived from this delimitation, and which are supposedly qualitative, into the calculations. These calculations must be helpful to specify the actions the planner can take for different social categories of transportation. Here, it is the purpose that such a model can be a planning tool that the planner can make use of. For this aim, actually any model available in the market should be compatible since we are only interested in the outcomes of any model.

Here, the objective of modelling becomes not to estimate the future after all. Instead, maybe the models should adapt to real-time changes. We can have estimations for either very short periods inserting routinely the previous estimations as fresh input data into the model of next periods, or inserting real time data into the model.

- We should try to find out whether we can achieve our goals of planning and policies we determined at the beginning for the future with the accountability by the model.
- whether the outcome of the model serves the ethical consideration in transportation, and thus, sensitive to the needs of those disadvantaged, too as well as to the general people
- whether we can figure out some innovative ways of measuring the qualitative aspects of a model (policies, qualitative improvements, technology, etc.).

In the remainder of the thesis, we will deal with these considerations and "how to evaluate the outcomes of a model" for two benefit classes in transportation.

2.3. The Case in Turkey

2.3.1. Urban Transportation Problems in the Major Cities of Turkey

This section will enable to overview the general policy environment which gained speed from the 50's and shaped the today's view of the transportation in Turkish cities, before we enter the modelling process, which might even determine the way we figure the form of the modelling chart.

Our contemporary transportation problems date back to the 60's when they tangibly appeared and when public consciousness was awaken with the then swiftly changing political environment. Turkish society had an initially gradual but lately growing interest in owning private automobiles that have increased the mobility of the society starting from the 60's. Responding this tendency, the middle income classes were encouragingly eased to buy their own cars with especially the availability of credited sales. Net increase in the rate of the national income per capita had also been the secondary factor that fuelled this tendency which was around 68% annually, resulted in the heightening of the purchasing power between 1950 and 1969 (Yerasimos 1976, p.1486).

According to Hamuroğlu, the automobilization process had also been promoted by the continuous construction of highways since the 20's: the increasing rate of constructions between 1920 and 1950 was five times, but it was 3.5 times between 1950 and 1960 (Hamuroğlu 1998, p.15).

With the central planning tradition, the policy-making has shifted to supporting of the public modes of transport, acknowledging that transit was well known not to survive without public subsidies that were coming basically from the central government (ie, Ankara) (Türkkan 1979, p.41). Interestingly, that subsidy condition was truly accepted to be natural and even found "healthy" simply because of its social sense of support (wealth equalizer), as largely believed, though some contrarily argued that heavy reliance on subsidies and low ticket pricing do not better-off the situation of poor but rather will worsen the quality of the services, of which the regular users are mostly the poor and middle income groups. Thus, this subsidization may make the public service provision incompetent with the private modes, which will lead to again unequal situation between public and private transportation. Even if originating from the social justice considerations, the low fares in public transportation did not help secure the place of public modes but maintained its position away from attracting private drivers.

The objectives of subsidies to public transportation were set as to (Türkkan 1978, p.47):

- support mass transportation systems
- provide a reliable service to those who do not use private modes
- sustain a transportation system that was oriented to the needs of elderly, young and handicapped (and economically disadvantaged), etc..

Meanwhile, Turkey's foreign oil dependency increased substantially that had gained speed from the early 60's, which is quite obvious from the energy consumption statistics: Oil consumption was 5% of all consumption items in 1950, 14.6% in 1960, 42.9% in 1974 and had then been expected to be 50-60% for the year 1982 (The Chamber of Mechanical Engineers, İzmir Branch 1975, p.32). That also marks no national policies on transportation matters had been considered then.

According to the Yerasimos' findings, the privatization in Turkey, that had begun followingly with the new (Menderes') government's development program in 1946, was very influential to determine the transport and economy related investments that were to happen later (1976, p.1346).

The Marshall Plan suggested to invest on many highway projects, and donated thousands of motor vehicles to activate the American goals on Turkey; 9093 km of roadway was increased to 34536 km in 1963, whilst railways increased its length from 7636 to only 7911 km. According to Max Thornburg's report, who was known to be very effective in the formation of policies on Turkey, in 1947, the allocation of state investments must be channelled into the infrastructure (especially, transportation and highway) instead of productive sectors, which was, no doubt, in accordance with the American purpose (Pekdemir 1997, pp.317, 329-30). Accordingly, the highway constructions by the American support were to be increased when coincidently Highways General Directorate (Karayolları Genel Müdürlüğü) was established in 1950.

Consequently, the adverse effects of this situation were that, due to the rural unemployment, the migrations to the urban centers caused inefficiencies in urban infrastructure and other social instabilities. In a sense, all the economic development plans were solely fixed so as to base on agricultural and rural development. Highway constructions, thus, became sort of idle investments.

The facts that Turkey was still a developing nation and it had a latent consumption demand awaken and that EEC had been encouraging only the mounting, preparing a good market for the European industries (Avcıoğlu 1998, p.927), and finally that since Turkey was heavily dependent on the foreign credits, lead to import their products including also the automotive parts (Yerasimos 1975, p.1600). Because of the automobile imports, there arose an economic deficit in the payment of foreign dept, which reinforced the mounting industry that had been established before. This situation created some pressures towards establishing a native automobile industry.

The first national mass automobile production was "Anadol" in 1966 (Tekeli 1971, p.10). The Fiat was in production line in 1969, and then Renault in 1972 (Hamuroğlu 1998, p.15). Yet, still the cost of the native production was much higher than the imported ones (Avcıoğlu 1998, p.886). The investments on automotive industry gained speed from the mid-sixties and the big firms such as Chrysler, BMC, Otomarsan, Otoyol, etc. were established in Turkey at this period. The preliminary marketing conditions had become all ready before they arrived (Türkkan 1979, p.711). In the meantime, a campaign to gear up the desires for automobile ownership and automobility was kept alive.

Through time, the rate of auto ownership increased much beyond the rate of what had been expected for the 2nd Five year Development Plan period. The view became familiar to the case in the 3rd Plan Period: The expectation for the end of the period was 50,000 sales per year, but, in reality, it reached 57,000.

Today, when we look at the motorization problem in Turkey created by automobility trend, it can be noticed that the phenomenon is a chronic syndrome appearing with the accident figures. According to the statistics, the accidents happened mostly due to driver's errors (around 75%) and also pedestrian's (around 15%), which is, of course, false. System-due (ie. automobile-based system) errors in a greater portion should also be included in this view[2].

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2 For further comments, the issue is largely held in the same Atauz' and Hamuroğlu's (1998) articles, and also in the Freund and Martin's (1993).

According to Table 1, most of the fatality and injuries occurs among the age groups of 21-50 and teenagers (Karayolları Ulaştırması 1992, p.74). Yet, this information may be quite misleading since it does not take into account the participation rates to traffic. Actually, it was verified that both young and elderly are more amenable to traffic accident: young is often careless and elderly is inattentive or defiant toward motor vehicles (AASHTO 1984, p.112). Thus, it does not make much sense, for these age groups are larger portion who comprises the most of driving population among others that outweigh other groups in driver's error representation.

Table 1. Fatalities and Injuries by the age groups in Turkey in 1996

AGE GROUPS	ANNUAL SUM URBAN			ANNUAL SUM TOTAL		
	dead	injured	**sum**	dead	injured	**sum**
1-6	237	3294	3531	357	5079	5436
7-15	265	7052	7317	441	10317	10758
16-20	156	6290	6446	304	9983	10287
21-30	287	11171	11458	742	20062	20804
31-40	255	8499	8754	741	16266	17007
41-50	219	5292	5511	585	10435	11020
51-60	171	2895	3066	376	5416	5792
Over 60	261	3079	3340	470	4568	5038
unknown	673	13873	14546	1411	22473	23884
SUM	2524	61645	64169	5428	104799	113227

Source: TCK (General Directorate of Highways)", "Trafik Kazaları Özeti", Trafik Şubesi Müd., 1996

It is important to note that most of the accidents are private car related according to the statistical findings in Ankara that accident proportion of the public modes in the urban areas is as less as one tenth of the private modes, which is almost non-fatal (Keskin 1992, p.76). This is because, to a greater extent, mass transit modes reduce the total number of trips, which proportionately reduces the number of accidents.

2.3.2. The Issue in the Five-Year Development Plans

Following the initial conditions that determined the first transportation structure and the "policies" driven for Turkey, and the first problems it had caused correspondingly, some macro level model searches of development plans were prepared which are resolved in the macro economic plans leaving to the consent of the political decision-making parties. The objectives and strategies of the Five-Year Development Plans from 1961 to 1993 related to the transportation were as follows (Olcay and Turhan 1993, pp.18-20):

- **In the 1st Five-Year Development Plan:** there was virtually no policy-making attempt for transportation.
- **In the 2nd:** The procedures that should be taken to lead the economic growth were warranted, though still no detailed policy existed.
- **In the 3rd:** The transportation infrastructure should be provided in some urban areas. Demand should be met at minimum costs. Some good applications in the world must be modelled. Railways should have a priority to meet a considerable amount of freight transport capacity.
- **In the 4th:** A master plan should be prepared and more attention be paid to railway and waterway transport. The highways should serve more to rural areas. For the first time, the role of intra-urban mass transportation was spelled out as the adopted policy. The infrastructure should be provided to meet the needs, at least, at the level of ordinary life quality standards expected (Türkoğul 1st Mass Tr. Congress, p.407).
- **In the 5th:** The concept of pricing and privatization of highways was stressed. Another important subject was the adopting of insurance system to the world standards.
- **In the 6th:** Again, the theme was the ways to increase the efficiency of railways.

From the report of Special Expert Commission on Urban Transportation (Özel İhtisas Komisyonu Raporu), we could derive out the intention stressed on the 7th Five-Year Development Plan (1995, pp.6-16). According to this study, in this plan period, it was confessed that no single transportation plan with a desired quality level had been produced for none of the cities. However, a couple of studies for the rail system projects in Izmir, Adana, Bursa and Kayseri. Again, among the proposals aiming to planning, operation, management, social environment and historical preservations, quite few would come true (like the buses run by natural gas in Ankara).

When compared with the Table 2 showing the accidents according to the planning periods, the policies put forward did not work well. It can rather be noticed

Table 2. The Rate and Distributions of Accidents by the Planning Periods

YEARS		TOTAL accidents	increase	dead	increas	injured	increase	Material Damage (Sum) (,000 TL)
	1970	19.207	100	3978	100	16.838	100.1	59,566
	1971	29.055	151.3	3898	97.4	19.601	116.4	67,789
	1972	29.874	155.5	3919	98.5	19.086	113.3	99,789
III Year Perio	1973	35.947	187.2	4204	105.6	21.801	129.5	141,759
	1974	41.107	214	4280	107.6	23.734	140.9	157,796
	1975	46.735	243.3	5125	128.8	27.847	165.4	309,173
	1976	50.628	263.5	5489	137.9	30.428	180.7	377,797
	1977	56.765	295.5	6281	157.9	33.677	200	554,509
IV Year Per	1978	52.077	271.1	5753	144.6	31.372	186.3	884,029
	1979	41.623	216,7	4536	114	26.427	156.9	1,215,267
	1980	36.914	192.2	4199	105.5	24.608	146.1	2,201,205
	1981	40.953	213.2	4441	11.6	29.744	176.6	3,410,483
	1982	46.249	240.7	4484	122.7	35.976	213	4,699,825
V Year Per	1983	55.208	287.4	5201	130.7	44.769	265.8	7,993,391
	1984	60.840	316.7	5781	144	50.521	300	1,157,282
	1985	65.831	342.7	5680	142.7	51.586	306	17,126,592
	1986	92.625	482.2	7315	183.8	71.264	423.2	39,213,742
	1987	110.207	573.7	7530	198	80.321	477	74,612,196

Source: Highway Gn. Directorate of Turkish Republic that especially after the 3rd Plan Period, when still the capacity enhancement and cost effective policies were favored, there was a steady rate of increase in the amount of accidents. However, we should not forget that the rate of automobilization had also gained speed starting from this period, following the Planning strategy.

On the other hand, the traffic accident statistics in the Table 2 present a linearly increasing rate through the Five-Year Development Planning Periods until the end of the Fifth Planning period (Karayolları Ulaştırması 1992, p.68). This situation, in a sense, shows the effectiveness of the policies, if applied, throughout the Planning Periods, at least not allowing it to be at an "exponential" rate.

The expectations in the 7th Plan period were (Commission Report, p.13):

- the extended use of the computer-based applications
- the implementation of the technological innovations in the private and public vehicles; the automation in the rail systems, the increase in the rate of safety & comfort, use of convenient fare collection that aims the integration between the modes, smart roads and intelligent vehicles, etc..
- the privatization should be welcome
- the shift of automotive industry to the developing countries when marketing area is reduced in developed countries

Among the various goals of the 7th Plan were familiar (especially to those mentioned in May 1983, p.169), but, for the first time, ethical concerns were spelled out there explicitly (Commission Report, 15):

- safe, comfortable and reliable travels
- reduced travel time
- reduced travel costs
- attain equity among the urbanites while travelling and via transportation applications
- reduced environmental impacts, the improvement of environment via transportation applications
- reduced foreign dependency

That the urban transportation planning procedure should be an integral part of the land use master plans and their implementation plans was strongly suggested in the same document. There offered also some other minor proposals for the operation of different modes (Commission Report, pp.15-16).

2.3.3. The Preview of Modelling and the Transportation Planning Attempts

In the planning sense, the first serious home interviews concerning transportation studies was carried out for the Ankara Master Plan in 1970. In this experience, especially the percentages of mode choice and trip purposes of the households were documented. A similar study was carried out by the METU students in 1974 to find out whether those who used "dolmuş" and used bus could be clustered separately and whether they would fall into meaningful socio-economic categories (Tekeli and Okyay 1979, p.91). The results were positive. A similar approach will be used in our "Correspondence Module" in Chapter 5: Equalization Process.

One of the main obstacles that prevented an effective modelling and transportation planning in the period between 1970 and 1980 was believed to be the widespread choice of "dolmuş". It is believed that the involvement of dolmuş in the transportation studies as a mode of "mass transportation" might portray a disorganized view, and further, an acceptance of an "outlaw" since it was operated "illegally" then. Thus, the modelling and planning procedures would be incalculable due to the uncountable nature of dolmuş. Despite, "dolmuş" was responding to the demand resulted from the deficit that public provision would not. According to Elker in his 1977 study (quoted from Türkkan, in the First Mass Transportation Congress 1978, p.44), dolmuş furiously took a portion of 44.7% of all travels, while 83.7% of the vehicles was private and official use in the traffic, and EGO responded only the 15 % of the total trips with its reserves of 0.5% among the total.

Additionally, this deficit had also resulted from the unparalleled situation that the population of the metropolitan cities (e.g., Ankara) had increased 2.6 times between 1960 and 1975, but the increase in the supply of public transportation vehicles was only 1.5 times, that led to the "marginal solutions" like "dolmuş" or rather would end up with owning an automobile. Rightfully, from the operator's point of view, the inability to allocate enough resources to sustain the increasing demand under the limited conditions has always led to the deferring of effective planning attempts. From the political mind perspective, it would be luxurious to channelize a great amount of funds to the serious planning and modelling attempts that are really costly and most of the time inaccurate.

Through the 80's, there were some experimental but awkward transportation studies mostly in the metropolitan level. With the rise of giant mass transportation projects such as the metro and other railway systems, the discussions converged on the economical and social feasibility (the contribution to city life) of those projects that are only to be rationalized by the transportation planning and modelling studies.

According to the conclusion of Special Commission Report for Intra-urban Transportation prepared for the VII. Five-Year Development Plan, the two important issues appeared agreeably to the need of urgent solutions:

- the long-lasting disaccord between the applications of Highways Gn. Directorate (Karayolları Gn. Müd'lüğü) and the local governments' urban projects and master plans.
- the lack of truly scientific transportation planning studies in none of the examples (just a couple of small scale studies to justify the approval of the highway or rail system projects as in Izmir, Adana, Bursa and Kayseri, etc..). Similarly, there has been no any R/D that is remarkable in neither theory nor practice in Turkey. The imported models have not fit the structure and needs of our cities.

One of the proposals and objectives set in the same report for the 7th Development Plan were basically was to <u>equalize</u> the urbanites *while* travelling by means of the transportation policies.

But, almost none of these objectives have been achieved. Many transportation studies were partial and incomplete just to rationalize the projects proposed by the local governments.

To summarize, it is viewed that Turkey initially had no "policy" in policy-making in the economic area that resulted in paying larger attention to the development of highways (most of which rural) and motorization in the agriculture; a highway and automobile based transportation, depending on foreign oil. In the next step, we see the motorization-related problems, congestion phenomenon and the steady increase in accident rates. That urged the first worries over "traffic problems" that were to be directed later to the concern of transportation problems by the 70's, when the first transportation planning considerations were spelled out in the Five-Year Development Plans (the 3rd one). Then, the subsidization and priority concerns for the public modes of transportation appeared as the policy objective to improve conditions of low income groups (even in the economical sense) when the adverse affects of automobilization on those groups and environment were recognized. However, the first ethical considerations such as equity in transportation, pedestrian rights and the transportation for handicapped and older people, the pricing, etc, came to the agenda much later.

Yet, the prime concern here is on the Transportation Planning Studies such as how they evolved within this environment. Transportation planning concept came with the master plans immediately required for the solution of the infrastructure problems of the urban areas. In general, the efforts in transportation planning and modelling were not satisfactory; they are partial, not comprehensive (except few studies), insensitive to the changes and local peculiarities of our cities; that is to say they are directly imported and applied in our cities as obligations. They are also suspected to be erroneous.

2.4. The Concept of "Disadvantagedness"

2.4.1. What is it called "Disadvantagedness"?

As referred to the definition in Terminology Section in Chapter 1: Introduction, the "disadvantagedness" is grammatically wrong word in English. Yet, it needed to redefine such term, as a keyword, within our thesis context replacing "who is in disadvantageous position in the urban traffic" or "the case that associates with those groups who are involved in this position". Shortly, the disadvantaged person or family is who is *relatively* more exposed to the problems mentioned above. In a broader view, disadvantagedness may appear due to four basic reasons:

- Personal reasons, (at individual level)
- Socio-economic reasons (at household level)
- System inefficiencies (at the local government level)
- Physical reasons (the independent level of environment: path, distance, topography, service, district levels)

However, disadvantageous positions can be many, and may appear in many areas and levels of transportation. To give examples, that also makes the intend of the questions asked in the home interview survey forms: one's dependency on the other members of the family, household size and conditions, personal conditions (such as being old or disabled), comfort, time spent, cost, trip production, speed and travel conditions, vehicle performance, security and safety, physical barriers and difficulties, dissatisfaction level from public transportation service performance (frequency, reliability, quality of vehicles, etc..), etc..

In this stage, it may be useful to express this *a priori* definition beforehand and reserving it to compare later to what it is in reality, which needs to be defined by scientific methods. The definition of disadvantaged is actually not a certain group or the groups but rather the intersection area of the different groups of disadvantaged that are defined from a different set of perspective and criteria (Brail et al, 1976). That can simply be illustrated as in the Figure 2. Each oval shape represents a disadvantaged group, or cluster of persons, of transportation from their viewpoint denoted as **A, B, C, D**, etc.. For example **A** may be the group of older persons, **B** may represent persons with disabilities, and **C** the inaccessible groups, etc. Here, the very intersection area (core) would ideally be our concern that is to mean "definitely" the disadvantaged for sure:

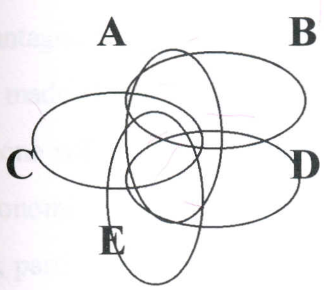

Figure 2. Overlapping of Various Disadvantaged Groups

Therefore, one might not have had to predetermine who actually the disadvantaged would be. It will be defined automatically through an objective selection process. The criteria set of this selection process will later be introduced in the application of cluster analysis technique (Section 3.9). In the definition of the problematic of the concerned disadvantaged populations, such a mathematical relation can represent this concept defined above:

$$\bigcap_{i=1}^{n} (D_i) / N \qquad \text{when, } N > Di$$

$$\text{and also, } N > \sum Di$$

Here, D_i denotes the i[th] category of presumed Disadvantaged, or cluster of persons exposed to the problems, and N all the population without the separation of disadvantaged. $\bigcap$ here denotes the intersection operation.

In the depiction above, actually all disadvantaged groups comprise a large family of disadvantaged group. Yet, in this study, as an approach, it is preferred to entitle a person, or household as disadvantaged if he is at the intersection area of a pre-determined number of "disadvantagedness" groups. On the other hand, the intersection operation is not a simple one but multi-variate that can only be handled by the computer use (clustering).

2.4.2. Which Groups Can Presumably be the Disadvantaged?

Some socio-demographic groups are likely to be exposed to the long-term disadvantageous positions in the urban traffic and they can easily be identifiable. These can be made "identifiable" by using the elaborate clustering techniques of which the simple one will be applied here. Yet, some groups such as the demographic (eg, age) and economic ones are *strongly* be expected to be disadvantaged. In the Western studies, particularly, access difficulty is seen the major source of the inequity between the transport advantaged and disadvantaged (NHS 1992, pp.30, 58). The study conducted for Sydney and Melbourne gives an idea about the family structure and access difficulties as shown in Table 3. (NHS 1992, p.32). In this, the same index study was performed for also income and transport mode. It is concluded in these studies that there is an obvious increase in access difficulty from core to fringe areas regardless the structure of family, income and car availability.

Table 3. Indices of Access for Core and Fringe Areas for Each Household Type, 1991

Household Type	Core	Fringe	All Areas
Pre-family singles and couples <35	0,5	1,3	0,7
Singles and couples 35-64	0,6	1,2	0,8
Couples with young child <10	0,5	1,5	1,1
Couples with older children >10	0,4	1,0	0,9
Sole parents	0,5	1,9	1,1
Older singles 65+	0,9	1,9	1,6
Older Couples 65+	0,5	1,4	1,0
Other Households	0,7	1,0	0,9
All Households	0,6	1,3	1,0

Source: NHS 1992, p.38

According to NHS, transport disadvantaged groups were defined under five categories (1992, p.59):

- **Young:** Preschool and school children, working or unemployed
- **Old:** Aged and frail
- **Poor:** Resource-poor and information-poor (migrants, new residents)
- **Home workers:** Home makers
- **Disabled:** Physically disabled and physically ill

Here, for the case study, it is first of all, tried to predict the conditions that cause the disadvantaged positions and the disadvantaged groups that are exposed to them. In detail, those conditions might be according to:

- whether the trips coincide with the busiest hours of the traffic flow (i.e., morning and evening peak hours). Let us call them shortly "peak-captive" groups who are expected to have regular work or school trips. If they waste quite a considerable time on the roads they might comprise one of the "disadvantaged groups". These groups can be found from the survey data of trip purposes and the trip departure times.

- the usual physical barriers to normal (abled) people while travelling. This is related to the worse travel conditions and the physical/access-barrier inefficiencies due to the fixed (long-term) barrier elements such as excessive slope, or, narrowness of the curb. These type of barriers may be man-made, such as railway dividing a neighborhood from the others, infrastructure inefficiencies, or natural such as topography. This information can be obtained from the survey data of perceptional responses.
- physical barriers to the disabled and frail persons. These barriers may coincide with the one to the normal people but may also exceptionally be the barriers that do not harm abled people but only the disabled. They can be called *a priori* the disadvantaged. The reasons for this are explained in the Section 2.5.3: "The Situation of Disabled and Special Standards for Them".
- similarly, it is the same with the elderly groups. The persons above an age is older and, thus, can be categorized as the "natural" disadvantaged due to their reduced abilities and the hostile environment insensitive to their physical capabilities as to the disabled. They have less trips as they get older, for the age 65 and over, usually below 5% of all trips (Banister 1994, p.166, Beyazıt 1989, p.10).
- less travel rate (trip production and distribution rates) due to limited income availability. This is one of the main reasons of being disadvantaged and many times called "economically disadvantaged" (NHS-Newman *et a*l, 1992, p.33). Yet, can they be assumed directly the disadvantaged? Most probably, but still not necessarily. But, there is the high correlation, for example between the bad trip conditions, and the trip rates, and the income, and we evaluate the disadvantagedness only while travelling. Likely, in the study of Beyazıt's done for Ankara in 1985, it is pointed out that when the level of income decreases the car ownership correlatedly decreases (1989, p.17). Likely, decrease in the leisure purpose trips is accepted as being disadvantaged (Banister 1994, p.160). Less distance travelled per capita might even be associated to being disadvantaged since car ownership may mean more distance travelled for the owners (Banister 1994, p.162).

- limited accessibility to the urban amenities. The information can be derived from the distance to the basic amenities and to the city center. Yet, access is somehow still related to the economic conditions.
- bad travel conditions due to the limited income availability. These are expected to the transit-captive groups who usually find the travel conditions and the service quality inefficient and low.
- uneasy travel conditions due to the socio-demographic conditions of the household. The reasons here other than the economic (income) one and probably related to the household lifestyle and demographic structure. A simple example of this can be the reduced share of private car usage per person in a crowded family.
- adverse travel conditions due to the inefficient local (public) transportation system and service provision. Inefficient and bad condition of the facilities may affect more especially those disabled, young and elderly (Simpson 1994, p.210). This information can also be obtained through the perceptional or some other relative responses of the survey data.
- difficulty in travelling due solely to personal reasons, peculiarities and in capabilities. However, this might sometimes be confused with the disadvantagedness by the disability. We mean some other reasons, here, other than disability and older age.
- difficulty in travelling due to the spatial distance (access) of the persons to the transportation facilities. This may also confused with the disadvantagedness according to accessibility. The focus here is the accessibility to the stops or carpark, etc..

Conclusively six major categories of disadvantaged can be defined in terms of socio-economic grouping:

- Disabled (handicapped) persons
- Elderly
- Very young
- Poor
- Inaccessible
- Those who are under-served or exposed to inconvenient travel conditions

In fact, poor and disabled probably expose heavily to the inconvenient travel conditions and physical barriers than the average persons, but *may* not necessarily to, either. A poor may have a car or become very accessible and, thus, may not experience the very adverse situations when travelling.

2.4.3. Offering A Method to Define Disadvantaged: Cluster Analysis

The clustering technique will be used in the study as a tool to separate those who are disadvantaged from the others. After clustered, this will enable us to know who is clearly categorized as disadvantaged, and it further requires the separation of the data of disadvantaged from the general data (Normal), with all variables considered, to a separate data sheet. This will be done primarily for person-based data and then be aggregated to the zonal averages.

It will not be inquired here whether the clustering is done properly, or not. The purpose is to present a method and the doing it in a right manner.

The answer to the question "what is a cluster" must be sought in the "value judgment of the user". "If using a term such as 'cluster' produces an answer of value to the investigator that is all that is required." (Everitt 1993, p.6). Here, simultaneous clustering of individuals and variables is adopted as the technique (Everitt 1993, p.134), which is a matrix form rather than one dimensional and quite complex to comprehend: In the first stage, the clustering of each individual variables are interdependent (overlapping clusters). Then, a re-arrangement of "optimal" clustering is done among the clustered items in data. Finally, the clustering is done on both the basis of individuals (n_i) and of the variables (m_j) all throughout the datasheet. The clustering on the basis of individuals interviewed is adopted (ie, *who* is disadvantaged is important rather than variable). Not any threshold value is introduced for grouping the values although could be.

Figure 3 explains how the clustering interdependently and separately be held first from the point of variables (a) and then individuals (b). The clustered values are shown bold. In the second data table (b), the values in the parentheses mean the values are at intersection of both clustering.

	m_1	...	...	m_j
n_1	**2**	9	4	**1**
:	4	8	**3**	**1**
:	**1**	**7**	5	**2**
n_i	6	8	**0**	4

(a) clustered on the basis of variables (columns)

	m_1	...	...	m_j
n_1	**(2)**	9	4	**(1)**
:	4	8	**(3)**	**(1)**
:	**(1)**	7	**5**	**(2)**
n_i	6	8	**(0)**	**4**

(b) clustered on the basis of individuals (rows)

Figure 3. Clustering According to Variables and Individuals

Various clustering techniques can be used to clearly identify the things from different dimensions into groups for some purpose. The process will be executed separately on SPSS Data Editor. As known, clustering can be made on the basis of either seeking high degree of <u>diversity between</u> (or, *external isolation*) any naturally divided clusters, or seeking high degree of <u>homogeneity within</u> (or, *internal cohesion*) each cluster (Nijkamp and Blaas 1994, p.38, Everitt 1993, p.54). Thus, this is to imply here that we need to pre-determine the type of clustering technique by goal before beginning the process of clustering. 'K-Means' type algorithm will be applied in which "each individual belongs to the cluster whose center is closest in Euclidian distance terms" (Everitt 1993, p.151). That is *internal cohesion* type clustering.

In this study, the separation of the urbanities into two basic transportation categories is aimed according to their travel conditions or the conditions affecting their quality of travel, first, to significantly identify the travel conditions of each. Second, it is aimed to learn the degree to which they separate from each other, so that the designer will know how far effort s/he needs to improve the disadvantaged group. Yet, it should be noted that the disadvantaged group will be defined relatively within the context of that society to be sampled, not the general. Thus, Aydın' situation is not comparable to Istanbul's conditions, or Turkey's averages. In Aydın, for example, those having 15 minutes of travel time can be categorized as disadvantaged while those having 100 minutes of travel time could be accepted as disadvantaged in the Istanbul case. That is, the principles of relativity work in this study.

Another important consideration that should be taken into account before applying the clustering is that all variables need to be standardized into the same unit scale since some variables are categorical, some ordinal some in categorical data some having interval scale (Everitt 1993, p.38-9). It is seen appropriate to scale up all variables to interval scale between 0 and 100. However, it is seen unnecessary, although advised, to weight the variables. Weighting of variables seems illogical and inconsistent within the logic of clustering which itself seeks objective evaluation of clustering. As in the study of Levine and Underwood's, distances of each individual value from the mean of certain groups could be taken as the gauge for clustering. But, this is not the SOFM technique and requires the finding of the mean values.

Since we have many variables to be subject of the cluster analysis, we will run the technique simultaneously for many variables, and thus, we will obtain the aggregated form of clusters (which is a sort of multi-variate clustering).

What is meant by "natural" clustering, or self-organizing technique, is that no threshold value was seen necessary to enter for the classification of the two separate groups. The clustering is done automatically by the computer itself and the threshold values are produced and organized in relation to the data input entered in this process so as to divide two major groups. This approach is quite objective because of no outer intervention. Thus, such a clustering under threshold values is not adopted in this study but only at the Cluster Filter study in Chapter 5, where a second set of clustering by computer's self-organizing clustering for each variable considered would be very complicate. Rather, Excel's filtering property can do the similar process excellently.

2.5. Standards to Determine Threshold Values

2.5.1. From the Literature

2.5.1.1. Social/Demographic Norms

Being older in Turkey is assumed to be after 60 years old and over which is mostly the age for retirement and acceptance to the nursing house (huzurevi). This is generally assumed to be 65 and over in the developed countries (Kaya 1994, p.1). Young is perceived as pre-school age and school age young, which can be taken as 6. We can assume the dependency ratio as 0,25 since generally there is one bread-earner in a four-member family. The latest information about the proportion of unemployed among the population is between 6-8%, which may vary in the case of Aydın. The percentage of disabled is offically declared as 7%. This has been much lower in the case of Aydın, but the findings from survey about disability may not reflect the truth. The accepted Lowest Salary (asgary ücret), which was then around 60 million TL, is taken as the base reference point and, the likert scale in the home interview survey is designed accordingly.

2.5.1.2. Expected Travel Behaviors

Regular trips for mid-size cities in Turkey is lower in general: less than 1.00 (as far as observed from the recent results of the transportation studies). Trip rate was found to be 1,58 in the Trabzon Study including pedestrian trips (1994). Vehicular trip rate was 0,82. In Turkey, vehicle ownership was observed to be 57,7 per thousand, and this is 32,5 for only automobiles. Yet, today, this may have increased up to 60 to 70. Trip rate was 0,43 for private, 0,83 for transit modes and 1,23 for pedestrian in Ankara for the AUTS study in 1988 (Beyazıt 1989, p.146)[3]. In American cities, trip rate varies between 1,65 and 3,09.

The rate for private was 77 for Izmir in 1990, 36 for Adana, 79 for Bursa, and 77 for Trabzon (in 1991). In 1992, car ownership per household was found to be 0,3 for İzmir. A lower value can be reasonable for Aydın (like maximum 0,25). Yet, car ownership trend has got a higher rate to date. Automobile ownership differs according to the income levels: 109,6 per thousand for high income, 44,5 for middle income, and 4,6 for low income. In the 1986 Ankara study, of all trip rate, 0,81 was work related, 0,44 school and 1,29 other (social) trip purpose. This was 23,9%, 15,1% and 61% for work, school and others respectively in 1987 Bursa study. This had been 32,2%, 17,4% and 50,4% for Ankara study in 1985 for work, school and other respectively to give an idea about modal split. In 1986 Bursa study, 39,3%, 5,7% and 55% for transit, private and other (probably pedestrian) respectively. In the AUTS study, 14% of all trips were found to be peak hour trips.

The trip rates according to the socio-economic groups from the upper level to lower level in Ankara (Beyazıt, 1989):

1	2,17
2	1,81
3	1,61
4	1,49
5	1,35
6	0,75
aver.	1,45

Waiting on stop must not be more than 10 minutes, but when considered the situation of elderly and disabled this should be less than 5 minutes. Travel wait for mid-size cities can not exceed 30 minutes. Much lower values can be expected for smaller cities.

2.5.1.3. Vehicle Related standards

It is known that bus system is the most flexible and convenient one for transit in the cities of Turkey, yet it would not be so in smaller cities such as with the population around one hundred thousand. They rather prefer to use minibus or midibus systems.

[3] These rates were then weighted.

The comparison of the two systems in terms of the system capacities (İzmir LRTS Project 1992, pp.123, 139) is as in Table 4:

Table 4. Vehicle Related Standards

	Capacity	Pass./hour	Headway (min)	Ave. comr. speed
Bus	100	500 - 8000	0.75 - 10	10 - 25
Minibus	12 - 30	800	0.75 - 5	10 -15

As seen in the Table 4, the seat capacity range of midibuses and minibuses are large but the ideal capacity for minibus is between 14 and 16, while it ranges between 17 and 35 as seated but ideally is around 24 for midibuses (Simpson 1994, p.17). If a normal bus is to be used, it can take 100 persons seated ideally, but can be enlarged up to 150, when this can be 200 persons in articulated buses (Simpson 1994, p.10).

In calculation of in-vehicle occupancy capacity, normally 4 persons per meter can be acceptable for peak hours. This can rise to 8 persons per meter (İzmir LRTS Project 1992, p.157) especially in metropolitan cities. But, in small towns even 4 would not be acceptable.

The maximum economic life of a typical transit bus is said to be 30 years, or 2 million km (Sayın 1987, pp.164-5). Dolmuş type minibuses have lesser economic life around 10 years. But, most of the time, this duration is over-utilized.

Design speed for buses in the arterials are between 60 and 70 km/h. This should be lesser for the minibuses. Maximum slope would be 10-12% .

2.5.1.4. Transportation Network Related Standards

Lane width of the roads is commonly agreed by the Directorate of Highway to be 3,5 m, or, at least, 3 m. climbing lanes should be 4 m. The width of collector type walkways (curbs) with the numbers of people walking must at least be two meters wide (Lynch and Hack 1984, p.209). Hight of curb should ideally be lower, but maximum be 15-20 cm. Curb width must minimum be between 2 and 2,4 m in the crowded streets. But, ideally, it must be wider. The maximum slope can be 5 % in the pedestrian walkways when also the handicapped people are considered (Koç 1994, TS-9111).

Design Speed can be between 100 and 120 km/h for 4-6 lane express roads. For 4 lane divided, this is 80-100 km/h. Design speed in urban arterials can be between 60-100 km (40-60mph) (may be as low as 50 under the restricted conditions of the road). This can be lower in the local streets: 20-30mph (35-50 km).

Two lane roads may have a rate of flow 2800 pcphpl. This may be lower than 2000 for typical towns in Turkey.

For transit stops, those standards are valid: For buses, 13m turnout (pocket) length with 3 m width, and the total approach length is 60 m.

2.5.1.5. Access related Standards

In the conditions of Turkey, walking distance to elementary schools can be taken as maximum 500 meters. This must not be more than 300 m for elderly and young. The pupils must not cross the arterial streets. Pedestrians should not walk more than 1,5 km to work, and 800 m to the local amenities (AASHTO 1984, p.112).

It can be said that the residence is inaccessible in all terms when 1,5 km away from the shopping and public facilities. Especially the Health Center should absolutely be within the range of 1,5 km (De Chiara 1984, p.8).

The access duration to a stop or parking area should ideally be 5 minutes (there is not a specific distance), which is related to the acceptable standard for walking to access any facility in a neighborhood. Walking to a stop can be acceptable between 5 and 10 minutes. Similarly, in Turkey, the waiting time in bus stops is commonly accepted to be 5 minutes (Keskin 1992, p.69). But, much more can be tolerable in metropolitan areas. Transfer time is acceptable between 5 (min.) and 15 (max.) minutes. 30 minutes of travel time can be acceptable for mid-sized cities.

2.5.2. From the Data

By standards defined from data, it is meant the averages (arithmetic mean) of the local values. Especially, the threshold values (standards) of function variables, that are to be used in the Cluster Filtering in Chapter 5, are obtained from the arithmetic means of the cluster centers of the two clusters, advantaged and disadvantaged, that are to be defined later in Chapter 3. Likewise, the local standards can be obtained from the frequencies of the "checklist (likert) values" of the variable at the home interview survey data.

The average household size was observed to be 3,5 according to the survey results, out of which the response rate was 3,2. Household size categories can be summarized as: single households comprise 5%, 2 person 21%, 3 person 21%, 4 person 35%, which is the highest, 5 person 10%, 6 person 4%, and 7 person 2%. Almost 4 % of the households is relatively under high income category, 32% is under the middle, and 65% is under the low income category. It is found that there is a vehicle (including bicycles) per 6,85 persons. Table 5 provides summary household level information for all Aydın City derived from the home interview survey. However, the percentages in the table are independent results to each other.

The determination of the local standards (threshold values) derived from the home interview surveys are provided under the Home Interview Design in Chapter 3. The threshold values used for each variable chosen can either be observed in the Cluster Filter in Chapter 5.

2.5.3. The Situation of Disabled and Special Standards for Them

As known, disabled or handicapped people, who has a large range of associated groups in the population, are much more exposed to the barriers than the normal

Table 5. Summarizing Household Related Results from the Survey

							school	Of the Primary School Travellers					Of all
	vehicle ownership	employed	unemployed	under 6	over 65	disabled	attend pupils	service	walk close	ride given	walk distant	used transit	crossed street
%	%43	%38,00	%8	%10	%7	%3,50	%14,50	%6,50	%66,50	%1	%19	%8	%22

people (called “abled”) while they are out on streets or while travelling. Presently, in our cities even healthy people are many times exposed to adverse conditions and can experience disadvantageous positions. Yet, self-disadvantageous position of disabled adds some more to their position affecting their moral feelings, too. Therefore, here, a special attention is paid to the situation of disabled and elderly.

It is axiomatic that the design for everyone (or, for ‘standard’ man) should level down to the design for disabled or handicapped, simply because they should be behaved equally as to others. They need to travel on streets as everybody can with no help. Shortly, the conditions of disabled ought make basis of all spatial design of transportation facilities. As suggested by Brail et al (1976), a special transportation system is required addressing to the special needs of transportation disadvantaged (specifically elderly and disabled). For example, most handicapped persons would demand transporting to special facilities or programs, schools etc., which pose a different travel demand characteristic. There can be three seriousness levels of disability when transporting: Mild, Moderate and Severe Handicap Conditions, each requiring different transportation system designation. For, example while mild handicapped might be transported by normal but modified transit systems, a moderate handicap condition may require a special design either in operation and vehicle design, etc. (Brail et al 1976, pp.48-49). Cost effectiveness criterion may be waived especially for the moderate and severe handicap conditions.

Therefore, the disabled and the household he/she belonged to is assumed as “straight” disadvantaged in our model without further investigation on the individual peculiarities. Likely, the disability will be accounted on the household basis even if only one person is disabled in that household.

It was agreed that the studies and design rules for disabled are poor in theory and practice. Especially, in Turkey, there are few resources, less data and theoretical study on the travel needs and design principles for disabled compared to the Western societies. The most impressive works among those are the “Ulaşılabilirlik İçin Avrupa El Kitabı” (1995) and the TSE publication shortly called TS: 9111 (1991). It was drastically noted that there were over seven million disabled people in Turkey, which was the figure for the year 1995[4]. **Though seems exaggerated, this is almost one sixth or seventh of our current population. And, over 30 million people, being their first degree relatives, are engaged in the difficulties of having a disabled member in households**. That is almost half the population. That is to say, disability is also the concern of the household and, therefore, this makes the household in disadvantageous position to some extent..

Some other groups are also accepted to be disabled, or handicapped, besides physical and mental disabilities in this figure: old people, very long or short people, those exposed to sports related accidents (most of which are temporary injuries), those carrying baby-carts on streets, pregnant, fat people, etc. all have to cope with the hostile environment not tolerating to their special situation or weaknesses (1995, p.12). Standards have been set for "standard people" with mean height or weight and the standard abilities, which has been a wrong and discriminatory assumption for a long time.

Another source mentioned that one tenth of the adult population in the developed societies, and 12 % of the adult population in the developing societies are determined to be seriously disabled (Sabahi and Aytöre 1994, p.3). It is important to consider how they will be transported and under which circumstances. Sabahi and Aytöre's study has spent a considerable effort in taking all these into account, but, specifically the problem of the orthopedic disabled and of transporting them by Light Rail Transportation (LRT), which would rather be a secondary concern for Turkey. Study emphasizes concludingly that especially the orthopedic disabled and elderly should be taken care of when boarding (on and off) the vehicles (1994, p.3).

Koç, in her recent work on the design of physical environments regarding the conditions of handicapped, especially expressed the importance of such studies, with the stressed definitions about the conditions of those disabled and their physical abilities given the conditions (Koç 1994). Physical disability could be in five forms:

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[4] Ulaşılabilirlik İçin Avrupa El Kitabı (European Handbook for the Access), Türkiye sakatlar Konfederasyonu: 4, March, Ankara, 1995

. mobility imparied
. reduction in swiftness (as in older people)
. visual disability
. hearing disability
. disability in speaking (or communication)

Her study concern focused on the mobility impaired groups and the required physical/spatial arrangements for them. She also starts with the assumptions that almost all people deviate from the "standard man" and specifically those "impaired" people who are less or far disabled are not negligible, and still the part of the general society, and should not be separated from the society, and therefore, should not be treated separately but be behaved like the normal people[5]. This assumption is solely based on the ethical concern and the equity principles in the related literature. People may differentiate from one another in this or that way, or in ability, but, in terms of the human rights, they are <u>all</u> equal in essence as others and these rights should be protected. One of the equal rights is naturally the freedom of movement and safe travelling. As one of the transportation policy objectives, equity recently has gained much emphasis on the consideration of providing the facilities to those who need them more and who are more vulnerable to the ever-increasing traffic problems (May 1983, pp.167-9). As mentioned previously, May included danger (fear of having accident) as an additional element to that of accidents which affects their mobility. ADA Act (Americans with Disabilities Act) requires that disabled and seniors (elderly) be ensured to access especially health related institutions or community resources. Therefore, it is reported in the Act that demand responsive systems should be constructed in meeting their travel demands[6].

The movement of disabled is analysed as only constrained to circulating in the outdoor spaces but not as having vehicular trips with the existing transportation system. The study verifies that also Turkey has an increasing rate of disabilities, thus, the design considerations should be ready for the phenomenon. The ethical urge exists

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[5] We will later return to this discussion of separate treatment towards disabled under the shedlight of equity concerns adopted.
[6] For this, it is useful to see all conclusions in Mini-white House Conference on Mobility and Transportation for Seniors, (Final Resolutions) APTA Staff, March 31, 1995

here that those disabled should be integrated into life as others and this starts from the physical environment (Gökçen 1999, pp.11, 121). Types of disabilities in this study appear as: temporary impairments (handicapped to a degree), activity impairment, mobility impairments, manual impairments, visual impairments, audial impairments and mental retardations.

When the related Turkish laws examined, some recent developments can be noticed as the annexations (additions) to, or, changes at the Planning Act (İmar Kanunu) of 3194 in 1997 and of the temporary law for the Metropolitan Area Management of 3030, and the related subsections of Social Support and Consolidation (Sosyal Yardımlaşma ve Dayanışma Teşvik Kanunu) Law of 3292[7]. Of these changes or additions, the first one generally recalls the attention on the adverse street conditions for the disabled people and the necessary planning steps that should be taken to rectify these conditions and refers to the related TSE standards to comply with[8].

The employment ratio is reset on the basis of the general population statistics alarming the critical unemployment ratio among those disabled while they are still able to work. According to the Employment Law and the Law of the State Officials, previous 2% of employment ratio was replaced by 3% (as additions to the Codes 13 and 53) of all workers in the businesses where 50 or over employees are employed has to be from those with disabilities ("Sakatlara Yönelik Hizmetler Raporu" 1996, p.63) This also has a potential to increase the trip production rates among disabled. The government should guarantee their access to workplaces safely.

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[7] T.C. Resmi Gazete (Official Paper), Yürütme ve İdare Bölümü: Kanun Hükmünde Kararnameler (KHK/572), Başbakanlık, 6 Haz 1997, no. 23011. The mentioned changes were:

1. Code 1. adds to the 3/5/1985 dated Planning Act of 3194
2. Codes 3. (r and s) and 4. adds to the 27/6/ 1984 dated Temporary Law About Metropolitan Area Management of 3030
3. Code 5. add, Codes 8. and 9. changes to 24/5/ 1983 dated Social Services and Child Protection Institute Act (Sosyal Hizmetler ve Çocuk Esirgeme Kurumu Kanunu)
4. Code 13. add and revision to 25/8/1971 dated Employment Law of 1475
5. Code14. and 15. add to 14/7/1965 dated The Law of State Officials (Devlet Memurları Kanunu) of 657
6. Code 17. add to 29/5/1986 dated The Law of Social Support and Consolidation (Sosyal Yardımlaşma ve Dayanışmayı Teşvik Kanunu) of 3294

[8] The issue about the disabled related acts is largely held in the Gökçen's thesis (1999, p.14)

Accessibility is seen as one of the important problems that needs to be solved urgently. The improvement levels for accessibility can be (Koç, 1994) handled at different scales of urban planning: throughout the whole city, at the urban center scale, or business areas, at the scale of landscape planning (recreational areas), and finally, at the scale of transportation.

A special term called "dependent disability" (muhtaç sakatlık) was accepted referring to the needs of priority groups in advance by the 5 th Five-Year Development Plan, which can be perceived as a turnstone in the history as the appreciation of the "neediness" (muhtaçlık), demanding some governmental and planning actions to help their situations, of those disabled groups in the Turkish society. Towards the recent years, the contend of disability as fractioned into various groups representing the significancies between the disabilities has been enlarged: Now, there are also such groups[9]: retired, widowed, orphan, low income families, veteran, alcohol and narcotic dependents, etc..

The pedestrian walkways can be designed to ease the access and mobility of the older, frail and disabled. Especially, the condition of walkways must be the starting point in the movement problem of these people. Where disabled people's residences locate, whether they are suitable would also be the important, ie, the location disadvantagedness that affects the disabled's conditions terribly. Yet, accessibility also means the distance to the bus stop (from or to home), to the walkway, to the carpark, etc. (Koç, 1994). For example, the car parked for disabled should maximum be at the distance of 30 meters.

The ramps and the walkways should be made of the non-slippery material. Similarly, loose materials such as sand or gravestone should not be used (Koç, 1994). The street furniture should be so carefully located on the streets that they define the space but not avoid the movement of both abled and disabled people. The streets are better if they are simple through which disabled can walk freely and safely.

[9] ibid., p.121

Coming to the mobility issue on streets, minimum width for wheelchair passages on a walkway is agreedly 815 mm, but, better if it is 915 mm [10]. For a 180° turning, it should minimum be 1525 mm. This can be 1220 mm for a walking man and wheelchair side-by-side (TS-9111, p.10) . For blind, there should not be any obstacle less than the height of 230 cm. The contour lines of topography should be followed as much as possible, not exceding 5^0 of slope.

It is the best if there is not any thresholds but, if necessary, they should not be more than 2 cm in height. The design should allow for level circulation. All the circulation area should be free of the obstacles (seat banks, boards, vending machines, etc.), and the hard corners be softened. Again, it is the rule of the thumb that those disabled should be able to circulate requiring no help[11].

There should at least be four seats in the car (of train) for disabled that must be close to the door on which there is the sign of disability. On a bus, at least one place must be reserved for the disabled.

The air conditioning should have a 25 cycles per hour to clean all the air in the car considering those who have breathing problems.

In the transit buses, the wheel chair handicapped must be free from any protrusions in boarding on and off and in circulating in the car. They should be served with the necessary equipment to raise, lower, opening, engaging and disengaging of the wheelchair as defined in the guide (ADA-Part 1192). The Lift must enable also those with walkers, crutches, canes and braces. Lifts should be equipped with handrails on two sides that will be graspable, and this must be available all throughout the vehicle.

Another important consideration is about the design of doors. Revolving doors and thresholds from which a disabled cannot enter should be avoided. The transit bus

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[10] TS-9111, 1991, p.10, The standard is also taken the same in Building and Life Congress (on Accessibility), and De Chiara's, Time Saver standards, 1984, pp. 528-543

[11] Ibid., p. 17

doors must be large enough allowing the easy entrance of fat persons, either. Both sides of the doors in the transit buses should be open when boarding.

The car park width for disabled should be at least 3.70 m, which can be reduced to 6.40 m for two places.

Chapter 3

CASE STUDY and DATA PROCESSING

3.1. The Data Required and Restrictions

The purpose of the case study is not to solve Aydın's transportation problems with a high level of accuracy but rather use the values derived from the Aydın's transportation reality that will be representative to a typical mid-size city in Turkey in the validation of the methods used to run the model.

That necessary but unavailable information such as traffic volumes and capacities are mostly calculated manually in this study but the accuracy of the calculations are fairly restricted. Thus, the aim was to achieve approximate results. The information is used in various steps of this study, therefore, the results are revealed not here but in their places of usage.

3.2. Why Aydın is Chosen

The city of Aydın was chosen among a set of alternatives considered for these reasons:

- Being proximate to Izmir where our institution and studies locate but being out of the metropolitan influence of Izmir.
- Being a mid-size city that fits the test purposes of the modelling (between 100,000 and 250,000)
- That the model requires the ready GIS (Geographical Information Systems) data which is available in Aydın. Aydın is one of the pioneering places in our country in digitizing and converting the urban data into GIS form.
- That the city poses an uncomplicated urban structure but instead an easily readable one. A simple urban structure provides many advantages in the test level of

modelling. In the meantime, the place to be chosen must be where the worries about future transportation planning have just started to arise.

3.3. About Aydın in General

The place for case study is the urban Aydın, which is compact and densely settled at the core and fringed with the loose agricultural settlements at the periphery. (See Figure 4). Thus, data and information will be collected for this area coverage. The population of Aydın was 107,000 in 1990, but now expected to be around 130,000 for the recent years. Aydın is historically an agriculture-based, food-processing center established at the fertile Menderes River Valley. It is a recently growing city in the Western Anatolia with some important investments other than agricultural sector such as the organized industrial area and the airport at the East side, and the new expressway surrounding from the Southern side[1].

Aydın city is regarded by the local authorities as the metropolitan area, and thus, has its metropolitan area planning boundaries (See Figure 4), that we would have taken as the concern area (see the map that shows metropolitan area). Though, the city desires the growth, it was noticed that this area is quite large, and would not suit our study purposes. We rather preferred the narrower Municipal boundaries in which currently 23 districts take place. Another boundary to define the concern area we regard would be the expressway surrounding the city from the west to south.

Aydın has the simple urban layout, and roadway pattern as well. There are mainly two axes of growth. One is the North-South axis of A. Menderes Boulevard. The other is actually the once expressway: Izmir-Denizli Highway. But, lately, the municipality has launched a series of roadway and boulevard constructions to diffuse the growth in different directions and provide better transportation connections between the settlements.

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[1] Aydın was chosen among the provinces "the most priority for development" as KOSGEB approved.

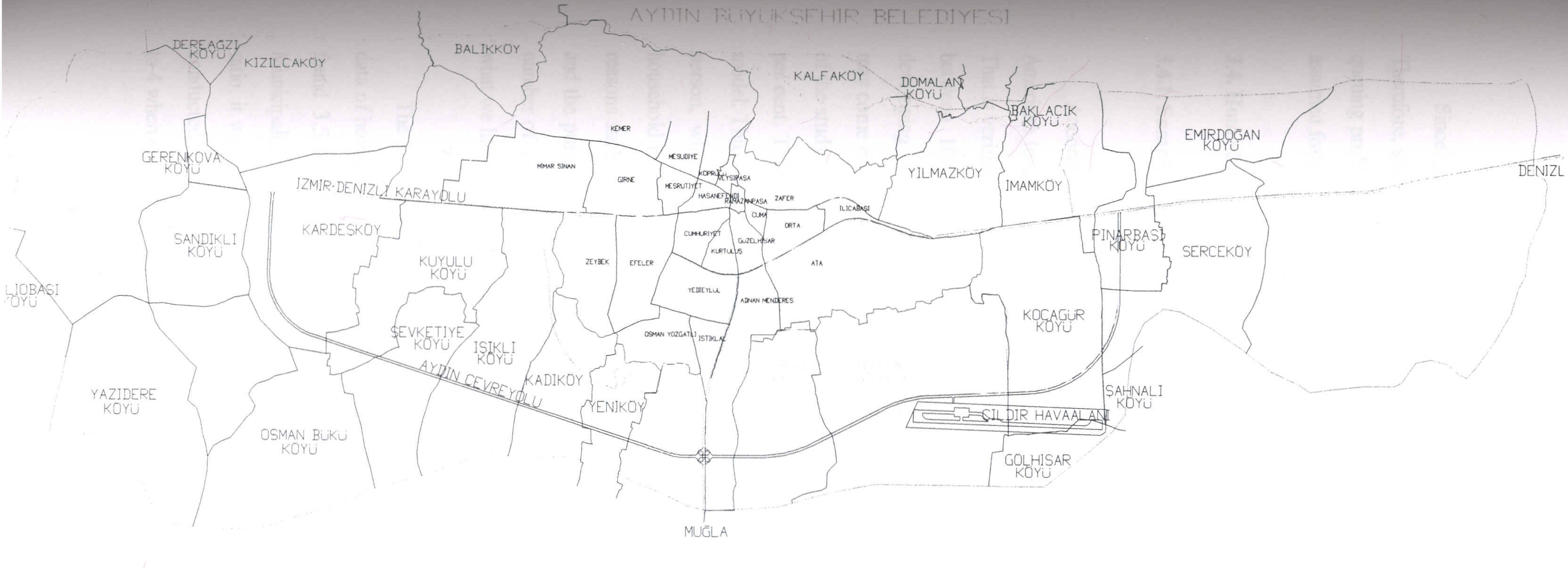

Figure 4. The General Settlement Plan of Aydın City

Since the city is small, it currently shows not any traffic congestion sign. Therefore, simple traffic assignment techniques such as all-or-nothing that considers no queuing problems at the intersections can safely be adopted. No left turn prohibition is assumed for all the city streets.

3.4. Home Interview Design

3.4.1. Sampling Size Method and Assumptions

According to Ortuzar and Willumsen (1994, p.79), the sampling ratio for the American towns with the population around 100,000 would at least be one to twenty. That is verified in another study as one sample per twenty households for the town size between 100,000 and 150,000 (Süel 1984, p.9). That would still be high for developing countries. For real planning studies, it should even be three per cent but may come down to one per cent, which may even be different according to the nature of the study. In this thesis work, it is tried to maintain the sampling ratio around one per cent. This ratio can even be found high for our study that is only to validate the model. Thus, we intend to take 360 sample households that would make around 1, 400 person, which is actually more than 1 per cent. Yet, finally we could have 326 household interviews and the number of personal interviews reduced to 932 for some reasons such as low response rate, unreliable responses, etc.. When all the constraints and the purpose of the study is considered, these numbers seemed efficient. Average number of members in households in urban Aydın was found to be 3,32 rather than 4, what we had assumed at the beginning (Aydın's Master Plan Report 1995, p.93).

The accuracy (verification) of the home interview results is checked from the data of household size. According to the survey results, the average household size is found 3,5 and according to the home interview survey conducted by the Aydın Municipality in 1994 (Aydın Master Plan Report 1995, p.93) with the 6,98% sampling ratio, it was 3,53. As of this coincidence, to some extent, the home interview surveys conducted for the thesis study can be said quite accurate. Yet, this average value raised to 4 when disaggregating the household data to individual data.

This 10% distortion (S^2_{ij}) resulted from the disaggregation is assumed negligible and found normal.

One of the most important statistical calculations in modelling studies is the size of the sampling. There may be many considerations on the sampling issue. One significant constraint is the money that can be allowed for the research. The other is the purpose of the study. Because of the nature of this thesis study that is only to test the model validity, the sample size could be taken at the least requirement. Though, the rule of thumb remembers us to take the sampling not less than 5000 in the urban areas of more than 100,000 population (If less, this can be 1000), assuming Aydın's population around 100,000, we can hold it down to between 1000 and 2000 samples. On the other hand, we can apply a sample size formula assuming the population of Aydın is around 130,000 for 1995 (this may be around 140,000) and the reliability range is between 95% confidence interval with the 10% error margin (Gülgeç 1998, p.231):

$(0.1)^2 = (1.96)^2\ 1\text{-}k\ /\ 130{,}000k$

$0{,}01(130000k) = 3{,}84\ (1-k)$

$1300k = 3{,}84 - 3{,}84k$

$k = 3{,}84\ /1303{,}84 = 0{,}0029\ \ \sim\%\ 0{,}3$

$k = 0.003$ (or, 0.3 %)

That makes around 400 samples. If we assume each household contains 4 persons, the number of households to be visited will be around 100, which seems too low. We insist that in such a stratified (ie, district-based) study, the number of people sampled would rise (should not be less than 1000 people). Therefore, it is intended to sample for 360, or so, households, in that also a non-response rate is considered to exist. But, as mentioned, this size had to be further reduced later due to the non-response.

There are both built-in parameters as default values or they can be altered on demand. The sampling error requires the calculation of the standard error term, which is simply found by the division of sampling error by the z term that means the "assumption of normal distribution" of data. If, for example, the accepted sampling error is 0.05 within the 90% confidence interval, then the standard error could be:

$$SEx = 0.05 / 2.576^{2} = 0.0194$$

It is also verified that, according to the 1995 interviews of Aydın municipality (The Master Plan Report for Aydın 1995, p.93), there were about 35,000 households, of which 32,000 are resided, in the urban Aydın area and 1 per cent of sampling is taken for our study.

A sort of stratified random sampling was decided to apply in the case study. The areas that are dominantly non-residential use were not considered. The number of addresses to be visited is adjusted according to the districts' relative population sizes.

For the stratified random sampling, first, the addresses are obtained from the Municipal Enumeration Records in the form of list of streets. On them are shown the number of households, but not the addresses themselves. Second, for random choice, C Plus package is used to generate the numbers for each street at each district, by also specifying the maximum number for each district and street. The results can be observed in the Appendix A.

Finally, the determined addresses were clarified and visited (See Appendix B for the permission document) expecting most of them found in their places. The interviewers are instructed about how to interview (See the interviewer instructions, in Turkish, in the Appendix B). Extra five addresses were randomly chosen to visit in the case of non-response from the regular address.

3.4.2. Home Interview Surveys and the Organization

The home interview forms are comprised of two parts with an authentic design as inspired from the other examples used in some studies in Turkey. Though it is quite

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[2] This value is found from the normal distribution table for 90% confidence interval.

innovative in its design, little idea is borrowed from these studies[3]. In the previous studies, the approach was usually the asking respondents their travel activities during the day before or the late 2 or three days. And every trip they made is recorded in a tabular form. It is assumed that sum of all the individual travels realized in a certain time frame makes the average view of all travels. Even if it is assumed, in general, that the aggregate collection of all individual responses from each individual makes the average view of the actual daily travels of the city, that is also true that collecting the average information directly from individuals themselves would be an acceptable representative information to some extent (for regular trips especially) (Ortuzar and Willumsen 1994, p.21). Probably, both approaches will have more or less the same accuracy levels. Typically, there was an emphasis on the socio-economic characteristics of the households, such as quality of houses, type of profession or occupation and land-use attributes of the place they reside. Second, the tabular format of survey forms was found quite complex. Instead, we preferred to ask questions in a normal text form with some more explanations because short wording makes the questions hardly understandable.

Here, it is experimentally assumed that what individuals reveal directly "their averages" can also make the same effect of taking their averages rather than collecting specific day(s) results. Thus, usually respondents are asked about their regular (which is everyday travel behaviors) travel activities on average instead of reckoning their every travel for a specific day. Therefore, the model will work for especially the regular trips.

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[3] These studies included their own home interview and/or field survey forms and were as follows respectively:

. Trabzon Kentiçi Ulaşım Etüdü – Ekler, Final Raporu, T.C. Ulaştırma Bakanlığı DLH ve Trabzon Belediyesi, Gazi Üniversitesi, Mühendislik Mimarlık Fakültesi Döner Sermaye İşletmesi, Ocak 1994

. 1992 Ankara Ulaşım Konut Anketi Sonuç Raporu, Ulaşım Planlama ve Raylı Sistem Dairesi Başkanlığı, Ankara BŞB - EGO Genel Müd'lüğü, Ankara, 1992

. Istanbul Ulaşım nazım Planı EvHalkı Anketi (obtained directly from the Municipality)

. Alp, Hakan, Private Car Ownership and Household Characteristics in Ankara, Master Thesis in METU, Ankara, 1989. Home interview forms

. Beyazıt, Sema, An Approach for the Identification of Trip Generation Characteristics of Households in Turkish Cities, Master Thesis in METU, Ankara, 1989. Home interview forms.

First part (Form A1) is devoted to reveal the socio-economic situation of households, and aggregately the situation of each zone (to be determined) for the modelling stage. The other part (Form A2) is for the information to be gathered from individuals of the households visited. The personal information, which is very essential for our study, is usually about the respondents' revealed opinions on the existing transportation system and their situation within this system.

When designing the questionnaires, especially, of the second part (personal), the objectivity of the wording of the questions were designed cautiously (See Appendix C). Yet, also the interviewer should be very cautious on objectivity. At the design stage, both the opinions of the transportation experts are asked and it was seen necessary to apply a pilot survey among a variety of people (22 persons). Upon this trial, many adjustments were seen necessary especially on the clarity of the questions and some questions were eliminated.

Noteworthingly, it should be re-emphasized here that typical weekday work/school travels solely are the concern of our study but not the weekend trips simply because we specialize around the citizens that are more likely to be regular (See the Assumptions in Chapter 1: Introduction).

Here, one-by-one what the questions are about and used for (i.e., what variable of data they provide to be used in the modelling) in our study and what survey approach and methods will be followed are explained for surveying and evaluating the results.

Under these considerations, a very detailed 13-page long survey forms were reduced to only a compact form of 4-pages (reducing in size, too). It is here bitterly understood that the broader (that is intended initially) home interviews are not suitable for obtaining healthy results (especially, for these kind of studies). The concise 4–page

. Isparta Raylı Sistem Etüdü (Konut Anketi hane Bilgi Formu), Ulaştırma Bak. – DLH ve Isparta Belediyesi. A sample of an interview form was obtained from the Ulaşım-Art planning bureau (Erhan Öncü & Rıfat Türkkan) while this study still continues survey forms are believed to be convenient in carrying out the home interview surveys easily.

3.4.3. The Method of Surveying

For the surveys, five people were recruited who are either from among academics or closer friends. It is essential that these people be trusted and have high education to be able to handle such interviews. The interviewers are preferred to be from Aydın area or from among those experienced in interviewing. Yet, the opportunities were quite scarce. Together with the conductor of the study, total of six interviewers are used.

Interviewers are trained for two days about how to introduce themselves and behave, and what to do with the forms. A1 form were to be filled by the accompany of interviewer (personal interview). But, the A2 form, which is about the personal travel questions had to be self-completion type and collected 2 or 3 days later.

When surveying, the interviewers introduce and reveal their IDs, and briefly explain the purpose of the study (See the Interview Guidance Instructions, in Turkish, at the Appendix B). Also, the meaning of term "trip" is given in this introduction, which is very important for common understanding of the term. Additionally, code numbers and other identification questions such as address and phone number are asked.

3.4.4. The Content of the Interview Questions and Data Coding

As will be found attached in the Appendix C (which is in Turkish), the meanings of the questions in the home interview survey and their variable (or, data) code correspondence are provided below. In the Appendix, also the threshold values that are used as the standard values are provided with check sign. The raw data could not be printed since it takes more than 120 pages even in concise form.

3.4.4.1. Section I. Socio–economic Household Data

1st Question: 'HH.SIZE' The number of the members of the household (Guests and those staying temporarily are not counted): this simply gives the size of the household which provides a very precious data that will be used in different calculations.

This will also be used in the calculation of the data for "Income per Capita" which can be denoted as 'INC.PER' and will use later also the joint data for income, 'INC.REAL'.

2nd Question: 'RENT' Did you rent the place you live in?: This question is for two purposes, therefore, it serves two data columns: One is to support the real income ('INC.REAL'), as one of the income indicators, assuming those who rent cannot afford to buy their houses, thus, they must be associated relatively to low income groups. The second is that the information whether a household rents or not will also reveal the degree to which they are associated to the "socio-economically" disadvantaged (or, disadvantagedness on the basis of household level) also in terms of transportation. However, it should not be regarded as the strong indicator of disadvantagedness but a poor one.

If the residence is rented, the code to identify is (1), if not, then it will be (2).

3rd Question: 'VEHIC' is about the vehicle ownership in general:

a) vehicle ownersip in household: This dummy variable is to inform whether the household has any sort of vehicle that can be used in transportation. It will strongly be used to define the household to categorize into disadvantaged in terms of private (mostly automobile) ownership. The variable term for the data column can be 'VEH.OWN'. If the household owns vehicle(s) then the dummy variable will be (1), if not (2).

b) now, this is to define what sort of vehicle and how many of them, if more than one: If the household has got no vehicle, this question will be passed. For those households who have vehicle(s) the data column name will be 'VEH.TYP', but the sub data terms for type definitions will be as follows:

'VEH.OTO' for automobile

'VEH.TICA' for commercial vehicles

'VEH.MINI' for minibus if (or, when) not used for commercial use

'VEH.MOTO' for motorcycles

'VEH.TRAK' for tractors

'VEH.BISI' for bycycles, and,

'VEH. OTH' for other types like service cars

c) for this part, it is asked whether it is a limited number of people who regularly use the vehicle(s): The variable name will be 'VEH.REG'

4th Question: 'EMPLOY' The employment and demographic situation in the household: This part is particularly important providing us a lot precious information.

a) The number of people who bring(s) income into household: The persons may not "work" in terms of regular earnings (salary) but may still make a living for the household. The remark in parenthesis "or, who provides income" is, thus, important to substitute this fact referring to total net income by any means entering in the household and also to define the dependency ratios. This will provide basis for categorizing the households into whether disadvantaged.

The variable name will be 'EMP.NO', and,

For the ratio found by proportioning to non-working members, 'DEP.RAT'

b) If some persons think themselves as unemployed, they should (or, may) state themselves so. This situation will be considered to be a potential condition to disadvantagedness. The number of people in such a case, but not the names, is asked and the term for this will be 'UNEMP.NO'

c) The number of persons, who are six yearsold or under: Those are considered to be producing no serious trips. yet, this information is also important in terms of defining both whether small children are seen potentially disadvantaged since they are resticted and dependent on their parents when travelling and whether they cause some dependency and burden on family especially restricting the mobility of parents. Yet, this question would not be spelled out openly such as "do your children create difficulties on you?". But, we can assume this will happen. The variable is called 'CHIL.NO'.

d) The number of older people: Similarly those who are sixty five years old and over can be considered to be disadvantaged due to the theoretical explanations made about disadvantagedness at the beginning of this study and their relative dependency on the family because of the retirement, disability to move and other reasons of getting old. They are physically as not strong as young. They may either need help and accompanying in getting their needs (and travelling as well). Under the existing conditions of traffic, travelling usually becomes struggling for them. Thus, it is possible to assume this group of age as disabled, and automatically as disadvantaged. This important variable is called 'OLD.NO'. It will have a poor weight for the disadvantagedness of the household.

e) Whether there is any disabled among the household members: is the most critical and, thus, most cautiously designed question that will both identify the person and the household as disadvantaged. Household is also labelled as disadvantaged because the disabled persons pose burden and dependency on the family to care after him/her. Under the question, definition of a wide range of disability (giving some examples) is provided for clear definition of disability. What is more important here, is whether the person identifies himself as disabled. If not, there is nothing to say. It is also seen necessary to attach an informative note explaining that disability should not be perceived as something to embarrass but a physical reality. The variable for this is 'DISAB.NO'.

5th Question: 'PEDE.WID' Here, it is asked whether the household members perceptionally agreed on that the width of the local walkways or curbs are wide enough, i.e., it is 2 m or over through which two wheelchairs can cross side by side. This requires a binary type of coding. If the answer is positive, then the household and the locality is thought to be labelled as advantaged. Yet, the accuracy of the answers should be checked by also the interviewer' supervision and the cross comparison between the responds of the same zone.

6th Question: 'INC.NET' Total net income of the household is directly asked given the three options as:

. if below 100 million TL, it will be marked as (1)

. if between 100 and 300 million TL, (2)

. if it is 300 million and above, (3)

However, the household members may not feel comfortable to explain their true earnings and such a question may be perceived like interfering with their privacy. Yet, asking the question is necessary in defining the "approximate" income level, as the most important one of the indicators. Even if not the respondent reveals the real amount, we assume he will approximate to the real income. The other income indicators (rent, vehicle ownership, the electricity bill, education level and the status, and the number of the members in the household) will support this data. It is very helpful to evaluate all income indicators with their reasonable weights to be determined. Income data is a necessary item in the determination of "disadvantagedness" in terms of cost considerations of travelling.

7th Question: 'EDUCA' Education related questions are asked:

a) The number of the members in the household having different levels of education is asked. This data will partially help support the income level data since it gives hints about the status (mentioned above) This will either be used in the poorly determination of the disadvantagedness due to the socio-economic structure of the household and also the permanent (regular) use of the transportation system. The assumption behind this is that the regular travellers are usually among the higher education groups because they have more regular and programmed affairs. Yet, very high education groups (like professors, managers, etc.) are not expected to produce regular trips and less likely in the peak hours.

The required data names for each education levels will be respectively: 'EDU.UNIV', 'EDU.LISE', 'EDU.ORTA', 'EDU.ILK', EDU.KURS'

b) for this part, whether there is any illiterate who can not write and read among the household member is asked. This will strongly support the disadvantagedness in terms of "inability" to read and understand the instructions and traffic warnings, etc. when travelling. Although this is a personal matter, it affects the situation of household also in terms of the status (and, maybe even income), thus can be aggregated to household data. The variable will be called 'ILLITER' and use dummy variables.

8th Question: 'ELEC. FATU' Asks the amount shown on the last electricity bill: This data will be only used as the indicator to support the income level data. Choices are only restricted to three:

. less than 5 million TL (then, will be coded as 1)

. between 5 and 15 million TL (coded as 2)

. more than 15 million TL (coded as 3)

9th Question: 'ATTEND' the questions are about current attendance to education:

a) <u>at present</u>, how many of the household members attend high school or university: which is to define how many trips can potentially be produced for regular education purpose that may mean long distances and may require vehicle use. This also gives idea about the current status of education. The data column, then, can be called 'STATU.EDU'

b) In this subsection, the number of the members in the household who are at the age of preliminary school (ie., 7 - 15 years old). This will provide the potential regular school trips that can either be through vehicles or walking. For either case, the existence of such trips may be assumed to be burden on households. 'ILKOK.YAS' will be the data name.

c) The general travel conditions of those who attend the preliminary education will recorded as: For the first child, the code will be (1), for the second, it is (2), and so on.

'SERV.EDU' will be used, if the child goes to school by service

'WALK.CLOS' used if the child goes to school by walking when the school is within 500 m.

'RIDE.EDU', if the child is given ride by acquaintance

'WALK.DIST', if the child has to walk to school when the school is far

'STRE.CROS', if the child additionally has to cross the very busy street (main street) on the way to school (when s/he walks).

'TRAN.EDU', if the child uses a transit bus or minibus, etc. for going to the school.

As might be guessed, 'SERV.EDU', 'RIDE.EDU' and 'WALK.CLOS' can show that the child travelling to school is lucky in his/her conditions. But, other indicators can be the "points" towards disadvantagedness and also be aggregated as the "household's disadvantagedness" because of the extra burden on the family.

10th Question: 'ACCES' measures the accessibility of the household residence to various urban activities: Thus, it is considered to be a very important measure of disadvantagedness.

. **'ACC.WORK'** will be the data name for the distance to the workplace,

. **'ACC.OKUL'** used for the distance to the nearest preliminary or high school,

. **'ACC.HOSP'**, for the distance to the nearest hospital or health center,

. **'ACC.SHOP'**, for the distance to the nearest big shopping center, bazaar or market place in which every consumption item can be found.

. **'ACC.RECR'**, for the distance to the nearest play ground or park, or any recreative facilities

. **'ACC.SOC'**, for the distance to the places in which social, cultural or religious activities can be found

If these activities take place within the distance of 500m, aggreedly by household members, then data cell will be coded as (1). If the activity is within 1.5 km, then this information will be ciphered as (2), and if more than 1.5 km, code is (3). This data is clearly be aggregated to household in this study. But, the accessibility could have been a personal information, too.

3.4.4.2. Section II. Personal Perception Data

In the beginning of this section (Form A2), there is an additional code number for the household members and name is not necessary. Each person must fill out the form by himself. A2 form can not be applied to those 6 years old or under since they are assumed to produce no trips. And, the persons up to 13 years old may need guidance by their parents when filling out the forms since they may be unfamiliar with such interview forms and difficulty in understanding some questions. The information gathered through these personal forms are valuable in terms of providing either basis for the household-aggregated data or individual data[4].

The person filling the form is identified by assigning each of the family member a code number, his/her age and sex. The person can also be identified by his travelling or personal peculiarities expressed in the responses.

1[st] Question: 'REGUL' is the number of regular trips of a person in an ordinary day:

a) In this part, the approximate number of both regular and vehicular trips done in a typical weekday is asked stressing on the words 'regular' which sounds implicitly done by vehicular. It is also emphasized that these trips are usually done at the same hours everyday. Here, it is intended to obtain only the regular trips that were expected to coincide with the work or school trips but it is not necessarily so in real life. This may either be converted to daily or weekly trip rates later. A trip is defined as one way travel not including the return (although each home-based travel will most probably have its return to home). It can be inferred from the nature of

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[4] Note that all data can either be aggregated up to zonal level if necessary. All individual data can be converted into household level or zonal data. Household data can either be converted to zonal data but not to individual data aside some exceptions. The data obtained at zone level likely can not particularly be applied for the individuals. That is to say, we can build the aggregations from bottom to top but not from top to bottom. Even the "individual" data obtained from the zonal data is an aggregated form (or, generalization) of individual data.

such travel that they are, in a great extend, the home-based "productions" trips. Here, 'REG.TRP' will be used for the daily regular trips.

b) To where these trips are destined: If these trips are regular, they are probably thought to be work or school trips. But, we essentially need which zone or district (even knowing the street name is best) the trips are destined. This is a very important variable for constructing the O-D matrix and for the calibration, which can be called 'DEST.TRP' column under which the zone name, or street name can be written.

2nd Question: 'SOC.TRP' The number of other trips not related to work or school, etc. in an average day: These may shortly be called 'social trips' thereafter, which may either include visits, recreational trips, health, shopping, or walking trips that seem not very obligatory. It is only necessary to learn the proportional share of these 'non-serious' trips among the total, or to the regular ones. It is essential here to inform the respondent not to involve the weekend 'social' trips which are much dominant in weekends.

3rd Question: 'DURA.TOT' Total time spent for the transportation (ie, all trips in a day): The total of only travel durations will be the concern. Those five options are given and will be encoded in the data as:

- if the total travel duration is less than 15 minutes, then (1) will be coded.
- if between 15 and 30 min., then (2),
- if between 30 and 60 min., then (3),
- if between 1 hour and 2 hours, then (4),
- if more than 2 hours, then (5)

4th Question: 'STOP.ACC' "How long does it take to arrive at the car park or bus stop from home?": Four options are provided:

- if less than five minutes, then (1) is encoded,
- if between 5 and 10 minutes, (2),
- if between 10 and 20 min., (3)
- if more than 20 min., (4) will be encoded.

5th Question: 'COST.TRA' is the average transportation cost the person spends in an average day: Those who use public transportation can only reckon their personal ticket costs, while those who use they private vehicles should also include parking cost and other daily costs that running a car requires onto the (daily) fuel cost. Again, five options are given and the encoding is as in the same fashion done before.

6th Question: 'TRANSFER' is about the transfers if a person has to make in a typical day:

a) The number of the transfers made is asked (typically when having regular trips to work place or school, ect.). Being obliged to make transfers is an unwanted situation while travelling. This can comfortably be thought to be a negative point towards. 'TRFER.NO' will be the data name.

b) What is the average time spent for transfers in a typical day. Thus, the question addresses to those when travelling by public transportation. But, those who ever use a public mode may pass this question without answering. Transfers are usually the case for public transportation. The name is 'TRFER.DUR'.

7th Question: 'WAIT.STOP' When using a public transportation mode, how long a person waits in general in the bus stop. Again, if public mode is never used, this question may be passed. Four options were seen enough for measuring.

8th Question: These questions are about the purpose and mode of trips:

a) The representative departure time for the work or school related trips: Times will be written with hour and minute notations and the data name will be **'DEPAR.TIM'**.

b) The representative return (arrive at home) time of the regular trips will be recorded: **'RETUR.TIM'**is the data name.

c) The mode chosen in general for those trips are asked: The options are provided in two envelops as public and private:

- if a bus is chosen, then (1),
- if dolmuş, then (2),
- if minibus, (3),

- if train, (4),
- if an institutional service, (5)
- if any other public mode other than above, (6)
- if a private car is used, then (7),
- if a ride is given by the family member, (8),
- if a ride is given by any other acquaintance or neighbor, (9)
- if taxi is taken, then (10),
- if motor-bike, (11),
- if bike, (12),
- if tractor is used, (13),
- if any other private mode is used, then (14),
- if trips are made generally by walking, (15),
- if a special vehicle designed for disabled (handicapped), (16) is encoded.

This data column will be called **'MODE.TRP'**. It is necessary to note here that trip departure and return times are generally expected to coincide with peak hours. If this is so for the person, the person may be exposed to harsher conditions of traffic because of the density, therefore, may be assumed to be "disadvantaged".

d) What is the time allowed for other non-work and non-school related (ie, social, recreational and shopping) trips in a day. This information will also be used in proportioning the time allowed for the regular (work/school purpose) trips. Three options were provided and the name will be 'DURA.SOC'.

9th Question: 'PERCEP' are the perceptional ones about the transportation infrastructure and system service quality:

a) Whether the person could mostly be seated when travelling during the week is asked. Five options are provided ranging from "always" to "not at all". The name is **'SEAT.COM'**.

b) Whether the vehicle is very crowded when the demand is high and the person is on foot. Again, five choices are provided ranging from "crushy-full" to "very loose". The name is **'COMF.FOOT'**.

c) When travelling, general evaluation of the conditions of the public vehicles is asked given the options below from the point of the respondent: Only there options of evaluation are given as good, medium and bad, which will be encoded respectively as (1), (2) and (3). The conditions of public vehicles and their corresponding column names will be:

- lighting is 'LIGHT'
- smell is 'ODOR'
- climate control is 'KLIMA'
- noise is 'NOISE'
- the comfort of seats is 'COMFOR'
- the drive quality is 'DRIVE'
- the general cleanness and maintenance is 'CLEAN', and,
- air conditioning is 'AIRCON'

The "major" variable name is **'VEH.COM'**. The responds from Questions 10 and 11 will be compared with the real cases by examining in the field surveys for testing whether the responses are reflecting the realities observed.

10th Question: 'DISAB' "If you are disabled (handicapped), when you make your daily travel..". The implicit purpose of this question is to define the disabled(s) in the household and to find the degree of disability he/she is involved in. If someone accompanies the person while travelling that means he/she is 'seriously' disabled and there is the dependency situation. If the person uses an instrument (stick, wheelchair,etc..) to compensate his/her disabledness, then he/she is thought to be second degree disabled. But, if the person is provided by a special, probably demand responsive jitney or taxi kind of, service or any kind of special transportation mean to make his/her journeys, then he/she is assumed to be a lucky one, and maybe not disadvantaged, probably due to the best way of compensation for the disability (although this may mean costly way of transportation). We do not think this latter one a common practice among those disabled who want to travel.

Then, the scoring of the three options provided will be accordingly, and,

If the disabled person is accompanied, the code will be (1),

If the person uses a special instrument, (2),

If the person is provided with a special "demand responsive", then (3).

11th Question: "Which of the conditions stated below best suits to your bus stop (either the nearest one to your home or work/school)?" Here, intentionally the perception of the respondent is sought. This variable will be named as **'STOP.COND'** and such conditions if exist will be marked:

- if there is excessive crowding at the stop and confusion, (1),
- the vehicle stops far backside or far front and opens the door there, (2),
- the bus stop is totally bare (up and sides are open), (3),
- there is no lay-by (approach pocket) for bus at the stop, (4)
- "location of stop is very unsuitable for me"(e.g., across the main street), (5)
- there is no information or explanation board, or schema at the stop, (6),
- the stop is unattended and there are the marks of vandalism, (7),
- the stop is located on a slope, (8),
- the stop has no seats, (9).

3.4.5. The Local Threshold Values

The threshold values that are going to be used later in the Cluster Filtering study in Chapter 5 are obtained according to the considerations listed below for each home interview question skipping the irrelevant ones. For the commonly accepted standards, refer to the Standards from the Literature study in Chapter 2.

For Household (hh) Based Questions:

Question 4-(a) the expected rate of employed over non-employed in the hh should be 1. When this value gets closer to 0 (zero), the disadvantagedness situation of hh increases.

(b) The critical age of young starts with the perception of and socialization with outer world. This coincides with the age in-between the kindergarten and elementary school enrolment ages, which is approximately 6 years old. Under this age, children are assumed to depend on parents while travelling.

(c) 65 is assumed to be the age of retirement (refer to the standards study in Chapter II) and of the slow reaction and reduction in physical abilities. After this age, there occur considerable reductions in trip production.

(d) The peculiar standards for disabled were reviewed in Chapter 2. The total proportion of disabled in Turkey is not less than 7% (may be up to 10%). The existence of any disabled in the hh seriously restricts the trip rate of the individuals in the hh.

Question 5- In the determination of the net income, the "minimum payment (asgari ücret)" determined by law can be the basis. However, in this study, a standard family (2 parents + 2 young) earning monthly less than 100 million TL (with respect to October 1998) is considered to be in serious difficulties at disadvantageous position. Yet, the evaluation must be handled at person basis (per capita). The local averages will be checked for the person level threshold value.

Question 8- The payment on the electric bill exceeds 5 million TL one, it is deemed that the hh is better off as of the income indicator.

Question 9- c) Pupils must be attending to the closest elementary schools within the maximum distance of 500m, which is a commonly agreed distance. This is also necessary rule in order to prevent the accidents. Those checking the box: walking close ('walk.clos') are assumed to comply with this rule. The pupils given ride and transported by a school service are assumed to be advantageous.

Question 10- It is advantageous if the urban activities are accessible within 500m. Some activities such as work place, the urban center, hospital, public facilities, recreation activities might be acceptable within 1,5 km. The hh's that can not retain this accessibility are accepted to be disadvantaged.

<u>For the Person based Questions</u>:

Question 1- It is expected that the trip generation per day must be over 1.

Question 3- Total travel time per day must not be over 1 hour for such small size cities. For Ankara, travel time for a typical peak hour trip was found to be around 30 minutes.

Question 4- Access time from home (or from the work place) to the bus stop or car park should be 5 minutes ideally. This can be maximum 10 minutes, but which is not suitable for small size cities.

Question 5- There is not a clear standard for the total daily travel cost. But it can be found practically after finding the average daily trip rate for the city. If, for example, trip rate is 1,5, this can be multiplied by the single ticket fare for public transportation, say 100 000 TL. Then, the average travel cost can be assumed to be 150 000 TL. However, this can still not be standard: This cost must be found for actively travelling people. A working male can make more trips than children and women. Thus, it can be assumed rather a person can make 3-5 trips a day and the daily travel cost becomes 300 000 or 500 000 TL. Thus, 500 000 TL can be the critical value.

Question 6- a) There is no statistics available for the number of transfers. The only measure we can think of is that a person can be arriving at the destination with only one trip. If s/he is obliged to make transfer, s/he can be assumed to be disadvantaged. Two transfers makes him/her more disadvantaged, etc..

b) Wait time for transferring should be the same with the wait time at the stop. It should not be more than 10 minutes. The local average will also be considered. An additional 5 minutes of access time to the stop where transfer will be realized can be added to that time.

Question 7- Local average will be the guide to define the wait time at stop. For small size cities, it must not be more than 10 minutes.

Question 8- a) This question is used to find out the local peak hours.

d) the time allowed to non-work (shopping, recreation, visits, etc.) trips must not be less than 1 hour. If less, that means the traveller has less spare time for him/herself.

Question 9- a) Even if not always, being seated in most of the travels is one of the important travel quality measures. Contrary to the metropolitan areas, in small cities such as Aydın all travellers should be seated during the travel. The ideal threshold value will be determined according to the averages.

b) If the traveller is on foot during the travel, the comfort while standing is also important. The check boxes 'rahat' (comfortable) or 'normal' can be the threshold values. The averages will be the guide.

Question 10- in the case the person is disabled, the degree of disability can be the further measure towards disadvantagedness. Here, that s/he needs the support of another person for his/her disability can be the dividing measure towards disadvantagedness. Because, even the disabled must be able to travel by him/herself. There is not such a disabled-sensitive transportation (eg, in bording on and off the vehicle). If the person is transported by a special para-transit service, then s/he can not be titled as disadvantaged.

Question 11- The disadvantagedness of the person in this question (about the quality of vehicle) can be determined according to the number of the "kötü" (bad) checked boxes. For example, it is assumed that marking 4 "kötü" boxes means the vehicle quality is bad for that person. Below this number, the quality can be normal.

Question 12- The conditions set in the Question 11 are valid for this question, too. The quality of the bus stop requires also the subjective evaluation for determining threshold value.

The final threshold Likert values can be clearly seen as marked with check sign at the Appendix C (Home Interview survey forms).

3.5. Inventories and Network Data

Inventories are obtained through various institutions and organizations that provided information about the public transportation routes, network structure and the vehicle and passenger capacities, etc[5].

Yet, it is admitted that the data are quite raw and sometimes informal, which is expected for a small city, thus, its reliability is suspected. For the informal data, it is tried to verify the accuracy of the data by the cross-check from different sources. For example, the data of vehicle capacities, and the number of private and commercial vehicles registered obtained from the Municipality are compared with those of the Drivers and Car Owners Association (Otomobilciler ve Sürücüler Derneği). Having some minor differences between the two sources, the data of each were consistent in general.

Total number of vehicles registered in the city of Aydın is 64643. That is to say, almost there is one vehicle for two persons in the city. When rated to the total number of vehicles, the ratio of commercial vehicles is around 10 %.

3.5.1. Public Transportation

The system was recently privatized due to the low demand and cost inefficiency to operate it publicly (by the municipality). When the municipality ran system, buses were used and it was understood then that the capacity was underutilized, which meant

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5 These institutions were primarily:

- The Aydın municipality
- The State Institution of Statistics (SIS) (DIE) (Ankara)
- The local Census Directorate (Nüfus Müd'lüğü)
- The Police Department (Emniyet Müd'lüğü)
- Drivers and Car Owners Association (Şoförler ve Otomobilciler Derneği)
- The mukhtars of the districts
- The Directorate of Traffic Studies (Trafik İşleri Müd'lüğü)

cost. With the privatization, the low capacity vehicles (minibuses) were seen suitable enough to meet the demand. Now, the buses are sold out to private.

There are currently 14 routes that rotate each week to provide equity both in terms of the incomes of each individual route operator and the citizens served. Thus, the whole system can be perceived as one operator unit with the equal vehicles at each route. It is learned that the total number of vehicles working all day is 139 (which can be assumed to be 140) within which each route utilizes equally 10 vehicles. Vehicles are usually the dolmuş type minibuses (about 10 are midibuses with 24 seats) with the seat capacity of 14 persons.

The frequency of vehicle departures is said to be 2 to 2,5 minutes from the terminal points of the routes. But, this is not so regular and may change along the route journeys. In the route-dense paths, as many as nine routes overlaps and the waiting time at stops (ie, the frequency at the city center bus stops) period decreases to the favor of users. Especially, The Adnan Menderes Boulevard is the fortunate path in terms of the overlapping of nine routes (See the total view of routes in the Figure 5). It was found in the screen line counts and verified by the observations in the bus stops that the occupancy ratio reaches at the full capacity and even a little excessive at peak times, but this drops almost half the full occupancy in average at the non-peak hours.

3.5.2. Bus-stops

The minibus stops are not specified on the map but the terminals only (the beginning and end stops). The stops are closed and buffet type only on the Adnan Menderes Boulevard (i.e., the main North-South axis). Most of the public transit stops are bare and undesigned.

Frequency of the services is asked to the drivers, to the personnel at the terminal stops where they regulate the frequencies adapting to the demand, and also to the Directorate of Traffic Studies in the municipality. The same answer was found to be between 2 to 2,5 minutes for frequency, which may however little change increasing in some busy paths and decreasing in non-busy paths.

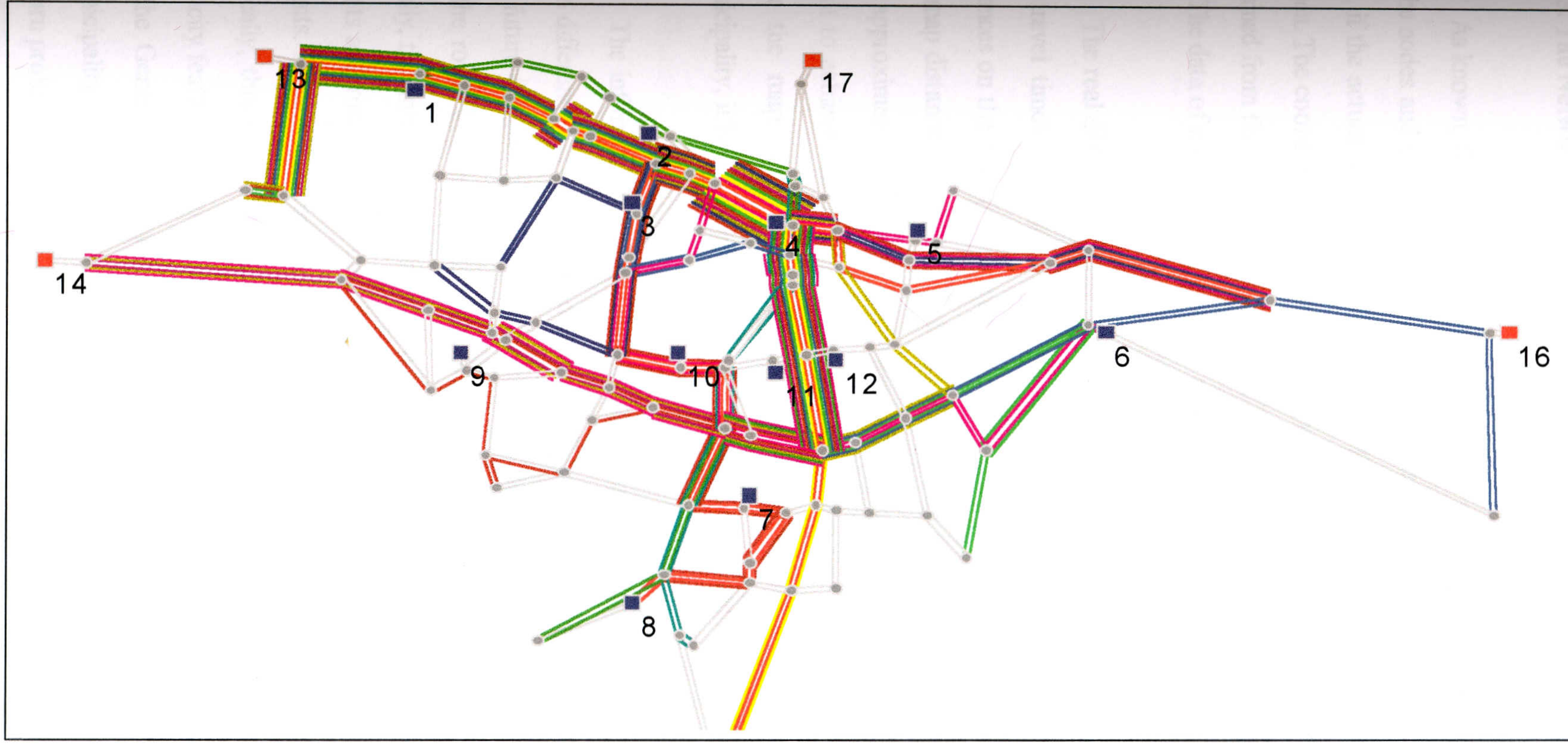

Figure 5. The Total View of Transit (Dolmuş) Routes in Aydın Over TRANUS Defined Links

3.5.3. The Network

As known, the network in transportation modelling is representatively composed of the nodes and the links connecting between them. The links are linear in TRANUS and, if the actual roads are two-way, the links are displayed as two direction on the screen. The coordinates of nodes that represent either the centroids or intersections are obtained from the GIS maps of Aydın. The data of coordinates are placed in Appendix D. The data of coordinates are used as the network input in TRANUS.

The real distances of the road segments are necessary for defining travelling cost (or travel time) variable but are hard to measure. Thus, we may take the airline distances on the map (or, screen) as the distances and can be calculated by converting the map distance to real km distances. This way of calculation is not a good idea but will approximate to the real case with an acceptable level of accuracy, for our purpose is not to achieve the very accurate results. When the map distances found for routes over the map were compared to the real route distances obtained from the municipality, it is observed that our values are very close to the real distances.

The information for the physical capacity of roads and streets are cross-verified from different sources obtained from the Land-use Plans showing the current situation and future (Master Plan), and also from the lane observations because the lane number on the road, in our calculations, is the major function of finding vehicle capacities. Finally, this information is also to be calibrated by the screen line counts on the chosen streets and roads. These calculations will be explained in the Section of Screen Line Counts. However, simplification is necessary for clarity of the network view. Thus, basically, three types of links (roads and streets) not only defined according to the capacity features but also the functional order of the links: Highways that are operated by the General Directorate of Highways, The Boulevards and the Streets by the Municipality. All types are assumed to have two way directions, which do not subject to turn prohibitions. This is nearly so in Aydın. Figure 6 presents the three type of links on the TRANUS based map.

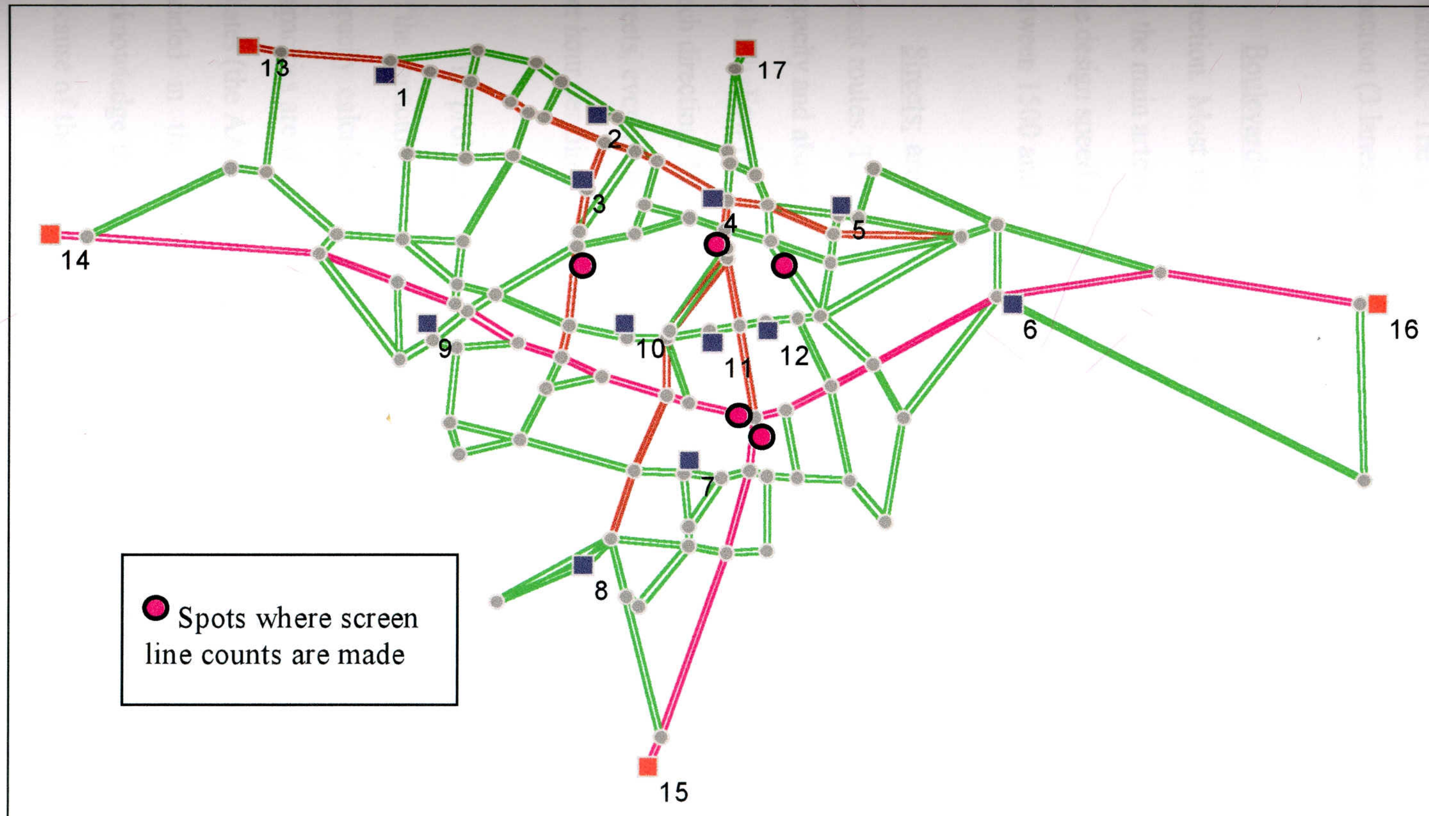

Figure 6. The Three Link Types (Pink:highways, red: blvds, green: streets)

These three types differentiate basically in the number of lanes as mentioned[6]:

Highways: usually three lanes per direction (where car parking and side obstructions are minimized). They are heavily comprised of the external traffic by-passing the city. The design speed is higher (50-60 km/h) under the restricted conditions. The capacity is calculated to be between 2800 and 4000 hourly per direction (3 lanes assumed in each direction).

Boulevards: capacious than streets with some three and some two lanes per direction. Most usually contain side parking that constrains the flow of traffic. They are the main arteries of the urban traffic, thus the main distributors between the zones. The design speed ranges from 40 to 50 km/h. The capacity per hour is calculated to be between 1500 and 3000 per hour per direction.

Streets: are the minor paths between the zones, some of which can even allow transit routes. They are also assumed to contain parking at both sides that restrict their capacity and also reduce the speed (maximum 40 km/h), which could have been ideally 50 km/h. Few may have two lanes per direction but usually assumed to be one lane for each direction. In our model, there is no one-way (one direction) and turn prohibited streets, even if there might be in reality. The capacity is assumed to be maximum 800 per hour per direction (it may be even below 500 in most places).

The problem in capacity calculation is that there is no healthy way of calculation of the capacities in Turkey officially. Most of the time, the American standards and the capacity calculation methodologies are adopted. Thus, first, the calculation of the capacities are done according to AASHTO's Highway Capacity Manual of the United States (the AASHTO's "Green Book", 1984). The basic concepts of that manual were briefed in the Mannering and Kilareski's book (1990). These resources also acknowledge the difficulty for estimating the capacities for especially the urban streets because of the many factors affecting during the day. There were some other methods

[6] Though there are three types of links, peculiarities of these may vary in some links.

for urban streets, but they were complicated enough usually basing on the intersection approach counts and calculations.

Despite, in this study, a much more simplistic approach is tried and when compared to the real data of DH ('Karayolları Genel Müdürlüğü'), it is found quite realistic. The method is based on the maximum five-minute counts at the screen line counts done at the evening peak-hour for calibration. The logic lies behind the analogy that the 15-minute counts are most commonly used in the Service Flow (SF) rate of a certain level of service. That is the capacity of the road for a given LOS, in which the rate is obtained (Mannering and Kilareski 1990, p.172-3):

$$SF = V_{15} \times 4$$

which is usually used in the calculation of Peak Hour Factor (PHF) or the Volume.

Here, the other traffic factors are not taken into consideration that affect the capacity of the road, which are used to be considered.

A rough but "approximate" capacity could be found in the same manner with maximum 5-minute counts we already have (AASHTO 1984, p.92):

$$SF = V_5 \times 12$$

Here, the maximum five-minute counts found for each street (and directions) are elected and multiplied by 12 (because there are 12 five-minutes in an hour) which best approximate to the capacity (AASHTO 1984, p.92). However, capacity is still something above, which needs the factor of peak hour. The peak hour factor could be 0,9 for such size city examples, if the level of service at peak hour is defined as D or E (TRB 1978, pp.143, 155). However, it is decided for Aydın case that the level of service at peak period could be much better than this (even lower than C), and therefore, the formula for calculation of the capacity is intentionally <u>reverted</u> as:

PHF = V / SF, and, the reverted is **PHF = SF / V**

Vmax = PHF x SF and, the reverted is **Vmax= SF / PHF**

(Note that V max is assumed now as "capacity")

Thus, the values calculated for the screen line streets were divided by the Peak hour value of 0,9, and the other streets according to their conditions and lane numbers are assigned a level of capacity. The results are provided in the Appendix E. Table 6 provides the summary of these results (See Appendix E for Data of 15-minute aggregated counts) for the screen line streets and, thus, for the three types of lines (Highways, boulevards and streets) as calibrated. The screen line counts are conducted at three points where the rail line divides the city into two parts so that it allows nearly only three major passages between these two parts. Additional counts are made at two approaches (İzmir and Muğla) of the Adnan Menderes Junction, which are, in fact, not of the screen line but accepted as they are.

However, these results found are certainly not very reliable due to the inefficiency and scarcity of resources when counting. Indeed, the counts must have been made for at least 5 days and 6 hours for each day (Gülgeç 1998, p.217). It is accepted in general that, at least, 12% of urban traffic is peak hour traffic. This may be up to 20 percent according to the type of the city and the behavioral characteristics in that city. This percentage is also verified here in this study when the peak hour trips were classified separately.

The Annual Average Daily Count results published by the DH as converted to the PCU values can also be checked from the Appendix E.

3.6. The District Data and Zoning of the Area

According to the Municipality resources (The Aydın Master Plan 1995, p.94) and the Provincial Directorate of Population Statistics, the number of districts and their 1990 populations are provided as a list in Table 7.

Table 6. Summary Table of Capacity Calculations based on 5-minute Counts for the Screen Line Streets

		Egemenlik			Adnan Menderes Bulvarı			Atatürk Bulv.			Muğla				Izmir		
		1st day	2nd day	3rd day	1st day	2nd day	3rd day	1st day	2nd day	3rd day	1st day	2nd day	3rd day		1st day	2nd day	3rd day
direction	min & vol																
N	max min.	25	55	25	55	50	5	45	40	40	35	50	50	E	35	35	40
	PCU vol	47,2	41,4	43,1	185,2	163,9	119,5	80,5	78,5	69,7	87,1	89,8	106,6		148,8	144,7	236,3
S	max min.	35	35	40	50	50	10	10	50	35	60	40	55	W	5	25	35
	PCU vol.	54,7	50	45,1	125,7	117,5	123,9	68,6	60	65	105,4	100,3	175,6		184,4	167,6	185,1
max. vol. / 0,9 :			**729,3**			**2469,3**			**1073**			**2341**				**3150,67**	
(ie. Capacity=) for peak hour			~750-800			~2500-2700			~1100-1200			~2400-2500				~3200-3500	
DAILY CAPACITY			4444,44			15000			6666,67			13888,9 calibr fact ,6				19444,4444	
		with calib. Fact, ,25	**3200**		with calib. Factor ,20:	**13500**		with calib. Factor ,20:	**6000**			**4167**			calib. Fact ,25	**14000**	
if 0,15:			5000			16666,667			7333,33			16000				21333,3333	
			5000			16700			7350			16000				21350	

Table 7. District Populations According to Two Sources (1990)

	Municipality	Dir. of Pop
1. Adnan Menderes	-	2503
2. Ata	3161	4259
3. Cuma	4771	4607
4. Cumhuriyet	7259	8069
5. Efeler	6725	5680
6. Girne	6201	5153
7. Güzelhisar	9644	8936
8. Hasanefendi	5071	5945
9. Ilıcabaşı	1190	-
10. İstiklal	764	-
11. Kemer	3164	3748
12. Köprülü	3271	3510
13. Kurtuluş	9984	8999
14. Mesudiye	6132	5973
15. Meşrutiyet	9388	7589
16. Mimar Sinan	-	- (default: 500)
17. Orta	6160	7247
18. Osman Yozgatlı	5649	9872
19. Ramazanpaşa	1348	1395
20. Veysipaşa	1986	1878
21. Yedi Eylül	6028	6024
22. Zafer	6918	6624
23. Zeybek	-	- (default: 500)

The average size of a district is found to be 5632. According to the Municipality resources, the total population of urban Aydın in 1990 was 107,008 and 109,711 according to the Directorate of Population Statistics. The total number of residences is 32,192. The home interview sampling is done according to the rules of proportional representation. That is, the number of sampling should be taken on the basis of the population of the districts.

The second problem is the projection of the 1990 population statistics to the 1998 values since the model will be for the current year. The population increase trend was shown in Figure 7, based on the population statistics in the Aydın Master Plan Report (1995, pp.160-9). Additionally, Table 8 presents the 1995 and 2000 estimations calculated in the Report by various estimation techniques. When checked from the graph in the Figure 7, estimation between the exponential and parabolic would be the most reasonable: a value between 135,000 – 140,000 for the year 1998. Yet, 1997 population statistics at the district level are not available and there is no defined way of calculating (projecting) the district populations, it is best to start from the total growth that the city recorded in the last 7 or 8 years. Since, Aydın's current population is unofficially declared in the Report as 133,842 for 1997, the total population growth has been around 0.3. Of course, it is impossible to reflect this figure directly onto individual district populations.

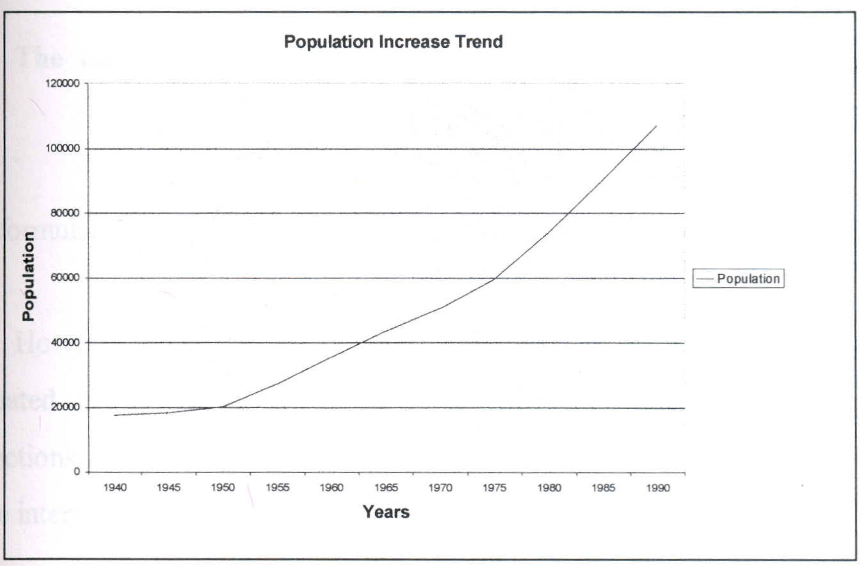

Figure 7. The Population Increase Trend of Aydın City

Table 8. Various Estimation Techniques of Population by the Municipality

Years	Linear	Exponent.	Parabolic	Plan's Provis
1995	129.259	131.000	123.869	130.000
2000	156.132	158.788	143.326	150.000

Source: Aydın Master Plan Report

Our assumption is that the outer districts must be more open to development than the inner ones. Some inner districts are even suspected to lose population. However, it is preferred to define three logical types of districts that have different development weights that are defined heuristically such as:

The central districts are almost stagnant:	1.1
The middle districts must have some higher:	1.2
The outer districts must be over the average growth:	1.4

According to this formulation, the central, middle and outer districts are defined:

The central districts (CD) are: Güzelhisar, Hasanefendi, Kurtuluş, Ramazanpaşa, Veysipaşa

The middle districts (MD) are: Cuma, Cumhuriyet, İstiklal, Köprülü, Mesudiye, Meşrutiyet, Orta, O. Yozgatlı, Zafer

The outer districts (OD) are: A. Menderes, Ata, Efeler, Girne, Ilıcabaşı, Kemer, M. Sinan, Y. Eylül, Zeybek

The formulation is likely: $P_{(CD)} + P_{(MD)} + P_{(OD)} = 130{,}000 < \text{current pop.} < 140{,}000$

However, various development potentials of each district are also intuitively evaluated. Here, **P** is the district population. As the result of this method, the 1998 projections of each district and the corresponding minimum representative number of home interviews could be as in Table 9.

Table 9. Population Projections of the Districts for 1998

	1998* population	min. no. of interviews
1. Adnan Menderes	3755	11
2. Ata	5963	8
3. Cuma	5528	12
4. Cumhuriyet	9683	24
5. Efeler	7851	20
6. Girne	7214	18
7. Güzelhisar	9830	25
8. Hasanefendi	6536	17
9. Ilıcabaşı	1666	4
10. İstiklal	1200	4
11. Kemer	5247	14
12. Köprülü	4212	10
13. Kurtuluş	9899	26
14. Mesudiye	7166	17
15. Meşrutiyet	9107	21
16. Mimar Sinan	700	4**
17. Orta	8696	21
18. Osman Yozgatlı	11846	24
19. Ramazanpaşa	1534	4
20. Veysipaşa	2066	5
21. Yedi Eylül	8434	21
22. Zafer	7949	18
23. Zeybek	500	4
SUM	136582	330

* Here, The populations of the Provincial Directorate of Population Statistics are projected, which seemed more official.

** Whatever the population is, the number of interviews that should be taken is set to be at least 4.

If 360 interviews were taken at total, one household interview must be representing almost 400 persons, which is actually less than 1 per cent. As seen from the above table, the total number of interviews should minimum be 330.

For the sake of the data correspondence, the zone boundaries must follow the boundaries of the districts taking care of natural and man-made barriers (river, highway, railway, etc.). Homogeneous distribution of density, land use type (residential, industiral etc.) and compactness considerations have been the other important criteria in the formation of zones. The merging process is rather applied, due to the insufficient data, from the small districts that have small populations, either, so that we can have larger data per zone. It is intended to have clustering of zones maintaining the average around 30 households interviewed per zone. Thus, it was seen necessary to have limited number of zones down to 12. For this intention, we will aggregate the district data to zone level data.

In Figure 8, the network representing the real connections in straight lines is reproduced in TRANUS as simple as possible. The centroids are located so that they represent the gravity centers of the zones. The light blue lines represent the inter-urban highways. Here, the purple small squares are the centroids representing the twelve zones defined heuristically[7]. The outlying red squares symbolically represent the external centroids from which external travels are made. In this figure, the node numbers are not included in order to avoid the noise in the view. In Figure 19, (See the figure in the next section of this chapter: Disadvantaged by Zones), the district and conforming zone boundaries can be seen.

3.7. Quantification of Nominal and Ordinal Values, Scoring and Scale Definition for Measuring

There are basically four types of measurement scales (Richardson *et al* 1995, pp.169-171):

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[7] Actually, the definition of centroid locations requires a state-of-the-art study and should be objectively determined.

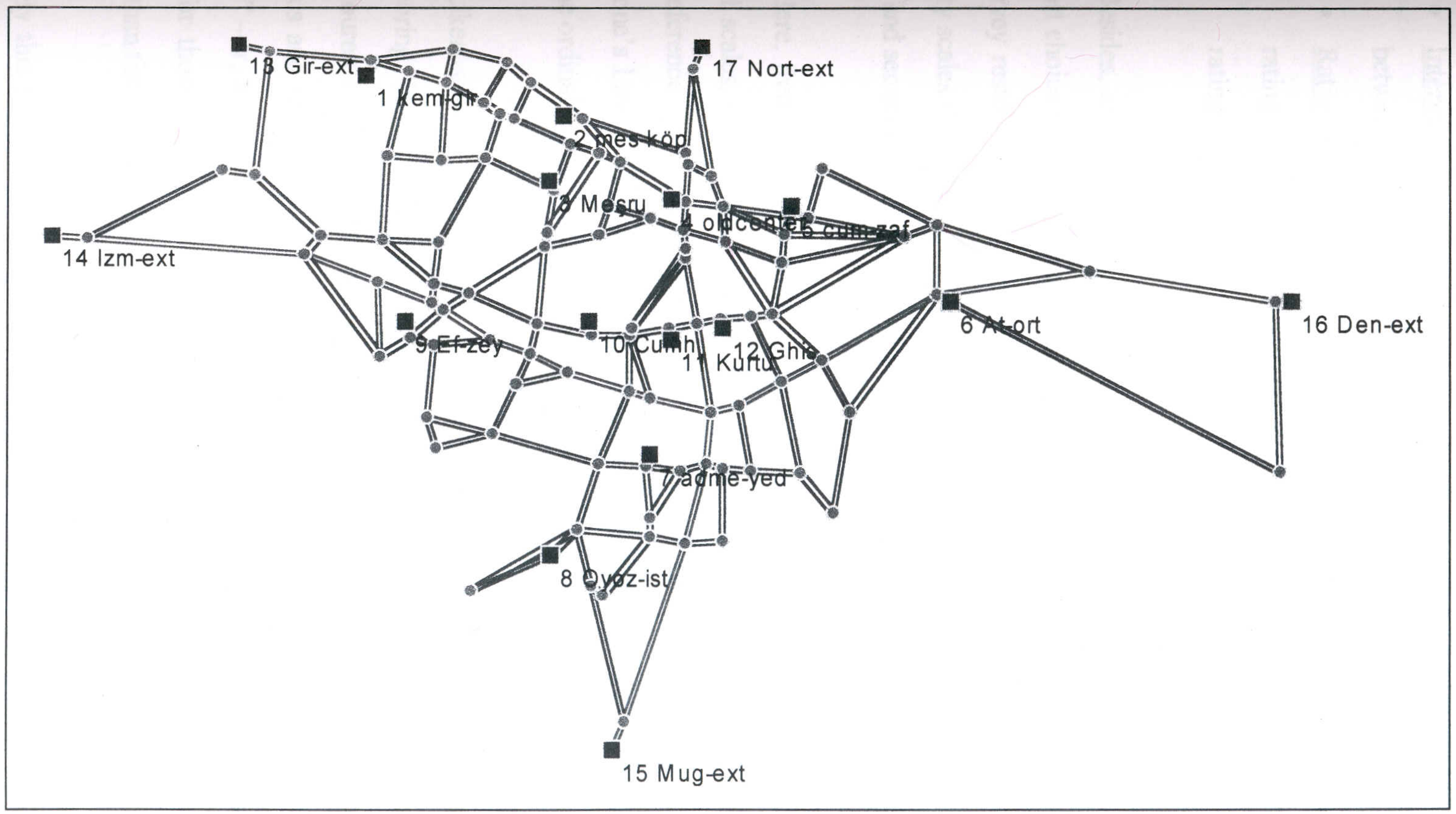

Figure 8. The Zones as Centroids

- Nominal scales: do not imply ordering but are used to categorize objects by naming each category.
- Ordinal scales : categorize the objects and also have ordering of them.
- Interval scales : not only categorize and order but also provide the distance between object ratings on the scale.
- Ratio scales : additional to others' properties, give also the distance of the rating to a reference point, zero, that enables the comparisons between ratings

Besides, attitudinal measurement techniques are used especially to measure the transport choice analysis. We now have to decide on what kind of scale we will have in our survey results or responses to be measured: paired comparisons, rank ordering, category scales that can further produce nominal, ordinal or interval scales, the Likert scales and semantic differential scales (Richardson *et al* 1995, pp.171-180).

Here, frequently the category scales will be applied, that can be convertible to interval scales, and rarely the others. The quantitative measurability of these values with reference to the common point value will be maintained by adopting the Thurstone's Law of Comparative Judgement (Richardson *et al*, 1995, pp. 174-5). So that, the ordinal values could be converted into cardinal values.

Likert scale is adopted and then the likert values converted into utility function type scoring. This is also called scaled criteria and has two basic aims (Papacostas and Prevedouros 1993, p.531): To obtain scaled single score (variable) for various related variables and to reduce the number of variables (creating "major" variables out of "minor" –or, atomic- ones), which will bring easiness in handling the database. The scale for those "major" (or, function) variables will finally be between 0 and 100, rather than their individual scales.

By this approach, the ratio values could be obtained in a sort of multi-variate way of rationing from over a group of questions (data variables). For example, a unitless single ratio value can be obtained for the 'dependency situation' of a family from the related set of sub-questions at the Question 4 (at Interview Form A1). Here, there are the questions asking (a) the number of people who work, (b) who wants to but does not work, (c) who are under 6 years old, (d) who are over 65, and (e) who are disabled. All these make a common value of dependency for the family, which can be found by a utility type of function. The ratio can be as such the positive elements (such as the number of those who work) can be divided to the sum of negative elements (others – who are seemingly dependent members). Finally, the rated value can be utilized as the dependency variable for the family that will differentiate from one to another. In a similar fashion, such technique is also detected in another study of Ülengin and Topçu with a similar concern of data (1997, p.1068).

The idea is borrowed from the Fuzzy Subsets concept (Yager and Filev 1994). "Fuzzy subsets are particularly useful for representing concepts with imprecise boundaries.." such as old, young, short, fat, etc. (1994, p.4-5). The possibility distribution range of a fuzzy subset (ie, the impreciseness) can be further reduced by introducing another subsets interrelationship to that subset:

> If a subset A has 4 membership functions about ages, which are fuzzy = under 20 (*a*), between 20 and 40 (*b*), between 40 and 60 (*c*), and over 60 (*d*), and,
>
> If a subset B has 3 other fuzzy membership functions = beautiful (*u*), fair (*v*) and ugly (*w*)
>
> A further C subset can be defined under 12 possibility of membership = A x B = under 20 and beautiful (*au*), under 20 and fair (*av*), under 20 and ugly (*aw*), between 20-40 and beautiful (*bu*), between 20-40 and fair (*bv*), and goes on..

Likely, if, for example, three categorical variables A, B and C can be brought into one united "function" variable:

> Where, A has 4 categorical scale, B has 5 categorical scale and C has 5 categorical scale.
>
> In a function, the richness of scale can be: AxBxC = 4 x 5 x 5 = 100
>
> That is to say 100 categorical scale.

The frequency of an item (variable) must give an approximate idea about the importance (weight) of that item and, thus, "usually"[8] used as the coefficient before the variable. For example, in the function about vehicle ownership, 'f(vehic)', it is found out that automobile's share (frequency) all through out the data is about 80%, while others were much less. The general principal of the function is to scale (rate) the individual value to the maximum value found in the data list: For example, if a maximum accessibility is found for an individual to be 28 point, this can be thought to be 100% accessibility ever obtained and all other individual values are rated over this finding since they can not exceed this value. While the one with maximum accessibility deserves to be 100 point, others will have lower values in the scaling. According to this ruling, the function variables are listed as:

f(vehic): is the function variable about vehicle ownership pattern and the formulated as using these minor variables:

100x(0,8(veh.oto)+**0,15**(veh.tica+veh.mini)+**0,05**(veh.moto+veh.trak+veh.bisi+veh.oth))/ **2,45**

In this formulation, the coefficients are found from the value frequencies of each minor variables. These represent sort of importance weights of the variables to be considered. f(vehic) is not, however, used directly a major variable but still as the minor of f(veh.avai).

f(veh.avai): is the function variable of vehicle availability for the person and calculated as:

100x[0,25+sq(vehic)/sq(hh.size-(veh.reg-1))**]/ 6,3**

here, sq denotes square root of the value in parenthesis. The scale is composed according to the limit values in the data set. For example, if one person has actually a value of 24 and this is the maximum value all throughout the data set, this is scaled to be 100, and vice versa for the person having minimum value to be 0.

f(access): is the measure of the accessibility for a person,

[8] Yet, in some places, designer's subjective (or, normative) weights are also introduced in the functions such as the situation of disabled multiplied 10 times in importance relatively to other

100x(2(acc.work)+**1,5**(acc.okul)+**1,8**(acc.hosp)+**1,5**(acc.shop)+1,5(acc.recr) +(acc.soc))/ **28**

Again, the coefficients are derived from the data frequencies as showing the importance of the accessibility element. Then, the frequencies are proportioned to general sum.

f(imped1): represents the cumulative effect of basic impedance (cost) elements such as total travel duration, distance to the stop and total travel cost altogether, in a multiplicative relationship,

100x(dura.tot x stop.acc x cost.tra)/ **60**

f(imped2): This also shows the stop-condition related impedance in a multiplicative fashion,

100x(stop.cond)+(trfer.no x wait.dura x wait.stop)/ **67**

f(imped3): represents mode and peak captivity together with the heavy emphasis (ie, 10 point for each increment of severity, 30 for the worst) on the situation of disabled. That is, the impedance effect must be much worse for the disabled.

100x[8(Peak1)+7(peak2)+**8**(type.mod)+**6**(dura.soc)+**(**30-(disab x 10))**]/ 56**

f(depend): measures the economic dependency situation of the person within the household.

100x(emp.no/(emp.no+(**0,36**unemp.no+**0,33**chil.no+**0,19**old.no+**0,11** disab.no))/ **3,3**

f(edu.fam): is the general educational status that reflected from the household level,

100x(0,3edu.univ+**0,34**edu.lise+**0,16**edu.orta+**0,2**edu.ilk-**0,1**illiter)/1,52

In this formulation, 'edu.kurs' variable is not even taken into consideration since its frequencies were so negligible.

f(ilk.trav): travel conditions of school attending children are measured and reflected to the household level and all individuals of the household,

100x[(8+**2**(serv.edu)+walk.clos+**3**(ride.edu))–
(2(walk.dist)+**2**(str.cros)+tran.edu)**]/ 12**

---

components of the function in the 'f(IMPED3)' function variable, or for catching the same unit scaling.

f(inc.real): is to approximate the real income of the household. To find the coefficients, multivariate regression method was used, in which there are many factors affecting the real income,

100(inc.net)**[0,6+0,04**rayic+**0,063x0,0015**(f(veh.ava))+**0,0023x0,0152**(f(edu.fam))-**0,002x0,28**(f(acces))-
0,3rent+**0,11**emp.no+**0,3**edu.kurs+**0,12**elec.fatu+**0,8**statu.edu-
0,17x0,033(f(depend))**]**/ **9,2**

Note that in this formulation, many function variables (in parentheses with "f") are used, too. Yet, this variable is not directly used but as a minor variable in f(inc.per) in order to find the income per person.

f(inc.per): is the division of income (real) per person such as,

100x((f(inc.real)/hh.size)/ **21,6**

This value will be used in all further calculations.

f(veh.com): is the function variable related to the vehicle comfort factors,

100x(light+odor+klima+noise+comfor+drive+clean+air.con)/ **24**

Here, minor variables are seen equal importance and no weights are assigned to the minor variables.

f(pub.com): is the measure for the inner comfort conditions of the public transportation vehicles,

100x**[**(1-(seat.com/10))**-((4**-comf.foot)/10)**]**

Of those, 13 function variables, 11 are directly used as the major variables in the calculations of the study (Since two of them were re-processed in the formation of other major variables). All these processes in four consecutive steps were summarized in Figure 9.

3.8. Field Survey and Screen Line Counts

The ideal weekdays for the most representative screen line traffic counts are said to be Wednesday, Thursday and Friday (Ortuzar and Willumsen 1994, p.78). It is assumed that it is enough to take the average of the peak hour traffic counts of these contiguous days. Peak hours are the most convenient time for screen line counts

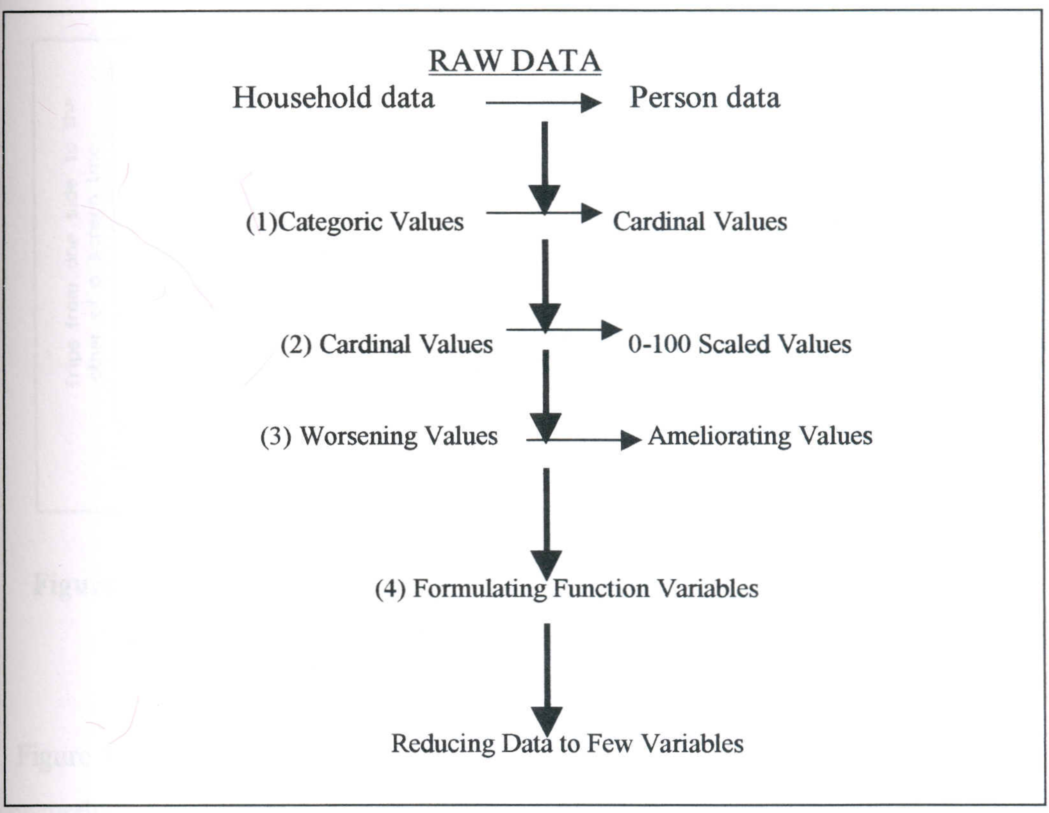

Figure 9. The Stages of Producing Scaled Function Variables

because of their consistency with the O-D data in these hours (See Figure 10). It is adequate to take only three days' and peak hour's average for such a limited study since the household survey data and the screen line data shows a consistency at these hours mostly. The screen line counts taken at three main boulevards (See the Figure 8) will later be used in the calibration of peak-hour trips of the Traffic Assignment Stage. The count forms for screen line counts can be seen at Appendix E.

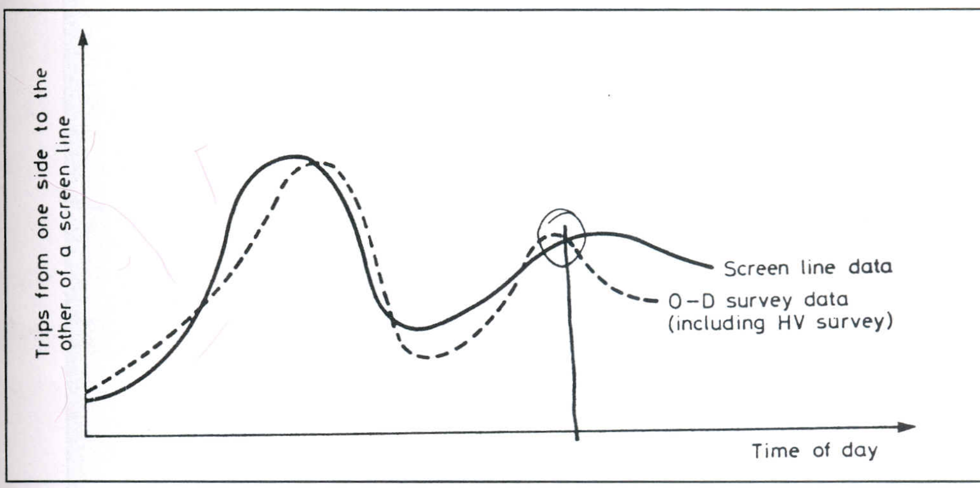

Figure 10. O-D Survey Data and Screen Line Data

Source: Ortuzar and Willumsen 1995, p.83

Figure 11 clearly depicts the density of return (usually characterized as evening) trips occurring at the hours between 17:00 and 18:00. It is seen appropriate to model the evening peak between 17:00 and 18:00.

The screen line counts, together with other observations, were conducted for the calibration reasons. It is observed that even at the peak hours, the traffic flow on the observed streets were efficient and certainly there occurs no congestion. That gives a hint that streets have still room to accommodate little more traffic load. Therefore, it can be assumed that even in the most peaked time interval, such as peak 5 minutes, the peak hour factor would be v/c value between 0,7 and 0,9.

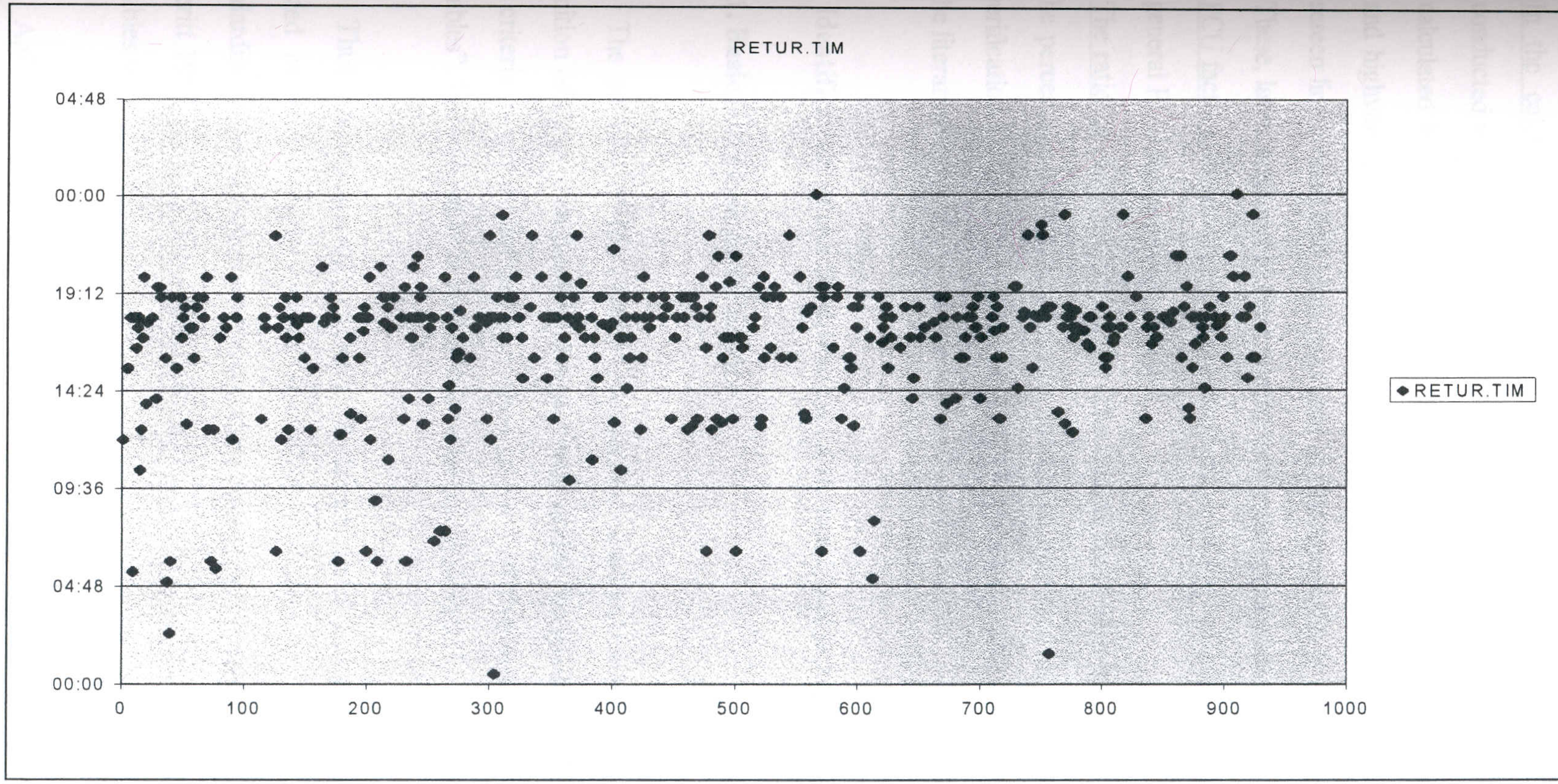

Figure 11. The Scatter Diagram of Return (Evening) Trips

The screen line counts have provided various information which are used in various places of the study:

1) In the calculation of capacities: the streets where screen line counts were conducted were used as the prototype streets where the volumes and capacities are calculated for. They formed the basis for three type of links (streets, boulevards and highways) to be used in TRANUS model runs. The summary results of the screen line counts had been provided at the Appendix E in the form of pivot tables. These, later, are used in the capacity calibration calculations.
2) PCU factors: according to the composition of the vehicles on the observed streets, general PCU factors were derived
4) The ratio of daily traffic factor: The counts have also provided information about the percentage of the daily traffic load that occurred at the peak hours. Another verification to the information of daily traffic factor was found in O-D survey, and the literature as well.

3.9. Identification of the Disadvantaged by the Cluster Analysis Method

3.9.1. Basic Rationale and Purpose

The purpose of the cluster analysis, as mentioned many times, is the clear-cut definition of those disadvantaged objectively under the given set of criteria and rules. The criteria, here, are defined according to the "relative evaluation of the 11 function variables". Each variable is considered to be equal weight.

Thus, the clustering property (K-Means in SPSS program) in computer is utilized as multi-variate option. Since other variables (minor variables) are not standardized into the same unit scale, they could not be taken into the cluster process (Everitt 1993, p.38-9). However, it should be noticed that the majority of those minor variables were already represented under the eleven major (function) variables.

Although clustering technique was only applied to those function variables for the definition of those disadvantaged, the technique is also applied to each minor variable itself, what we may call "individual clustering", at which there is only the single-variable clustering. Individual clustering is used to define which minor variables pose the maximum amount of disadvantaged in themselves. This is used in the verification of other studies (refer to the discussion in the next section: 3.9.3. "Disadvantaged by Zones").

3.9.2. Disadvantaged by Individuals

If there were only up to three variables, the clustering could be seen visually as three-dimensional view. But, it is hard to perceive the form of clustering when they are more than three (especially for 11 variables). The similar method with K-Means clustering is used in the study of Levine and Underwoods in order to assemble the group affiliations of similar interests (1996, p.108).

Clustering could be done only after all function variables had been standardized in value scale as ameliorated values when the values increase. Thus, it is easy to allocate all values into two groups simply since if the values are lower they tend to fall into disadvantaged category (ie, 2) and if they are higher they tend to fall into advantaged category (ie, 1). Final output of the clustering is that:

- To which cluster an individual belongs to (by appointing, for example, 2 if advantaged and 1 if disadvantaged)
- The distance of the individual to the center of the cluster.

In this study, it is enough to know to which cluster an individual belongs to. The number of disadvantaged individuals is 629 out of 932 and the rest that could be defined as "advantaged" is then 303. Those disadvantaged are used as the preliminary disadvantaged population in the modelling for the disadvantaged, but final output is modified in the second set of clustering criteria (according to the binary variables: DISAB, EVN/RET and MOR/DEP, peak or transit captivity), which is done manually.

Table 10. Final Cluster Centers

Final Cluster Centers

	Cluster	
	1	2
	1	2
VEH#AVA	6,37	54,73
VEH#AVA	6,37	54,73
ACCESS	45,88	50,48
ACCESS	45,88	50,48
IMPED1	86,51	85,05
IMPED1	86,51	85,05
DEPEND	58,53	64,81
DEPEND	58,53	64,81
EDU#FAM1	36,68	43,41
EDU#FAM1	36,68	43,41
ILK#TRAV	63,78	69,70
ILK#TRAV	63,78	69,70
INC#PER	9,43	18,63
INC#PER	9,43	18,63
IMPED3	73,40	73,94
IMPED3	73,40	73,94
VEH#COM	37,59	38,41
VEH#COM	37,59	38,41
IMPED2	95,89	96,07
IMPED2	95,89	96,07
PUB#COM	68,17	68,47
PUB#COM	68,17	68,47

3.9.3. Disadvantaged by Zones

It would be useful to define also the disadvantaged zones and associate their disadvantagedness to various characteristics of the zones. Thus, first, in the following Figures 14, 15, 16, 17 and 18, various characteristics of the zones were presented. Then, in Figure 19, as refined, disadvantaged zones were displayed for the comparison reasons.

The disadvantaged zones were defined by two ways: One is simple, directly defined from the clustering of the aggregated zonal values (means). In that, it was necessary to find whether the zone is defined clearly as advantaged or disadvantaged (The results of the findings are depicted in Figure 19 based on the results in Table 11.). Second method needs some calculation and appliance of a simple scoring technique. The final clustering outputs of each variable (both major and minors) were deciphered as 1 and 0 (if disadvantaged). The lower the value, the greater the disadvantagedness. Here, differently from the first method, the disadvantagedness is in terms of scoring for comparison reasons. Thus, the measure of disadvantagedness is **relative**, in two dimensions (matrix) as variable dimension and zone dimension. The second method supports the results of the first one.

It is once more verified in the spatial (zonal) results that disadvantagedness is related to low income, low car ownership, number of household size, and somewhat loosely with the educational status. Especially, that the greater number of household size associates with the low income (thus, disadvantagedness) had been verified in the thesis study of Beyazıt's before (1989, p.109).

When the scores were examined, for only minor variables, those useful conclusions can be made: While Aydın has superior (advantaged) demographic conditions (ie, number of old, unemployed, children and disabled, literacy, closer school trips, etc.), it has high disadvantagedness scores in these situations: Land value, bike owning, number of employed, education status, giving ride to school children, access to social activities, total travel time, travel cost, conditions of disabled, and odor in vehicle. And, the most disadvantaged zones seem to be 2, 4, 6,7 and 8, which is quite closer to the findings of the first method. The conclusions for major variables can be: The zones 2, 5, 6, 7, 8 and 9 seem disadvantaged, which is a subjective evaluation. And, those variables are the ones where the most disadvantagedness are observed: IMPED1 (a function variable for general costs like total duration, total cost and stop access), INC.PER (income), IMPED3 (captivity and disability related), VEH.COM (comfort in vehicle) and IMPED2 (stop wait and related conditions). The graphic in Figure 12 also summarizes the scoring of the disadvantgedness by Zones.

In Figure 12, getting closer to the right means getting closer to advantagedness. The dots in red lined circumference are those relatively advantaged, but the ones in teal lined are those getting disadvantaged.

Based on the cluster analysis results of SPSS for the zone level aggregated data, the aggregate zonal disadvantagedness can also be mapped according to the findings provided in the Table 11. Figure 19 shows the disadvantaged zones. These geographical results should be compared with the findings in socio-economic Figures 14, 15, 16, 17 and 18.

Table 11. Zonal Disadvantagedness

Zones Categ♣.	Distance to cluster center
Zone 1----1	8,36840
Zone 2----2	12,02733
Zone 3----1	15,35380
Zone 4----1	9,96137
Zone 5----1	13,20420
Zone 6----2	10,91487
Zone 7----1	13,39301
Zone 8----2	14,27663
Zone 9----1	14,36605
Zone 10---1	15,78642
Zone 11---1	11,15824
Zone 12---1	13,49564

♣If the category is 2, the zone is dominantly disadvantaged

3.9.4. Adopted Level of Aggregation

Data aggregation is observed to have structured on five iterative stages horizontally, which are actually the disaggregation stages. Through these stages, data transform (evolve) from person and household level data to zonal data vertically. The

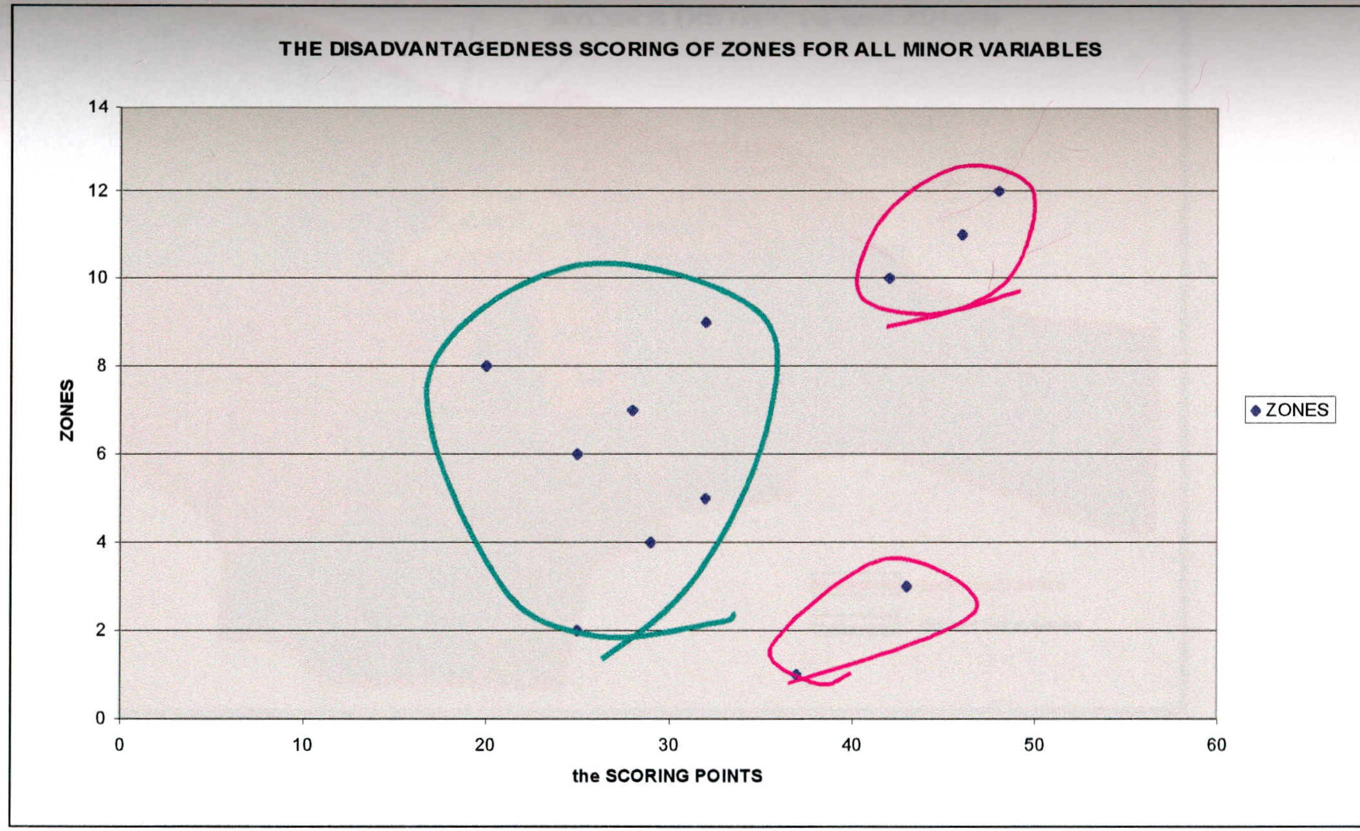

Figure 12. Scoring of Disadvantagedness by Zones

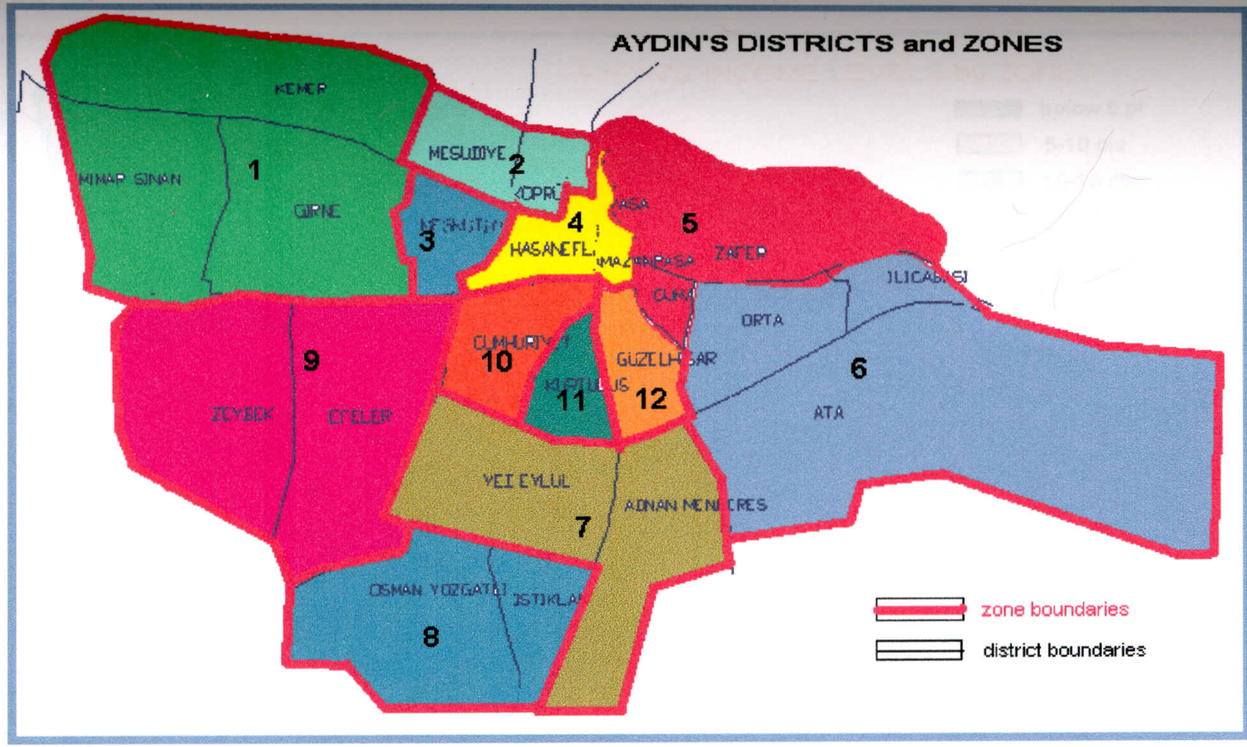

Figure 13. Aydın's Districts and Study Zones (TAZs)

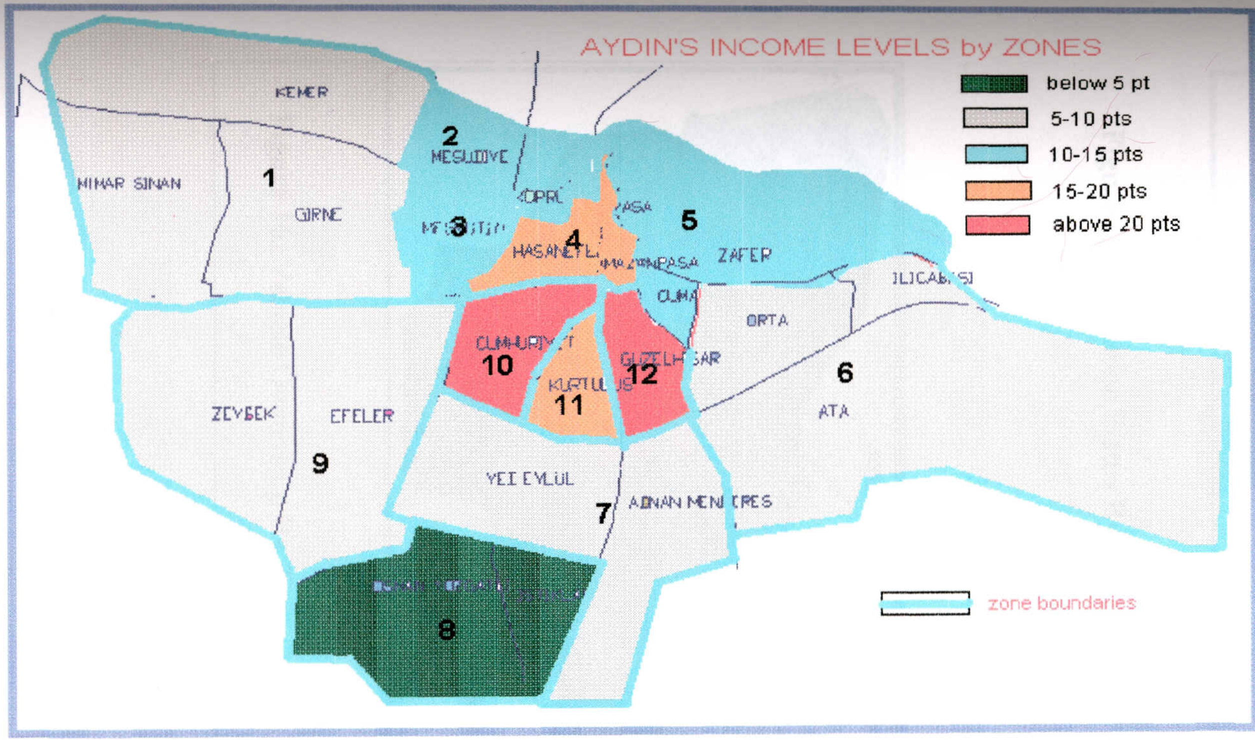

Figure 14. Income Levels By Zones

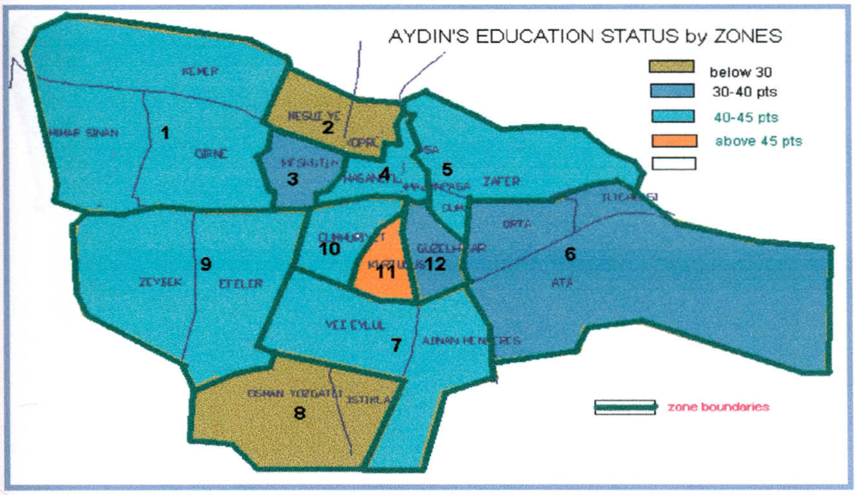

Figure 15. Education Status By Zones

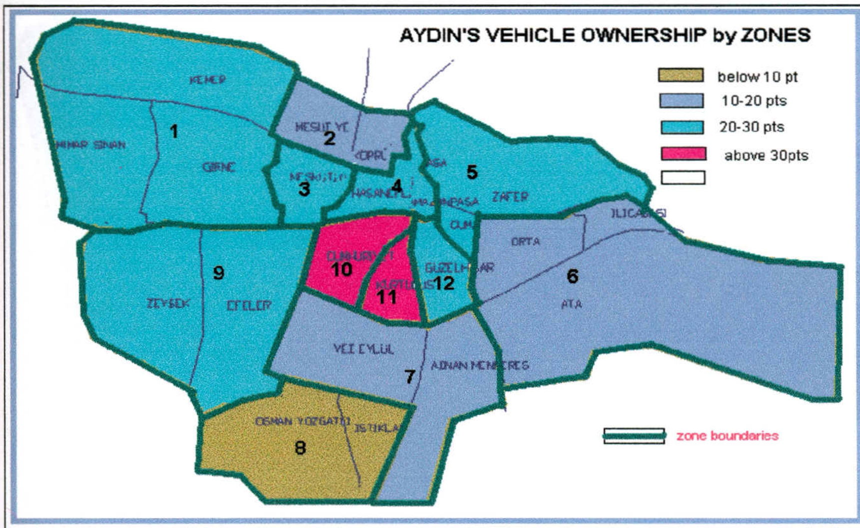

Figure 16. Vehicle Ownership By Zones

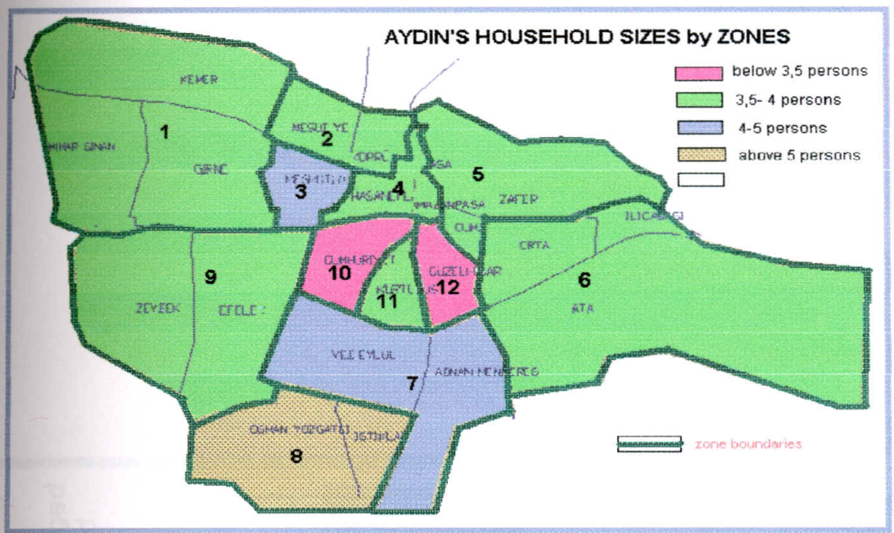

Figure 17. Household Sizes By Zones

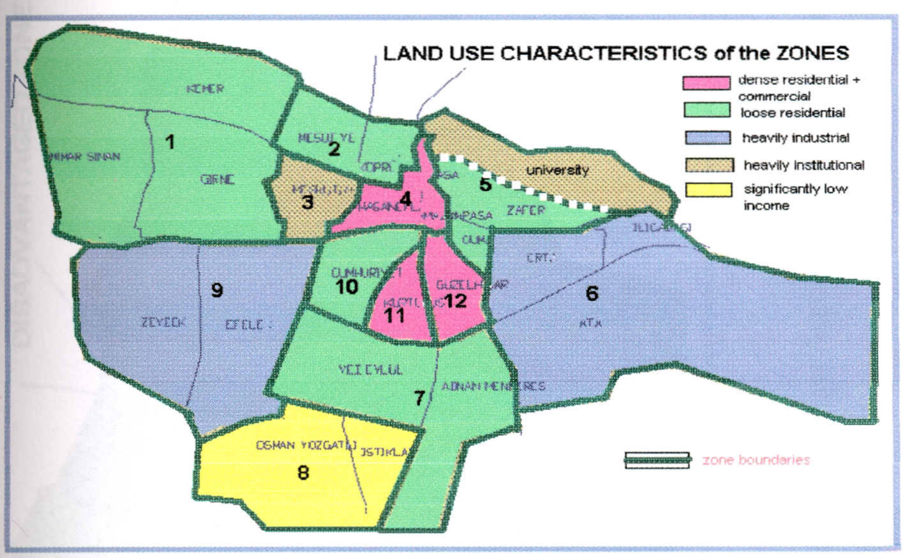

Figure 18. Land Use Characteristics of the Zones
(Source: AydınGIS center – density map: Tarama.plt)

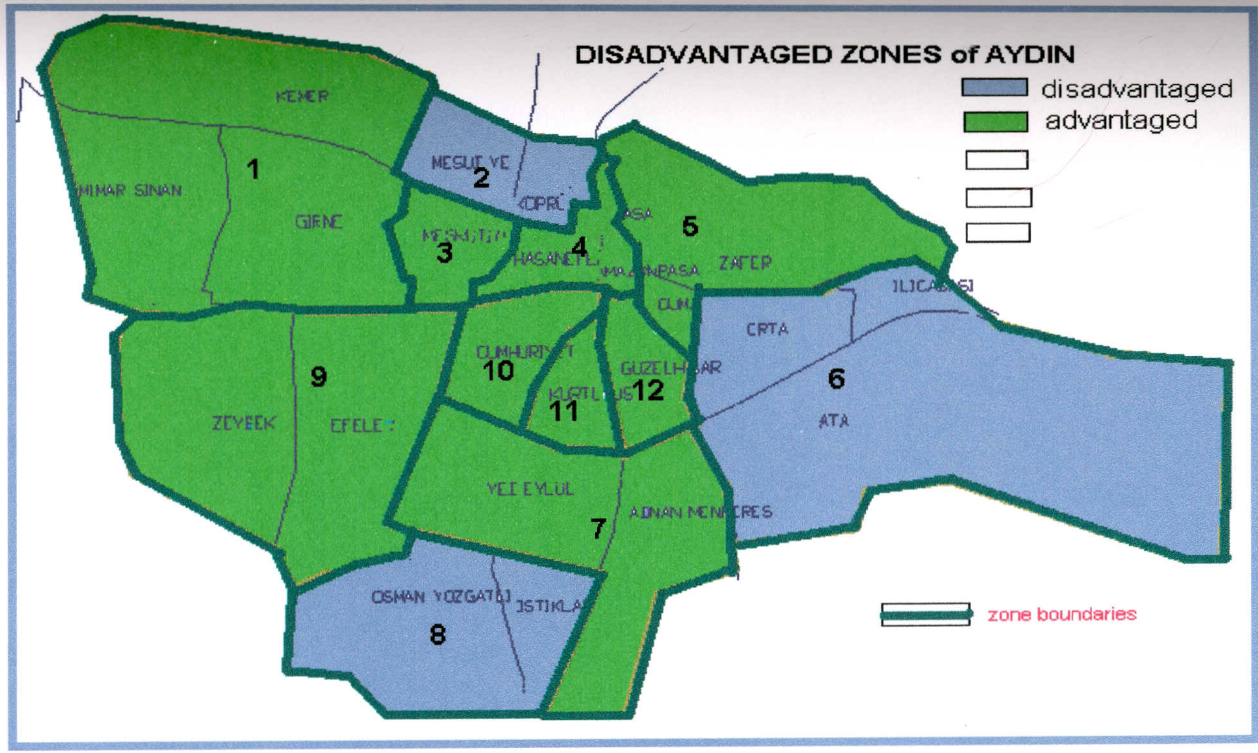

Figure 19. Zonal Disadvantagedness According to the Direct Result of Clustering

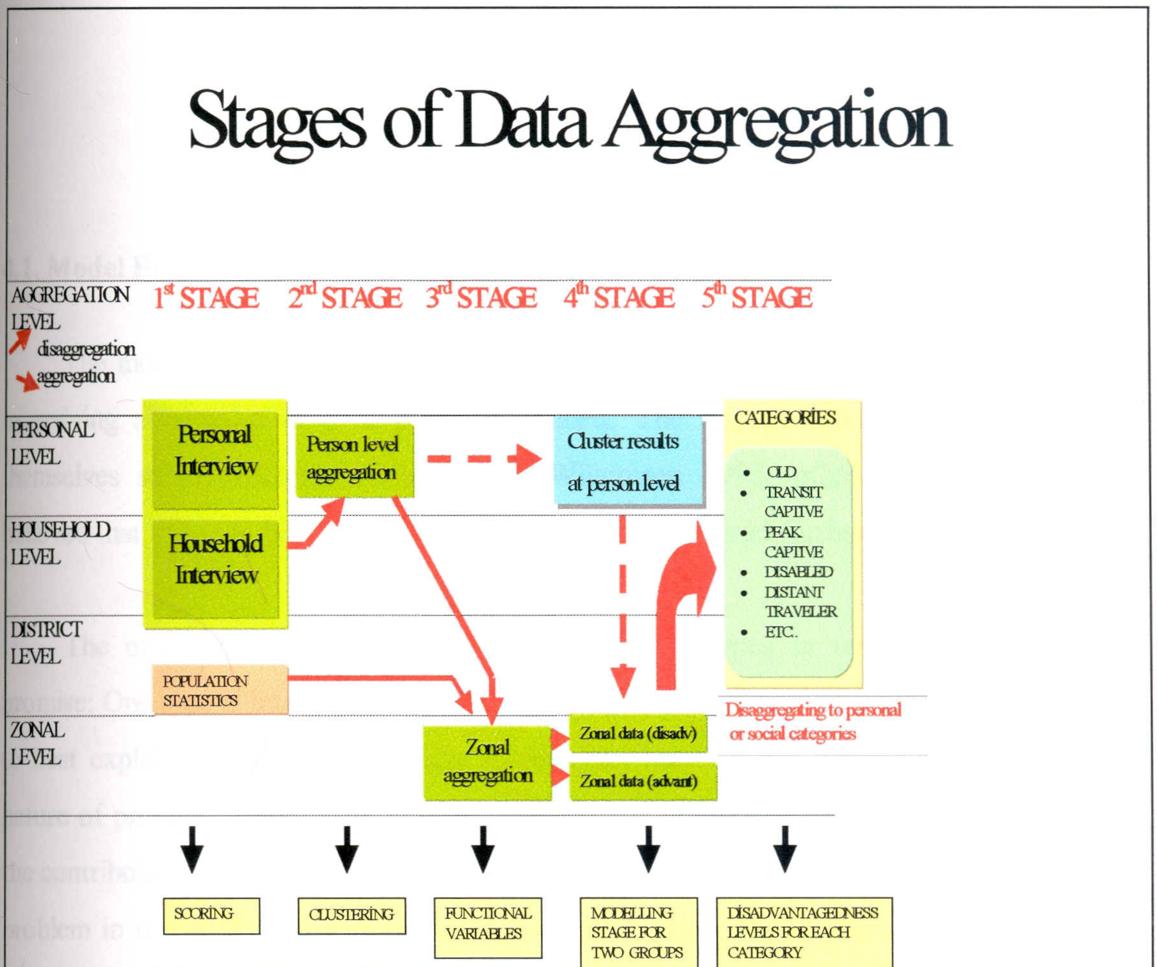

Figure 20. The Aggregation Stages and Evolution of Data

Chapter 4

MODELLING PROCESS

4.1. Model Building

The model of this study can simply be described as policy-driven and normative in arriving at a solution of a problem defined. The transportation models do not themselves solve problems (Ortuzar and Willumsen 1995, p.26). Therefore, it is believed that they can be true planning models if they can lead further toward solution.

The model can basically be conceived in two types in terms of what they promise: One type is into modelling and describing of an existing phenomenon; they try to best explain or reduce complexity in real life; they do not bring criticism to the nature of problem. Other type is to understand the failures of the problem and, thus, the contribution of the model is to fix these failures; first, with criticism to the nature of problem in reality, brings formulation for the correction; the model says the existing thing *is* that, but it says *should be* this, by showing the ways for correction. Therefore, the latter type models are called normative, which is adopted in this study.

To begin with, first, it is important to clear what we want or desire to see in a model. How should an ideal (normative) model look like? Thus, first of all, it is intended in this study to take into consideration every possible variable for the model of the disadvantaged category for the validation of the approaach. Thus, around 100 variables are considered for the model. These inputs are later expected to be eliminated according to their relevance in the model. Then, the most suitable variables will be elicited to clarify which variable would be relevant for further studies or modelling about disadvantagedness.

To set a nearly perfect modelling approach, those "check" criteria may apply to the model's performance by the "criteria for the best model". According to that, a model should be (Goulias 1995, Papacostas and Prevedouros 1993, p.9,13):

. simple
. useful
. consistent and accurate
. inexpensive and cost effective
. sensitive and flexible to changes
. realist and representative
. decisive (whether it is useful for what we want)

Whether the modelling approach regards those criteria will be evaluated briefly at Chapter 6: Conclusion.

The classical models tried to forecast the future needs for the target time usually in segments. But, the integration of "target goal" together with the target time must bring the monitoring at these segments, that requires a new modelling evaluation. That would also mean true dynamism into modelling.

Where this has historically been in the prediction type models:

$$D_t \longrightarrow D_{t+1} \longrightarrow D_{t+2} \longrightarrow \mathbf{D}_{t+3}$$

The dynamism of the model can be quite different from the other conventional ones as represented below:

$$D_{t-3} \longleftrightarrow D_{t-2} \longleftrightarrow D_{t-1} \longleftrightarrow \mathbf{D}_t$$

D_t represents, in fact, an "ideal" situation (target goal), a future where targeted goal is met, rather than a chronological future. That is, since target future is determined by the goal set, it may not be necessary to define a certain time for meeting the goal (Atalık 1995, p.107,142). According to that, in every planning sequence, the transportation policies are to be updated regarding the realization of the ultimate future's (t) policy. Because, the intermediary events or decisions can also affect the future of "goal". The checking and revision of goals at each step is readjusted according to the relative position to the ultimate future in order to achieve it.

Upon this conceptual mapping, the descriptive structure of such an integrative model, that is to identify the distance to be shortened, can symbolically be summarized by the mathematical explanation as:

$$M_i = M_t \left[1 + k \left(1 - S_t/S_i \right) \right]^p$$

k and p are the constant parameters (to be defined at will), where $0 \leq k \leq 1$ and $p \geq 1$.
and, $S_t \leq S_i$
$_t$ represents the existing situation, $_i$ represents the ideality.

M_i is the "ideal" model proposed
M_t is the conventional local model already applied
S_t is the existing transportation situation (stands for the disadvantaged)
S_i is the ideal situation (stands for advantaged and disadvantaged together)

The main problem in this prescriptive expression of the model would be the definition of the parameters. But, this should never be minded since this is simply the conceptual (or, logic) summary description of the model, thus, they can stay undefined.

To explain this mathematical model, we could have used a schematic (or, action plan) representation as in the Figure 21 which may help the understanding of the model.

The main model that needs the run and the validation must base on two compartments: In the first compartment, we will try to put all relevant variables into the linear regression type model prepared for the disadvantaged category. Here, a regression model with many variables that is used in Trip Generation can be used to define which variables are really the effective ones by applying T-test and also by the R squared value. If the T-test parameters are too small, those variables can be ignored. R squared will give the idea about the reliability of the whole regression (if it gets close to 1). This model will give us the differential values of the disadvantaged that can be used in the second approach as the joint coefficient next to the standard parameters (such as β in Trip distribution) to show the effect (change) of being disadvantaged on the Normal's (conventional) model. That is, we simply proportion the model's outcomes of disadvantaged with that of the conventional model's that is applied for general to get the "disadvantagedness ratio (Dx)" on the basis of the model generality.

4.2. A Typical Modelling Process[1]

Up-to-date conventional planning approaches have been engineering type models, with relatively complex mathematical algorithms. Lately, the simulation modules have been developed to integrate policy impacts (environmental, physical and social), that are simulated as the evaluation step of the model. There is the need for simpler handling and previewing of such conventional models. Here, a typical model will be examined in a closer look with its four-step procedures.

Before beginning the procedures of transportation planning, the concern area and the sub-areas (TAZ) among which traffic flow occur must be well defined. The four-step (conventional) transportation planning with the most known package programs requires these studies:

4.2.1. Trip Generation

The purpose of Trip Generation is to find the number of total trips from, or to, (ie, generated or attracted) each TAZ (Traffic Assignment Zones). To specify the Trip Generation Model, usually the method of Cross-Classification Analysis is used which is based on household trip making data. The usual variables are: income, auto availability and household size. Cross-Classification can be done as three separate processes:

. trip production
. trip attraction
. internal-external trip generations

If data are in limited amount, trip generation can be proceeded with linear regression method.

[1] This part is collected from the Coursenotes CE 422 (Goulias 1995)

In most UTPS softwares, the regression is a multi-variate type with one intercept, which is α value, and two or three coefficients that are β values:

The model: $Y = a + ß(X1) + ß(X2) + \varepsilon$

where, for example, Y can be the trip rate a person travels in a day, X_1 income variable and X2 the household size variable.

Summary statistics that are involved in most of the statistical tools of Data Editing Packages (such as SPSS, Minitab, etc.):

Intercept (alpha): intercept tells us that the data values we have got to begin from about an initial dependent value (Y) on the regression graph.

Coefficient (Betas): For example, show the effectiveness of income's coefficient may be very strong in relation to the household's coefficient effectiveness on X1 to get a one unit of Y value. If we assume household size is zero we only need to put an X amount of income factor value to get a Y value. The coefficient of X1 may have usually a negative effect on the income values and the coefficient of X2 may have a magnifying (positive) effect on household values. However, this is not related to the effectiveness of X values and their coefficients' role.

t-statistics: are found for both the first X and for the second X, which informs about the consistency of the variables. t-statistics shows whether Xs are rejectable or non-rejectable when the effectiveness levels of both coefficients (betas) are to be tested. Similarly, the smallness of the P-values proves that their effectiveness seems way beyond doubt. They are equally important variables to be taken into account. Contrarily, F-values has the same role but with the bigness of the values.

R-squared value: If R-squared is very high, that means the overall regression process is reliable with the available factors taken into account and there can be very little (almost non) factor(s) left out (epsilon factor which we do not know about) in the process to be taken into account.

Trip Production is the easiest one using the home interview data. Trip productions can be obtained by using either growth rates empirically found or by the regression model. Trip Attraction is, however, can be confusing and the data is hard to find, and the findings are not clear and reliable as in trip productions. It needs acquiring the data of the urban activities that attract the trip productions. Thereupon, we need to define the rates showing the attraction magnitudes of activities. After all these procedures, trip attraction rates can also be found by simply dividing number of attractions into the number of employees in the activity/location category for each TAZ or for general. These rates can be treated as if they are the coefficients (Xs) of the regression model. In the models, other possible variables can be added, too. If there are large trip generators or attraction activities (like stadiums, etc.), the analysis should be separate process for them.

It also requires to find the trip productions by trip purposes (HBW, HBO, NHB), by means of local surveys, or, if not available, borrowing from similar examples. For example, a chart of which one side is by the trip purpose (Home Based-Work, Home Based-Other and Non-Home Based) and the other is by the type and location of work or activity (Home, Non-retail, Downtown and Other Retail) can be prepared.

Internal-external trip generations usually make up 10-20 % of all trips in urban areas. In rural areas, this can be even up to 50%. These trips can be evaluated separately as internal-external (the end can be either inside or outside of the study area) and through trips which have no ends in the study area, therefore, handled by only growth rates. Internal-external trips are considered as to be produced at cordon line and evaluated as attracted by the inner TAZs, and, the production trips attracted by exterior (cordon) zones. Alternatively, these trips can also be handled by proportioning of trips (i.e., growth rates) as is done in through trips. To find the factor rates, the number of all internal-external trips can be divided into the total number of all trips, or just internal trips.

The classical inputs for the productions are number of households by income. Productions can be found by simply multiplying the number of hh by the rates by income. If the trips multiplied by the purposes, trips by the purposes can be obtained.

Likewise, the inputs for the trip attractions can be the estimated number of hh, employment levels, and the calibrated trip attraction rates (explained above). Attractions by purpose can be found in the similar way with trip productions by purpose.

Finally, total number of productions and attractions should be almost equal. If not, adjustments can be made to find values close to true values. If there is more than 20% of difference between the two, entire procedure needs to be re-evaluated. Especially NHB trips can be problematic.

The adjustment procedure needs to find an adjustment factor rate in terms of production. For an example, it can be found this way:

r = total area (study area) HBW productions/ total area HBW attractions

If this value is multiplied by a specific zone's attractions, the true value can be approximated. The same method can be repeated for other purposes, too.

Here, we need to distinguish the terms used, because of the confusion:

Origin and destination: mean the beginning point and ending point respectively, but, does not hold true for production and attraction. Origin destination data shows where the trips begin and end, by purpose, by mode, and characteristic. There is usually enough data for these in literature, therefore, there is no need for collecting large sample surveys.

Additional surveys conducted for taxi and trucks, external cordon surveys, and also motor traffic v. transit ridership can be useful.

Depending on the size of the study area, number of trip purpose classifications can vary most basically as HBW and HBO trips, in which produced trips begin or end at home, and NHB, in which the trips begin or end at home but attracted non-home based. It can either be as the produced trips at origin or attracted to the destination beginning and ending at non-home. In distinguishing between the two, it is easier to separate the trips as home based or non-home based.

4.2.2. Trip Distribution

Trip distribution is the estimation of the trips expressed in a two dimensional matrix of rows and columns that show the numbers of trips from each TAZ to another (including itself). The cells of rows of the matrix correspond to traffic flow between TAZs from which trips originated and the cells of columns to which trips are destined (attracted). Thus, the notation T_{ij} represents the number of trips between origin i and destination j. Oi is the sum of the originating trips from zone i and Dj is the sum of the trips ended (or, attracted) in Zone j.

The estimation technique is simply based on the idea that all TAZs in the region compete to attract the trips. Trips are to be estimated for each cell for each pair of origin destination. The attraction power symbolizes the "willingness" to travel from one TAZ to another, which is actually the function of the combined trip generation "masses" of each pair (in Gravity Models), and also the distraction, or friction effect which symbolizes the cost of the travel born by the distance factor. Cost can be general in terms of distance, time, money, impedance or other friction effects. Mainly three methods can be used depending on the purpose and data availability to estimate the trip distributions:

. Growth-factor Methods
. Synthetic or Gravity Models, and,
. Intervening Opportunities Models

Growth-factor Models simply use the growth rate factor estimated from the previous studies. The estimation can be done by multiplication of this value by the previous trip matrix values. However, this is especially useful for <u>short-run future</u> estimation in which we can multiply the rate by current trip matrix values (if available). It does not take the changes in transportation costs into the account. And, if there was an addition of another TAZ after the base-year, the model cannot be applied to this new TAZ.

Gravity Models, on the other hand, are analogous to the Newton's Gravity Law. They do not rely on the previously observed trip pattern as in Growth-factor Models, but the existing individual attraction levels between each pair of TAZs. The expression of the model is:

$$T_{ij} = \alpha\, O_i\, B_j\, A_i\, D_j / f(c_{ij})\text{ , or,}$$

$$= a_i\, b_j\, \Sigma\, F\, \delta_{ij}^{\ m}$$

There may be other derivations of the expression; O_iD_j is the amount of attraction generating power, which is in inverse relation to the cost function. α (or, k_{ij}) ie., a calibration parameter, which may not be useful in very complex set of matrices.

In the trip distribution stage, it is necessary to calibrate both A and B coefficient values for all O_i and D_j (that is column and row sums) matrix cell summations. We can find them from each other but for this it requires the availability of β values for each.

In Intervening Opportunities Model, not only end points attract the trips but also the intervening activities may help the cumulation of attraction. This model takes also the intervening factors on the way to the attraction point (this may contribute to distraction as well) into the account between the two nodes of origin-destination. A calibration factor showing the effect of the(se) intervening factor(s) can be added to the row/column balancing process as a factor, since it cannot be handled in the classical matrix form.

The total of O_i and total of D_j should be equal to each other, and T_{ij} as well, because, in a closed system of the travel study, every trip maker who departs (travels) to somewhere within the boundaries of the city should be returning from somewhere logically. Since O_i is supposed to be equal to D_j, it may require making necessary adjustments if there are minor differences (very minor ones can be ignored).

Finally, there is a need to calibrate the model to achieve the results as close as possible to the base-year trip pattern.

4.2.3. Mode Split

Mode Split step is to assign the trips onto various (basically as private and public) modes, or operation types, and requires to employ an adopted theoretical approach. Below are provided basics of some well-known methods and utility theories used in mode split:

Stratified Diversion Curve Model: This method is based on the survey findings of previous studies relating some basic performance (or, service) indicators of transit service compared to auto performance (waiting time ratio, cost ratios, travel times) to the specific conditions (hh income, auto or transit availability, etc.). The combination of cross-relationships was expressed in nomographs showing each possible match of transportation situation. The nomographs are especially short-cut tools to find the probability of actual usage of transit travel as derived from its market share in relation to given different conditions. This is a quick way of defining the magnifying effect of a travel mode in decision making of modal choice. However, it needs having collected a lot of data for each set of combination. This method also does not provide information about the true behaviors and is restricted to only binary choice.

Impedance Based Quick Response Model: is similar to the Diversion Model. It is a binary choice model that bases on the evaluation of comparison of both impedance of auto and transit in general by weighing their specific conditions of time and cost spent (out-of-pocket for consumer). Cost and time impedance is converted into unitless impedance value for comparison reasons. The modal choice is derived out of this comparison in terms of the probability percentage that transit is to be chosen. However, the personal characteristics like income or preferences and trip condition by purpose cannot be reflected in this model.

Disaggregate Probability Model based on Utility Theory: This is a derived model from preference survey studies. In such a model, it is possible to identify alternative modes more than two. It is assumed that users are rational enough to choose the best option for themselves. Therefore, the function is a utility function similar to the formulation of Quick Response Model. The formulation is composed of two stages:

1- find the utility levels for each mode weighing (with parameters derived from regression methods) the variables (cost of trip, age, hh size, etc..) affecting the utility levels.

2- use logit model, which is the rationing of the utility level of a specific mode to the sum of the utility levels of other available alternatives. The magnitude of the ratio will give an idea about the probability of which mode is likely to be chosen as the best choice.

This model is found the most accurate and theoretically sound which reflects the empirically found consumer preferences. It is helpful in policy analysis stage.

4.2.4. Traffic Assignment

In the Traffic Assignment step, Stochastic User Equilibrium is assumed to be the best because it takes into account both the capacity restraint and stochastic effect (randomness) and provides a behavioral/ realistic kind of approach. It is different than the Wardrop's Equilibrium in a way that an individual driver can reduce his cost switching his/her route. Another random factor is that costs may differentiate from one trip maker to another, from one link to another, from one time to another, etc. The stochastic effect is expressed in Gamma, Gumpel and error terms in the general cost formula:

$$Cost_t = Cost_0 \left[1 + A(V_{t-1} / C) \right]^B$$

Here, $Cost_0$ is the cost of free flow, A is taken as a parameter of 0.15 as empirically observed, V_{t-1} is the volume after the previous increment of volume, and B is the parameter of 4.

Congestion and intersection delays can also be reflected in the model, because network flow heavily depends on those conditions on a given highway segment, which affects the traveler's route choice. It is also assumed that everybody on the route has got the perfect knowledge of the traffic conditions so that s/he can make the best choice that will maximize the travel cost. All alternate routes are available options to choose.

The model is very difficult to handle, thus, needs a sophisticated software and massive amount of local highway data (like the data on intersections, volumes, hourly traffic volumes, etc.). GIS-based software is preferred for providing the geographical monitoring of the area to be modelled. It can easily be updated when input information or simulation policy changes. All the modelling procedures defined above can be automatically handled with the necessary statistical procedures determined, or otherwise it can apply default procedures. The Windows version of the package is much easier and user friendly than the DOS versions.

Here, the fifth step, which is Evaluation Step, will not be introduced since it is assumed to be integration to these four steps of conventional planning.

4.3. The Logical Consistency and the Process Flowchart

The modelling approach called 'ideal' model (modelling as advantaged and disadvantaged) and the conventional model (for normal, without separation) must be comparable ("speaking the same language") to each other. This necessitates also that the summation of the trips of both disadvantaged and advantaged must be equal to those of Normal's. Thus, it must be the expression of the findings from the two models mostly in rates and proportions (percentage) such as trip production and distribution rates (or, proportions or percentages) and likely the modal split and traffic assignment percentages (or, proportions). By this, they will be comprehendible and comparable.

The meaning of the model in search of achieving policy goals, which formulates the modelling concept is described as:

If, $$M_i = M_t \, [\, 1 + k\,(\, 1 - S_t/S_i\,)]^p \qquad 0 \leq k \leq 1, \quad p \geq 1$$

assuming; $\mathbf{Tt} + (S(disadv)_t / S(adv)_t) = 1 = (\mathbf{Ti} + S(adv)_i)/(S(adv)_i + S(disadv)_i)$

If, $(S(adv)_i + S(disadv)_i) = S_{(N)i}$

$= \mathbf{Ti} + S(adv)_i / S_{(N)i}$ $\qquad S_i \geq S_t$

where, **Tt** is the existing disparity (difference) between the disadvantaged and advantaged

Ti is the ways (means) or policy measures for the equalization

Then, $\mathbf{Tt} = (S(adv) + S(disadv))_i - S(adv)_t$

(By convention, **Tt** and **Ti** should be equal to each other as the objective of the planning policy)

And, $\mathbf{Ti} = 1 - [S(adv)i / S_{(N)i}]$

The schematic explanation of the above representation is provided in Figure 21 as the Action Plan of this conceptual explanation.

Notice that, in the modelling sketch in Figure 21, to which the modelling approach is adapted, ideality replaces the term "future". Future now is where the ideal case comes true. ΔS is the integration into the modelling in the chart representing the differential between the situations of Normality and the disadvantaged.

A more closer look is necessary for the inner processing of the modelling part in this flowchart. That requires a separate flowchart for modelling, or run of the two models, that shows what sort of data is used and how it is processed, and finally what it produces (output) (See Figure 22). Though not much different than the run of the conventional steps, the difference really lies in the separation of model runs for each transportation categories (the disadvantaged and Normal) and in the comparison of the outputs of each run. The model running mechanism is provided in a separate flowchart as modelling sequences in Figure 23.

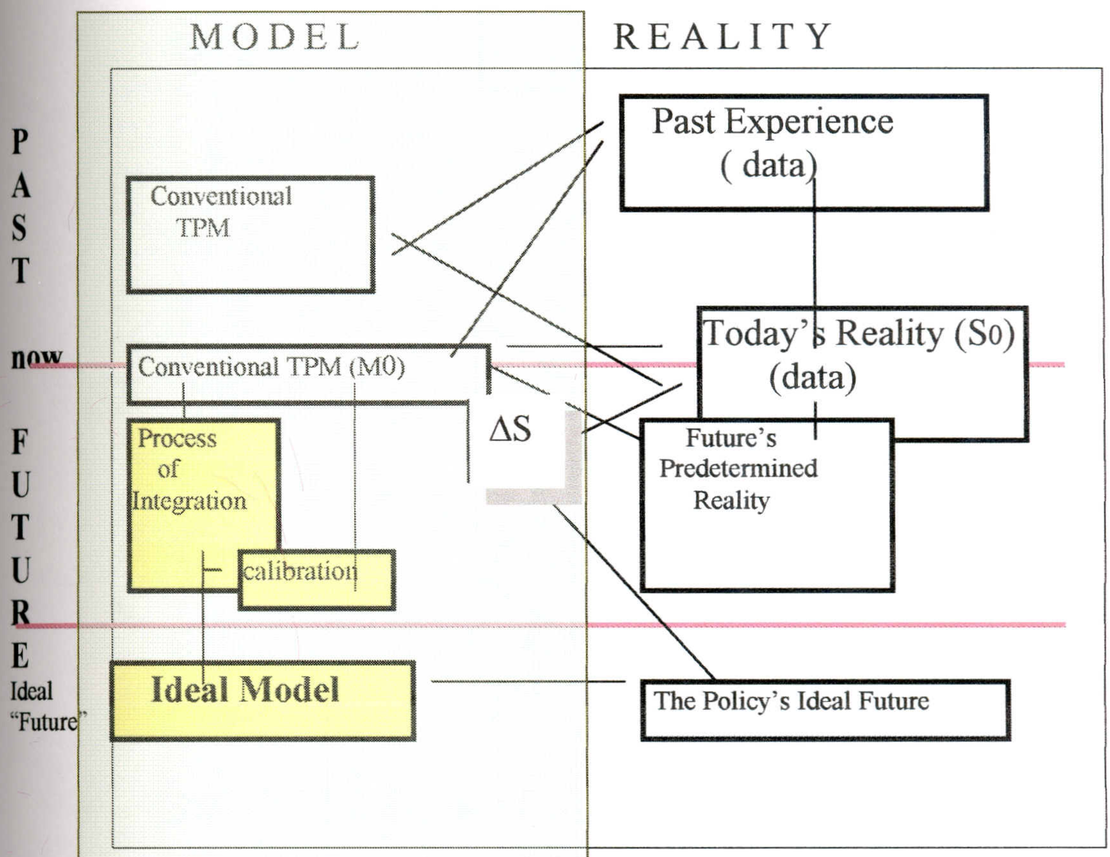

Figure 21. The Sketch of Model and Reality, Ideality and Future

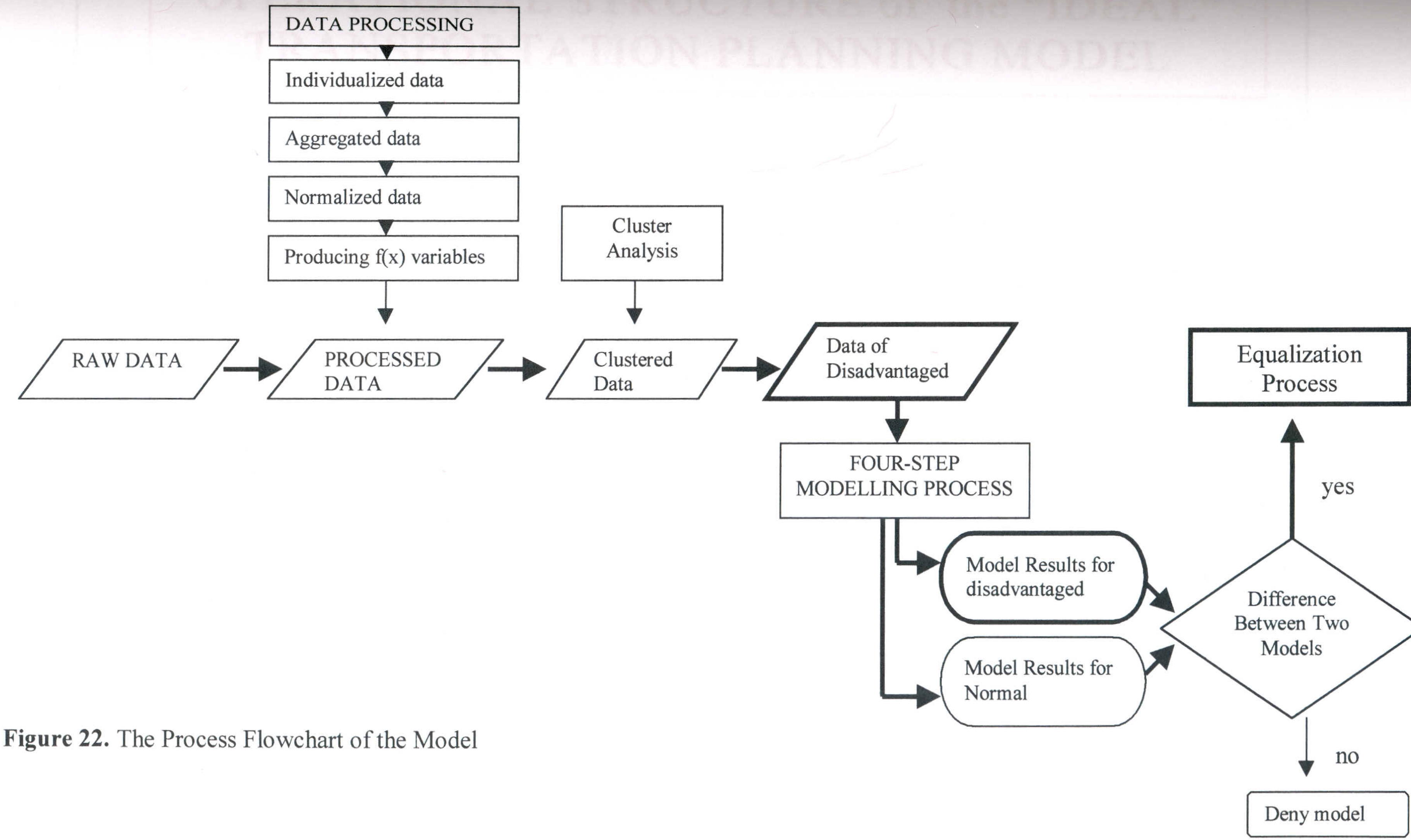

Figure 22. The Process Flowchart of the Model

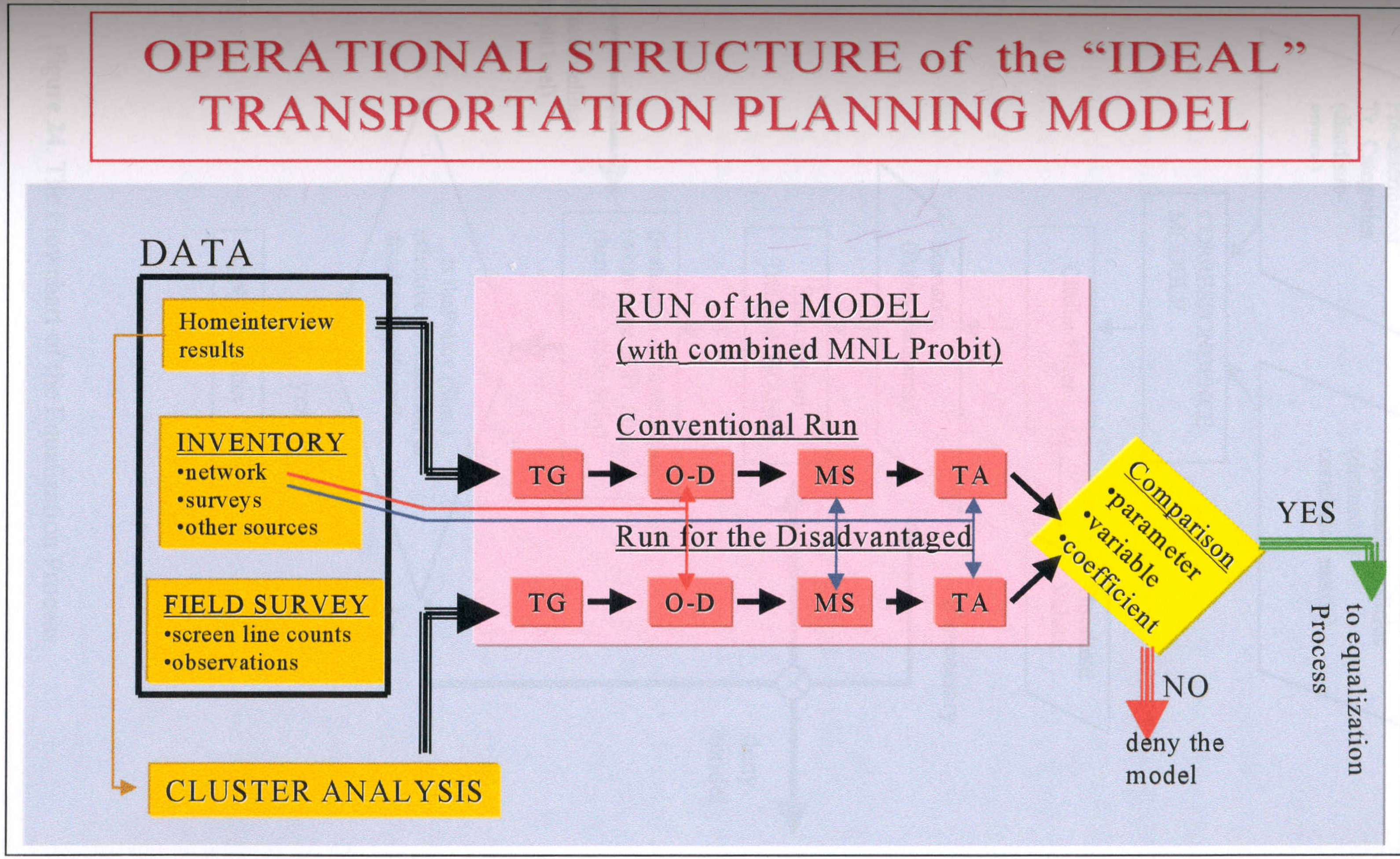

Figure 23. The Inner Flowchart of the Model

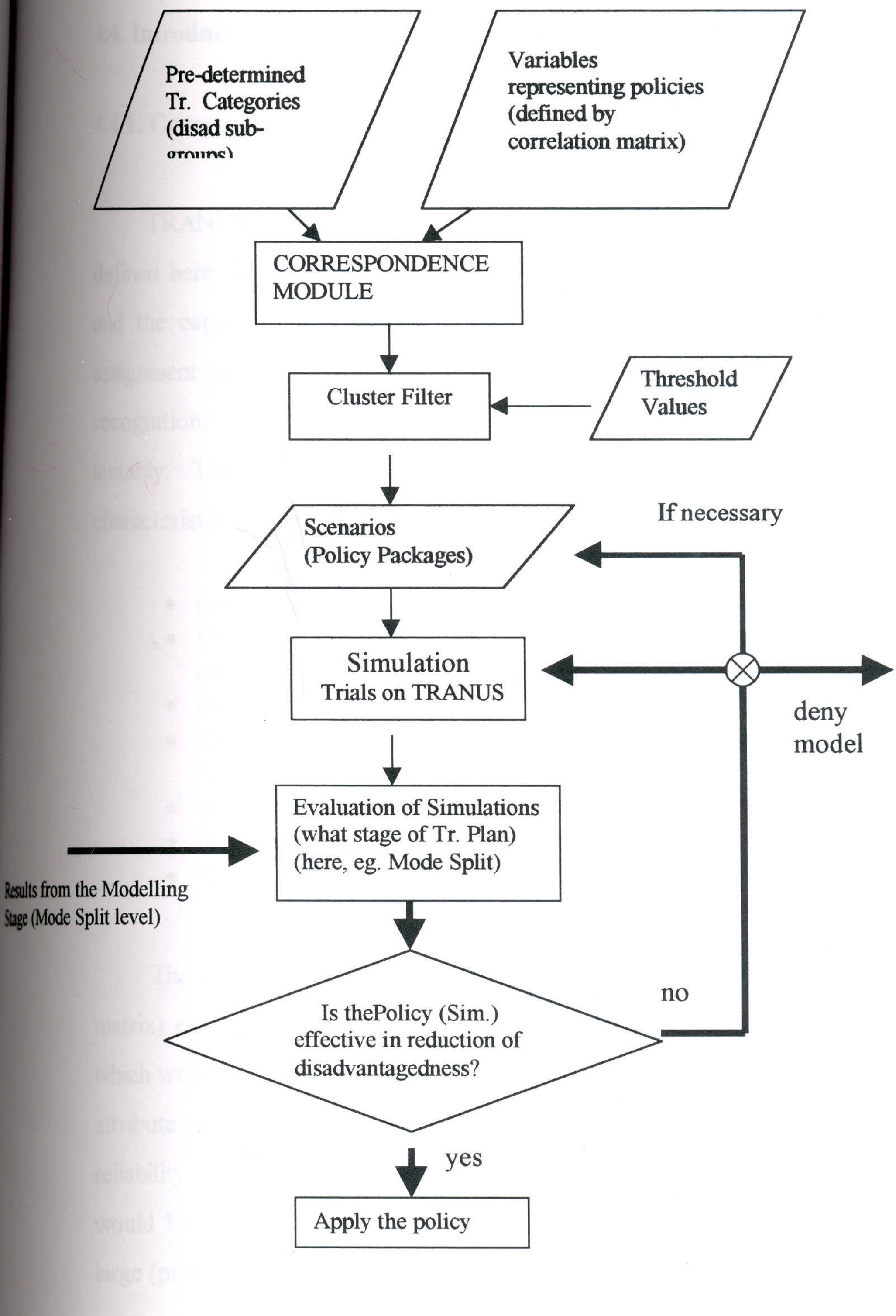

Figure 24. The Flowchart of the Equalization Process

4.4. Introduction to the Transportation Planning Package: TRANUS

4.4.1. Criteria for Selecting the Package

TRANUS is used in the validation of the transportation planning model approach defined here. This will provide speed, the advantage of mass information processing and the capability to calculate relatively complicated algorithms (especially at the assignment stage) and procedures inserted in the model that are sometimes beyond our recognition. It requires a careful selection of the software that meets our purposes suitably. Thus, for convenience, software to be selected should have such characteristics primarily:

- favorably proceeds conventional four steps but an inexpensive one
- flexible to use (only some parts might be used) and user friendly (pull down menu)
- involving an evaluation (simulation) sub-model
- data transferability across the joint models or other external data bases (like Microsoft Excel and SPSS)
- that can be easily recognized and operated in a short period of time
- involving readily social and ethical parameters.
- GIS compatibility

The PC should be capable of large data manipulations (like O-D distributions matrix) even if we intend to use limited number of zones for simplicity (12 zones), which would otherwise be difficult to handle by hand calculations. A PC, with its speed attribute can help great time savings, and thus, the costs of modelling. Accuracy and reliability is another important aspect for choosing the PC type. The PC requirements would be (preferably Pentium II) the higher speed (233 Mhz microprocessor) with large (preferably 64 or, at least, 32 MB) memory size.

Up to now, we have come up with four alternative packages that would most likely promise to satisfy our purposes. These are:

- TRANUS
- EMME/2
- TranPlan, and
- MINUTP, or, MEPLAN

Among those, TRANUS was chosen because of the reasons explained in the remainder of this paper with reference to the manual of its latest version 6.0. It, first of all, looks quite flexible and simple to use, with lesser data it requires. EMME/2 also was powerful software for consideration with even superior attributes, making it still eligible, but with less flexibility and adaptability to windows environment. It is also said to be not for new beginners (Ferguson *et al*, 1992, p.238) TranPlan, on the other hand, has been the most frequently used software in Turkey, but complained that its visual attributes are weak (but, we are not well informed about the latest versions). MINUTP (or, MEPLAN) are rather compatible to the conditions of Western societies of which the transportation behaviors are modeled and transit is much less considered. They require lots of data that developing countries lack. And, MEPLAN is quite devoted to land use modelling rather than the transportation.

Now, the adaptability of TRANUS to the special modelling requirements is reckoned. Here, the most remarkable properties of TRANUS that can be suitable for any ordinary model will be explained, and which attributes of our model need to be adapted to its logic structure. Therefore, this study will rather be a kind of manual description explaining a classical transportation planning with the aid of TRANUS as adjusted to our model's processing.

4.4.2. The adaptability of the Package and the Necessary Adjustments

TRANUS has been developed by Thomas de la Barra and B. Perez (MODELISTICA) since 1982 (Barra 1989, p.143), in which input-output techniques of micro economic rules are used. Domencich and Mc Fadden's (1975) theory on utility was adopted where discrete choice analysis and random utility theory are further developed.

As of land-use integrated (activity location), TRANUS is actually a Lowry-derived model that focuses on the impact analysis between the time lags of land use change and transportation change. The package is "to transform potential demand to actual trips, and assign them to the many transport supply options" (TRANUS Manual, 1998, p.9). With this, the package is especially used in the simulation of policy impacts in the Evaluation conformingly.

TRANUS 6.0 is a Windows convert. It can be used in any recent versions of Windows environment (like Windows 95). This attribute makes it user friendly. Data can be easily copied down from another Windows sources (eg, Excel) to any database within the package. Several files can be opened simultaneously. The interactive database called TUS (Tranus User Shell) is an important program at which data can be edited, viewed and analyzed.

The decision theory of utility is adopted assuming that individuals chose between the options (in modal split and traffic assignment) according to the utility perceived. One should be alarmed here at how individuals from different groups perceive utility differently. Utility is known to be a subjective, thus, stochastic (probabilistic) matter (TRANUS Manual, General Description, p.3). Utility needs to be converted to be aggregated function of those categories mentioned. The most representative of this function is the Weibull Distribution that yields consequently a nested MNL (Multi Nomial Logit) model enabling many statistical manipulations in deriving aggregated results.

4.4.3. Operational Structure of the TRANUS Model

There are six basic operational units (programs) linked to each other iteratively:

LOC: is about the data procesing of the location of activities. Prices, description of current land use policies, transportation costs and set of parameters have to be known.

FLUJ: is an interface between socio-economic inputs and transportation that reads the matrices produced by LOC.

PASOS: is the multi-path search in which the data of network file and related parameters are asked.

TRANS: is the transportation model that uses network file, path descriptions, functional flows (as categorized).

COST: is the interface converting transportation (TRANS) inputs to activity locations that requires the matrices of costs by transport as signified by the model.

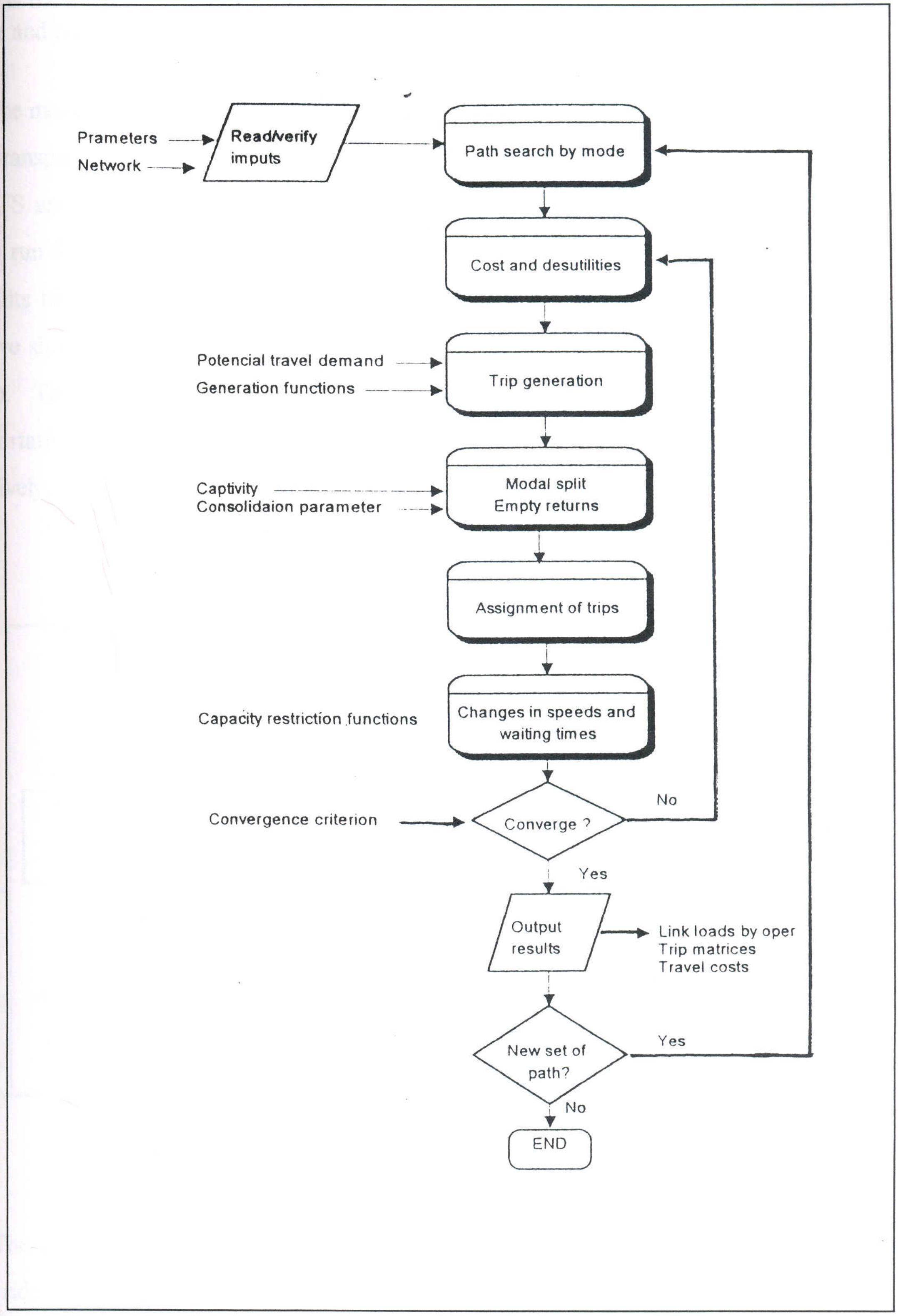

Figure 25. Operational Structure of Transport-only Part of TRANUS
Source: TRANUS Manual

EVAL: is the evaluation part that compares different alternative scenarios. Here, both land use and transportation results are to be evaluated together.

The model designed in this study requires just the normal operation of four steps of any transportation planning package, thus, only the transportation part (TRANS) of TRANUS and path finding (PASOS) will handle that. For the initial flows, we also need to run FLUJ at the beginning. The "ideal" model builds on the comparability of the results both from conventional run and the run for the disadvantaged separately. Thus, we should run TRANUS for both model compartments (for disadvantaged and normal). The operational structure and the sequence of programs of the Transportation-only part of TRANUS are explained in the Figures 25 and 26 respectively.

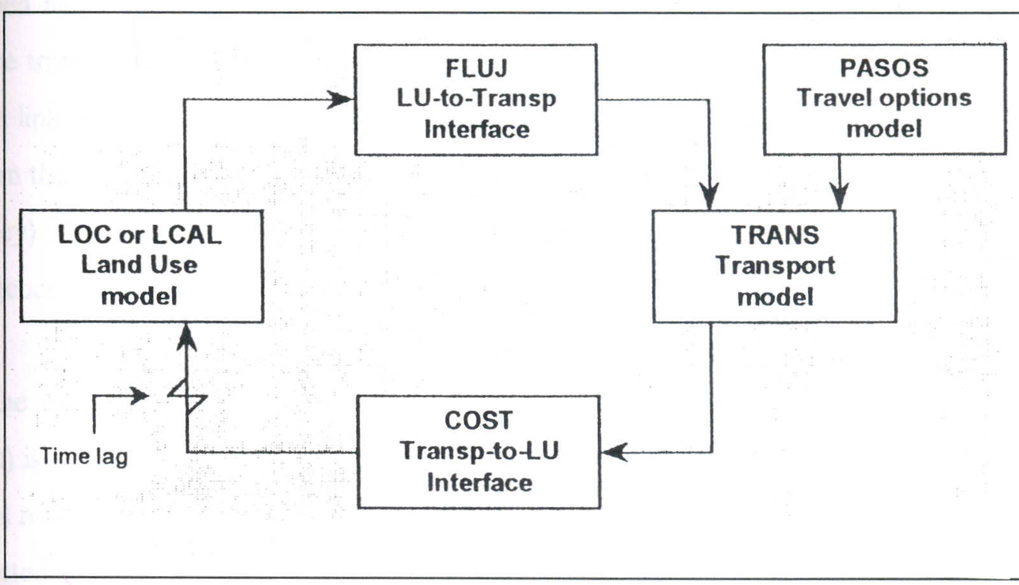

Figure 26. The Sequence of Programs

The calibration of the model can be done by the **classified** traffic counts and transit ridership (from the occupancy ratio counts that will be undertaken), regarding the actual speeds. The stated preference surveys would also be helpful in the calibration (but, we will not use this in the Aydın case). If desired, all socio-economic data can be in GIS form or database. For obtaining realistic values, only the mid-block screen line counts on some arterial streets and the O-D surveys will be used. Also, the vehicle occupancy ratios and some surveys on the stops casually measuring the quality of transit services will be useful in the validation of the data to be obtained from the home interviews. Nevertheless, TRANUS requires that the individual data obtained at households be aggregated (converted) to zonal values or categorical results. The user could freely define either the number of variables and their contents. Population may be divided into different categories like income and social categories (and probably to advantaged and disadvantaged).

Naturally each link (segments) has to be defined in terms of its characteristics: distance, capacity, link type, free-flow speed (or given Design Speeds), etc. Also, the frequencies of transit services, if any, data of tariffs and schedules may be included in.

Trips are distributed to modes by the MNL procedure (combined program). Combined mode split and assignments are also made by using another MNL model: Trips are transformed into vehicle units (PCU or other) through the occupancy ratios for each link. Finally, a capacity restriction based on the actual volume/capacity ratios is used in the assignments. The output will be new volumes, speeds and wait times (or, frequency) for transit services. This procedure repeats several times until the convergence values are obtained.

The evaluation process in TRANUS is tree-like: when a change (or, set of changes) is made in any of the variables or constraints (as inputs), or the results of the previous models (as outcomes), the model re-runs and traces all the way down through the affected steps.

According to the manual, the Windows applications can be copied to any other Windows applications, even to the word processing documents, or to spreadsheets, easily.

In the transportation calculations, which is our sole concern here, those main characteristics have to be known well:

- link type and speeds on each link
- link length
- physical capacity (volumes)
- public transportation capacity
- prohibited turns (we do not intend to use this, therefore, it may be default)

According to TRANUS, Wardrop's algorithm of equilibrium, the incremental approaches and all-or-nothing methods are found not meaningful and realistic since TRANUS does not assume human as behaving totally rational. Individual can not figure out all the costs and benefits, but the system. Thus, the model adopts a stochastic nature of equilibrium (Ortuzar and Willumsen 1994, pp.241-4).

4.4.4. GIS Network Transferring

As mentioned earlier, TRANUS is already a GIS-based program that can manipulate GIS databases (Like ArcINFO and MapINFO). External data in graphic, or geographic, form can easily be transfered (copied) to TRANUS database as text or DBF files (GIS-to-TRANUS) (Manual, FAQ, p.4). TUS can be used to display the results of simulations in graphic forms that might also be transfered to any other GIS environment (but from the DOS environment) (TRANUS-to-GIS).

Most of the graphical information in transportation applications and results appears in linked-based, route-based or path-based. Network attributes like capacities, routes, assignment results in vehicles, passengers, tons, level of services, wait times, etc. can be displayed. Color screens, plotters, printers, etc. are accessible.

4.4.5. The Formation of Database, Database Aggregations

TRANUS makes the calculations on the basis of zonal values. Therefore, most of the inputs to the model should be ready as zone aggregated values. For aggregations of the individualized (person level) data, refer to the Sections: **Disadvantaged by Zones** and also **Adopted Level of Aggregation** in Chapter 3.

4.4.6. Evaluation of TRANUS

In the model, there is no need for the land use integration because it is not intended here to forecast the future trips, albeit land use parameters actually do play important role. Second, land use data is the matter of zone-related (aggregated) variables and the household aggregation is related rather to household characteristics but not land use (Bruton 1975, p.103). They are used to find the attractions, such as the number of jobs available, volume of retail sales, school attendance, etc.. Although being not much satisfactory without the use of land use part, TRANUS package is thought to be demanding less data and offering large flexibility. The purpose of this study is just to test a model that intends to include such social/ethical parameters. As one of the distinguished features from the other models, TRANUS, as far as introduced, seems welcoming some of those parameters. Furthermore, it includes the evaluation part at the end in which we can simulate some scenarios though its evaluation considerations are only cost-based and not very comprehensive.

Unfortunately, the model has some major divergences (properties) from the other conventinal modelling approaches. It uses the combined multi-nomial logit (MNL) procedures, in that all four stages reduced into one-stage algorithm (which is utility based) as in not discrete form. Thus, our modelling should be adapted accordingly and requires a parallelling learning phase of the package operations en route the modelling studies. Because, it runs the sub-models quite differently (for, example, the first stage is not the trip generation but the assignment of the routes that may change after the secondary and tertiary iterations).

However, the study does <u>not</u> concern on how the program should run but whether it provides the results we need for all stages or simply the final output. But, it may be adequate to know at what stage of the program we should compare our real volume counts (from the screen line counts) with those of the package's results for calibration.

As a conclusion, whether TRANUS can compatibly be used to run the models in that package and suits the variables defined, and inversely, whether the model proves to be working with any popular software will be figured out. It is deemed, at that point, that TRANUS can be used in the validation of the model, because of its flexibility and can be used for the future land use integrated projects at larger scales that ought to require less data. But, this does not mean that the package is the best one for the model, which was not the aim, here, to prove.

4.5. Data Correlation Matrix

Correlation matrix would be useful to define which variables are interrelated. Thus, this information will also be useful in the composition of the "Correspondence Module" that will take place in **Chapter 5: Equalization Process**. The Correspondence Module will decipher the correlations between the "disadvantagedness" levels and the policy variables that are relevant to that information. In order to do that, it is necessary to know first which variables are strongly linked (correlated) to each other. A sample correlation between two data sets is through:

$$r_{xy} = S_{xy} / S_x S_y$$

A statistical data editor SPSS is readily used for this process. By this, a large correlation matrix is obtained. The correlation matrix is also important to find the correlated variables to input in the regression analyses for the trip generation stage.

Another advantage of obtaining correlation matrix, to estimate the degrees to which the variables are effective as latent policy variables (that is, they can be the **areas** of policy making). The most correlated variables were marked. The correlations between only the function (Major) variables are also calculated (See Appendix F). Correlations are taken also for the disadvantaged population *per se*, but are not taken into the consideration. Instead, the correlation matrix for disadvantaged where only the function and some important (as observed from the correlation matrix for normal population) variables are considered. The correlations for disadvantaged are little different than the correlations for normal (all) population. The reason and nature of the difference could not be reasoned.

4.6. Run of the Conventional Model

Before beginning the process of modelling, it should be reminded that the first two steps (Trip Generation and Distributions) of modelling for both Normality (ie, conventional model) and for disadvantaged are done manually. Because of the complexity of the procedures, together with speeding considerations, the last two steps (Mode Split and Traffic Assignments) will be run on the software (TRANUS). Thus, it should also be noted here that the effects of simulations in which the planning policies will be applied could only be monitored at these last two steps. Monitoring the results at the Mode Split level is the best because it inherently bears all the first two steps still at the zone-to-zone basis. On the other hand, since the Traffic Assignment step is difficult and not meaningful to apply for this study, only the visual monitoring of the LOS levels is seen enough.

Here, it should be noted that only the base year model runs would be described (for both Conventional and the model for Disadvantaged, but not a targeted future). The simulation runs will later be described in the Simulations Section of Chapter 5.

4.6.1. Trip Productions

4.6.1.1. Multivariate Linear Regression

Because of the insufficient data, we are unable to handle Categorical Analysis, which is usually preferred in the transportation studies in Great Britain, for the trip generation stage, which requires larger data and can only be applied to household data. For example, there should be at minimum 50 items of data for each zone/variable-category (Papacostas and Prevedouros 1993, p.320, Ortuzar and Willumsen, p133-6, Gülgeç 1998, p.93). Instead, regression analysis method was preferred that bases on the most correlated data. Besides, regression analysis also serves the elimination of the irrelevant variables into such a new modelling approach.

The regression could have been done in stepwise fashion if not solved by multiple regression method. The purpose here is to find the trips produced by one person per day, which is called daily trip rate.

The multi-variate linear regression is made successfully only on the basis of zone-aggregated data, which are derived from the individual level data since the correlation results looked quite low with the individual and household data. As explained in Chapter 3 before, zonal aggregation is simply the mean of all individual data (for all data columns). It is agreed that this technique of aggregation is not really healthy and that it artificially creates much higher R^2 values (Ortuzar and Willumsen 1994, p.127-8). Thus, only up to three variables are allowed to enter the regression model, to sustain some degree of freedom in the regression. Actually, this is just for that reason to apply this level of aggregation to obtain such higher R^2 values, and, therefore, the zonal aggregation is preferred. Still, with this higher R^2 values, the model results are not trusted, therefore, only the trip rates from the survey, which are the overall trip averages per zone, are used as the trip rates.

4.6.1.2. Definition of the suitable variables (R Square and t- Tests, F-Value)

By using the most correlated variables as determined in the study of correlation matrix, many linear regression combinations with different variables have been tried on the SPSS software to achievc the best model giving the best R^2 results with the low P-value (or, high F values). Instead of trials, also the method of stepwise regression was tried but the results were far from being satisfactory as good as the random trials according to the correlation values. The summary results for the regression from trials are provided in Tables 12:

Table 12. Summary Results of Linear Regression for Conventional Model by Trials

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,886	**,785**	,704	,1631

a Predictors: (Constant), DEPEND, INC.PER, statu.edu

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3,131	,494		6,345	,000
	DEPEND	-3,933E-02	,011	-,722	-3,615	,007
	INC.PER	-4,046E-02	,013	-,847	-3,051	,016
	Statu.edu	2,022	,455	1,076	4,446	,002

a Dependent Variable: reg.trp

Besides the R^2, t and F- values are found remarkably high which increase the validity of the chosen variables in the model.

From these results, it is known that those variables listed below become the most effective in explaining trip making behavior of people on the basis of zone aggregated information:

- **DEPEND:** function variable for dependency in the household (**a**)
- **INC.PER:** function variable for the income level per person (**b**)
- **Statu.edu:** minor variable for the educational status of the person (**c**)

By inserting the coefficient values, the regression model can be set as:

$$\mathbf{T_i} = 3{,}131 + 0{,}04\mathbf{a} + 2{,}02\mathbf{b} - 0{,}04\mathbf{c}$$

The most correlated variables and the regression analyses produced in SPSS for both trial and stepwise can be examined through the Appendices F and G respectively. In the regression trials, it is also observed that some different variables such as comfort and disability can be the effective variables besides car availability, and household size when the number of variables are increased. But, for example, if variable for disability ('disab') is removed, there will be very less change in the view. That is, it seems still not very strong factor in the model. The number of variables can be further reduced.

When this model is applied to the Aydın's data variables, a relatively high value of 1,73 per capita for daily trip rate is found, in which pedestrian but regular (work/school) trips are also included. Some may think that this value is high for a medium sized city but there is the fact that the trip rate over time may have increased compared to the latest (10-20 years) results due to rapid developments (and increased car ownership) that stimulated extra demand for trips. Also, regular pedestrian trips are within this figure. For example, trip rate is very high in the U.S.: The average daily trip rate was found 3,88 (NPTS data, 1990) for Non-consolidated Metropolitan Statistical Areas of the Middle Atlantic census region. The trip rate was found to be 1,72 in Ankara even in 1985, of which pedestrian trip rate was 1,23 and the vehicular trip rate was 0,43 (Beyazıt 1989), Of course, the trip rate is expected to be high in metropolitan areas. But, there, in turn, the portion of pedestrian trips must be lower.

The model's trip productions for each zone are calculated by multiplying the result of the model by the total zone population. The results are given in the Table 13:

Table 13. The Trip Productions for the Conventional (Normal) Model

Zones	zone populat.	regression Model	The trips produced*	Average Reg. trp
1	12261	1,81	23.075	1,88
2	11378	1,75	17.147	1,51
3	9107	1,87	14.626	1,61
4	10136	1,94	19.694	1,94
5	13477	1,88	26.132	1,94
6	15359	1,74	29.090	1,89
7	11938	2,02	24.807	2,08
8	13046	1,23	17.312	1,33
9	9251	1,54	12.924	1,4
10	9683	2,12	20.828	2,15
11	9899	1,40	12.710	1,28
12	9830	1,51	15.816	1,61
	135365		**234.162**	total trips produced

*Note that trip productions includes also intra-zonal trips. Later, intra-zonal trips will be excluded at Mode Split stage. 34% of the trips is intra-zonal.

It should be noticed that the zones 1, 4, 5, 6, 7 and 10 produce more trips per capita than the rest. These values were for the regular trips other than 'social' (or, irregular) ones. Though, the real disadvantagedness would be observed, and, the trip generation model can be possible for social trips using multi-variate linear regression, they form the less reliable data than the regular ones. The concern for the social trips can be later examined as of further studies. Here, in the limited scope of this study, the trip productions for social trips would be less relevant to proceed.

4.6.2. Trip Distributions and O-D Matrix

The trip distributions from each zone to other are calculated manually. As mentioned before in the Assumptions and Limitations, the distribution matrix will be calculated on the basis of the doubly constrained gravity (synthetic) model. Yet, Attractions (D_j) are found in the calibration process iteratively because the modelling approach here did not use the land use inputs and modelling of attractions were not probable from the land use variables at the Trip Generation stage.

The simplest distance decay function is adopted which is d_{ij}^{n}. Such functions may be assumed to be depending on different conditions of the city:

- **$\exp(^{-\beta cij})$**, here, cij is the any cost that relates to distance decay but most of the times it is directly the distance (d) and it requires the calibration of β
- **c_{ij}^{-n}** , here, n can be any value between 0,6 at minimum and 3,5 at most, and said that usually taken to be 2 in most of the studies (Ortuzar and Willumsen 1994, p.159).
- **$C_{ij}^{n} \exp^{(-\beta cij)}$**, which is the combined form of distance and cost factors where both d and β were to be calibrated.

Here, it is preferred to adopt the TLD (Trip Length Distribution) sort of calibration for estimating the **n** power (it is the only parameter of β to be calibrated in our model) of the Gravity Type distribution model. It is possible to use the OD (survey) destination data found for each district (or zone) to obtain the relative number of trips and trip lengths for each zones. However, the relative distances between the zones could be calculated and they are categorized relatively under 8 basic distance categories that would be enough to create the distance decay slope. That is, therefore, here, the term "frequencies" used and it is called TLD method. According to the OD calibration results, such a diagram is obtained that was enough to prove that the distance decay function is more or less sort of $\mathbf{d}^{\beta}$ (See Figure 27).

The raw OD values, which are really weak to represent reality, first, are converted to realistic Distributions calibrating oi of raw OD to the Oi values from Trip productions in the rate of both population/sample ratio and the overall trip rate, in which non-response rate is also considered. After the process, the values of oi became quite closer to the original Oi values. Additionally, such "Trip Rate Factor" of 1,67 was used in this process simply because the survey's OD information was per trip. Finally, for fine tuning, the individual oi values are fitted to the original Oi (ie, of Trip Productions) values since it is necessary that both the oi of advantaged and disadvantaged be equal to the oi of Normal Model. After this process, following through the steps in the Gülgeç's book (1998, pp.VI-126-142), these values are calibrated in order to check whether the TLD values found are realistic fitting the TLD of OD (or, TLDo) and to find the β values. Through the linear regression, the beta value for the Model for normal is found –1,22 where R^2 was 0,57.

In the calibration process, also the Ai and Bj values as well as Oi and Dj, and finally K factors are obtained. For the future planning calculations, these parameters can be used in their places in the T_{ij} formula. Dj can be iteratively be calibrated from these $O_{i,}$ values as described in Gülgeç (1998). The formula for the Trip Distributions was:

$$\mathbf{T}_{ij} = \mathbf{o}_i \, D_j \, K_{ij} \, F(\mathbf{c}_{ij}) \,/\, \textstyle\sum_j D_j \, K_{ij} \, F(\mathbf{c}_{ij})$$

One of the drawbacks of this study is the use of distances instead of travel time (cij) because of the scarcity of data. The distances are calculated on the map from zone to zone centroids. Table 14 provides the distances. The distances are measured mostly

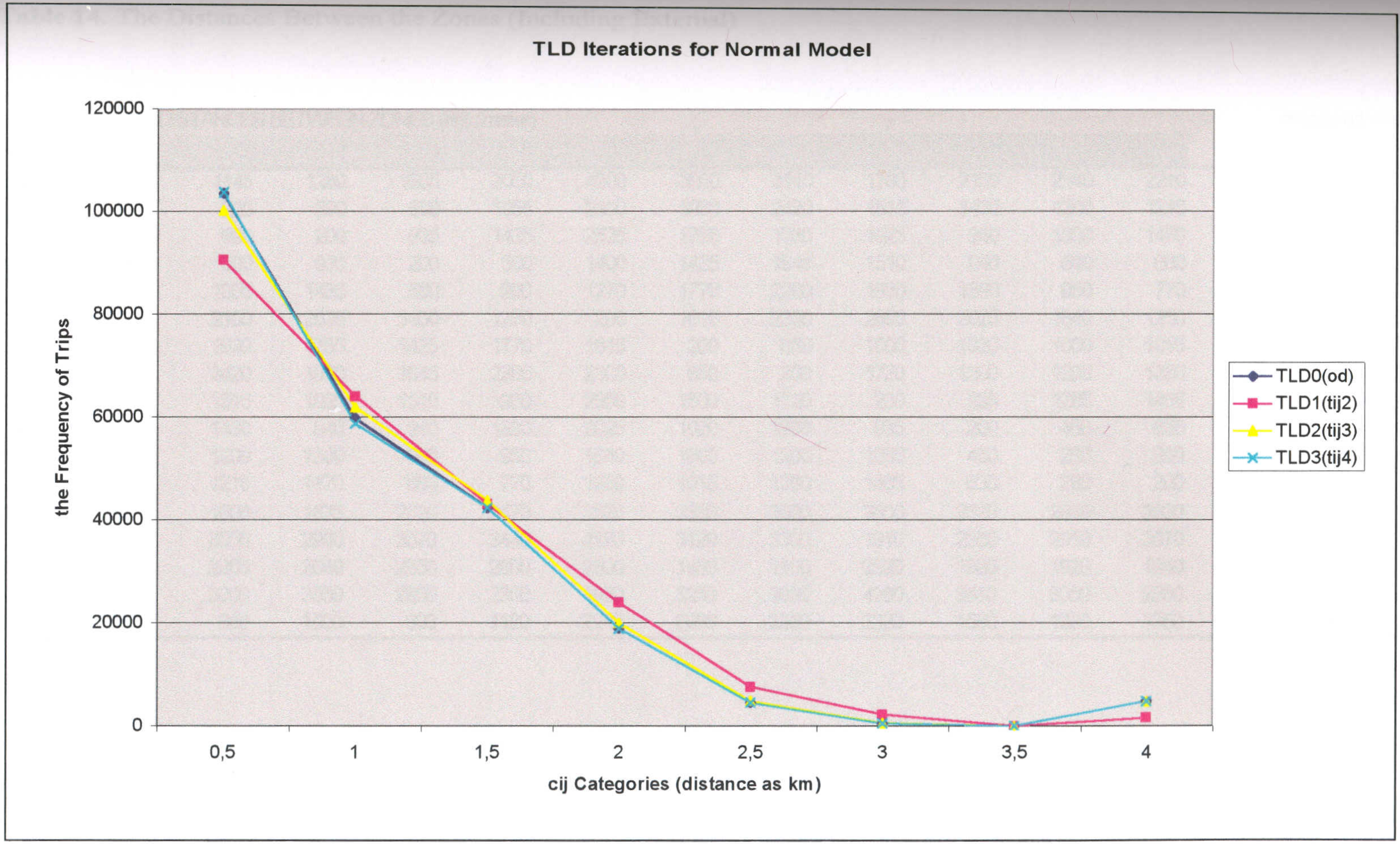

Figure 27. TLD Fitting to the TLD of OD Trips in the Calibration Process According to Eight Distance Categories

Table 14. The Distances Between the Zones (Including External)

DISTANCES BETWEEN ZONES (dij) (meter) — measured mostly over arterials

ZONES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Kem-gir (1)	200	1145	1280	1600	2050	4000	3000	3110	1785	2120	2140	2210	520	2920	3050	4300
Mes-köp (2)	1145	200	690	600	1055	2100	1930	2420	1515	1430	1200	1215	1600	3550	2900	3300
Meşru (3)	1280	690	200	935	1435	2535	1755	1930	1025	940	1300	1470	1675	2900	2680	3550
Has-veys-ra	1600	600	935	200	550	1400	1425	1645	1510	940	640	660	2020	3070	2350	2800
Cum-zaf (5)	2050	1055	1435	550	200	1270	1770	2200	1960	1390	950	770	2470	3440	2800	2350
At-ort-ıl (6)	4000	2100	2535	1400	1270	200	1615	2300	2650	2025	1640	1250	3520	4180	2590	1680
Admend-yed	3000	1930	1755	1425	1770	1615	200	650	1500	1020	1000	1015	3330	3120	1460	3250
Oyoz-Ist (8)	3110	2420	1930	1645	2200	2300	650	200	1720	1200	1200	1380	3500	3300	1100	3930
Efe-zey (9)	1785	1515	1025	1510	1960	2650	1500	1720	200	935	1285	1465	2600	1910	2520	4280
Cumh (10)	2120	1430	940	940	1390	2025	1020	1200	935	200	450	630	2520	2550	1900	3410
Kurtu (11)	2140	1200	1300	640	950	1640	1000	1200	1285	450	200	280	2610	2910	1920	3050
Ghisar (12)	2210	1215	1470	660	770	1250	1015	1380	1465	630	280	200	2630	3070	1940	2880
13	520	1600	1675	2020	2470	3520	3330	3500	2600	2520	2610	2630	200	2500	4270	4720
14	2920	3550	2900	3070	3440	4180	3120	3300	1910	2550	2910	3070	2500	200	4400	5700
15	3050	2900	2680	2350	2800	2590	1460	1100	2520	1900	1920	1940	4270	4400	200	4160
16	4300	3300	3550	2800	2350	1680	3250	3930	4280	3410	3050	2880	4720	5700	4160	200
17	2250	980	1500	690	1190	2240	2065	2350	2320	1580	1330	1350	2660	3800	2980	3440

over arterials as air-line distances. Intra-zonal distances are assumed to be 0,5 km for each zone.

The total outcome of the trip distribution model calibrated with true OD and zone-to-zone Trip Production values is given in the Table 15.

Table 15. The Calibrated Trip Distributions for Normal

	1	2	3	4	5	6	7	8	9	10	11	12	Oi
1		2.940	6.370	4.900	490	4.165	74	74	490	490	490	490	20.972
2	492		503	2.514	1.508	1.508	1.005	76	1.508	1.005	2.011	2.011	14.142
3	46	1.246		1.651	623	935	935	312	623	312	561	1.184	8.426
4	68	936	2.012		1.404	1.404	1.404	71	2.012	140	608	2.948	13.009
5	1.441	502	502	4.019		3.014	2.512	76	2.009	502	1.758	3.265	19.601
6	585	850	1.134	5.101	1.700		1.134	86	1.700	567	1.587	2.721	17.164
7	348	675	506	4.723	2.024	2.361		51	337	675	2.867	3.542	18.109
8	50	48	638	1.277	638	511	958		734	638	958	638	7.088
9	59	362	1.811	1.811	55	55	725	55		725	362	55	6.075
10	96	643	3.217	2.252	1.287	97	1.287	97	1.287		1.930	2.895	15.089
11	45	317	1.902	2.949	1.902	317	317	317	317	317		1.997	10.699
12	373	394	789	1.972	789	1.183	789	60	1.183	197	2.564		10.292
Dj	3.602	8.915	19.385	33.168	12.421	15.550	11.138	1.273	12.202	5.568	15.696	21.747	**160.666**

Growth rate approach is not considered for the modelling here because, first, there is no any idea about the previous trip pattern to start from in Aydın. Second, growth rate would provide no idea about how disadvantaged could respond to distance or other friction parameters. However, it can not either be said OD data for the calibration of Distributions are much reliable due to low sampling ratio.

4.6.3. Mode Split

Actually, TRANUS sees this stage not necessary. But, when a mode preference value for "modal constant" parameter in TRANUS is entered it makes necessary adjustment. Since the Mode Split is the essential part of the study, we will try to figure out such a modal constant for both normal and the disadvantaged.

Utility approach is used (ie, probit approach) to calculate the proportion of modal utilities. General utility for a mode (which is public or private) of a category (advantaged and disadvantaged) is derived from the major variables of IMPED1, IMPED2 and IMPED3 that evaluate the general subjective satisfaction levels from the mode. These variables had been designated to be the variables for measuring travel characteristics from the point of users (time, comfort, service level, etc.). But, the relationship can best be explained by only IMPED3 variable through the regression analysis when TYP.MOD variable (type of mode chosen) is used as the dependent variable and where R^2 is 0,78 (See Appendix G).

$$\mathbf{U}_{publ}\text{ (TYP.MOD)} = -2{,}287 + 0{,}036\text{ (IMPED3)}$$

$\mathbf{U}_{norm}^{publ} = 0{,}38$ for Normal

(this will be $\mathbf{U}_{dis}^{publ} = 0{,}41$ for the disadvantaged)

Utility here is defined as the direct average result of those variables without taking separate weights for each. Finally, these results are achieved from the home interview survey:

$U_d^{pri} = 85{,}6$

$U_d^{pub} = 58{,}4$

$U_a^{pri} = 84{,}3$

$U_a^{pub} = 40{,}9$

where, U represents the modal utility of group (*d* or *a*) for a mode (*pri* or *pub*).

d or *a* represent the group disadvantaged and advantaged respectively, and, *pri* or *pub* represent the mode choice.

The sum of Utilities is defined as:

$$\Sigma U = U^{pub} + U^{pri} + U^{e}$$

In this summation, U^e represents some undefined mode choice(s) or aggregate mixed choice of both private and public. The sums for Normal, advantaged and disadvantaged are found to be:

$\Sigma U_k = 269{,}2$

$\Sigma U_d = 153{,}6$

$\Sigma U_a = 138{,}2$

Here, the probability calculation is in terms of the probability of choosing a public mode that can be expressed in the formula, where *i* subscript is used for either advantaged or disadvantaged, as:

$$P_i^{pub} = U_i^{pub} / \Sigma U_i$$

If the exponentials were used in the formula, then the findings for both normal and disadvantaged would become away from the survey's findings such as: 0,33 for normal and 0,43 for the disadvantaged. Thus, the use of exponential calculation is not preferred.

Finally, the survey's aggregate probabilities of choosing a public mode for disadvantaged groups, 0,38 for Normal (and, for the advantaged is 0,3) and 0,41 for the disadvantaged are respected. Since the results are almost close, the overall modal choice probability for all groups is assumed to be around 0,4 that corresponds to the value of 1,6 (for Normal) in the "modal constant" parameter of TRANUS package[2] Thus, 1,8 is considered for the advantaged (less preference) and 1,4 (more preference) for the disadvantaged. When no categorical mode choice is considered, but only between private and public, it is 1 (default value for the best mode) for private and 1,6 for public respectively. 3 is assumed for walking. Surprisingly, there is not significant difference between the two categories at this stage of modelling.

Note that TRANUS also calculates the modal preferences from zone to zone and on the links basis, considering the other network and system characteristics, distance, the capacities of the links chosen that affect the choice of mode. These calculations are automatically done in the package and beyond our cognition in this study.

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[2] The modal constant parameter has to be between 1 and 2 for vehicular trips, if 1 is assumed for private mode and 2 is for pedestrians, in the TRANUS package.

4.6.4. Traffic Assignment

The thesis study does not particularly concern the Traffic Assignment stage but "monitors" the results on the links whether the capacities are exceeded or not when the policy decisions are applied. The scope of this study does not allow looking into the disadvantagedness levels on every link. However, the assignment results will be provided for the base year and each simulation for general comparison.

Generally, v/c ratios below 0.75 are acceptable, and moderately unacceptable if between 0.75 and 1.00. Insufficient streets where delays occur will be determined on the Traffic Assignments map. The alternative solutions to these occurrences can be capacity increase or proposing of new highways. It is observed in this study that most v/c ratios in the streets where screen line counts are made are less than 0,6. That means there is no serious congestion problem.

The overall total equivalent vehicular traffic loads (together with the external traffic) on the links are found from the Base-year (conventional) run at TRANUS as in the Figure 28. Total volumes (total passengers) of vehicular traffic are presented as private and transit. It can be noticed in the Figure 29, that the share of transit outweighs that of private.

The most important consideration, however, at this point is that whether there appears any link with low level of service (LOS) and the unacceptable waiting times, which are provided in the Figure 30 and Figure 31 consecutively.

As seen in Figure 30, there are only the two lower LOS assignments at the North-eastern bound (Gazi Bulvarı) links. One is B level, which is not problem, and the other is C, which is ignorable. The C level on that link may be due to the external traffic effect. The program was also run for the base year without external traffic and all links appeared as A level (which means free flow of traffic). Waiting time is also ignorable (Figure 31).

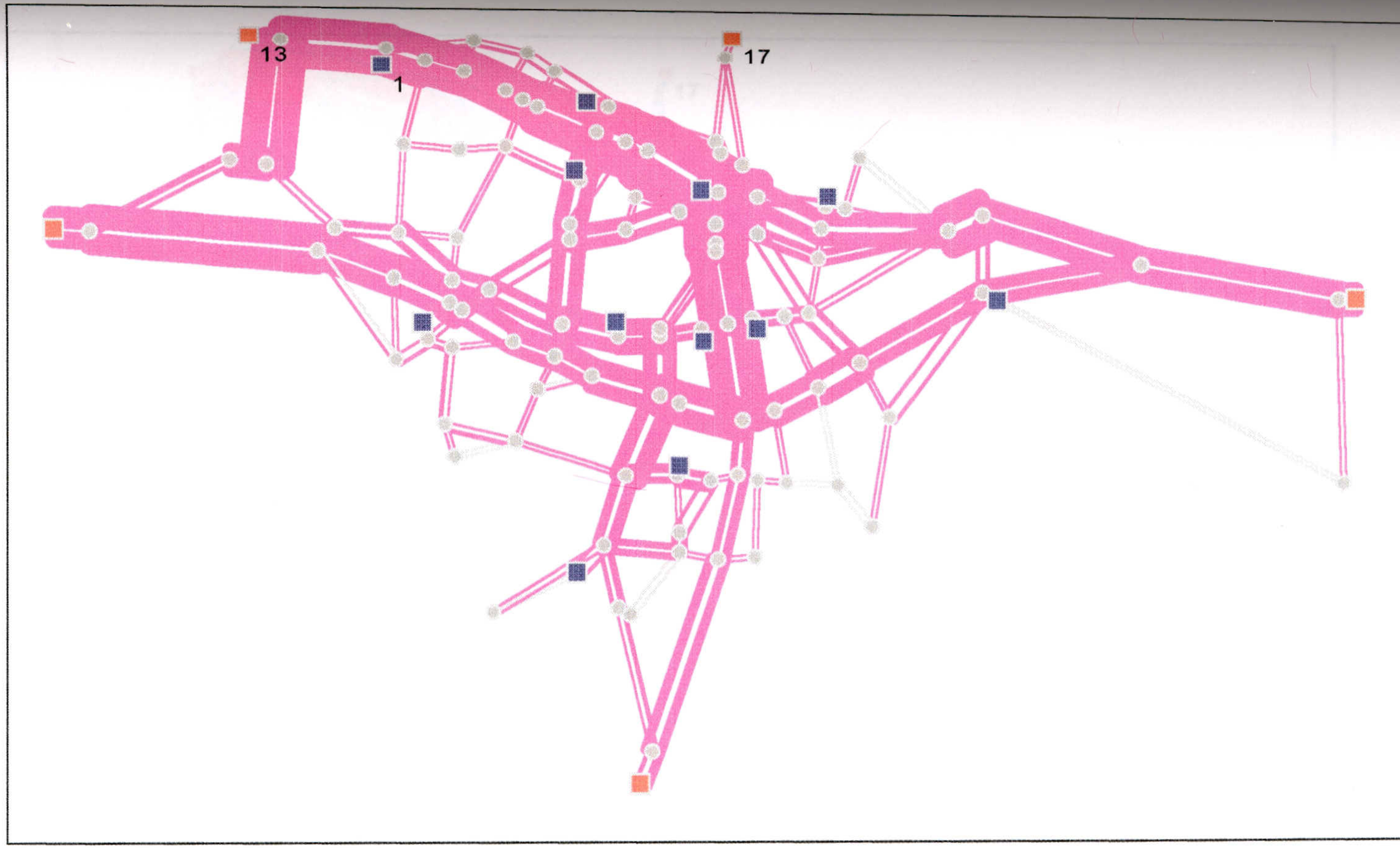

Figure 28. PCU-converted Total Vehicular Traffic Volumes (no pedestrian) with the External Traffic

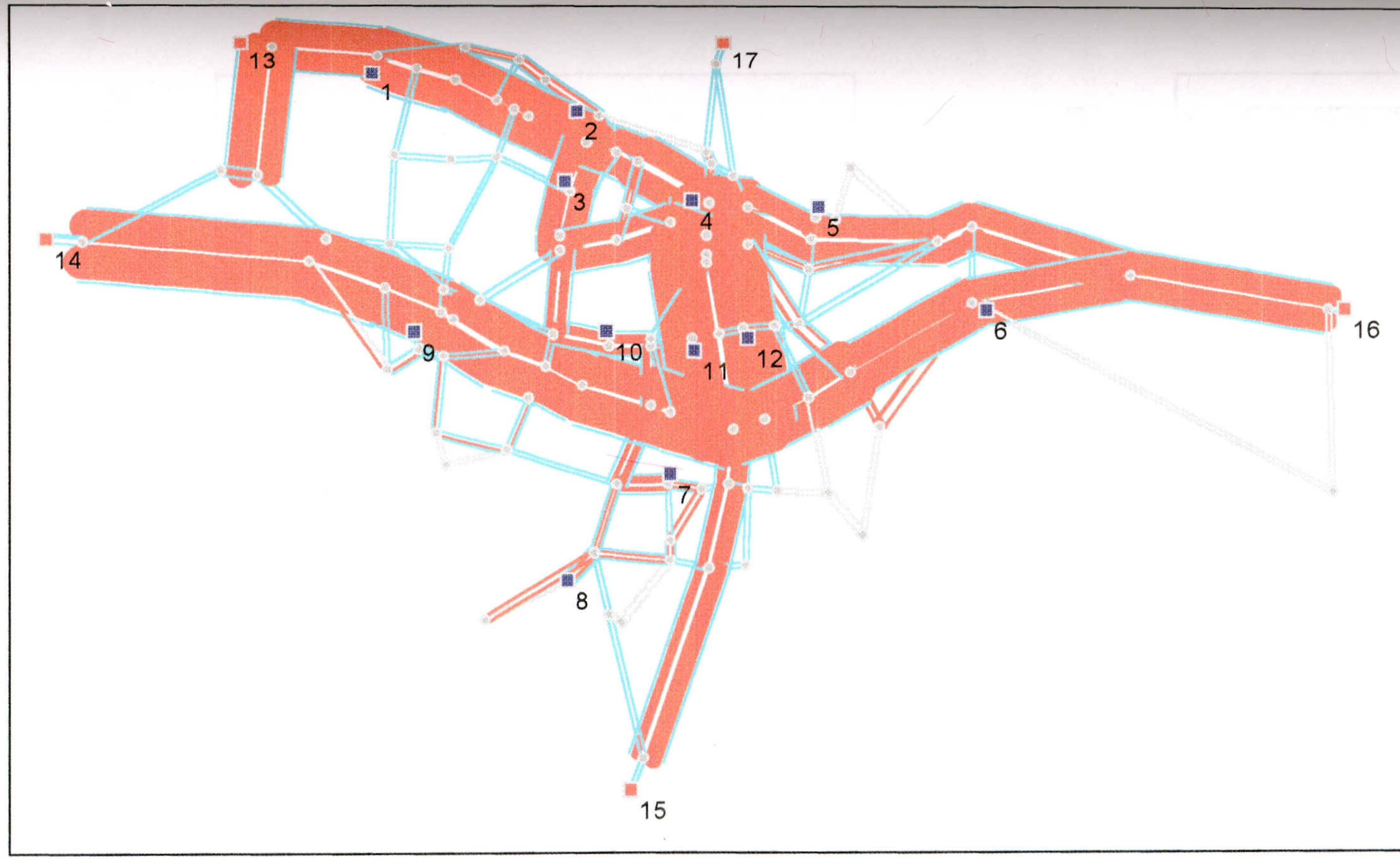

Figure 29. The Volumes of Transit and Private (private is blue, which looks negligible)

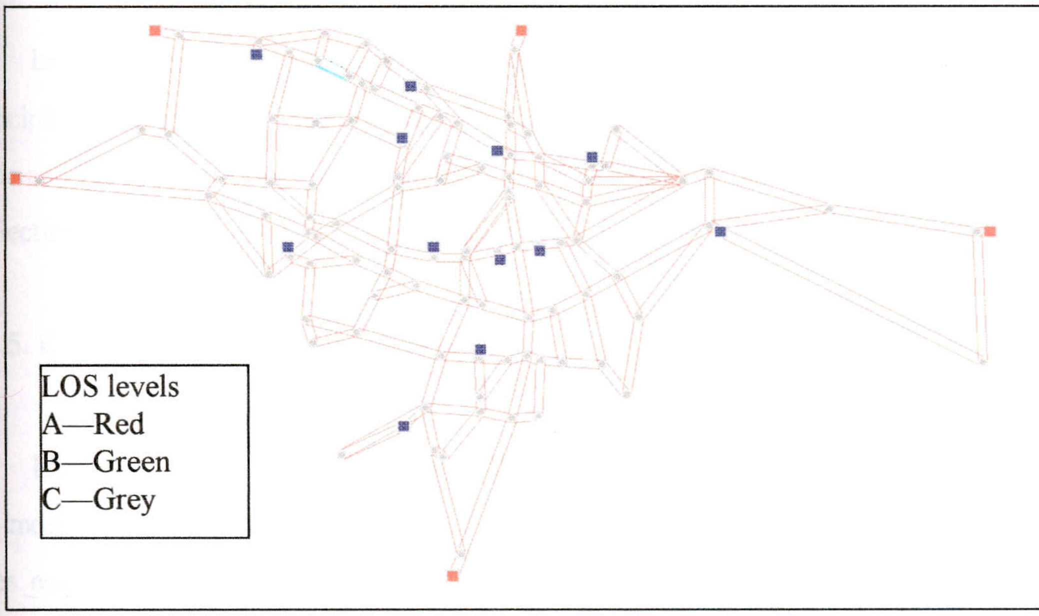

Figure 30. The LOS (Level of Service) of the Base Year Assignments Together With External Trips

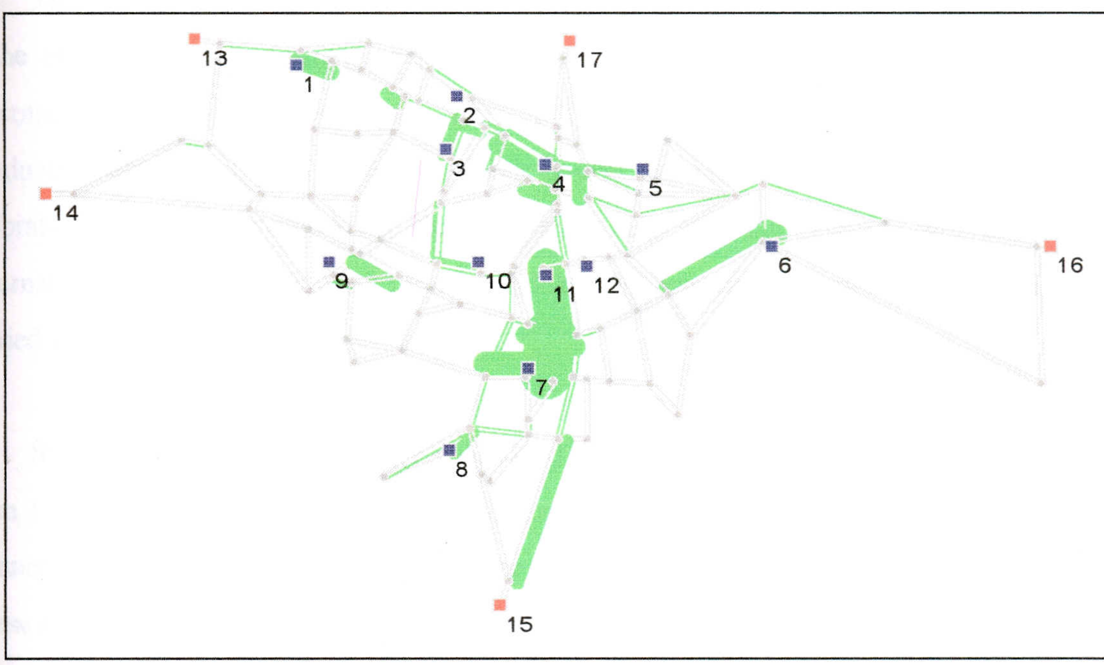

Figure 31. Waiting Times for the Base Year Conventional Model Run

In these assignment calculations, the utility theories and the capacity restriction principles were utilized in the program. Note that the assignments are totally left to the logic and theories assumed in the package itself (See the Explanation about TRANUS in Section 4.4.).

4.6.5. External Traffic Consideration

Identifying the external traffic and taking its effect into consideration is one of the most complicate matters throughout the modelling phase. The fact that this study does not concern the external traffic but that it is undistinguishable from the urban traffic makes the complicacy by the external traffic. Thus, in principle, it is decided in advance to have two base year runs, one with external traffic to see the effects the external traffic may cause, and other with no external traffic which can be modelled easily.

The problem of identifying external traffic could have been solved appropriately if the external cordon counts, or any other survey method that would reveal the external trips, were ever conducted. Since, only the internal screen counts could be conducted (only for three days and for peak hours), the counts will be utilized in the calibration process for contrasting, that may even help to some extent identifying the external (on the vehicle type basis) traffic. Below are presented a simple method, which is tried for the case of Aydın, *per se*.

Such F_j, attraction values, are calculated on the basis of the O-D data derived from the home interview surveys to find the external trip distributions in a simple manner. The number of attracted trips per zone is rated to the general summation. These rates show the attraction power of the zones.

Using Inter-zonal Distributions Approach, the zonal attraction coefficients (F_j) were used for the external zones. However, these attraction values do not count for the interaction between the external zones (by-pass external traffic), since the attraction values derived from O-D data pertain to external in and out trips to the city. Attraction then, directly the approximate trip amount observed must be replaced for each pair of zones in the trip distribution matrix.

Then, the attraction values for external zones obtained from the O-D data were multiplied by the daily numbers of trips entered from these zones. Yet, one fallacy in directly applying this method is the ignorance of the much heavier share of the by-pass traffic that just passes through the city as not affected by the attractions of the zones. Yet, the method still seems rational and this by-pass affect, as seen in the Base Year Assignments with external traffic, is still obvious even if ignored. The attraction power values for the external centroids had been found as in the Table 16.

Instead, the traffic loads of Base year run for Normal situation without the external trips that TRANUS produced on the links as assignments were used as the real calibration values (as if real counts). The model-run values are granted to be accurate. After adjusting with the traffic count values from streets where the screen line counts are made, the final assignments were compared to the assignments of the Base year model results with the externalities (ie, external centroids were included). The difference between the two sets of values on the links practically meant the pure externalities on the links. For the Screen Line Streets, the vehicular and passenger ratios of external traffic respectively are: %6,6 and %61,5 for Egemenlik, %4,5 and %76,8 for Adnan Menderes, %1,7 and %10,4 for the Atatürk Blvd, %24,7 and %80,3 for Muğla Highway, and, %9 and %85 for the Izmir Highway.

Table 16. Attraction Power Values of the External Zones

External Zones	Attraction Power values
13 (Girne exit)	0,006
14 (Izmir H.way)	0,059
15 (Muğla H.way)	0,035
16 (Denizli Hway)	0,014
17 (North exit)	0,008

Another advantage of using 'inter-zonal' approach is that values are found on the basis of zonal interactions (ie, trip distributions as passenger volumes), which adapt to the modelling stages concerned in this study.

With the PCU factor, Table 17 informs that vehicular external traffic is around 21% and passenger external traffic is around %80 on the Muğla approach. This is 7% for vehicular traffic and 85% for passengers on the Izmir approach. Note that these findings were obtained from the Adnan Menderes Junction, which is almost the center of Aydın. The ratios must be much higher at the exits of these arterials. Yet, TRANUS can exaggerate passenger numbers and the findings might be erroneous since the occupancy ratio for the external trips on Izmir Highway is almost 200 per vehicle!.

Table 17. Proportions and Occupancies of the In-Out External Trips in İzmir and Muğla Highways to the Total Traffic

	Muğla Highway		Izmir Highway	
	trips	%	trips	%
vehic	2623	0,21	5499	0,072
passeng	55097	0,8	92658	0,85
veh/intra	2069	5,25	5104	2,73
pass/intr	10855	(intra occ	13920	(intra occ)
veh/ext	554	79,86	395	199,34
pass/ext	44242	(ext. occ	78738	(ext. occu)
occupancies		21,01		16,85

Notes: 1-It is assumed that out-to-in traffic equals in-to-out traffic
2-The number of vehicular trips on Izmir Highway is around 4000, and, 2600 on Muğla Highway
3- Though the vehicle occupancy is around 3 for out-in, this may be higher for general external traffic

The results only need to be corrected by the traffic calibration coefficients, which will be defined later, but here the application of calibration factors is relaxed deliberately. But, it should be remembered that there are many assumptions taken in the calculations of external traffic and this may have caused distortions in the accuracy of the results. In the models, the external traffic will be subtracted and only the intra-urban trips will be the concern.

Total number of intra-urban trips is around 159000, while this is 193000 for external trips. When compared to the daily total sum (which is 352067), the ratio of external trips (passengers) is %50-55 for Aydın city. But, this should not be confused with the vehicular travels: The ratio must be much lower for vehicular trips since the average occupation rate is much higher (approximately 15-20 person/vehicle) with the external traffic. Thus, the ratio of vehicular trips becomes around %15-20.

For the Bursa study, the rate of external trips was found to be 0,63, where the through traffic was observed to be tremendous (Sayın, 1987). In this study, it is assumed the total external (by-pass, in and out external traffic) traffic volume (excluding pedestrian volumes) is about 50% of total traffic volume (See the Appendix H). These results also provide the peak hour factor information: 0,1 for İzmir Exit and 0,225 for The Muğla Exit. Yet, the distribution of the external traffic in the inner arteries must show variances. As previously explained, zone-to-zone external trips were calculated on the basis of the attraction powers that can either be applied to the external zones (See the external trips results for the base year). But, to see the net results of the urban born traffic, these trips were excluded in the simulation comparisons.

It was observed later in the trip assignments of TRANUS that even the trip assignments with external traffic do not cause any serious capacity restriction on the links but only with one link with C LOS level.

4.7. Run of the Model for Disadvantaged

4.7.1. Trip Productions

4.7.1.1. Multivariate Linear Regression

The same technique as in the case for the model for Normal (Conventional) was applied for the case of the model for disadvantaged, which is the try-and-error without considering the stepwise approach.

4.7.1.2. Definition of Suitable Variables

Again using the most correlated variables from the correlation matrix, linear regression possibilities with the highest R^2 value are tried on SPSS. The summary results for the trials are given in the Table 18:

Table 18. Summary Results of Linear Regression for the Model for Disadvantaged

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,831	**,690**	,574	,2235

a Predictors: (Constant), DEPEND, PUB.COM, VEH.COM

Coefficients

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Model		B	Std. Error	Beta		
1	(Constant)	5,977	2,493		2,397	,043
	DEPEND	2,635E-02	,011	,503	2,424	,042
	PUB.COM	-6,022E-02	,028	-,428	-2,154	,063
	VEH.COM	-4,685E-02	,026	-,371	-1,782	,113

a Dependent Variable: REG.TRP

In this model trial, t and F-values are relatively high, which verifies the validity of the model. The variables of the model for disadvantaged are quite different than the model for Normality, except the variable DEPEND:

- **DEPEND:** function variable for dependency situation of the person in the household (exits in the Model for Normal) **(a)**
- **PUB.COM:** function variable for the travel conditions of the person while travelling in the transit vehicles (does not exist in the Model for Normal) **(b)**
- **VEH.COM:** function variable for the comfort conditions while travelling (exists in the Model for Normal) **(c)**

By inserting the coefficient values in their places, the regression model is:

$$T_i = 5{,}98 + 0{,}026\mathbf{a} - 0{,}06\,\mathbf{b} - 0{,}046\mathbf{c}$$

The most correlated variables and the regression analyses produced in SPSS for the Model for disadvantaged can be examined at the Appendices F and G. Additionally, comf.foot, EDU.FAM, #6 (sixth stop condition) and noise could be the effective variables. Such variables, even if minor, as related to stop condition, noise in the vehicle, comfort and the school travel conditions can be effective in the modelling for disadvantaged. Yet, unexpectedly, there is not disability-related variable in effect to the travel behavior. In both models, usually the Major (function) variables could be used as explanatory variables, except 'statu.edu' variable which is a minor variable.

Table 19. Trip Rates and Productions of the Zones for Disadvantaged

ZONES	Model's trip Rate	Survey's trip Rate	disadvantaged population	Productions*
1	1,72	1,93	7802	15042
2	1,77	1,59	9510	15111
3	1,14	1,17	5657	6624
4	1,95	1,88	7659	14437
5	1,99	2,3	7067	16268
6	1,71	1,49	11384	16985
7	2,02	1,9	8661	16499
8	1,24	1,31	12042	15799
9	1,48	1,3	5829	7601
10	1,73	1,94	3289	6394
11	1,64	1,39	5377	7452
12	1,4	1,51	5990	9063
SUM	**1,64**	**1,65**	**90267**	**147277**

*The Productions include intra-zonal trips, which constitutes %31 of the trips, but are later excluded from the calculations

As seen in the Table 19, still a higher trip rate, which is average of all zones, is observed for the disadvantaged: 1,65. This value is little lower than the value found for the Normality. Again, in this model for disadvantaged, survey's trip rate is trusted and used in the calculations.

Here, especially the Zones 1, 4, 5, 7 and 10 produce more trips per capita than the rest. This figure coincides with the zones found for the Normality, except the sixth zone.

4.7.2. Trip Distribution

The same calibration procedure as defined for the Normal's model is used for the disadvantaged. According to the TLDs found as the outcome of the calibration process for the disadvantaged group, a slightly different slope of β (ie. here only **n** superscript for the distance power) is obtained for the gravity distribution model (refer to the findings at the Appendix G): -1,12

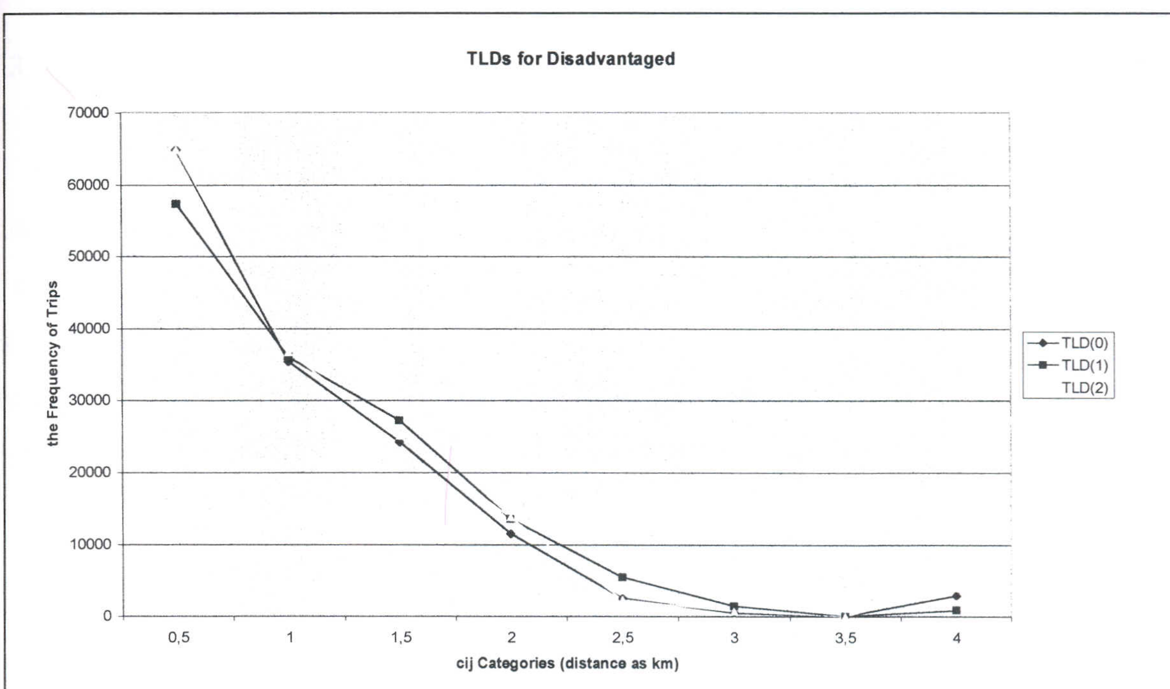

Figure 32. The TLD Distribution for the Disadvantaged Population

Although, this shape is slightly different than the one found for the conventional (normal) model, we can assume they are almost equal. Thus, we can assume the power of **d** for the disadvantaged groups around -1. That is also to say there is not a significant difference between the advantaged and disadvantaged in terms of the power of distance function.

The same doubly-constrained gravity model is valid for the case disadvantaged.

First, **oi** values are calculated in the rate of population/sample on the basis of O-D data. These **oij** values are multiplied with a "trip rate factor" of 1,53 that covers the trip rate deficiency of the OD information. Then, for fine tuning, the new **oi** are fitted to the original (Trip Productions) Oi values. The final outcome is calibrated to obtain the Beta value.

Final output matrix is obtained in the similar fashion defined for Normal model and the zone-to-zone values for disadvantaged are demonstrated in the Table 20.

4.7.3. Mode Split

Modal split for both Normality and the disadvantaged was explained above in the Section 4.6: Run for Conventional Modelling. There appears no serious difference in the modal utilities between the Normality and the disadvantaged. However, the package itself produces the trip distributions by mode and category, which displayed "structural" difference. The utility function is expected to be explained by IMPED variables, but solely can be explained by IMPED3 with the regression analysis, where R^2 is 0,72 as:

$$U_{publ}^{dis}(TYP.MOD) = -2{,}17 + 0{,}035\ IMPED3$$

According to the results of TRANUS, the number of public trips of disadvantaged is greater comparatively than the advantaged and the number of private trips of advantaged is greater than the private trips of disadvantaged. The Mode Split results for advantaged and disadvantaged can be checked at Appendix M.

Table 20. The Final Matrix of Trip Distributions for Disadvantaged Model

zones	1	2	3	4	5	6	7	8	9	10	11	12	sum(Oi)
1		1.053	5.265	2.633	527	3.159	97	97	527	790	263	97	14.507
2	556		556	2.223	1.112	556	556	102	1.112	1.112	1.946	1.946	11.776
3	54	879		1.554	54	54	586	54	293	54	54	54	3.691
4	97	1.053	1.211		527	1.580	790	97	685	158	527	2.265	8.991
5	1.453	484	89	2.421		1.937	2.421	89	968	89	1.211	2.179	13.342
6	494	91	988	3.460	988		988	91	494	494	1.236	1.730	11.055
7	56	56	303	3.640	910	1.759		56	303	303	1.972	2.427	11.785
8	328	60	328	656	656	525	984		754	656	984	656	6.586
9	63	343	686	343	63	63	686	63		686	63	63	3.124
10	99	99	535	535	535	535	99	99	99		803	803	4.241
11	66	359	66	1.796	1.078	66	66	359	359	359		898	5.474
12	420	420	77	1.261	420	1.261	77	77	840	210	1.681		6.745
Dj	4.213	8.234	13.038	25.947	9.775	17.426	12.053	10.367	10.895	7.053	12.714	15.428	**101.317**

4.7.4. Traffic Assignment

At this last stage, the reasons causing differences between Normal and Disadvantaged are not sought but differences caused by the previous stages up to Mode Split stage are monitored at the traffic assignments.

The visual assignments should have been in the form of categorical separation. But, the display of this separation is not possible in TRANUS. Here, the visual assignment results will be presented without the consideration of external traffic. Because, it has already been verified at the Normal model run (conventional run) that the traffic freely moves (LOS A) even in the case external traffic exits. The total equivalent vehicular traffic assignments are presented in the Figure 33.

In the Figure 33, since the external traffic is excluded, the neat view of intra urban traffic assignments can be seen. The volumes of both transit and private (pedestrian is not the concern) are provided in the Figure 34. In the Figure 34, it can be noticed that the share of private passengers is very low compared to transit.

4.7.5. Traffic Assignment Calibration

The modelled values are little above the values found for the streets where screen line counts are made. The counts must be the more realistic ones that should be relied on. That is not to say that counted values are one hundred per cent accurate but are more approximate to the reality than the modelled ones as can nearly be as 90%, when especially the counting errors are considered at the screen line spots. Assuming that the counted values are more realistic, the modelled values should be adjusted to the counted values. Averaging the ratios of count values to the modelled ones can do the correction in the counted values.

However, it is true that the accuracy of the values is questionable due to the less known proportions of the external trips circulating in the traffic. The calibration is affected by this ambiguity.

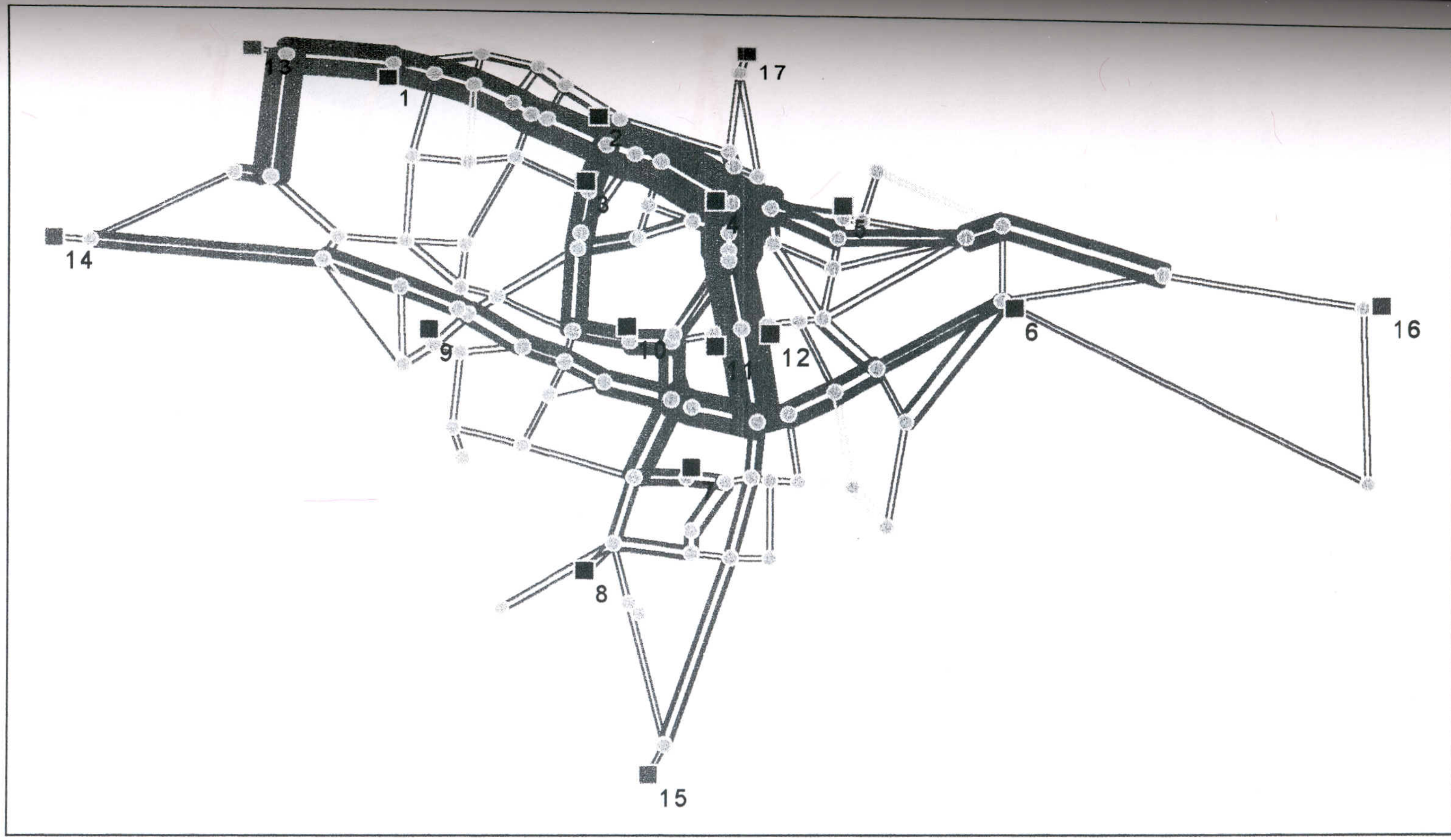

Figure 33. The Equivalent Assignments for the Base Year Run for Disadvantaged Consideration
(External traffic is excluded)

Figure 34. The Transit and Private Volumes (passengers) for the Base year Run for Disadvantaged

Instead of looking at the direct ratios between the traffic counts of the screen line streets and the assignment values of the model produced through TRANUS for the same streets, rather a common adjustment factor is searched for all streets by link types. The method is simple: The modelled ones are not the peak hour values but the count values were (that is why **capacity factors**[3] 5 and 7 are taken in TRANUS for streets and highways respectively). To reconvert the peak hour values into daily values again for obtaining the scaled rationing (between model values and count values), count values first must be multiplied by 5 and 7 according to whether they are street or highway respectively. These capacity-factor-multiplied count values are now actually the observed daily (vehicular) trips. Then, the multiplied values are proportioned to the modelled values and general adjustment factors according to link types are: a general value around 1 can be accepted for lay streets, 3,5 special for Egemenlik Boulevard, but 2 is for all other boulevards and around 4-5,5 is for the highways found (though the sampling size is relatively low: only five sample streets). (See Appendix I). Thus, to find realistic capacity-volume relations, actually the daily capacities defined for each link must additionally be divided to those adjustment factors. Or, alternatively, we should multiply, for example, the model values by 2 (adjustment factor) for boulevard type links, to obtain realistic values closer to count values done for peak-hours, <u>if</u>, of course, the count values are trusted. Table 21 for final summary results shows this for each screen line street.

Finally a factor value for each link type (highways and streets) should be introduced for better results respectively for each link, which must be divided (as calibration factor) by all (daily) capacity values, to obtain <u>daily modelled</u> values. This procedure can be done for all street and highway links over TRANUS (ie, for over 360 links). **Yet, the assignments are <u>not</u> adjusted to count values and only the modelled values are used since: the main focus of this study is not to find realistic values for a real planning study; and the study is not seriously about capacity problems reported in TRANUS on links, although higher model values must be**

[3] Capacity Factor parameter in TRANUS is used to convert the peak-hour assignments to daily hourly trips, which is what is intended in this study. Since the capacities are once calculated on the basis of peak-hour vehicle numbers, they are required to convert to daily travels, and mentioned Capacity Factors were used to normalize the values to daily hourly travels (0,2 was peak-hour factor for streets and boulevards converting to daily values, and 0,125 was for the highways).

used. Shortly, the procedure of adjustment of assignments for each link is deliberately skipped, assuming that all modelled values are true.

Table 21. Summary of Assignment Adjustment Between the Screen Line Counts and Modelled Trips Assigned by TRANUS

	Egemenlik Street	**Ad. Mend. Boulevard**	**Atatürk Boulevard**	**Muğla Highway**	**İzmir Highway**
Counts (peak)	376	1210	632	906,5	1318
Model's trips*	501	3535	1487	1120	2173
Counts mult.by capa. fact.(5 or 7)	1880	6050	3160	6342	9226
Adjust. Ratio to model trips**	**3,75**	**1,71**	**2,12**	**5,66**	**4,24**

*The arithmetic average of both directions on the link is taken. By "trips", daily vehicle volumes are meant where PCU factor is not added. The external trips are also inherent in these figures.

**These adjustment factors are special to the link

In case, these simple calibration factors found above can be applied either to the simulation results at will to check whether the capacity is overloaded or not. It is expected that the LOS levels will be much worse when these factors are applied.

4.7.6. The Capacity Constraint

Defining the maximum capacities is also one of the toughest tasks and also requires a set of assumptions within the limits of this study to go on the work. To make the planning analyses, and for the completion of whole planning process, we must make sure that the links are not overloaded. If the links are guaranteed for easy flow of traffic (ie, LOS levels of A, B, C, and hardly D), this will allow the model work with no consideration of congestion.

First of all, the true capacity values are found for the streets where screen line counts are made. Then, with the analogy to other streets that resemble in physical characteristics to the screen line streets, the same capacity assignments are assumed for all other links. By the physical characteristics, it was basically meant the relative quality of the road, the function (highway, arterial, local distributor or street) of the road and the number of lanes per direction. Thus, the capacity definition for a particular link is decided on the basis of the type of the link. That also adapts well to the 'Link Type' parameter of TRANUS and its requirements. Small local streets (sokak) are not considered among the links. The information about number of lanes on the considered roads and streets are obtained from the Master Plans and verified by the personal field observations. Thus, as mentioned earlier, we had basically three type of streets. These three types were analogous to the screen line streets.

It was described earlier that the capacities had been found on the basis of Five-minute counts for the peak hour, of which the highest values are taken and multiplied by 12 to find the capacity hourly (maximum flow rate). The results can be assumed as the observed capacities. This was not very healthy but would be quite approximate to reality. However, the daily capacities are also calculated.

Table 22. The PCU Equivalents

vehicle type	PCU equivalent
car/minibus/taxi	1
transit minibus	1,2
lorry/pickup	1,5
bus	1,5
bike/motorcycle	0,3
others	1,1

Source: T.C. Directorate of Highways, McShane & Roess 1990, p.398

The method of finding the maximum capacity was set as multiplying the results by peak hour factor, which had been defined as 0,9. In Table 23, vehicle counts with and without PCUs are given in a summarized form for the screen line streets. PCU rates are also provided in that table. In Table 24, maximum capacities together with the v/c ratio for the peak hour are provided. Finally, in Table 25, daily capacities are presented by integrating the daily volume conversion factors. When maximum approach volume is around 2000 pcphpl for three lane (40") roads, and when load factor is 0,7 (around LOS D), usually, the conversion factor from peak hour to daily values can vary between 12 and 20 per cent (Pignataro 1973). If, however, urban arterials with no access control and signalization on the intersections, which are the usual case for Aydın's streets, are also affected by these constraints and the daily conversion factor can be between 8 and 12% (AASHTO 1984, p.54). But, this standard is for the urban areas in the U.S. and therefore, maximum rate adopted in this study is relaxed to 20%.

Table 23. Actual and PCU-standardized Vehicle Counts for The Screen Line Streets for Peak Hour

vehicle counts (average for two dir's)			**factor**	**(PEAK HOUR)**
streets	with PCU	with no PCU	**PCU/obs. veh**	PCU factor
Egem.	436	374	1,17	0,17
Ad.Mend	1285	1210	1,06	0,06
Atat	714	633	1,13	0,13
Mugla Y.	1135	907	1,25	0,25
İzm. Y.	1725	1319	1,31	0,31

Table 24. Observed Capacity and the Verified Capacity for the Peak Hour

Streets	OBS.capacity	max. Cap	**CAPACITY**	v/c ratio
Egem.	750	833	850	0,51
Ad.Mend	2500	2778	2800	0,46
Atat	1100	1222	1250	0,57
Mugla Y.	2400	2667	2700	0,42
İzm. Y.	3200	3556	3600	0,48

Table 25. Daily Capacities of the Screen Line Streets with the Daily Conversion Factors

Streets	daily counts	daily conv. fact	max. capac.
Egem.	2180	0,2	4250
Ad.Mend	6425	0,2	14000
Atat	3570	0,2	6250
Mugla Y.	3914	0,29	9310
İzm. Y.	13800	0,125	28800

When checked from the v/c ratios in the Table 24, it practically looks like the traffic flow in those streets are barely below C of LOS even at peak hours, the most critical being Egemenlik Boulevard. Finally, three types of links, with the observed screen line streets, are assigned those capacity values per direction as shown in Table 26 (the values are truncated leaving room for some maximum).

4.8. The Comparison of Two Models

4.8.1. On the Differences Between the Models

It is the very essence of the thesis study to see what sort of differences might be confronted by comparing the model for conventional and the model for disadvantaged and what they do mean in terms of policy-making. One way of expressing the effect of the difference may both be in terms of the coefficients placed before the variables or calibration parameters testified or the differences in the final results themselves, what may be called "structural differences". Mostly the differences in total outcome (ie, structural) will be the concern in this study.

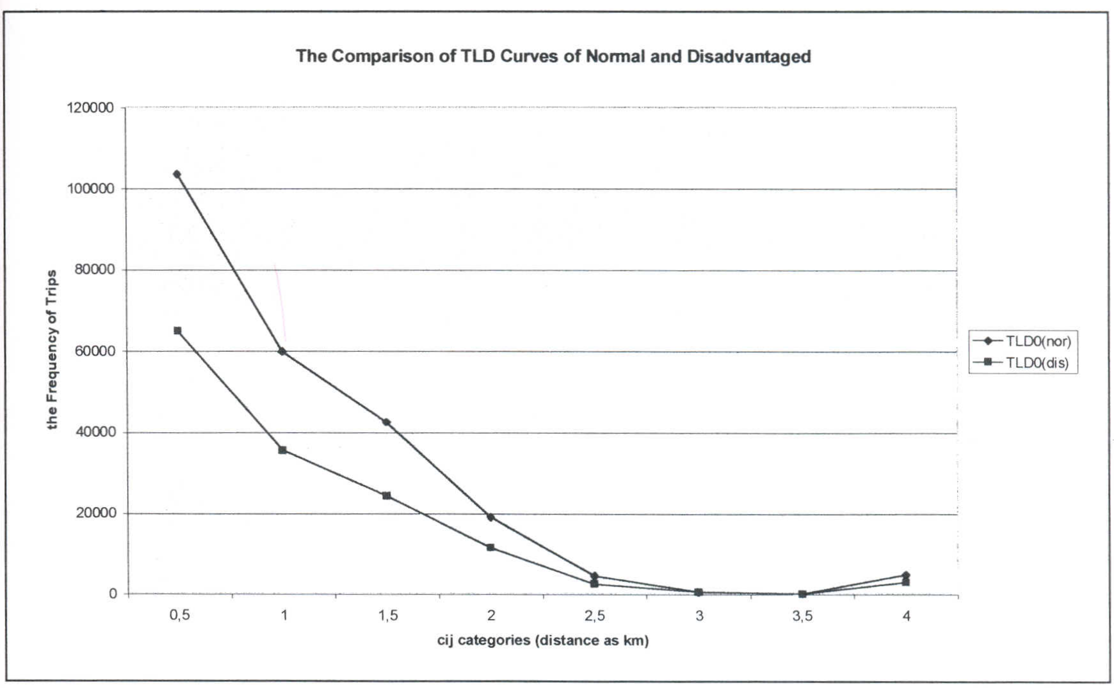

Figure 35. TLD curves of Normal and Disadvantaged Models

Table 26. Final Capacity Values of the Links to be Assigned on TRANUS

Links	**Hourly Capac**	**Daily Capac**	**Volume (daily)**	**Obser'd Peak**
Izmir Hway	4000	**28000**	14000	1725
Denizli Hway	4000	**28000**	11000	Less than 1725
Ad. Mend Bl.	3000	**15000**	65000	1285
Muğla Hway	2800	**19600**	4000	1135
Egemenlik Bl.	1000 (or, 850)	**5000**	2200	436
Other Blvards	1500	**7500**	1000	714 (Atatürk Blv)
Streets in general	800	**4000**	Less than 500	
Walkways		**10 (assumed)**		

Yet, the vital differences appear in the calibration values (α or β, etc.) that simply means the difference that comes from the data facts (yet, still the error and unknown factors not included in). Parametric differences were slight as in the Beta values of Trip distributions for Normal and the disadvantaged (See Figure 35). But the curve patterns are the same. Hence, the calibration differences appeared almost the same for both models[4].

In the case of parametric difference, consider two different β values for both Normal and Disadvantaged, then, it would mean:

β^{dis} and β^{norm} seriously exist.

Therefore, the short-cut estimation of the trip distribution values for the disadvantaged could be plausible, if both T_{ij} for Normality and the β^{dis} are known. β^{dis} should then be integrated in the right place in the Trip Distribution model. When necessary, had a significant difference between calibration values of both Normality and for disadvantaged been observed, β coefficient for either disadvantaged and the calibration differential $\Delta\beta$ could be found from the Gravity type Trip Distribution Model:

$$T_{ij} = \alpha A_i O_i B_j D_j (d)^{-\beta}$$

If α is ignored for the time being (or assumed to be 1), and,

$(A_i O_i B_j D_j) = U$ as reduced into one single representation

Although Normality is the sum of both advantaged and disadvantaged (N = adv + disadv), this rule do not hold true for the β calibration parameters. Since it might even be true that $\beta_{dis} \geq \beta$ (normal), and sign of $\pm\Delta\beta$ changes, then, $\beta_{dis}=(1\pm\Delta\beta)x\beta$

[4] For example, in Trip Distribution calculations, taking distance solely as $f(c_{ij})$ instead of travel time would be less efficient to represent the reality and much sharper distance decay differences between both categories.

and the "differential ratio of disadvantagedness" $\Delta\beta = 1 \pm (\beta_{dis}/\beta)$ must be accepted and the formulation can be for the awareness of the factor of disadvantaged:

$$T_{ij} = U\ (d)^{-((1\pm\Delta\beta)\ /\ \beta_{dis})} = U\ (d)^{-\beta}$$

$$\text{Log } T_{ij} = \text{Log (U)} - \ \beta \text{ Log (d)} = \text{Log (U)} - (\beta_{dis}/(\Delta\beta\pm1)) \text{ Log (d)}$$

$$\text{Log } T_{ij} - \text{Log (U)} = - \ \beta \text{ Log (d)}$$

$$\beta = \ \beta_{dis} / (\Delta\beta\pm1) = (\text{Log (U)} - \text{Log } T_{ij}) / \text{Log (d)}$$

To shorten the equation: if $[(\text{Log (U)} - \text{Log } T_{ij}) / \text{Log (d)}] = J$

To find only $\Delta\beta$ (which can be now assumed to be ratio of βs);

$$\Delta\beta = (\beta_{dis} / J), \text{ or,}$$

$$\Delta\beta = (\beta_{dis} / [(\text{Log (U)} - \text{Log } T_{ij}) / \text{Log (d)}]\ )$$

Or, to find only β_{dis} if demanded and if only $\Delta\beta$ and T_{ij} for Normal are known;

$$\beta_{dis} = \Delta\beta \times J$$

If all the content of U is inserted in the formula, then;

$$\Delta\beta = \beta_{dis} / [(\text{Log}(A_i) + \text{Log}(O_i) + \text{Log}(B_j) + \text{Log}(D_j) - \text{Log } T_{ij}) / \text{Log (d)}]$$

However, when there are the number of data (observations), this general formula, that could be used for single (average) values, is to be applied as (Atalık 1996, pp.120-1):

$$\beta = n \sum \text{Log(d)Log}(T_{ij}) - \sum\text{Log(d)} \sum\text{Log}(T_{ij}) / n \sum (\text{Log(d)})^2 - (\sum\text{Log(d)})^2$$

The β_{dis} and $\Delta\beta$ values can be found in the similar fashion as defined above.

In the case U is to be found from this:

$$Log(U) = \sum Log(T_{ij}) - \beta \sum Log(d) / n \qquad \text{, or,}$$

$$\overline{Log(U)} = \overline{Log(Tij)} - \beta\ \overline{Log(d)} \qquad \text{(ie, the insertion of the Mean values)}$$

This conversion is still partial: A_i and B_j (or a common A_i value) can further be integrated to the model in the same fashion, whose formula reversion does not require logarithmic calculation.

Likely, if both T_{ij} (ie, for Normal) and $T^{dis}{}_{ij}$ (for disadvantaged) are known, that are already found in this thesis work, an overall (or, let say 'mean') β^{dis} or A_i value can be found by reverting the formula (Logarithmic calculations of the parameters).

Here, for simplicity, instead of parametric difference, rather a heuristic method is offered, which may not provide the perfect results but rather approximate to obtain a general coefficient of disadvantagedness:

$$T_i \cdot \frac{T^{dis}{}_i}{T_i} \longrightarrow T_{ij} \cdot \frac{T^{dis}{}_{ij}}{T_{ij}} \longrightarrow T_{ijk} \cdot \frac{T^{dis}{}_{ijk}}{T_{ijk}} \longrightarrow T_{ijkn} \cdot \frac{T^{dis}{}_{ijkn}}{T_{ijkn}}$$

As can be seen in the depiction above, the disadvantagedness proportion obtained at each transportation planning stage can be applied as the "structural" Dx only at its specific place. Better, only the cumulative results at Mode Split or even Traffic Assignment can be regarded, if we already know D_{ijk} ratios, because each stage bears the cumulative results of the preceding one. For example, in this study, the Mode Split stage will be the focus stage to find a "disadvantagedness ratio" (ie, D_{ijk}), which is actually not different than D_{ij}, for both public and private trips but different in parametric terms. In this formulation, it is only needed to know results for disadvantaged for a case study (eg, Aydın's). The proportions obtained can be applied to other similar cases.

It should be tested whether multiplying the disadvantagedness proportions by the Normal's results will really give the closer values to that of the disadvantaged ones, say, for each matrix cells of Trip Distribution stage. For example, the overall disadvantagedness proportion had been found 0,63 (call it D_{ij}-Factor). Let us see whether the values in each cell of factor-multiplied Normal distributions get closer to the values for disadvantaged when we apply this factor over the trip distributions. It is observed that the values in individual cells do not get closer as so much expected. It is tested that overall error margin (or, variance) between the T_{ij} of Normal and that of the disadvantaged can be fruitful. Yet, relying on individual cell results would still be unhealthy. But, the results were much better than D_{ij}-Factor multiplied Results: Individual cell results were much closer to the real cell results of Disadvantaged.

This is especially useful in the absence of data of disadvantaged at all at Trip Distribution stage (ie, trip distributions of disadvantaged) but only the total number of trips (that can be figured from the ratio of disadvantagedness). If there is only the knowledge of which zones are likely to be disadvantaged and the total numbers of trips of both Normal and Disadvantaged, we can obtain an approximate Tij values for disadvantaged. A specific adjustment factor χ (error margin between the Tij of Normal and disadvantaged) must be known (it can be of previous study or imported) and be added to the formula that can be applied to each cell of the trip distribution matrix:

$$T_{\chi\ ij}^{dis} = T^{nor}_{ij} \cdot (1-\chi R)$$

R = -1, if the zone is not disad'd
R = 1, if the zone is disadv'd

Where, $0<\chi<1$ is assumed

$T_{\chi\ ij}^{dis}$ is an approximation in the iteration and can be added or subtracted to the former T^{dis}_{ij} values found (ie, the process may be iterative) according to its sign. The sign is the outcome of whether the zone or zone-pairs are disadvantaged (ie, whether the trips of disadvantaged in the cell are more, or less, than that of Normal. In the case of zone-pairs (ie, being disadvantaged from both O_i and D_j), a higher χ value can be applied to the cell. On the other hand, if the zone is *relatively* advantaged, the sign (R) must be the reverse (-1). For a much elastic formulation, the algorithm must be further developed. Hence, some other formulations can be invented where a mean χ is to be integrated in different forms. This parametric value can be derived from the error margin mentioned above in the form of $\pm\chi$ according to the direction of the error (if minus, then χ can be -, or vice versa). However, If the trip distributions of disadvantaged are not known, then the signs for each cell can not be known exactly. Instead, the sign can be guessed by knowing which zones and zone-pairs might be disadvantaged and advantaged: 1 will be assigned to those disadvantaged and –1 to the advantaged. This way the values in the individual zone pairs (cells) will get much closer to the reality of disadvantaged. Such integration also helps in finding a special value of χ_{ij} for each cell when necessary. Such adjustment factor can either be used in the calculation of future disadvantaged trips (if assumed these factors stay constant in time!). The same idea can similarly be developed for other parameter calibrations. However, an overall (mean) value for χ should be concluded (calibrated) from the real data, or, an assumptive increment value can be introduced at the beginning at will.

Finally, the convergence whether total trips are becoming equal should be checked:

$$\sum T_{ij}^{\ nor} = \sum T_{\chi}{}^{dis}{}_{ij}$$

If not, then some fine tuning can be possible by the rate $(\sum T_{\chi}{}^{dis}{}_{ij} / \sum T_{ij}^{\ nor})$.

Yet, after the adjustment, it cannot be checked whether the individual cell results get away from the reality or not. This is the weakness of the method. Therefore, it is advised not to iterate the process more than 2 or 3 times. But, in this case, the Tij results may not be so appropriate.

Again, for the Split Mode Stage, the same logic can be furthered:

$$T_{\chi}{}^{dis}{}_{ij(priv)} = T^{nor}{}_{ij(priv)} \cdot (1-\chi_{(priv)} R) \quad \text{,and,}$$

The results will not be so healthy, but, when there is not the data of disadvantaged at the Mode Split stage, this is the best one can do in getting some raw information about the mode split results of disadvantaged. If we do not know the Trip Distribution results, the formula may alternatively become:

$$T^{dis}_{ij\ (priv)} = D_{(priv)} \cdot T^{dis}_{ij}$$

$$T_{\chi}{}^{dis}{}_{ij(priv)} = T^{nor}{}_{ij(priv)} \bullet (1-\chi_{(priv)} R)$$

Where, $D_{(priv)}$ is the disadvantagedness ratio if known (which is the parametric factor multiplied by the population factor)

The same process can be applied to the public trips. Second and third iterations may be necessary until the convergence of the total trips (therefore, the total trips or the ratios must always be known) is maintained. Another weakness of this algorithm is that the signs actually may change while iterating. And, there is no way of knowing the change in the signs. If there is the way of knowing the change of the signs (R=1 or –1), the results out of the process would be very accurate.

Consequently, the nature of disadvantaged-specific rates must look like the friction (or, impedance) coefficient(s) of disadvantagedness that is/are usually used in the trip distribution stage. It is conceptualized that it is sufficient to configure the total (structural) difference (D_X) in the outcome of the two models, whatever the stage is, and since the population factor is already known, the difference between the structural difference and the population factor will yield the parametric difference that we may not have to know what it is.

While friction values usually represent the distance decay effect, the disadvantaged-specific rates in our model would be to represent the friction effect of being in a disadvantaged position. Policy-off differential rates between the Normal and disadvantaged could be calculated at different stages of planning (See consecutive

Tables 27, 28 and 29). The stage of Traffic Assignment is ignored because it does not provide zone-to-zone matrix information but links only.

Table 27. Difference Between the Normality and Disadvantaged at the Trip Productions Stage ("Structural" Difference)

Zones	oi (normal)	oi (disad)	Difference	Rate (D)
1	23034,82	15039,27	7995,54	0,65
2	17157,66	15111,27	2046,39	0,88
3	14655,58	6622,48	8033,11	0,45
4	19700,95	14416,47	5284,48	0,73
5	26131,79	16246,59	9885,19	0,62
6	29066,78	16986,42	12080,36	0,58
7	24856,11	16486,99	8369,11	0,66
8	17300,67	15766,85	1533,82	0,91
9	12957,94	7584,02	5373,92	0,59
10	20879,85	6382,86	14496,98	0,31
11	12696,03	7449,92	5246,11	0,59
12	15813,71	9055,90	6757,80	0,57
SUM	**234251,88**	**147149,06**	**87102,82**	**0,63**

Table 29. Summary (Structural) Differences Between Normal and Disadvantaged (Mode Split Differences)

Categories	Public Trips	Private Trips	Total		Ratio of Public	Ratio of Private	Ratio to General		
							Pub.	Priv	Al
Advantaged	43916	13022	56938		0,77	0,23	0,28	0,08	**0,3**
Disadvantaged	98530	2282	100812		0,98	0,02	0,62	0,014	**0,6**
Normal (total)	142446	15304	157750		0,90	0,10			
Ratio of Disad.	0,69	0,15							
Ratio of Dis/Tot	0,62	0,014	**0,64**						

Table 28. Attraction Level (Aj) Differences at Trip Distributions Stage

Differences at Attractions

ZONES	Ai(norm)	Ai(dis)	Absolute Difference	Rate of Differ.
1	0,02	0,026	-0,006	-0,3
2	0,05	0,053	-0,003	-0,06
3	0,1	0,08	0,02	0,2
4	0,17	0,17	0	0
5	0,08	0,062	0,018	0,225
6	0,11	0,105	0,005	0,045454545
7	0,08	0,093	-0,013	-0,1625
8	0,06	0,085	-0,025	-0,416666667
9	0,08	0,081	-0,001	-0,0125
10	0,04	0,042	-0,002	-0,05
11	0,08	0,093	-0,013	-0,1625
12	0,12	0,107	0,013	0,108333333
SUM	0,99	0,997	-0,007	-0,585378788
average	**0,0825**	**0,0831**	**-0,00058**	**-0,0487816**
			~%0	**~%5**

Table 30. Zone-to-Zone Disadvantagedness Proportions (Dx) at the Mode Split Stage for the Private and Public Modes

RATES of DISADVANTAGEDNESS AMONG **PUBLIC TRIPS**

zones	1	2	3	4	5	6	7	8	9	10	11	12	Oi
1		0,54	0,82	0,54	0,93	0,71	0,70	0,70	0,93	0,95	0,86	0,24	**0,70**
2	0,94		0,94	0,90	0,82	0,51	0,68	0,75	0,82	0,97	0,94	0,84	**0,84**
3	0,62	0,78		0,98	0,09	0,09	0,94	0,17	0,54	0,17	0,30	0,62	**0,61**
4	0,73	0,97	0,70		0,51	0,98	0,67	0,74	0,58	0,82	0,81	0,82	**0,77**
5	0,95	0,88	0,15	0,62		0,65	0,97	0,56	0,48	0,15	0,71	0,68	**0,68**
6	0,91	0,15	0,96	0,85	0,75		0,96	0,66	0,42	0,92	0,92	0,80	**0,79**
7	0,65	0,11	0,74	0,79	0,59	0,89		0,67	0,92	0,59	0,83	0,75	**0,75**
8	0,93	0,72	0,65	0,65	0,97	0,96	0,98		0,97	0,97	0,98	0,97	**0,90**
9	0,62	0,90	0,45	0,29	0,63	0,62	0,95	0,63		0,95	0,18	0,63	**0,58**
10	0,65	0,20	0,25	0,28	0,58	0,40	0,11	0,65	0,11		0,36	0,51	**0,34**
11	0,70	0,93	0,05	0,71	0,65	0,10	0,25	0,93	0,93	0,93		0,56	**0,57**
12	0,93	0,93	0,15	0,74	0,65	0,98	0,15	0,71	0,48	0,88	0,73		**0,70**
Dj	**0,72**	**0,59**	**0,49**	**0,61**	**0,60**	**0,57**	**0,61**	**0,60**	**0,60**	**0,69**	**0,63**	**0,62**	8,22
													0,69

Table 30 (Cont'd). Zone-to-Zone Disadvantagedness Proportions (Dx) at the Mode Split Stage for the Private and Public Modes

RATES of DISADVANTAGEDNESS AMONG **PRIVATE TRIPS**

zones	1	2	3	4	5	6	7	8	9	10	11	12	Oi
1		0,08	0,25	0,10	0,52	0,19	0,17	0,15	0,52	0,62	0,36	0,03	**0,17**
2	0,55		0,56	0,37	0,25	0,08	0,15	0,18	0,26	0,72	0,54	0,27	**0,30**
3	0,08	0,21		0,78	0,01	0,01	0,60	0,01	0,08	0,01	0,03	0,08	**0,12**
4	0,20	0,69	0,16		0,07	0,80	0,15	0,18	0,09	0,29	0,24	0,22	**0,20**
5	0,63	0,37	0,01	0,10		0,12	0,74	0,10	0,07	0,01	0,16	0,12	**0,13**
6	0,50	0,01	0,65	0,34	0,17		0,64	0,15	0,05	0,50	0,50	0,24	**0,24**
7	0,13	0,01	0,21	0,24	0,10	0,40		0,10	0,44	0,10	0,25	0,18	**0,19**
8	0,57	0,14	0,14	0,14	0,68	0,63	0,75		0,74	0,70	0,77	0,70	**0,43**
9	0,15	0,43	0,05	0,03	0,08	0,09	0,59	0,08		0,60	0,01	0,14	**0,09**
10	0,12	0,02	0,02	0,03	0,10	0,06	0,01	0,12	0,01		0,03	0,06	**0,04**
11	0,14	0,53	0,00	0,15	0,12	0,01	0,03	0,53	0,53	0,42		0,06	**0,09**
12	0,53	0,53	0,01	0,15	0,11	0,76	0,01	0,18	0,06	0,33	0,12		**0,13**
Dj	**0,30**	**0,25**	**0,17**	**0,20**	**0,19**	**0,26**	**0,32**	**0,15**	**0,24**	**0,36**	**0,25**	**0,18**	**2,14**
													0,18

As seen in the Table 29, the cumulative (average) value of D_{ijk} found for the Mode Split Differences is about %64; this is %36 for advantaged and %76 for the disadvantaged. More specialized rates such as rates of public and disadvantaged trips to all, or, private and normal trips to all (all yellow colored) can be observed in the Table 29. It should be noted that since the number of disadvantaged trips is greater in general, sometimes also the private trips of disadvantaged *seem illusively* greater than the private trips of advantaged in the T_{ijk} cells. The Policy-off zone-to-zone differences are calculated and the Table 30 summarizes the final outcome. At the table, those blue colored cells represent highly disadvantaged zone-pairs and those orange colored represent relatively better zone-pairs.

4.8.2. Reflection of the Model parameters to the TRANUS Parameters

The parametric values inputted in the 'ideal' model have to be converted to the parametric scales of the TRANUS. Additionally, there are also the parameters in TRANUS that are not contained in the model but that have to be entered. These parameters are deemed redundant and kept as they are defined as default, or, after consulted to the distributor agency of TRANUS, they are given some symbolic values, which have to be **the same** constants for both normal and disadvantaged model runs.

Below are the major parameters as converted to "TRANUS values" for both model runs. The consulted values are usually the same for both runs and they are marked in *italic* letters within paranthesis for the sameness. If the model values are converted to TRANUS values, these are shown in **bold** letters and also the real value used in the model is explained next to the word "model ="; if one value is different for Normal model run, it will be "Nmodel ="; if different for disadvantaged, it will be "Dmodel =", and for Advantaged "Amodel =" etc.. The same procedure applies for the public and private modes specifically:

Value of Travel Time: Nmodel = *120*   Dmodel = *90*   Amodel = *200*

This method is consulted to TRANUS for the calculation of the parameter: The most frequently applied method is that the value of travel time can approximately be found on the basis of the hourly income of a person and taking the one fourth of this income. This applied to the average value of person based income ('INC.PER') data. The values in terms of TL (,000 is extracted) found are rounded for simplicity.

Value of Wait Time: Nmodel = *200* Dmodel = 15*0* Amodel = 4*00*

In the similar fashion, on the basis of hourly income of a person, the 40% of the income are taken to find the values.

% Vehicle Availability: Nmodel = *0,09* Dmodel = *0,04* Amodel = *0,27*

These values are the average car ownership per family observed for each data category

Min. Trip Generation Rate: Nmodel = 1,*72* Dmodel = 1,*62* Amodel = 1,*9*

The rate for the "regular" (work/school) trips is assumed to be the minimum trip rate for a person.

Max. Trip Generation Rate: Nmodel = 3,*16* Dmodel = *3* Amodel = *3,5*

The maximum trip rate is assumed to be total of both regular and social trips. Thus, the social trip rates per person are added to the regular trip rates at each category.

Demand Elasticity: (*0,06*)

Modal Split Elasticity: (*1,6*)

Path Choice: (*2,6*)

Path Overlapping Factor: public = (*1,6)* private = (*1)*

Max. Number of Paths: public = *(5)* private = *(3)*

Modal Constant: public = (***1,6***) Nmodel = 0,35-0,40 private = 1 pedest = 3

This parameter represents the modal choice utility. For the Mode Split stage, it was already found to be a probability value around 0,38 for the choice of public mode and it was assumed to be the same for both model runs. The best mode should be assigned as 1, and the worse (which may be assumed here as pedestrian) is 3.

Time Factor: public = (16) private = (20) pedestr = (20)

Time Factor means how long the operator type operates in a day in terms of the number of hours.

Distance Tariff: public = (0) private = (30) pedestr = (5)

Distance tariff means the extra out-of-pocket cost onto the travel cost paid to overrun the distance. It is assumed zero for public mode since the user already pays the fare. A symbolic value (which is the same for normal and disadvantaged model runs) of 30 TL is considered for the private mode. Relatively, the pedestrians must be paying around a symbolic distance cost of 5 TL, since motorbikes are included in the category of pedestrians.

Min. Wait Time: public = (**0,05**) private = (**0**)

Minimum wait time at the bus stop is the percentage of duration (minutes) to an hour. If the minimum waiting time is assumed to be around 3 minutes, that may be corresponding to 5% of an hour (60 minutes).

Constant Operation Cost: private = (50)

Operation cost is the cost paid by the user for the travel. It is valid usually for the private modes (since there is not tariff cost for them as in public). For public mode, it is not necessary. **The % of cost paid by user** is symbolically defined as (%80) for private. It is expressed in terms of the percentage of the total cost.

Frequency: (20 - 30)

Frequency of the transit service is determined as the number of service available at the stop in one hour. Since the frequency of transit operation in Aydın is defined to be 2-2,5 minutes in general, this corresponds to 20-30 in an hour.

Target Occupation: (*50%*)

As consulted to the TRANUS agency, the acceptable target occupation rate in average during the day can range between 50-60 %. This may even be over 100% in peak times.

Capacity Factor: street = (5) boulevard = (5) highway = (7)

It was already found that the hourly capacities entered in TRANUS could be turned into the daily capacities when multiplied by a coefficient factor, 5, for both street and boulevard type links. And, it is 7 for highway type links.

% Speed Reduction when v/c=1: street = (*60*) boulv. = (*60*) Highw.= (*60*)

It is advised by TRANUS that, for such mid-size cities, theoretically, the percentage in speed reduction when congestion occurs approaches to 60%.

v/c max. reduction: street = (105%) boulev. = (110%) Highw. = (115%)

When the traffic nearly stops (zero speed) the v/c ratio must be over 100% (usually assumed to be between 100 and 120%). A lower value for street, a medium value for boulevard, and a higher value for highway type of links are assigned.

Speed: in km

	Street	**boulevard**	**highway**
Public	(40)	(50)	(60)
Private	(40)	(50)	(60)
pedestr	(5)	(5)	(5)

Penalization: assumed to be (1) for all

Equivalent Vehicles: public = (1,3) private = (1)

Overlap Factor: street = (*1,6*) boulev. = (*1,1*) highw.= (*0,7*)

It is advised to express the importance of the link type by assigning lower value towards zero for main arteries, and, towards 2 for local streets.

Although the parametric values are hold constant for both Normal and disadvantaged for the base year model runs, not to cause changes in results due to parametric changes, most of the relevant ones have become the parameters where changes are made in the simulation runs. These changes can be checked at policy formulations in the simulations. As of principle of this study that bases on the Dx (Differences between normal and disadvantaged) results, all changes ought not to exceed 50%, or so in average, of the original parametric value.

Chapter 5

EQUALIZATION PROCESS

5.1. Theoretical Basis for Equalization Process

5.1.1. On Equity and Equality

The modelling described in this study is equity-based, and a normative approach. Thus, the principles of equity should be introduced beforehand. The problem, at this point, turns out to be "how" to equate those disadvantaged groups to the Normality (or, average) without seriously depriving the advantaged in principle. The evaluation stage welcomes any effort towards amelioration in virtual reality (simulations). Yet, it is acknowledged that the situation of disadvantaged and supplying the equity is much more complicate matter in real life than the virtual reality. To supply equity, first of all, the basics of equity must be well recognized, that is the know-how part. Thus, before the policy analysis, the basics of equity will be briefly and clearly introduced without going into the details. Second, who is going to be the subject of equity treatment will be defined. And, third, establishing the measurement method for judging equity is an important issue, which is the most difficult one (Sharp 1990, p.131, Mandell 1991, p.467-8).

Who is going to be subject of equity, which are in total labelled as the "disadvantaged" is already analyzed in this study previously in the theoretical part (Chapter 2). In the Matching Process in the coming section, which socio-economic and demographic groups are meant to be "disadvantaged" will be determined. For the measurability problem, actually the whole thesis study serves to define a measure telling whether equity is maintained (totally or partially), or not.

The classical method of Gini coefficient is a measure of equity, based on Lorenz Curve satisfying the principle of transfers especially between the better-off and worse-off. It uses the area between Lorenz curve and the diagonal line of equality (45°) as the guiding reference for measuring the inequities[1]. It assumes the average absolute deviations from the mean as the measure of inequity that when partial transfers are made towards the worse-off group, the coefficient approaches to 0 (zero), which means the improvement. As another approach, similarly, “perceived net envy level” developed by Sen (1973) (quoted in Mandell 1991, p.469) is based on measuring the degree of envy of the worse-off group on the better-off group as the unit of equity. This is rather related to perceptions and measured by frequent interview surveys. Lorenz Curve and Gini index used in the determination of the area of inequities are criticized by Mandell, on a case study of public library, that it is arbitrary and hard to interpret especially for what it means and what to do with it (Mandell 1991). It provides information but does not provide a quantifiable measure (Atalık 1996, p.56-7). Besides, the principle of transfers (ie, the Robin-Hoodish taking from rich and giving to poor) may not be satisfied as a condition all the time.

As known, the measure in our study, resembling to the logic of Lorenz Curve in principle, is described as the “present difference” between the disadvantaged and Normality, or between the existing situation and the ideality (See the Model’s Logic at Chapter 4). Where ideality (ie, the state of Normality) is achieved, it can be said equity is *totally* maintained. If this requirement is not totally met, then the equity is still supplied but *partially,* which can be represented simply as in the Figure 36.

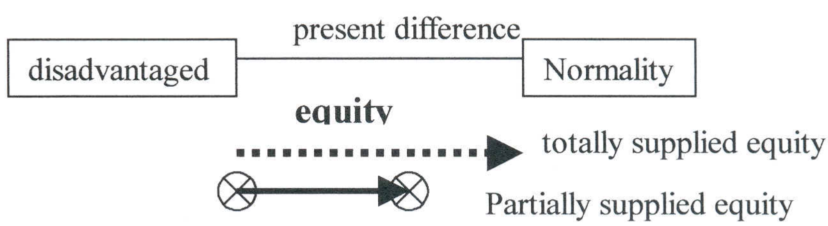

Figure 36. Difference Between Disadvantaged and Normality As the Measure of Equity

Equity is the search of equality, or the struggle to equate. It is not a static term like equality that represents the ideal state, but a thrive to reach that ideality. That is,

[1] For simpler explanation, especially refer to G. Atalık’s “Uygulamalı İstatistik” (1996), in the

therefore, any partial equity should be welcome. Equity also differs from the term "equality" in that while former represents the equation on the basis of deserve just at the process itself, latter represents the equation on the basis of sameness at the initial input or final output (Sharp 1990, p.131, Savas 1979, pp.146-7). There is still major debate over "the equality of inputs versus equality of outputs". Sharp, however, signifies further six different types of equity according to which equity standards may vary: strict equality, need, effort expended (ie, getting involved in the activity), money invested (also called "market" equity[2]), results and ascription. Before, different equity types had been defined (Symons 1971, p.60), most famous being three (Harvey 1973, p.100): according to need, contribution to common good, and according to merit. Yet, these equity types will not be examined in detail, here.

Although, it looks, the effort of the modelling here is to equate on the basis of sameness (trying to reach Normality), the final situations of two groups are hard to equate. Here, the equation effort is "how to" side of equality and the treatment of what disadvantaged more deserved than advantaged. The treatment should be in the form of search, effort and is about the process itself. Thus, such an effort can be said to be equity supply process. Consequently, it is our consent that the equality of final output seems more meaningful than the equality supplied at the beginning (input). Therefore, in this study, the equity principle of "equality of outputs" is adopted.

Besides, since the disadvantaged is the needy and we try for the improvement of this category, need type (or "according to need") of equity is also adopted as of the guiding principle in this study[3]. Yet, since it is argued that the redistributional effort is a function of resources available, and, thus, has many complications behind in practice, the issue of financial abilities to supply equity, which might be the efficiency side of the view, is appreciated but will be avoided for the consideration, here. In fact, small local governments that usually have to cope with the shortages of fiscal resources tend not

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determination of the area of inequity on the graph.

[2] This equity standard must be interpreted as "who pays more tax rather than who pays more" at which the money will be invested.

[3] See also the discussion in Harvey 1973, pp.98-118. One of the nine areas in planning where need type equity should be searched is transportation (p.102). It should also be noticed that need can be in terms of "felt" need, potential demand or real need.

to engage money spending for equity matters. The social control (Piven and Cloward's) thesis argues that this effort might be awaken where there is a real threat, or social disrupt, coming from the disadvantaged, or dissatisfied (Sharp 1990, p.35) that *must* shut these voices.

Besides the "neediness" condition, or, being less benefited from the transportation activities, the disadvantaged may even be harmed badly: In such a case, compensation in different terms may come into the agenda of policy measures. According to the 'judicial' approach, one of Thomson's assessment of project impacts on environment, "..[P]roblem may cease to be a problem if those adversely affected could be fully compensated." (1973, p.147). He immediately adds: "Motorists should not be permitted to pursue their own advantage at other people's expense and therefore, equitable case exists for subsidizing public transport out of motor taxation."

As mentioned, transportation service is a *distributional* one, at which local governments are expected to perform well, and which lies just at the heart of the equity matter. It is also because, as explained before in the ethical worries described in Chapter 2, transportation and accessibility is the basic requirement for a citizen to commit the urban community and life, sharing from the resources of it.

Transportation planning is not only about solving physical problems or enhancing the existing capacities, etc. but also about social justice. Actually, some authors perceived transportation problems as <u>social</u> problems rather than engineering (Webber 1982, p.62):

> "Those who don't have random-access capabilities will be increasingly disadvantaged, increasingly worse off over the course of time (..) relatively immobile, disconnected, and dissatisfied citizens."

According to Moriarty and Beed's findings in Melbourne (1991), as confirmed by OHIM results (1994), the most disadvantaged groups were determined to be women, the elderly and low income households who deprived mostly of the deterioration of public transport, and decline in the pedestrian friendly environment[4]. But, this view may quite differentiate in the developing societies. That is also to say disadvantagedness view is different in the Western Developed societies than in the developing, depending usually on the dispersed city structure resulting in inaccessibility problems. Interestingly, it was also stressed that, although car ownership has increased in time, the severity of being disadvantaged has also increased correlatedly. But, it is difficult to understand why those disadvantaged live in suburbs though these are the worst locations for the disadvantaged.

Another peculiarity of transport disadvantaged is found to be the lower trip rates than average and the dependency on public transport (Moriarty and Beed 1991, p.143). For providing equity, reducing private car travel, employing non-monetary measures such as restriction of car parking, priorities enabling public transport (frequency or alternative modes) and pedestrianism are proposed (1991, p.144), and probably a more urban coverage. Pricing and monetary measures are either suggested as a strong tool for equity (Webber 1982, p.61); mostly in the "Robin-Hoodish" manner, taking from private car owners and giving to the transit riders to subsidize the costs of public modes but mostly failed (NHS 1992, p.82).

The problem seen as access inequity in another Australian study (NHS 1992, p.58)[5] is related to the inequities of location and of being without a car or only one car. Most of the disadvantagedness was related to being inaccessible.

Yet, all these priority considerations and improvements for the disadvantaged will also mean cost upon local governments. The implications of the applications on general welfare should also be considered in reality.

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[4] The disadvantaged position of women is not evaluated as disadvantaged sub-category within the context of the thesis study because of their large representation among the population comprising almost half the population as a demographic group.

[5] The basic results of this study were provided in the Chapter 2, in the study defining presumed groups of disadvantaged (See Section 2.4.2.)

5.1.2. Definition of the Policies and Priorities

Policy measures can be among those general sets, which are both demand and supply type (Hayashi and Roy 1996, p.262):

-Regulation (bus priority, exclusive lanes, unleaded gasoline, land-use zoning, etc.)
-Taxation/Pricing (fuel tax, land-use tax, development charges, etc.)
-Investment (provision of road network, mass rapid transit, land development, etc.)
-Operation (transit operation, area traffic control, flexible work hours, etc.)
-Education (car pooling, ride share, using mass media)

To construct a pool of policies to choose from, alternatives in common practice have been conditionally in these traditional application forms such as: Building new or extension of the existing highways, or increasing capacity, signal solutions and changing the type of highway, relocation or channel of demand, restriction of demand (TDM), changing design speed limits, etc. Yet, there can be further policy areas to be invented. This invention process can be a system of policy-definition based on the correlated variables. This study is limited by the abilities provided in TRANUS software for defining the range of policy alternatives and manoeuvres.

Barra develops a method to explore policy range, which is particularly discussed for TRANUS, in a systematic and sequential way in order to find the optimum policy and make policy design process stand on a more firm basis (quoted in Hayashi and Roy, 1996, p.283):

- Explore a policy variable,
- Compare it to one or more objective variables,
- Simulate with repeated runs,
- Define "undefined" values, then find their optimum values, such as:
  (1) transit frequencies undefined
  (2) find the optimum values for transit frequencies from demand conditions

Conclusively, in a more holistic and strategic manner, the range of policy alternatives can be under those headlines as directly quoted from Richardson *et al* (1995, p.23):

- do nothing
- change transport technology

- construct new facilities
- change methods of operation
- substitute some other activity for transport
- change the regulations or legislation
- change pricing policies
- change public attitudes
- tackle the urban problems which cause transport problems

Of those, within the framework of the case study, compatible TRANUS package parameters can be the first five policy alternatives conveniently and also the one about changing the pricing policies (7^{th}). Here, it is assumed, we are free to propose any set or mix of alternatives since the study is a hypothetical one, and since there is no worry on any cost effectiveness of our alternatives (for the explanation, refer to the Section 1.2.3. Assumptions and Limitations at Chapter 1: Introduction). But, it is more likely that cost-effective measures and pricing policies for the users will take place as effective tools for the policy packages among the simulation steps.

However, impacts of those cost effective and pricing policies may be quite complicate and are not easily observable in the very short span of impact observation (Button 1995, p.40). Thus, the policy activity for pricing is better to be narrowed to specific observation fields. There are voluminous works in the literature about the pricing issue. Yet, generally the aim of pricing policies in the literature has been in the form of road pricing and reduced the congestion problem. Wealth distribution impact of pricing is employed but cautiously held since the results are still ambiguous. Whilst, there exists such a counter-argument for the example of wealth distribution impact of road pricing, which can be related here to the situation of economically disadvantaged in terms of the disadvantagedness due to the low income, summarized in a statement as: "..within car owning group (even) there are some who are not high income earners and society may wish to protect them from.. burdens.." (Button 1995, p.40).

It is worth to note the role of benefits from road pricing as outlined in three rules in the recent study of Goodwin's for each road space and the revenue obtained from the pricing (1995, p.151). Social issues include accessibility, impacts on different social groups, land values and other economic impacts (Kılınçaslan 1994, p.111). Here, more concern is devoted to the latter (social) set of indicators but in terms of physical travel conditions that actually relates to the former set of indicators (speed, travel time, capacity, fares, comfort, etc.). Such indicators will be checked to measure the effectiveness levels of policies at the end of this chapter.

From deontological viewpoint, Goodwin proposes "the rule of three" on the distribution of resources to the policy areas as a measure. Road space benefits are usually to reduce congestion and environmental damage, and the revenue benefits are more related to both improve the conditions of the street and provide equity. Thus, here, the revenues obtained should be spent according to "the rule of three" as such (Goodwin 1995, p.151):

- one-third must be expended to the very substantial environmental improvement and quality of roads (including pedestrian and non-transport uses),
- one-third must be expended to effectiveness of alternative modes, especially public modes, and bus priorities,
- one-third can be conceived as general tax revenue according to the priorities of the groups or localities (some may be increased, some may be reduced as compensation) to create "funds" for the disadvantaged, or, worsen the advantaged, alternatively[6].

In the thesis study, those three sorts of pricing evaluation will be kept in mind when formulating the policy scenarios. Here, the pricing is accepted as a demand management tool to equate the conditions between those advantaged and disadvantaged.

[6] Yet, according to Pareto Optimality principle, we should, at least, not worsen the situation of anybody. But, in the simulation game environment this principle may be ignored and advantaged may be worsened as in the form of heavy charges and penalties.

The point is, as set from the very beginning of the thesis, "try to get as close to the ideal as possible". This is all what can be done as a guiding objective in such a normative modelling approach, where there may lie about many uncertainties and ambiguities about real life. As pointed out, there is no one "good" way of policy analysis as a universal technique to apply in every case, but case specific try-and-error approaches (Morgan and Henrion, 1991, pp.36-7).

5.2. Correspondence Module (Category Analysis)

5.2.1. Introduction to the Technique Used

This module of modelling process will simply enable us to associate the various transportation (social) categories to the neediness levels via correlating to their disadvantagedness levels (scores). This is, in other words, a correlation process between the latent disadvantaged groups (ie, social classes or regions) and various disadvantagedness levels or conditions in order to define the suitable policy-making strategies. Who are the ones most likely (or, frequently) to cope with the disadvantageous positions? These are expressed in terms of percentages falling into different categories. Another advantage of this process is the ability to compare the groups by their disadvantagedness levels and associate these levels to their policy priorities. That is similar to the idea of multiplication of probabilities in the matrix format[7]:

[Disadvantagedness Percentages] x [Various Transp. Categories %]

$$P(x)\, P(y) = x \cap y$$

The method of defining the policies that would be relevant in the context of our study can be the listing of the variables that could be effective, and then trying to define the organic ties (mapping) to each other by means of the correlation matrix that

[7] The multiplication idea is also explained as the "Probability Tree" in The Cluster Filter Study in this Chapter.

was established before, although there is the risk of uncertainty in such analyses. That property that the correlation among the variables is especially useful in the determination of the area of policy identification and analysis has been known for a long time (Krueckeberg and Silvers 1974, p.136). This will provide us what variables are meaningfully correlated, thus, when one of them is altered or played, which others will be affected by this modification. However, in this study, although its use in measuring the degree of the effectiveness of one item (policy), there is no room to employ sensitivity analysis. Instead, the task will be done in a simple linear way, just deploying the chosen policies in the form of scenarios and examining their impacts. A laborous policy analysis may require a much extensive surveying, a try and error analysis with frequent and iterative refinement process as in the flowchart in Figure 37 proposed by Morgan and Henrion (1991, p.42).

The correlated variables will provide rough information about whom we will deploy our policies for. This knowledge is important because when we define the policies, we have to either know what variable is affected by what others, too. Even knowing the degree (or, strength) of correlation is useful in determining the "amount" (or, let say frequency) of the policy implementation. As known, "1" means strong correlation (which usually appears when the variable is correlated with itself) and "–1" means the strong negative correlation, that is, when the values of one variable increase the other's decrease just showing the inverse movement. If the correlation value approaches zero that means there exists no correlation. Especially, we should not trust the variable pairs presenting correlation values below 0.5 (or, -0.5).

But, the sole determination of correlated variables is not enough in the determination of the policy-making actors (elements). This will only provide us the playground (or effectiveness degree) and <u>knowledge of priority</u> for policy-making in a more scientific manner. That is the determination of presciption and rules when playing with the game of policy-making. Knowing the <u>degree</u> (amount) of policy application and the priority of policy (which policy to apply once) are other important considerations.

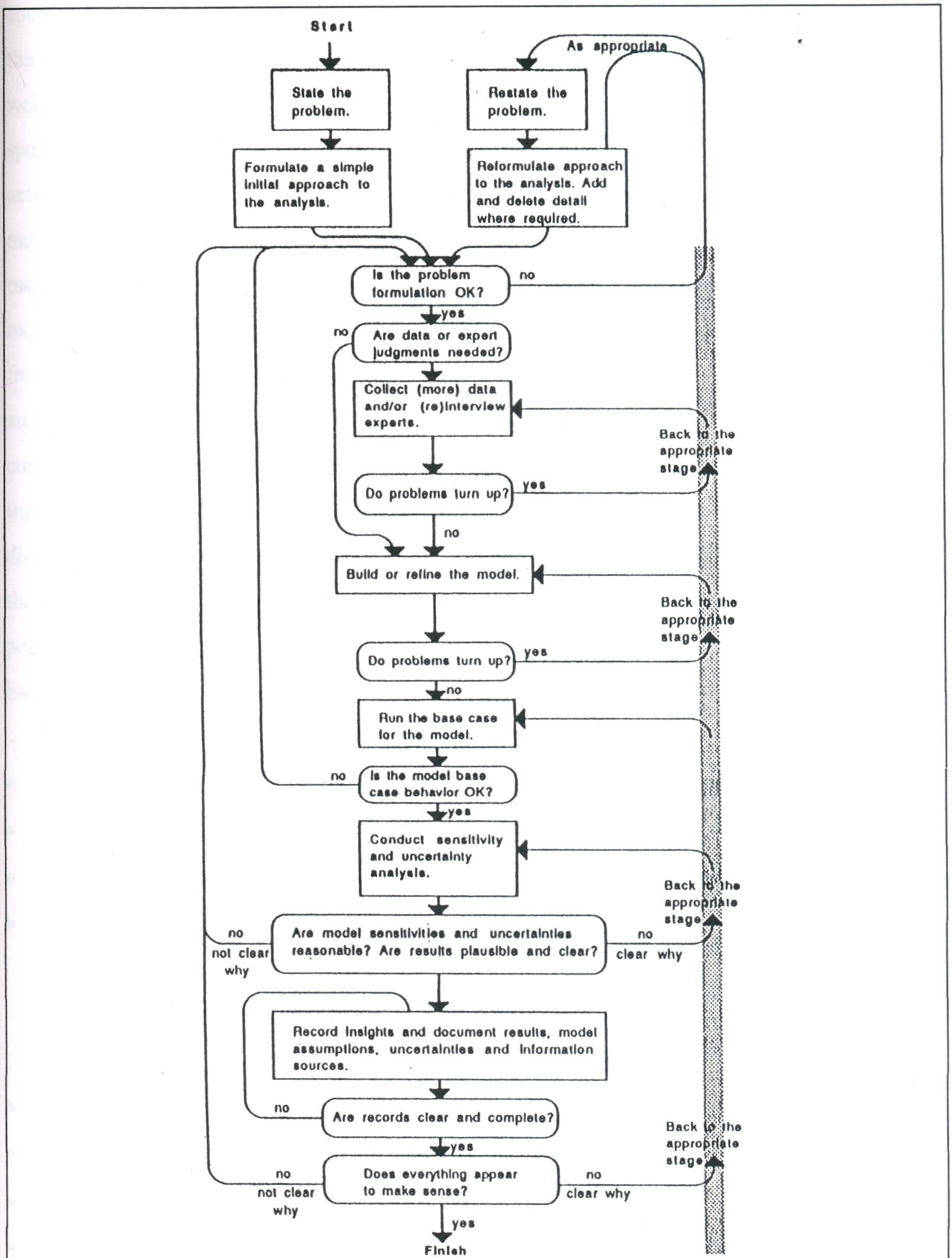


Figure 37. Good Policy Analysis in Iterative Refinement (Source: Morgan and Henrion 1991, p.42).

The correlated transportation categories can also be expressed in spatial terms such as the zones or transportation routes, etc., which would be more meaningful from the perspective of city planning. This module is especially useful in defining the weights, or the priorities of the equalization policies. That is to say, by this method, spatially it is easy to determine which districts are primarily in need of help or policy action (that is also the saying of "spatially who" is more disadvantaged) because there must be the priority treatment according to the sole criterion of need. Then, also the magnitude of the help is to be defined which is expressed here as "weight". Now it requires to employ the pre-defined transportation categories which can be transferred from the study done at Chapter: 2, Section: 2.4.2. Also, the disadvantageous positions and those who are exposed to them will be defined, which can be many, as the correlated variables but here will be limited number of important ones. Some transportation categories can be assumed to be disadvantaged from their self-disadvantageous conditions usually. There, the disadvantagedness is indigenous. But, the disadvantaged positions, however, unwillingly faced external conditions due to personal or external reasons. Thus, they are exogenous. The Transportation Categories had precedingly been defined as:

- Peak hour travellers (ie, peak captives)
- Low income groups
- Those who are obliged to use public modes of transportation (transit captives)
- Those who are access impaired to basic amenities (access impaired)

The Disadvantageous Positions in transportation are:

- Having insufficient walkways and curbs
- Being disabled
- Being old (over 65)
- Having no vehicle to freely travel
- Suffering from the high dependency ratio in the household
- Being exposed to the bad travel conditions and discomfort
- Being inaccessible enough to the transportation facilities (bus stops in our case)

The categories may be numerous but those defined above are relevant categories to the case study. As observed, the disadvantagedness may be due to personal conditions, to the household conditions or to the transportation system performance and physical realities of the city (such as topography). As previously mentioned, those groups are defined to be more disadvantaged (NHS, 1992): non car owners, low income groups, disabled and frail, and inaccessible most of which, to a greater extent, income related. For example, in thesis study done by Beyazıt, low income people are also the groups who are more exposed to the peak hours (1989, p.156). As another Turkish example, in the Bursa study, a strong correlation is observed between the trip rates and the car ownership and income (Sayın, 1987). In the same study, it is found that pedestrians are associated with the low income groups.

The correspondence matrix is especially expected to connect the disadvantageous conditions to the transit riders and low income groups, and also the disabled groups. This must primarily be done at the person database but, can also be done at the zone basis. For example, if the disadvantagedness ratio is relatively high across the transit captive groups, or, peak-hour captive groups then this stimulates the policy-maker to take precautions, first, against those "disadvantagedness-causing (-bearing) factors" or conditions to remove them from the transit riders. That is simply to say, how well we could diagnose the illness, so far we could cure. This procedure is similar for the zonal categories of households. Then, for example, the priority treatments or special policies are zone-specific and are called "the zonal policies".

It should be noted here that, ANOVA method could have been used in the correlation search, but warned that, in the case of multi-variate analysis that is what we truly had in this study, linear regression analysis would be much more tractable in social sciences than ANOVA (Krueckeberg and Silvers 1974, p.161).

5.2.2. On the Evaluation of Policy Weights

The basic problem becomes determining of the appropriate policies and addressing them to the right places. The process can be simply described as:

1. Finding the policy type
2. The policy area (objectives) where the policy to be applied
3. Where (geographical area - zone) the policy to be applied
4. To whom (At what level of sub-category of disadvantaged)
5. At what specific links (transportation routes, streets) (not considered in this study)

As related with the correlation matrix method defined above, for policy determination such steps will be followed as described in the sketch in Figure 38.

The logic behind the cluster filtering is based on the intersection areas of the various disadvantageous positions. As mentioned frequently, there might be various dimensions of being disadvantaged: while many overlapping onto each other, some may not overlap but some may even lie at the domain of advantaged. The example drawn in Figure 39 can best explain the situation in the form of Venn Diagram, suggesting first the universe (N) (all population) is the Normality and the Event of Disadvantaged (D) is the complement of Advantaged (A):

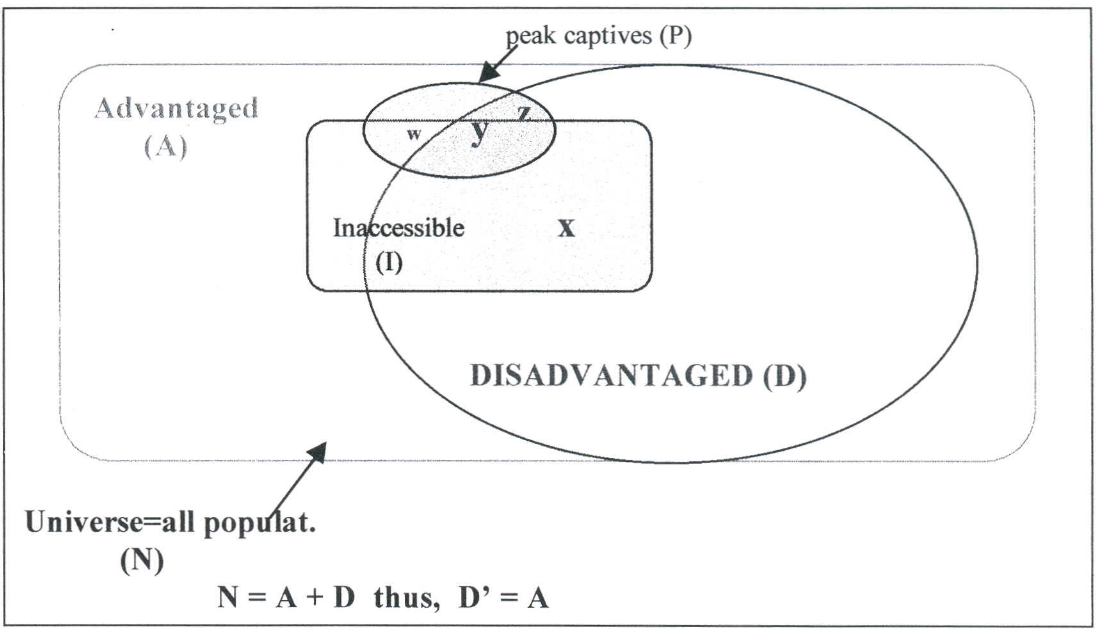
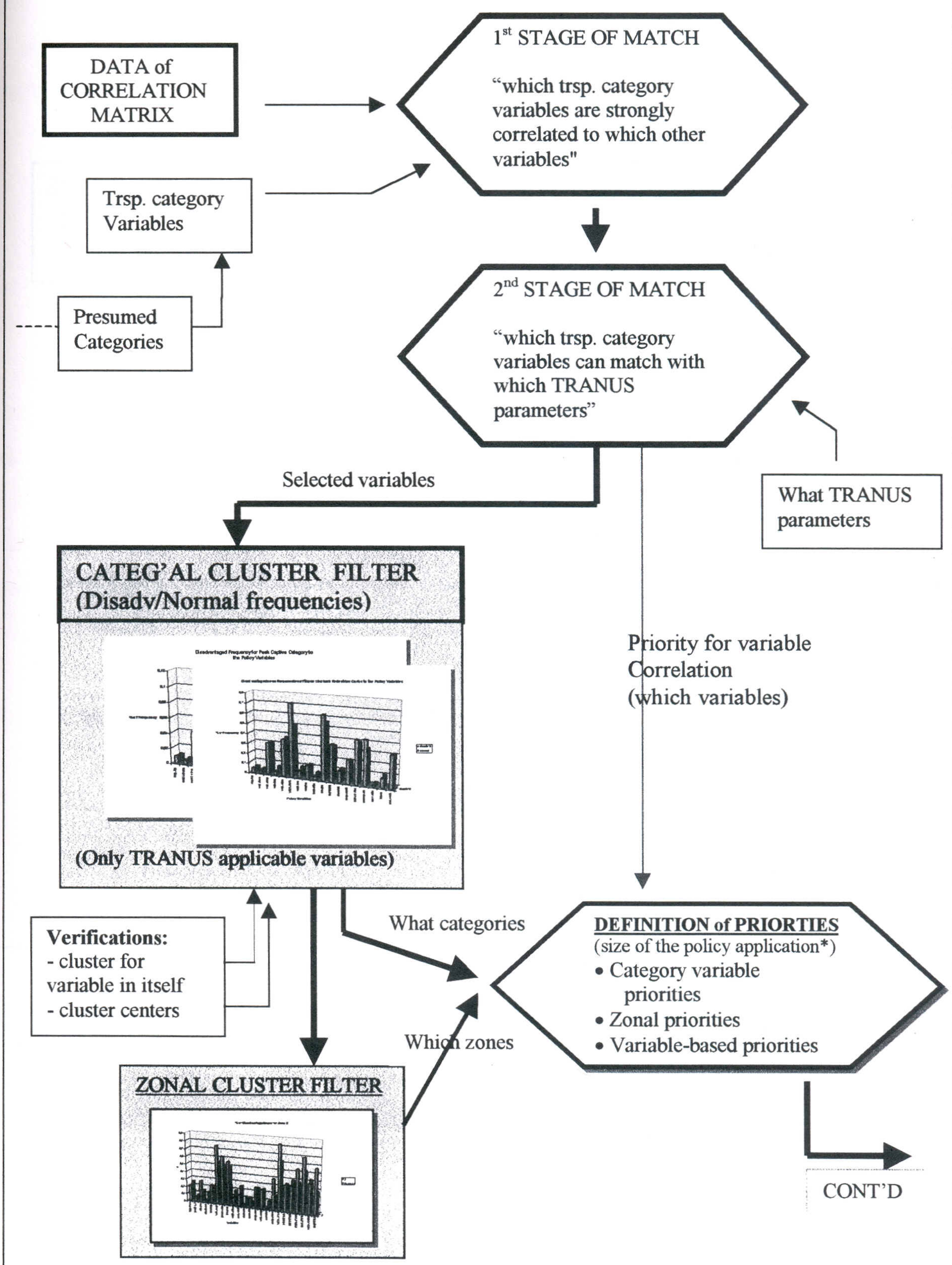
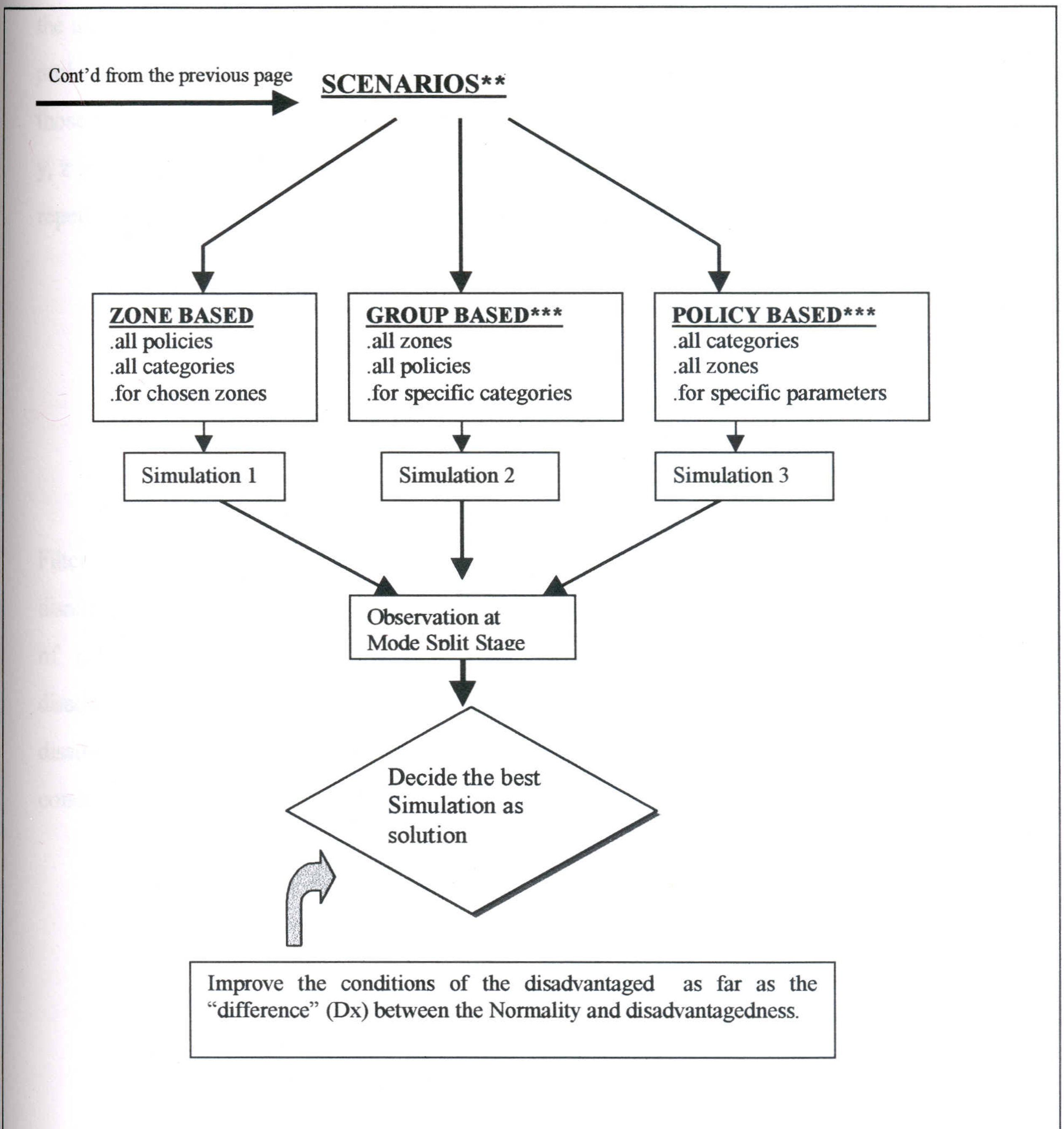


Figure 39. The Venn Diagram of Disadvantagedness

As an exercise, what if one wishes to define such a disadvantaged group in the composition of these situations: all inaccessible people being within the region of disadvantaged and additionally those peak captives only within the region of disadvantaged but also those intersecting with the advantaged inaccessibles. This

The PROCESS of FILTERING





*Size of the policy should be around %50 change in the impact from the existing situation, that is defined as the Dx general ratio.

**It must be checked that scenarios must not overload capacities of the link networks, that can be monitored at the traffic assignments. The monitoring verifies the viability of the simulation.

***those applicable on TRANUS

Figure 38. Process of Filtering

readily looks a perplex question. However, such a complex situation can be solved by the aid of the graph above and knowing the basics of groups analysis and conditional probability (Atalık 1995, pp.18-37). This composition of disadvantagedness includes those small fragments of intersection, represented by small green colored letters: w, x, y, z in Figure 39. First of all, we should be aware of the overlapping cases that may be repetitive in the calculations. The composition (L) can be formulated as:

$$L = (w+x+y+z) = (I \cap D) \cup [(P \cap I) \cap A] \cup [(P \cap D) \cap I']$$

Instead of A, D' could be used interchangeably.

With the same logic, the procedure can be easily executed under Excel's Data Filter property only taking pairs of intersections between each individual disadvantageous positions (ie, variables), like being inaccessible, at the general cluster of disadvantaged. Cluster Filtering only requires the number (frequency) of disadvantaged of the particular situation (variable) over the general category of disadvantaged (or, all). The individual disadvantagedness categories would be conceived as conditional probabilities as:

$$P_{Di} = P(D_i / D) \cap P(D)$$

Where, $\sum_i P(D_i) \geq P(D)$

$$\sum_i P(D_i) = P(D_1) + P(D_2) + P(D_3) + \ldots + P(D_n)$$

The steps of Filtering Process as depicted previously in the Figure 38 are explained in the following section.

5.2.2.1. First Stage of Match

In this beginning stage, only the most correlated disadvantaged-category type variables are found. That is, it is the definition of which categories (peak captive, old, disabled, etc.) are associated to which other variables, determined by the higher correlation values (by checking from the higher significance levels marked as two stars in the SPSS output view files). For this, the correlation matrix previously prepared for all variables was used. The transport category variables are formed according to the presumed disadvantaged categories previously determined. The resulting output of this study is summarized in Table 31. The significancies and the approximate correlation values can be tracked from Appendix F (Most Correlated Variables). This study also reduces the size of the work to the next stage.

5.2.2.2. Second Stage of Match

In this stage, inevitably, which of those category-correlated variables can be handled in TRANUS environment are checked. This also filters the incompatible parameters that would not, or hard to, be handled in TRANUS, and thus, further reduces size of the job for the next stages. The TRANUS parameters that adapt to the variables are listed in not here but in the Section 4.8.2, which are apparent in the simulation stages.

5.2.2.3. The Cluster Filter (Categorical)

The filtering of disadvantaged for each variable over both the disadvantaged cluster and over Normal (all population) is the essence of the evaluation procedure. It shows the ratio of a particular disadvantaged group (e.g., old) over the whole cluster of disadvantaged. This required a simple but laborous work since this procedure is repeated for each category-related variable defined. It should be kept in mind that major significance of cluster filter for both the Normal population and the disadvantaged population lies in the fact that **if filtered value in the disadvantaged population gets closer to the value found for the Normal, it shows the degree to which so far a policy variable is disadvantaged for the specified category**. The results can be checked at Appendix J where the star superscripts meant the cell is strongly disadvantaged.

Table 31. Correlated Transportation Categories and Variables

Code	Tr. Category	Transp. categ. Variables	correlated variab
A	peak captive	peak 1, 2	IMPED3 reg.trp
B	lack of curb	pede.widt	IMPED2 stop.cond trfer.no wait.dura wait.stop
C	disabled	disab.no disab	veh.bisi / walk.clos edu.univ
D	old	old.no	veh. Ava edu.fam
E	low income group	INC.PER	soc.trp
F	non-vehic. owner	veh.own	VEH.AVA cost.tra
G	access impaired	**Access** acc.work acc.okul acc.shop acc.recr	VEH.AVA INC.PER comfor tran.edu wait.dura disab
H	transit captive	typ.mod	IMPED3
I	depend impaired	DEPEND	VEH.AVA other demographic/soc
J	uncomfort. trip	PUB.COM VEH.COM	IMPED2 emp.no wait.stop
K	personal incapab.	N/A	
L	inaccess. Facilitie	stop.acc	IMPED1 IMPED2
M	transfer makers	Trfer.no	stop.cond

The cluster filter process is similar to the idea of conditional probability rather than the probability tree. Because, the multiplication of the probabilities works in an inverse manner: First, the probability of the variable in the subcategory, which is in the main category of disadvantaged, is found, not in the universe, then, this is multiplied by the main category's probability, which is the probability in the sampled Universe. If the disadvantageous situations are perceived as the probabilistic events:

$P_{cf}(A) = P(A/B)$

If $P_{cf}(A)$ represents probability of filtered individual cluster (concern group of disadvantaged),

A is the number of disadvantaged of one dimension (event)

B is the number of disadvantaged of one another dimension (another event), which is generally the overall disadvantagedness of subcategory.

Likewise, this can easily be explained by the probability tree concept only if the events were mutually exclusive as in the Tree diagram in Figure 40:

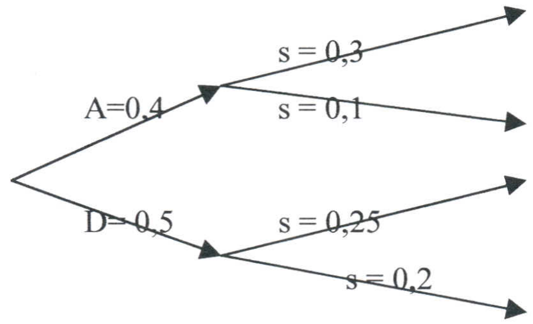


Figure 40. The Probability Tree Approach

In the conditional probability as defined above, the cluster filtering logically means that the disadvantagedness A can only occur (or accepted to be disadvantaged) if only also the disadvantagedness D exists for the person (or, zone) who experienced p(A). That does not require the condition of mutually exclusive. On the other hand, in the Figure 40, which shows the logic of Tree Diagram, the probability of choosing D (advantaged) and S (sub-category such as elderly) is not ideal because being old is also probable in group A.

The Filtering Process required the threshold values for each individual variable be considered. These individual threshold values are the values to define the disadvantaged from the advantaged. By threshold values, sort of second set of clustering process is applied to define the correspondence between the variables. The values are obtained from the cluster centers of each variable. The arithmetic mean of both cluster (advantaged and disadvantaged) centers for each function variable is used as the threshold value (ie, the standard). If such values are not available, or not efficient, commonly accepted standards or any subjectively defined standards would be replaced (See Section 3.4.6: the Local Threshold Values). Threshold values can be seen in the Tables of Appendix J by which the frequencies found in a matrix form. The threshold values there are picked according to both the commonly accepted standards and also subjective evaluation. The values with the (> greater than) sign represent that the threshold value is greater than the "check box" value shown on the home interview survey forms (See also Appendix C for the threshold check box values). For example, the number of households with disabled with the travel cost (the cell: 'disab.no' x 'cost.tra'>3) greater than "check box" marked 3, that is above 500 TL, is 15 observations for the disadvantaged category and 18 for Normal (adv. + disadv.). These threshold (standard) values are generally found from the "check box value" frequencies of the considered variable between the disadvantaged and advantaged. Only, few values are completely taken subjectively. Notice that the subscript stars in place of threshold value cells are for the function variables and, as mentioned above, the threshold values for them are found by taking arithmetic means of both clusters centers. The overall summary result can be seen in Figure 41 for the disadvantaged only. The same figure can also be seen for Normal in Scenario 2 (Notice that both have similar views!). All individual results (for each category) can be seen at Appendix J.

Final results of Cluster Filter is the attention to the categories and related variables that we must focus on when we produce our policies for the improvement of the disadvantaged. It should be noted that meanwhile also the focus variables are readily determined (from the higher correlations).

The findings can be verified from the cluster center results. The cluster centers in some variables such as 'VEH.AVA' and 'INC.PER' are very different between the

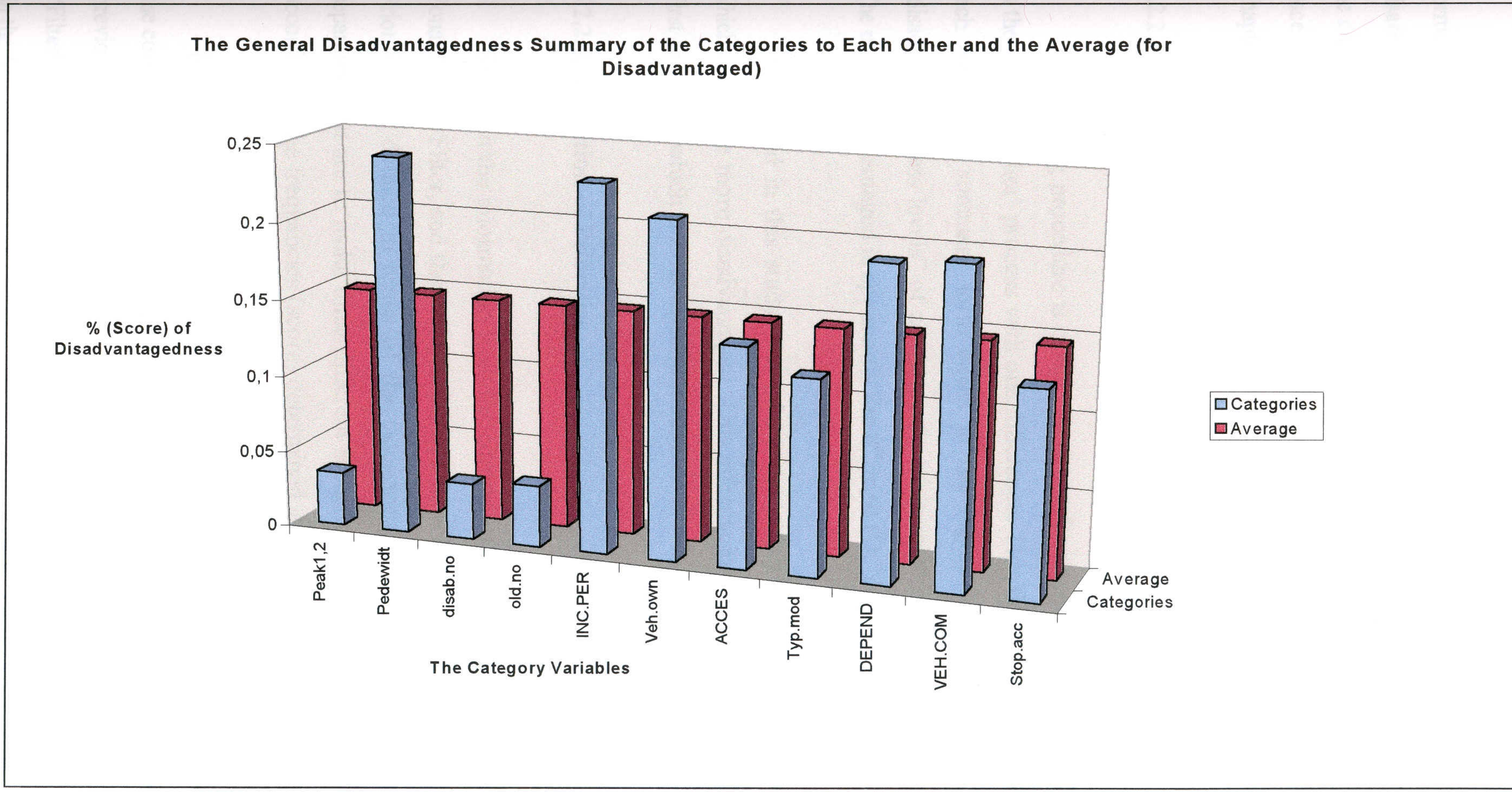


Figure 41. Overall Summary of Disadvantagedness Levels of Category Variables

normality and disadvantaged, which is the sign to the **existence of the strong disadvantagedness problem** in these fields. Finally, both the cluster filter results and the cluster centers are consistent that can be checked from the clustering study. The place of the matching process module can also be checked from the Figure 24 in Chapter 4.

5.2.2.4. Zonal Cluster Filter

The filtering procedure is exactly the same for zonal filtering as described above in the 'Cluster Filter' process with one difference: This time the procedure is done for each zone. The summary form exists in the Figure 42 in Scenario 1. Here, the "disadvantagedness levels" of zones are found in relation to the average of all zones. The most disadvantaged is apparently the 8^{th} zone (O. Yozgatlı and İstiklal Districts).

It is aimed in this study that ***where*** the policy could densely be applied. Or, which zones are more disadvantaged. This information will constitute the basis of the First scenario (which is Zone specific), later.

5.2.2.5. Definition of Priorities

Based on the information from the correlation matrix, Categorical Cluster Filter, Zonal Cluster Filter, and the policy areas can more or less be cleared. Respectively, the Priorities are defined in terms of the categories, zones and variable-based policies separately that are to make three different scenario approaches. Priorities must be also according to the frequencies (score) determined as the result of the filtering processes.

Relevant policies had been noted across the category variables as inferred from the correlation magnitudes and the correlation signs (+ or -) in summarized form in the previous Table 31. Additionally, the disadvantagedness level differences between the "Filter" results for disadvantaged and for Normal provide basis for priory definition as in the form of category-variable (policy) matrix, which is formulated as:

$[d_{ij}]^{dis}$, $[d_{ij}]^{Nor}$; we have two matrices for disadvantaged, and for Normal, respectively

if $(\Sigma_i d_{ij} / \Sigma D_i) = R_{ij}$; individual ratio of disadvantagedness for the specific category of disadvantagedness (D_i)

$\Delta_{ij} = (\Sigma d_{ij} / \Sigma D_i)^{dis} - (\Sigma d_{ij} / \Sigma D_i)^{Nor}$;results as matrix of differences,

$\Delta ij = (R)^{dis} - (R)^{Nor}$

$R_{ij} = \Delta_{ij} / (\Sigma d_{ij} / \Sigma D_i)^N$ or, $= \Delta_{ij} / (R)^N$; ratio of the difference to the matrice of Normal

Here, d (out of D) represents the number of disadvantaged for the individual category of disadvantaged (eg, number of old people), while D standing for only the total number of disadvantaged observed in the variable (i) as the result of clustering, d for the disadvantagedness for both variable and the category (ij) (here, j stands for category). It can be perceived as the intersection area of (i) and (j). Thus, d can at most be the value of D. When Σ is added, symbolically it means, here, it is the frequency for that matrix cell. The matrix results can be examined in the Appendix J.

However, to find the weighted (or, relative) importance of the disadvantagedness (ij), it is necessary to multiply the disadvantagedness ratio (R) results by the percentage (or, proportion) of that specific category in the general disadvantaged cluster. The resulting matrix in Appendix J provides the final and more refined results. This matrix clearly depicts which variables are closely linked (the word "correlated" is especially avoided here) to which categories. The policy areas are defined accordingly. In the table, strong relations are colored with dark red and the loser relations with light blue.

The same procedure is repeated for the Normality (no cluster consideration) for comparison. But, much loser relations are observed. The summary output of this study is given in Table 32.

When exceeds the average value, the category variable is assumed to be much amenable to being disadvantaged. However, these results must be approached with

Table 32. Disadvantagedness Ratios for Each Category Found for Both Disadvantaged and Normal

For Disadvantaged

Categories	Scores	Average
Peak1,2	0,035	0,147
Pedewidt	0,244	0,147
disab.no	0,037	0,147
old.no	0,04	0,147
INC.PER	0,236	0,147
Veh.own	0,217	0,147
ACCES	0,142	0,147
Typ.mod	0,126	0,147
DEPEND	0,2	0,147
VEH.COM	0,203	0,147
Stop.acc	0,132	0,147

for Normal

categories	Scores	Average
Peak1,2	0,033	0,127
Pedewidt	0,217	0,127
disab.no	0,035	0,127
old.no	0,048	0,127
INC.PER	0,182	0,127
Veh.own	0,167	0,127
ACCES	0,15	0,127
Typ.mod	0,108	0,127
DEPEND	0,161	0,127
VEH.COM	0,186	0,127
Stop.acc	0,113	0,127

suspicion. First of all, the level of disadvantagedness is only in terms of the number of people exposed to the sort of disadvantagedness. For example, although the severity of being disabled must be much front-coming, looking at the results, disadvantagedness level is low for disabled since the disabled is lower in number relatively to others.

5.2.3. Three Scenarios as Policies

TRANUS can be used to simulate the policy impacts as the alternative scenarios to be designed. As the very promise of the thesis, the scenario design will be towards eliminating the differences in transport quality between the disadvantaged and Normal.

The evaluation process in TRANUS is tree-like: when a change (or, set of changes) is made to any of the variables or constraints (as inputs), or to the results of the previous models (as outcomes), the model re-runs and traces all the way down through the affected steps. Yet, it is said to be meaningful with land use inputs, since it mainly seeks the cause-effect interactions between land use variables and transportation variables (TRANUS Manual, p.14). In time lap simulations, to see the interactions between the land-use and transportation decisions, time should be specified for target year. The evaluation can be made for users, operators or the administrators primarily in terms of monetary costs and benefits. The sole cost/benefit evaluation would, however, not be fully satisfactory for we may want to see also technology, environment, quality and comfort, etc. impacts as the results of the policies. In this study, the evaluation only concerns the evaluation for users.

According to Nijkamp and Blaas (1994, pp.83-4), scenario is in a form of a path from present to future, through which intermediary process is described. The description of these processes may either serve to the realization of desired goals or expected results. One with expected results is of descriptive models. In such a normative study aimed here to supply more equity, path is described rather as to serve the desired goals. Thus, what is searched for, here, is the assessment of desired impacts rather than expected, though usually the term “assessment of expected results” is used (1994, p.35). It should be reminded, however, the passage of time is sudden in the simulation environment of this study and the processes, although existent, are non-traceable for one session of simulation. Therefore, the reasons and processing of impacts can only be analysed by sensitivity analysis technique, which is not yet covered in this study.

The principle is simple: Assessment is based on the idea that effects solely accrue from the policy. Thus, the results must be perceived as, whatever change may happen, the "policy-relevant consequences" even if in the form of compound impacts as both direct or intended and indirect or unintended (Nijkamp and Blaas 1994, p.37). This is simply to say we may not know for sure what unintended impacts may appear together with the intended impacts as the results of the policy application. As expressed before, uncertainty rules out in this area.

Results (impacts) can be evaluated on the basis of an impact matrix that may contain (Nijkamp and Blaas 1994, p.157):

- metric (cardinal) information,
- rankings (ordinal), or,
- qualitative (verbal) information

Yet, another form of evaluation can be set as in words: "which alternative is in agreement with a certain policy criterion", where especially the evaluation is difficult because of the non-comparability of criteria, and there is even not relative importance (weight) between criteria (1994, p.157). Then, it may also require assigning weights on the type of assessments, and the objectives. And, the conflict matrix between criteria may be established when necessary. It is emphasized that especially in the case of equity, a detailed presentation of impacts is necessary to see the view from different perspectives (1994, p.40) Yet, it is an important issue whether assignment of priority weights onto criteria is a correct attitude in terms of objective evaluation. It is seen appropriate in this study <u>not</u> to assign weights between criteria and to resolve the conflicts between them. Rank order (of simulation alternatives) technique for each criterion (indicators) is adopted (1994, p.158). A simulation alternative getting highest success (score) across the criteria is to be selected.

Simulations by creating experimental environment promise such advantages and conformity: a short-cut impact analysis under the given or assumed conditions of reality to be. They provide an environment of what we can not have in real life because the impacts in real life can be observed:

- in very long period of time
- detected and analyzed expensively and/or with a very great effort
- very complex to analyze and to make sense out of it

Sort of Knowledge-Based (KB), three scenarios will be employed for simulations and their output will be contrasted in order to find the best solution. The solution containing the applicable policies must prove that the mode split results of the model run for disadvantaged will, at least, approximate to those of the model run for Normal (for all), or approximate to the expected results (to be defined in the simulations) set.

The aim of KB (Knowledge Based) scenario-making is to avoid random (or, casual) try-and-error and uncertainty of the type of policy but under the shedlight of scientific knowledge. It is decided the three scenarios should be derived systematically from three different perspective. Such three dimensions (knowledge sources) in the evaluation of the model simulations are clarified: Zones as spatial dimension, Categories as the social dimension and the Policy Variables as the policy areas (objective variables). But, the intention here is to employ only the most effective policy as far as possible. Otherwise, a combination of few policy variables should be applied if no such a unique strong policy is available.

The principle of scenario-making is that when one scenario is hold specific for one situation the other two are relaxed. Thus, three scenarios are formulated conforming to these dimensions devoting to one or two items in each scenario. Likely, one scenario should address to spatial terms and be Zone-specific, and one should address to social terms (ie, category sensitive), and the other should address to the policies (ie, variable-based) themselves:

5.2.3.1. The 1st Scenario (Zone-based)

In this scenario formulation, the policy attention will be set as to "which" zones to choose primarily for policy application. This scenario is a sort of spatial policy-making. The hint (knowledge) for the policy determination can be obtained from the chart in Figure 42, which is the general disadvantagedness of the zones of which all the values of policy variables are averaged across the zones.

This chart derived from the disadvantagedness ratios study by using the Excel/filter property provides us information in terms of setting a guide for priority: Which zones to treat since it tells which zones need more help. For example, the most disadvantaged zone is clearly the 8th one (O. Yozgatlı and İstiklal districts). The other significantly disadvantaged zones are 2nd (Mesudiye and Köprülü), 6th (Orta, Ilıca and Ata districts) and 7th (A. Menderes and Yedi Eylül) as compared to the average, which primarily constitute the Southern and Eastern parts of the city except the 2nd one that takes place in North-eastern part. After the "focus" zones are defined, it is also necessary to define the "focus" policy variables and categories. However, those will be held as the same TRANUS parameter values of both policy variables for all categories and for all the zones. The focus policy variables for all zones were found to be: 'VEH.AVA', 'inc.per', 'unemp.no', 'edu.fam', 'IMPED2', 'wait.stop', 'walk clos' and 'acc.work'. Additionally, 'dura.tot' can be used in policy making though its effect is not seen so powerful (See the Chart in Appendix J).

The "concern" categories above the threshold value of average are likely to be: those who lack curb in their neighborhood (pedewidt), low income people (inc.per), those who do not have vehicle (Veh.own), those who suffer from dependency in the family (DEPEND), those who are exposed to discomfort while travelling (VEH.COM). Further, access impaired (ACCESS) and those inaccessible to the bus stops (stop.acc) can also be used as policy variables when available though they are below the threshold value of average. However, sub-categories under the generic category of disadvantaged are not manageable in TRANUS.

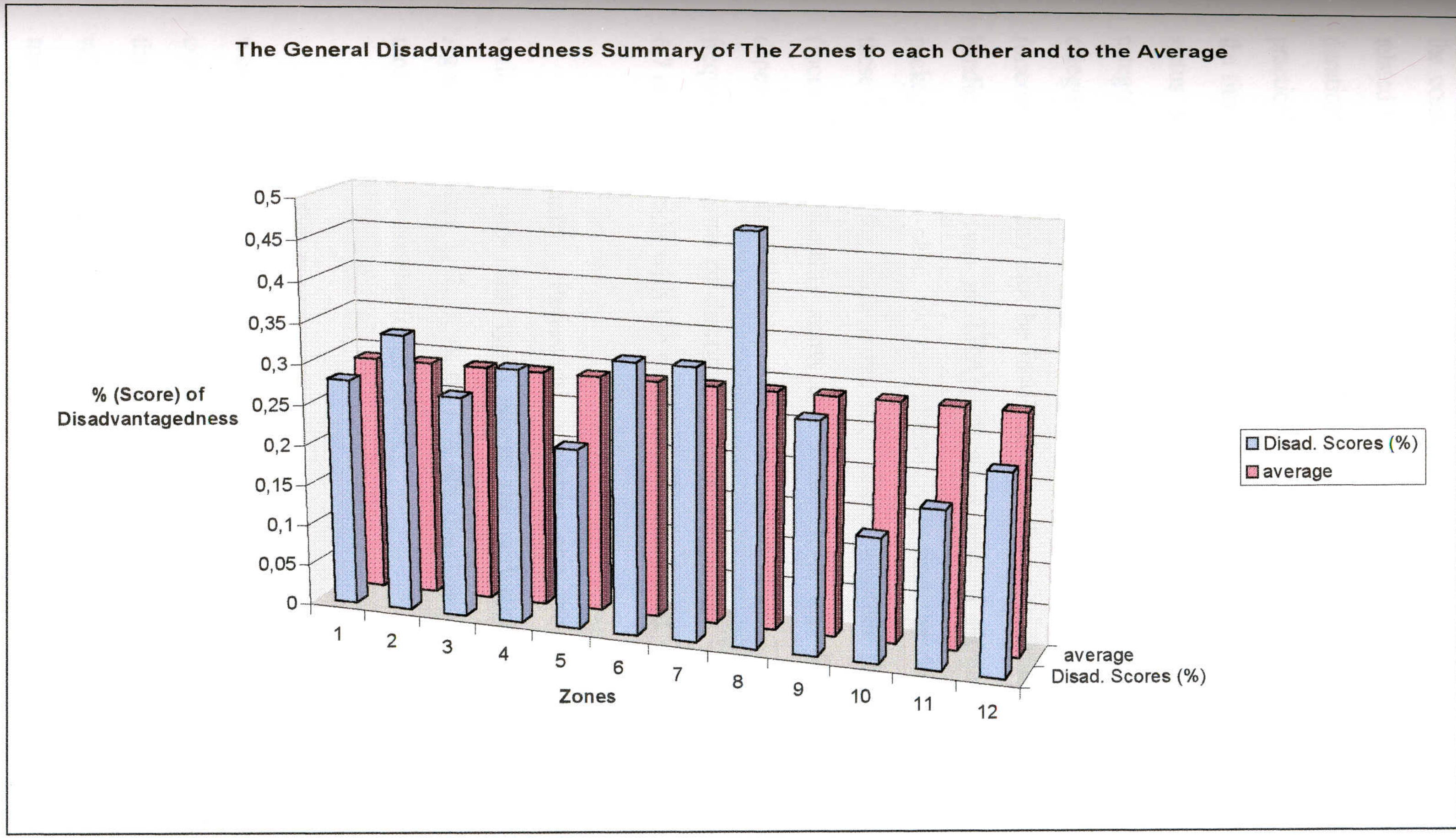


Figure 42. The Disadvantagedness Levels of the Zones

Looking at these findings, the policy formulation could be in such a manner for the concerned zones: The most significant disadvantagedness measures seem to be related with the vehicle ownership and income level. Education status and the waiting duration as well as accessibility in travels are secondary status variables. Thus, it practically seems reasonable to reduce transport costs for low-income groups, reduce the time spent and increase the accessibility somehow for especially the low income-status related categories. When checked from the Table in Appendix J where the category-policy variables filter matrix shows the relations between each pair of category and policy variables, also DEPEND (dependencies) and VEH.COM (discomfort group) can be involved into the consideration. However, it is difficult to handle the last two in TRANUS since related parameters are non-existent in the package. In this case, we can alternatively find the disadvantagedness frequencies of these variables for each zone, then check whether they are dense in the concerned (focus) zones. Results show that zones 3,7,8 and 9 are disadvantaged in terms of dependency ('DEPEND'), and, the zones 4, 6,7,8 and 9 are disadvantaged in frequency in terms of discomfort while travelling (VEH.COM). Of those, fortunately 6,7 and 8 coincide with the focus zones determined.

Additionally, 'Pedewidt' variable can be handled by creating pedestrian walkways (as new link type) where the pedestrian density appears at those zones. Again, the zones 1, 2, 3, 4, 6, 7, 8 are disadvantaged in terms of 'pedewidt', and of those, 2, 6, 7, 8 are the focus zones.

Shortly, for zone specific scenario, it can be generalized that the parameters and ways to improve the travel conditions of the South-eastern districts in terms of travel costs, comfort, and waiting time should be searched in TRANUS. This can be done through monetary policies (in all links concerning these zones) in favor of those zones, with reductions in waiting time of the public modes by frequent services, adding some more transit lines serving these areas. Also, pedestrian walkways should be introduced where the pedestrian density appears. These applications may improve the travel quality of the people either at these zones or all people of Aydın. It is impossible to know what impact may appear before the simulation. The certain policies (to be applied in the simulation) will be explained in detail in the Simulations section of this

Chapter. The results will be compared with those of the other scenario (simulation) results.

5.2.3.2. The 2nd Scenario (Category-based Scenario)

Second scenario pays attention to the categories: which categories for priority? The answer is again found from the disadvantagedness levels of each category, where they are attached to the most related variables. That is, categories are called with the related variables, and named, too, since they are obtained from the household interviews and they appear as "variable" in the data sheet.

This scenario is a sort of "social" one in terms of people groups by departing the disadvantagedness into various sub-categories (ie, presumed groups). Out of 11 sub-categories, 'pedewidt', 'INC.PER', 'Veh.own', 'DEPEND', 'VEH.COM', and 'ACCES' though being under the threshold value of average, are found significantly disadvantaged. Thus, they are the "focus" categories of all.

However, it is interesting to note that both the categories of disabled ('disab.no') and old ('old.no') seem less significant to make policy on because of their relatively small representation, although their values were strengthened as an approach. Indeed, we should consider especially the situation of those two groups in our simulations, because of the special emphasis devoted to them in this study.

Similarly, the parameter values look as the same for all zones and policy variables while it is not for all the categories. Because, here, policies are to be taken for chosen categories only when they are for all zones and policy variables. But, to get rid of the confusion, it is healthy to employ impacts of one or two parameters.

The information of "what" category to chose is obtained from the chart derived from the Categories-Policy Variables matrix of Disadvantagedness (as derived out of the Policy Matching Process) in which each pair of category and variable is examined by filtering (See Figure 43):

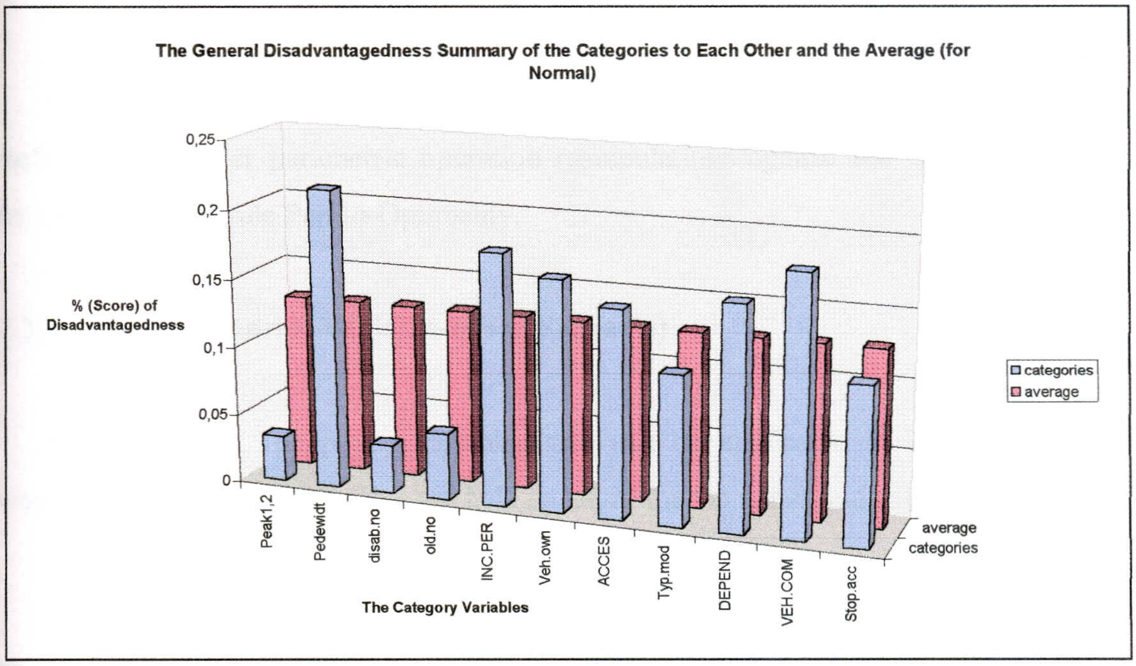


Figure 43. The Disadvantagedness Levels of the Categories

However, the problem is that sub-categories can not be separately handled in TRANUS but only as the advantaged and disadvantaged. Thus, it is necessary to look at the issue in terms of policy variables that are strongly correlated with these chosen categories. It is observed again that these are correlated with the income-status, waiting time, accessibility (to work/school place heavily) and comfort related variables, which is not different than the results in the 1st scenario.

Then, apart from the others, in this scenario, we should not deploy policies for specific zones but for all Aydın. However, though seeming insignificant, the emphasis should be stressed for the **disabled** and **older**. Various policies that ease their travel conditions (in terms of strongly correlated variables) such as pricing, avoiding charges, special para-transit operator with frequent service and stops, etc can be considered where the frequency for these categories are dense. It is found that the zones 2, 3, 6, 7 and 8 are the old dense zones with the emphasis on especially 2, 3 and 8. Likely, the zones 3, 4, 8, 9, 10 and 12 are the disabled dense zones with the emphasis on 4th, which is the traditional center of Aydin. The zones 8 and 12 should also be paid special attention. When we look at the policy variable correspondence for both disabled and old together, 'wait.stop', 'walk.clos', 'VEH.AVA', 'IMPED2' (but, this is heavily related to waiting at stops again, thus can be omitted) and 'unemp.no'.

In the TRANUS simulation, alternatively, category of disadvantaged can be benefited in the other parametric operation manipulations against the "advantaged", which is against the rule Pareto Optimality.

5.2.3.3. The 3rd Scenario (Variable-based Scenario)

Similarly, here, the policy variables that can be applicable in TRANUS are chosen while the parameter values are held constant for the zones and categories.

Significantly disadvantaged variables are chosen for the "policy area". Policy area, or policy application area, meant the variables or subjects of concern for disadvantagedness where the policy type is determined for application safely. In a sense, the scenario based on policy variables literally has to be the TRANUS-driven (TRANUS parameters) for the policy formulation.

Checking from the chart in Figure 44, which is the summary form derived from the Category-Variables matrix of Disadvantagedness (ie, Matching Process), the similar results can be observed as in the previous scenarios, heading income and vehicle ownership variables.

It is important to check which other variables (ie, category variables) are in relation with which others further to specify the direction of the policy. The policy variables are found correlated with all others mentioned before. The most effective variable 'VEH.AVA' can be used here as the single policy variable also because of its high correlation with all other categories except the collinear ones. It has also parallelling reflection on income level, but, since it is impossible to put money down into the people's pockets, and to give a car to everyone, we need to employ some other cost effective tools for users, which will indirectly cause the same effect.

Shortly, vehicle availability can be the dividing measure in policy application area on public mode users and private mode users. That is to say, if we have alterations on the situations of either public mode or private mode on the Links data of TRANUS, it seems we may have significant changes (impacts) on the disadvantagedness levels

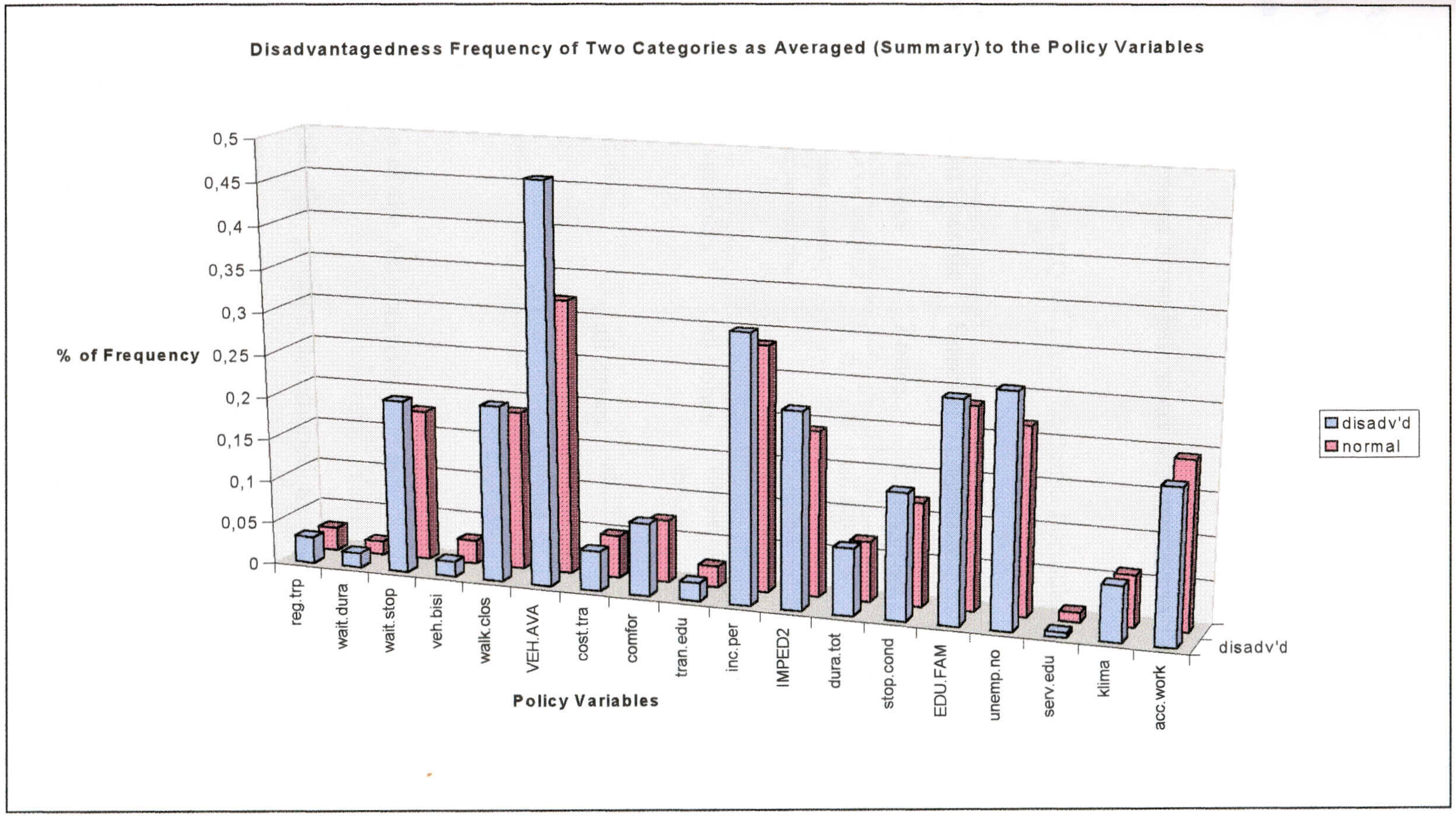


Figure 44. Disadvantagedness Levels of the Policy Variables

(towards amelioration). Links data of TRANUS is the appropriate place for the changes on 'VEH.AVA' and all other correlated variables (especially, income level – 'INC.PER') and on categories.

Thus, in this scenario formulation, singly the changes about the "Modes" of TRANUS assuming to represent the 'VEH.AVA' as yard stick to observe the changes in the conditions of disadvantaged and other income-status and access related policy variables will be handled for all zones and sub-categories.

All three scenario formulations are summarized in Table 33:

Table 33. Summary of Three Scenario Formulations

Scenarios	What spesific Variables	Specific Zones	Specific Categories	General Approach (in words)	Tranus Applicable?
Zone-Specific	VEH.AVA, INC.PER, Wait.stop, acc.work, Unemp.no, walk.clos	2, 6, 7, 8	all categ's	Apply all chosen policy variables for all sub-categories, But only for chosen zones	Hardly
Category-Specific	all variables	all zones	Veh.own, old.no, disab.no	Apply the policy variables Correlated with the chosen categories	Hardly
Variable-Specific	VEH.AVA	all zones	All (in terms of modes)	Public Mode will be empowered By cost effective & penalty applications against private	Yes

5.3. Simulation of the Alternatives

To activate the policies determined as the three scenarios in the TRANUS simulation environment, they should be turned into "TRANUS applicable" parameters (which is done in Section 4.8.2 before). Nevertheless, TRANUS is truly limited to activate different forms of policies. It has usually the link and operator based penalty and changeable parameters between 0 and 1 that can also be category specific. Another problem is that, we have no idea about the scaling limits of these parameters. That is, what a parameter between 0 and 1, or any number more than 1, etc. in

TRANUS means is totally a question mark and the interpretation is up to the designer. Probably, it is open to the designer's subjective interpretation. The application examples are few.

As of the pre-defined principle of this study from now on, if the existing value in a parameter is any value between 0 and 1, for example, the increased or decreased value as of the policy results of the scenarios should not exceed the 50% of the value of impact (value of existing) because this is nearly the base of overall structural disadvantagedness difference in outcome between the two model runs. That is, it is not that the range of parametric (input) values must deviate at most 50% but that the range of impact (output) should maximum deviate up to 50%. For comparability, it is tried in a "blind" manner to maintain almost the same amount of parametric change (impact) on all simulations increasing the input dosage in the next simulation.

As discussed earlier, this is because the "Dx" (the Average Ratio of Disadvantaged) between the actual values of disadvantaged and Normality are found 0,63. As a guide in the definition of the degree (amount) of policy application, the difference between this proportion and the normality (which is 1) was seen appropriate as the upper limit of policy change. It is targeted that a final %63 change in the output will close this gap. And, the policy should be viable. For example, if a new transit operator is added in a new route, it must be viably working in that route and should not detract any from other routes.

The logic of the 'ideal' model, in fact, instructs that the disadvantaged trip values must get closer to the values of Normal in both private and public modes in order to serve the purpose of equalization. However, here, the logic must charge inversely because we are unable to alter the situations of wealth (and, car ownership, etc.) to get turned the trip values of disadvantaged closer to that of normality (and, also to that of advantaged). Instead, improving the conditions of the transit or any other elements that are more associated to the disadvantagedness in reality looks possible. Then, whether transit and pedestrianism have attracted more trips from both disadvantaged and even from advantaged categories must be checked to testify that the policies to make transit and walking more attractively working. In this case, any improvement should be welcome as a success.

If the 'Base-year' model run for one-category (ie, the run for Normality) is the "no policy" run, the changes in the simulations must be compared to the outcomes of that run. Yet, comparing only the outcomes is not much meaningful but also the inputs, which is the comparison of the parametric changes between the TRANUS input files of both Base- year and simulation runs.

Yet, there is the difficulty to document the inputs entered to a software: Although, what policy actions were applied was explained above, what parametric changes these correspond to should be reviewed in Section: 4.8.2. But, the parametric changes in TRANUS are not easily (one to one) perceptible or transferable in a document like this. This also requires such a devoted introduction section, here, that shows how the software works, too. The scope and objective of this study does not allow doing that.

For this reason discussed above, only the **output** (because of the principle of "equality of outputs") of the simulations will be observed as whether they indicate **any** sign towards an improvement in favor of the disadvantaged rather than searching the interrelationship between the input and output results (ie, sensitivity analysis). We will have such indicators: (a) changes in the number of trips in terms of both category and mode, (b) changes in some impedance or cost indicators calculated by the package, and (c) the other zone-to-zone basis changes and their aggregate results. Primarily, the (a) and (b) type of changes will be assessed for they present neat view. After these assessments, (c) type indicator will be analyzed. The evaluation is solely made on the Mode Split stage of modelling.

5.3.1. The First Simulation

The First simulation is zone-based that requires special policy decisions towards the concerned ("focus") zones that must explicitly be designed concording the

TRANUS' abilities. Derived from the scenario formulation above, the policy areas and the applicability in the TRANUS environment are given in the scheme of Figure 45.

As can be observed in Figure 47, the additional transit routes worked (from the thickness of the lines) in the expected manner: They attracted volumes from the disadvantaged zones in general. Similarly, In Figure 48, offered pedestrian walkways could attract pedestrians from the disadvantaged zones to the city center. The volumes can be checked in Figure 49.

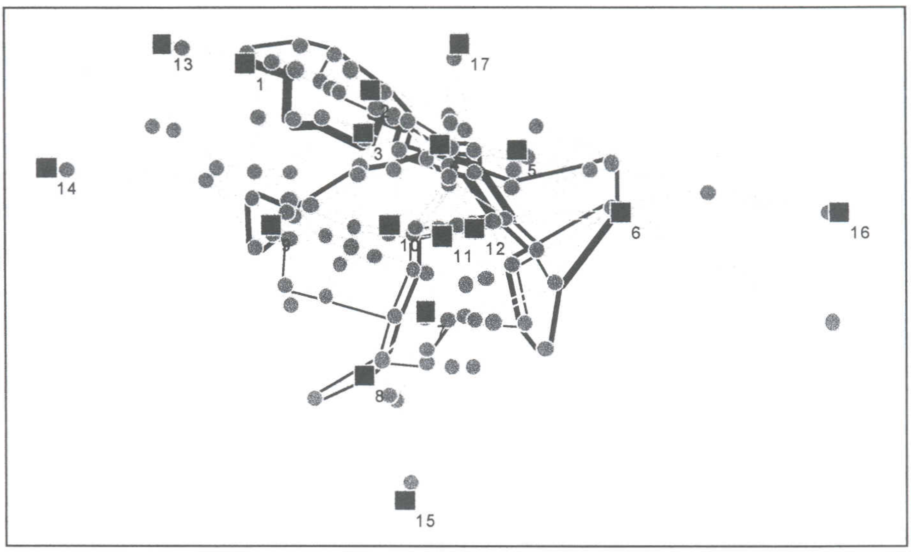


Figure 47. The Total Volumes (Passengers) That Additional Transit Routes Attracted in Simulation 1.

As can be understood, if the results of the simulation application fit the expected results as summarized in the Figure 45, then that is to mean the simulation works in the way designed for. When checked through the summary results, indeed, the results appear as the expected results of the first simulation.

Policy Areas

- Travel cost (decrease)
- Comfort (increase)
- Wait time (decrease)

→

Policy Application Means in TRANUS

- More frequent transit services
- Reduce transit fares
- More transit routes with some comfort parameters increased
- Transit service patronage increased
- Pedestrian walkways in the disadvantaged regions (at the pedestrian dense links)

↓

Formulated in the form of

- 3 transit routes (Figure 46), one providing direct access to the center and public amenities for the "focus" region, one providing a ring service between the northern and the southern focus districts, and one being a peripherial ring routing between other routes also trying to increase patronage on the previously unserved areas.
- Those transit routes pass through some links without stopping: 3 (14 of 46 links were closed), 8 (10 of 36 links were closed), and 13 (18 of 46 links were closed).

↓

Expected results (Impacts)

Because of reliance on the transit, the combination of more transit services, reduction in user costs and increased comfort, and additionally increased pedestrian access in the focus zones must end up with some overall increase in the transit trips, and either increase in pedestrian trips (at the Mode Split stage) in favor of disadvantaged, while decrease in the private car trips (and increase in transit trips of advantaged)

Figure 45. The Simulation Policy Formulation of Scenario 1

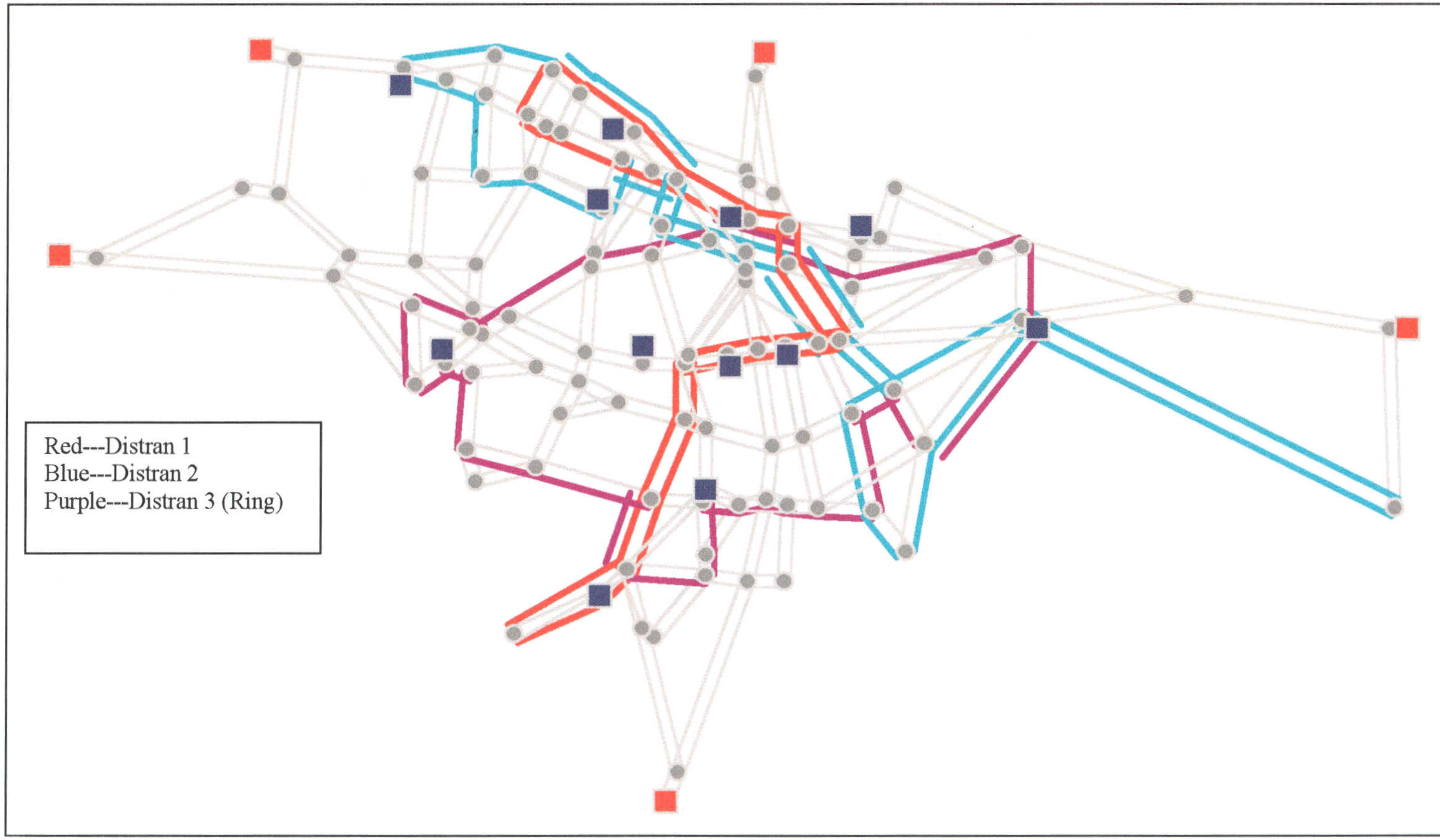


Figure 46. Additional Transit Routes Proposed in Simulation 1

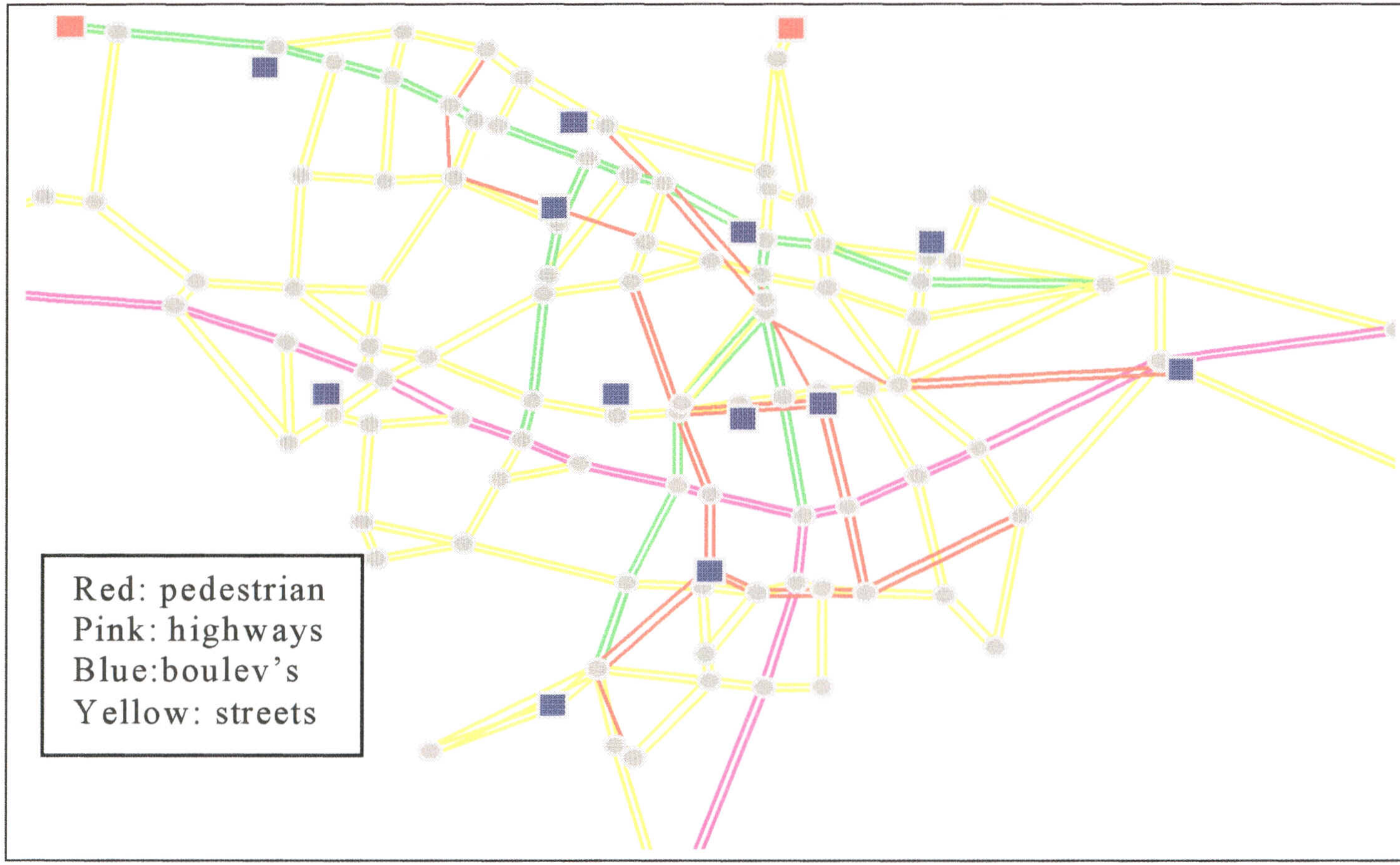


Figure 48. New Pedestrian Links Proposed in Scenario 1

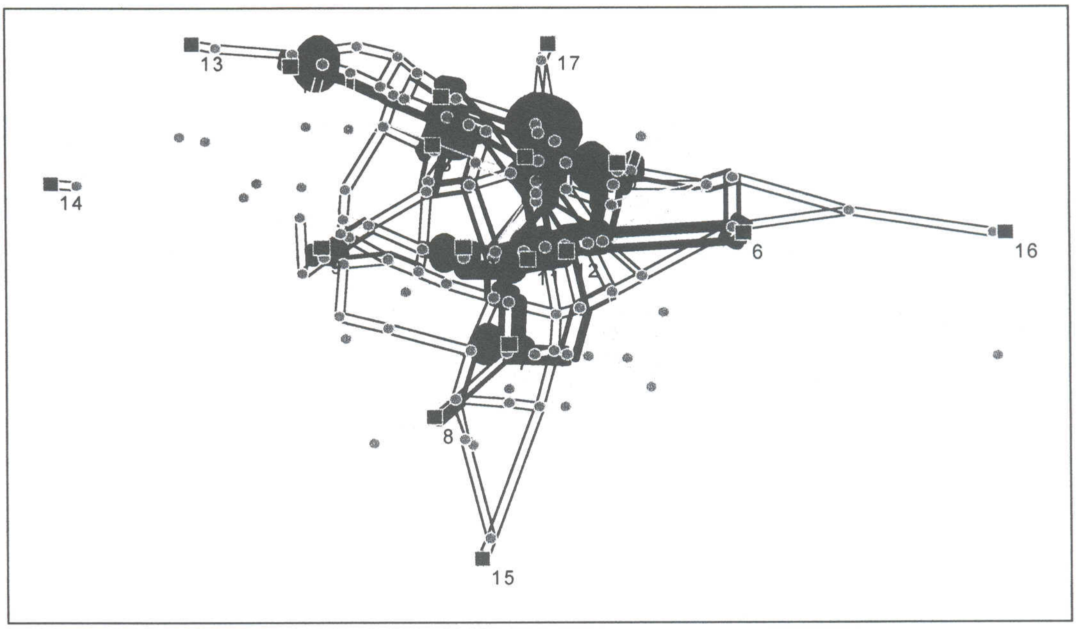


Figure 49. The Pedestrian Volume Assignments after the Additional Walkways in Simulation 1

Table 34. The Summary Results of the First Simulation

TOTAL TRIPS BY CATEGORY AND MODE							
Category	Modes....						
CatId	CatName	Public	Priv	TOTAL			
1	adv	49553	7385	56938			
2	disad	99091	1721	100812			
	TOTAL	148644	9106	157750			
STATISTICS BY TRANSPORT OPERATOR							
OperId	OperNam	Trips	Units-Dist	Energy	Costs	Income	Revenue
1	Priv	9106	13406	0.	2009829	584290	-1425539.
2	dernek	58204	139922	0.	0.	5820358	5820358
3	pedes	194094	105492	0.	0.	527459	527459

On the Table 34, "dernek" means all the transit operators. To compare the results of the first simulation with the Base year, Table 35 provides the same results for the Base year results of both model for Normality and model for two categories (the results for the normality should be regarded):

Table 35. The Summary Results of the Normal Model (One-category model):

TOTAL TRIPS BY CATEGORY AND MODE							
Category	Modes....						
CatId	CatName	priv	publ	TOTAL			
1	normal	9838	151815	161653			
	TOTAL	9838	151815	161653			
STATISTICS BY TRANSPORT OPERATOR							
OperId	OperNam	Trips	Units-Dist	Energy	Costs	Income	Revenue
1	dernek	58017	138500	0.	0.	5801692	5801692
2	private	9838	14632	0.	2195611	635715	-1559896
3	pedestr	199474	121398	0.	0.	606990	606990

Table 36. The Summary Results for the Model for Two Categories (advantaged and disadvantaged):

TOTAL TRIPS BY CATEGORY AND MODE							
Category	Modes....						
CatId	CatName	Public	Priv	TOTAL			
1	adv	43916.	13022	56938			
2	disad	98530	2282	100812			
	TOTAL	142446	15304	157750			
STATISTICS BY TRANSPORT OPERATOR							
OperId	OperNam	Trips	Units-Dist	Energy	Costs	Income	Revenue
1	Priv	15304	22373	0.	3405115	977266	-2427849
2	dernek	61935	146544	0.	0.	6193514	6193514
3	pedes	192264	101463	0.	0.	507314	507314

On the other hand, the categorical results must be compared with those of Base-year for two categories, which we can assume them "no policy" default values to be contrasted with the simulation values:

Base-year (two category):

Public trips of advantaged: 28 % of all trips

Public trips of disadvantaged: 62% of all trips

Private trips of advantaged: 8% of all trips

Private trips of disadvantaged: 1% of all trips

Whilst, the results of the first simulation are as:

Simulation 1 and the changes from the Base-year:

Public trips of advantaged: 31 % (+%3: a considerable increase)

Public trips of disadvantaged: 63% (%0: no change at all)

Private trips of advantaged: 5%(-%3:fairly good reduction, ie, improvement)

Private trips of disadvantaged:1% (%0: no change at all)

These results can be interpreted as the policies worked in such a manner that encouraged the private travellers of advantaged to use the transit. Goals are not, however, fully attained in this case.

The LOS information is provided in Figure 50 as the results of the Trip Assignments of the simulation 1. It seems there is no any capacity problem in the links.

5.3.2. The Second Simulation

The design of the second simulation, as explained before in the scenario definition, is based on the categorical evaluation targeting most disadvantaged groups, which is, this time, not specific to certain zones but to all zones (areawide applications).

Thus, the policies will be diverted to the category areas as defined in Figure 51.

As can be observed in Figure 53, additional transit services were useful in attracting passengers especially the paratransit service for disabled (and old). The extra routes especially worked for the Southern (Zone 6) districts.

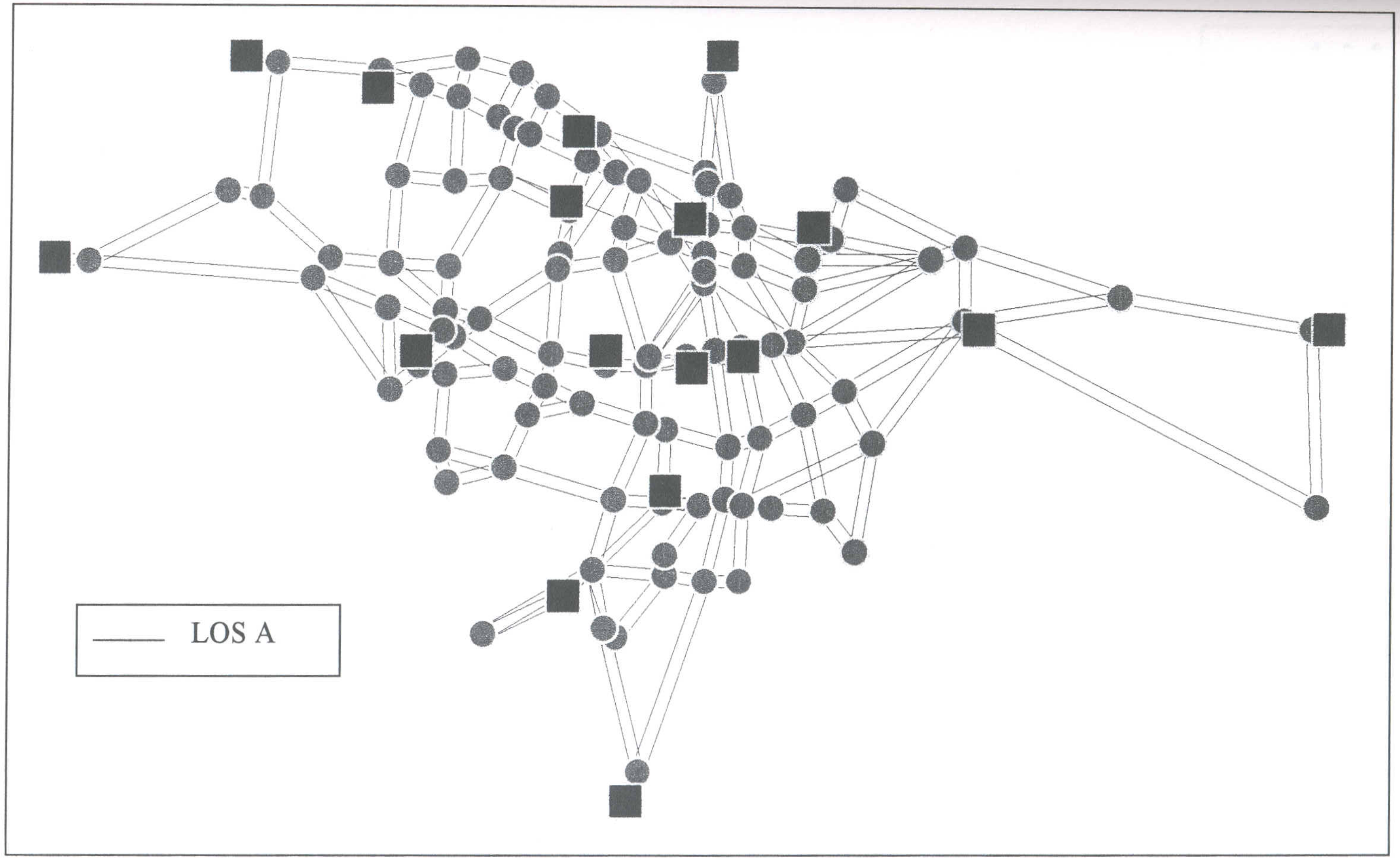


Figure 50. The LOS Levels in Simulation 1

Policy category areas

- Low income
- Non-car owners
- Disabled
- Old
- Discomfort groups
- Dependency-bound groups
- Inaccessible (far residents)

→

Policy Application Means in TRANUS

- On-call Special Transit for Disabled
- Serving priority to disabled and old dense zones
- Serving distant places
- Penalties (as discouragement) to car owners
- Encouragement to low income & non-car owning groups

↓

Formulated in the Form of:

- One special operator that has not routes but is an on-call service for disabled and older
- Two additional ring routes under the transit operator
- These additional routes with the extra routings serving largely the zones 2, 3, 4, 6, 7, 8, 9, 10, 12 and expanding the patronage.
- The operating cost of private mode is increased and the fare for public is reduced as far as one fourth
- Penalties against the advantaged in using the public modes, as far as 3 times for normal transit and 5 times for the special transit
- Reduced transfer costs for transit and special transit
- Transit frequencies are increased and in-vehicle occupancy rate is increased for the additional Ring services.
- To provide priority, the speeds for special transit are increased a little for all link types.

↓

Expected results (Impacts)

Still because of reliance on the transit, the combination of more transit services, a special transit for disabled, discounted user costs and increased attraction for public types while the advantaged were discouraged, and increased accessibility must end up with some overall increase in the transit ridership, (and either increase in pedestrian trips) in favor of disadvantaged, while decrease in the private car trips (and increase in transit trips of advantaged)

Figure 51. Simulation Policy Formulation for Simulation 2

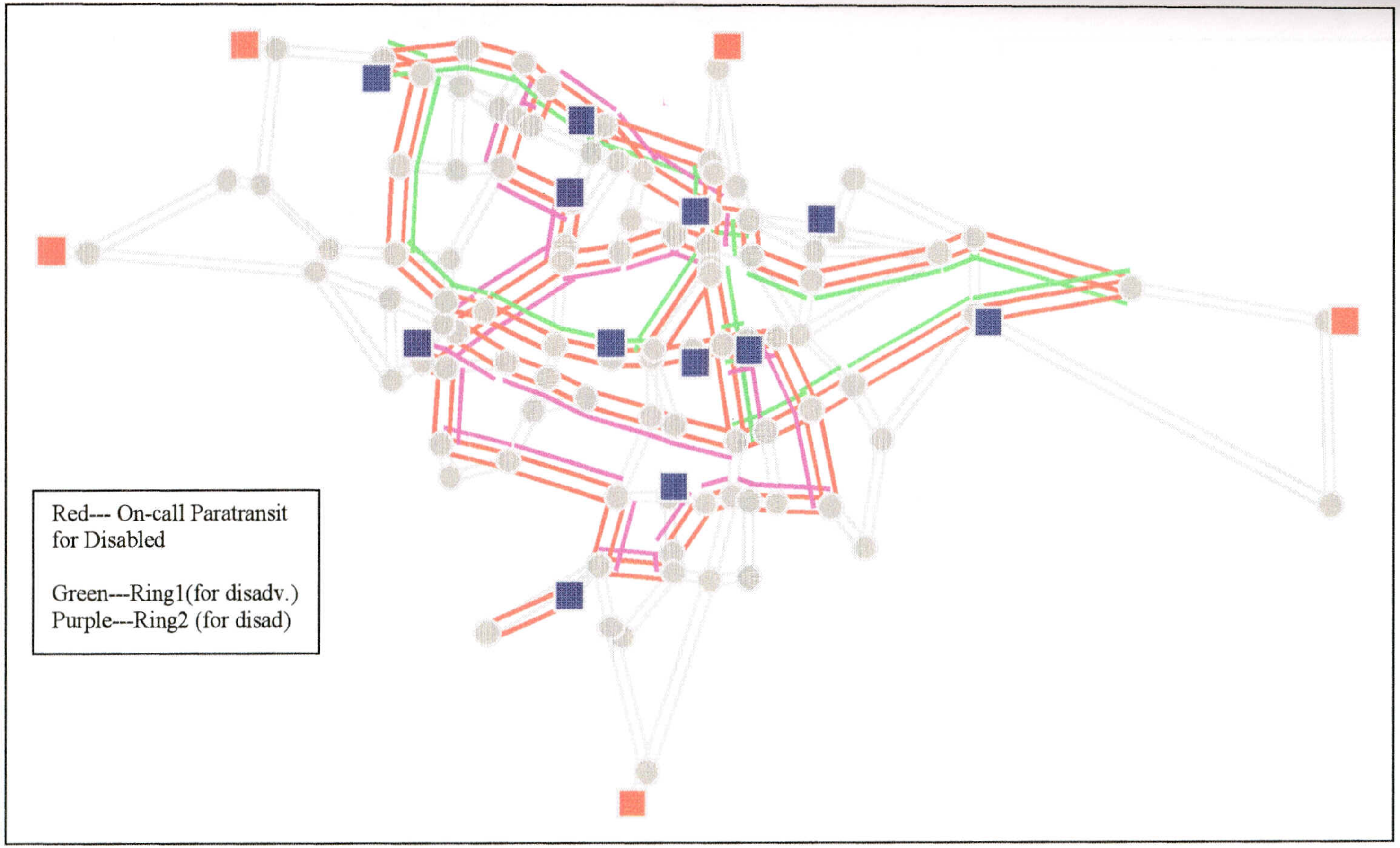


Figure 52. Additional Transit Routes Proposed in Simulation 2

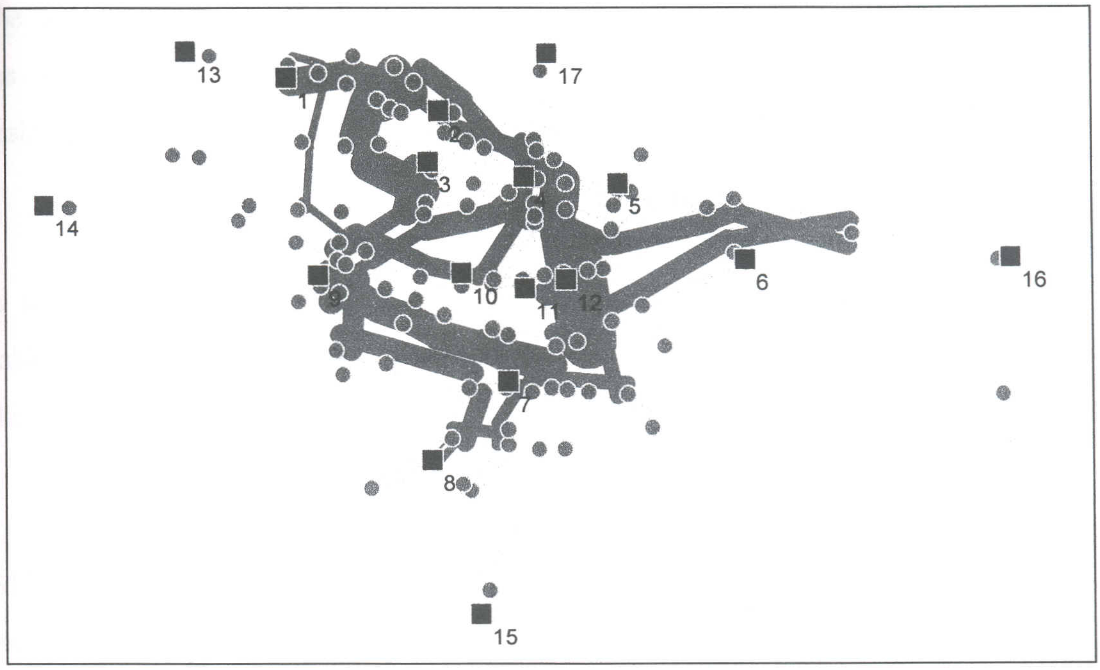


Figure 53. Total Volumes of the Additional Transit Routes in Simulation 2 (Paratransit Service for Disabled is dominant)

The results (Mode Split stage) of the second simulation are given in the Table 37:

Table 37. Summary Results of the Second Simulation

TOTAL TRIPS BY CATEGORY AND MODE							
Category	Modes....						
CatId	CatName	Public	Priv	TOTAL			
1	adv	42265	14673	56938			
2	disad	99856	956	100812			
	TOTAL	142122	15628	157750			
STATISTICS BY TRANSPORT OPERATOR							
OperId	OperName	Trips	Units-Dist	Energy	Costs	Income	Revenue
1	Priv	15628	23695.	0.	5410497	1653590.	-3756907
2	dernek	10494	27185	0.	0.	1276208	1276208
3	pedes	256772	34418	0.	0.	172089	172089
4	D-paratr	117454	298172	0.	0.	7871121	7871121
5	Ring	0.	0.	0.	0.	0.	0.

As compared to the Base year (one category) results, this simulation's results are not better than the first simulation, when all transit types and special transit is assumed to be under public mode. Public trips of advantaged report very less increase yet public trips of disadvantaged are very good when compared to the first simulation. There is a considerable reduction in the private trips in both categories.

However, when looked at the results of the newly added transit routes (Rings) and the special transit individually, it can be noticed that only the paratransit for disabled attracts a great portion of trips as the result of the "exaggerated" encouraging policies applied for the use of these facilities in this simulation.

The ratio of private trips to public trips in the Base-year situation is 0,11 (15304/142446): However, if the pedestrian is excluded from this view, the net ratio of private over 'dernek' (transit) plus paratransit will be: 0,25 (15304/61935).

This figure in the second simulation is 0,11 (15628/142122) for private/public ratio and 0,12 (15628/127948) private/total transit except pedestrians, of which 92% is by newly added paratransit service. That means there is a considerable increase now in private trips and shift to the newly added paratransit service in the public trips. But, some trips have fled to pedestrian trips.

However, to compare the results with respect to the advantaged and disadvantaged separation, it is necessary to make the comparisons with the Base-year of two-category. Another advantage of such comparison is that the total numbers of trips in both the Base-year and the simulations are the same (ie, 157750). Thus, the ratios must be taken over this total amount.

This view must be in favor of disadvantaged in the scenario 2:

<u>Scenario 2:</u>

Public trips of advantaged : 27% (-1%: no significant change)
Public trips of <u>disadvantaged</u> : 63% (0%: no change at all)
Private trips of advantaged : 9% (1%: less change)
Private trips of <u>disadvantaged</u> : 0,05% (% 0,5 a considerable change)

Under this simulation, since it did not work well to attain the expected results, some modification are made and another derived simulation is obtained called "modified version of Simulation 2". Shortly, the modifications were about increases of the tariff for advantaged and the capacity increase of the special paratransit and the ring services. The penalization of advantaged is hypothetical. It is not questioned here how we can penalize in terms of fare increases such a non-existent "advantaged" class in reality.

In Figure 54, LOS information is provided for the simulation 2. There are some problem links which means the capacities of these links must either be increased or some other solutions be considered for those links.

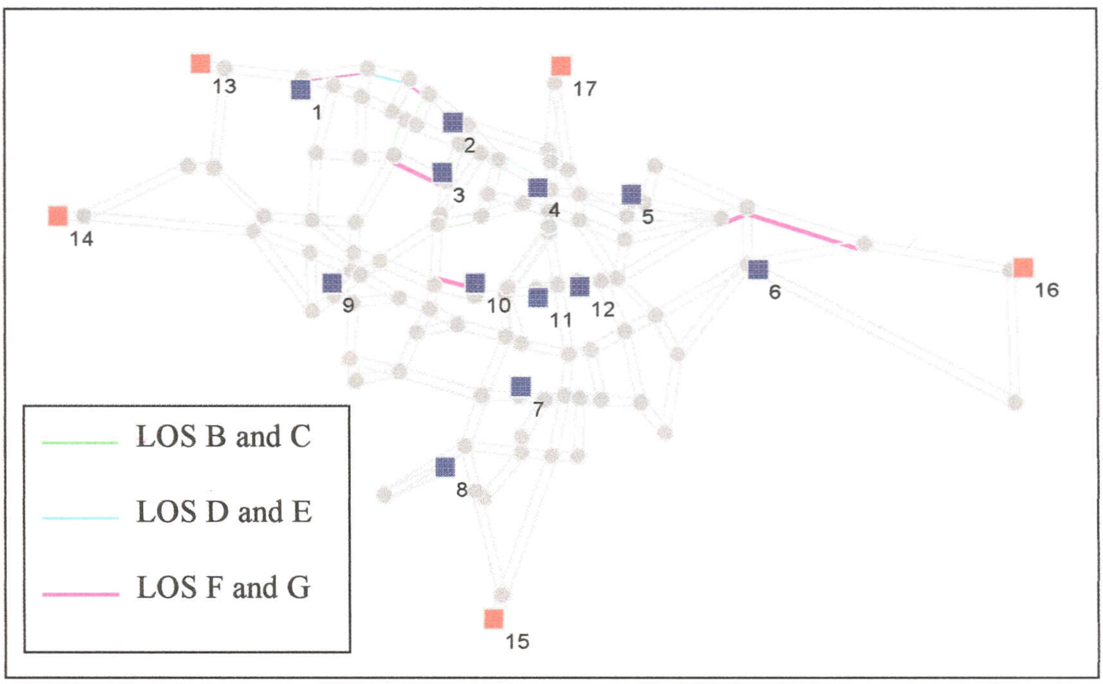


Figure 54. The LOS Levels in Simulation 2 (See problems on some links start to appear)

The results were unexpectedly disappointing, ending up with very small changes in especially private trips. It can not be said whether there is improvement, or not, without elaborating on the reasons:

Modified Simulation 2:

Public trips of advantaged : 28% (no significant change)

Public trips of disadvantaged : 63% (no change at all)

Private trips of advantaged : 8% (less change)

Private trips of disadvantaged : 1% (less change)

5.3.3. The Third Simulation

The principle at this simulation, as being experienced from the results of other two simulation approaches, became playing with fewer and real effective parameters. In the first and second scenarios, combinations of many parameters were formulated but did not work well. As of the principle, the emphasis, as derived from the effect of the income related variables heavily, is on the wealth impact. Thus, design of the third simulation must be simpler. The manipulations will usually be made on the link type commands of TRANUS. Cost effective tools must have the same impact indirectly as the re-distribution of wealth. Thus, the emphasis is primarily on the cost related parameters. As found out, these variables that show the disadvantagedness situations are primarily the vehicle availability and income, and to some extent dependency and accessibility. Differently, the input amount is increased little above the 50% to get more impact in this simulation.

In this simulation, there proposed an area-wide network of pedestrian ways (Figure 56), which should be interpreted as sort of penalization of private drivers. Serving this purpose, even some streets are turned into walkways. The application of this policy has resulted in a favourable demand increase in walking as can be observed in Figure 57.

Policy Areas

- Income
- Car ownership
- Accessibility

→

Policy Application Means in TRANUS

- Much less cost to transit users
- Turning many streets into pedestrian-only walkways
- Strong penalties and cost burden to car owners, decreased access, decreased speed for private cars
- Increased accessibility, speed for walkers and transit
- Other cost effective applications

↓

Formulated in the form of

- Reduced tariff (30%) for transit and increased operation duration
- Increased cost for private cars (such as tax, parking, gasoline,etc)
- Areawide pedestrian ways where vehicular (and especially the private) travels are penalized (See Figure 56)
- Reduced transfer cost for transit
- Increased frequency of transit operator
- Speed reduction and penalization (3 times)for private in streets
- Increased speed for transit, 10 times charge for private and 3 times penalty for pedestrian on highways
- Reduced speed and 2 times penalty for private on boulevards

↓

Expected Results

The same expectations of the previous simulations are valid

Figure 55. Simulation Policy Formulation for Simulation 3

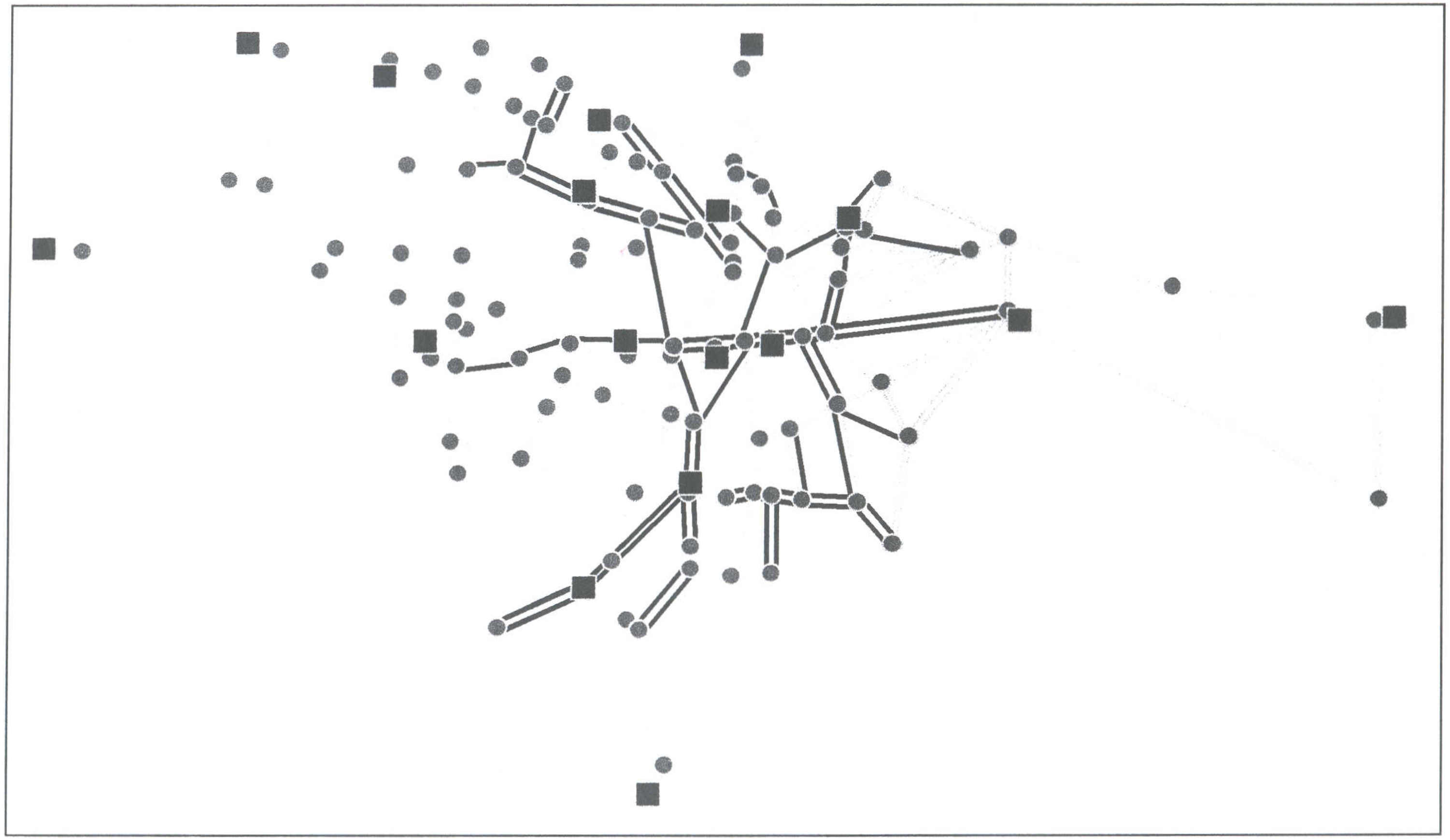


Figure 56. Areawide Pedestrian ways (including bicycle) in Simulation 3

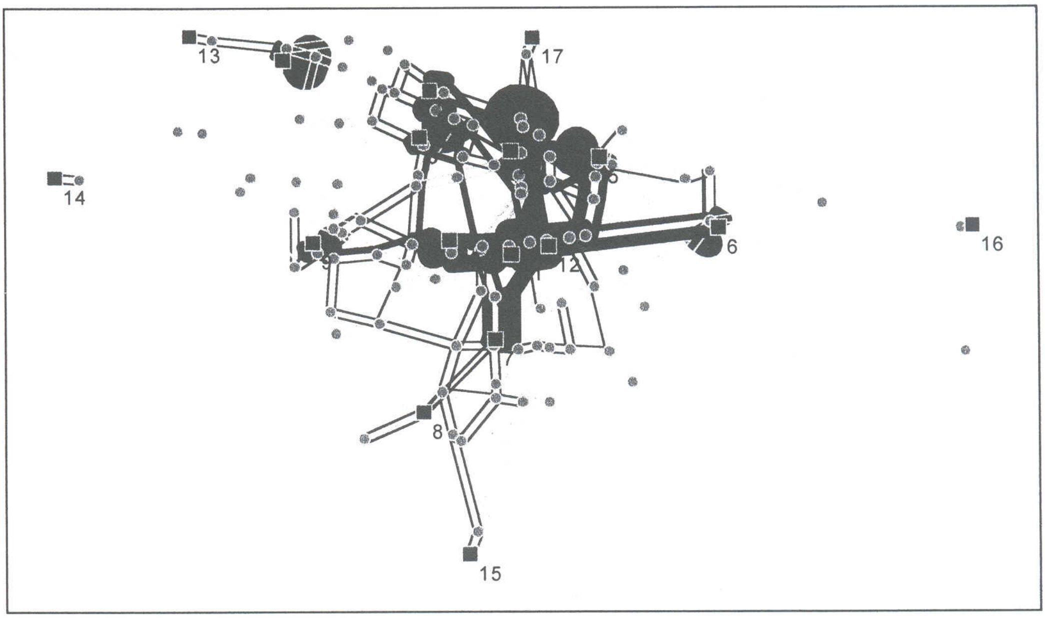


Figure 57. Total Pedestrian Volumes Attracted By the Walkways After the New Additions in Simulation 3

The summary model run results are provided in the Table 38:

Table 38. Summary Results of the Third Simulation

TOTAL TRIPS BY CATEGORY AND MODE							
Category	Modes....						
CatId	CatName	Public	Priv	TOTAL			
1	**adv**	51328	5610	56938			
2	**disad**	99854	958	100812			
	TOTAL	151182	6568	157750			
STATISTICS BY TRANSPORT OPERATOR							
OperId	OperName	Trips	Units-Dist	Energy	Costs	Income	Revenue
1	Priv	6568	10432	0.	3053838	584795	-2469043
2	dernek	77191	168016	0.	3888.	5961961	5958073
3	pedes	209318	87443	0.	0.	437216	437216

When the results were compared to the Base-year (two category) results:

Simulation 3:

Public trips of advantaged : 32% (+4%: significant change)

Public trips of disadvantaged : 63% (%0: no change at all)

Private trips of advantaged : 4,5%(-3,5%: very signif. change, impr'ment!)

Private trips of disadvantaged : 0,6% (-0,4%: signif. change, no improvement)

Significant improvements occurred especially in the case of private trips: while the private trips of advantaged decreased sharply, the private trips of disadvantaged also showed no progress. It can safely be said that the Third Simulation is the best in terms of the trips made by categories.

Likely, the LOS results are displayed in Figure 58. Again, mostly the created pedestrian links pose the problem areas, which is artificial, in fact, that shows the impossibility for the vehicular movement. Yet, there are also few links (thick purple color means F,G and H level of LOS) at the Northeastern part and on the Gazi Boulevard (LOS D and E) near the traditional center, which pose a genuine problem because these are the existing vehicular streets. However, the problem can be overcome hypothetically by adding parallel links that may lead the sharing of the traffic among two links. Actually, there may be other realistic solutions as well, but this is not the concern of this study. Accordingly, there might be other solutions proposed particularly that increase the capacity for those links.

In the next section, other evaluation techniques from different points of view will be applied to the simulation. Finally, the best simulation will be chosen.

5.3.4. The Results and Evaluation

Simple evaluation techniques will be used to assess which simulation is the best. This is to measure that whether the policies applied in the frame of the scenario simulation maintain the approximation of the disadvantaged to the normality (note that not to the advantaged that is another category in the model, which is out of the concern). The approximation to the advantaged is not desired in the model but the normality summing both advantaged and disadvantaged.

Those display and reporting programs under TRANUS are used for the evaluation of the results (TRANUS Manual):

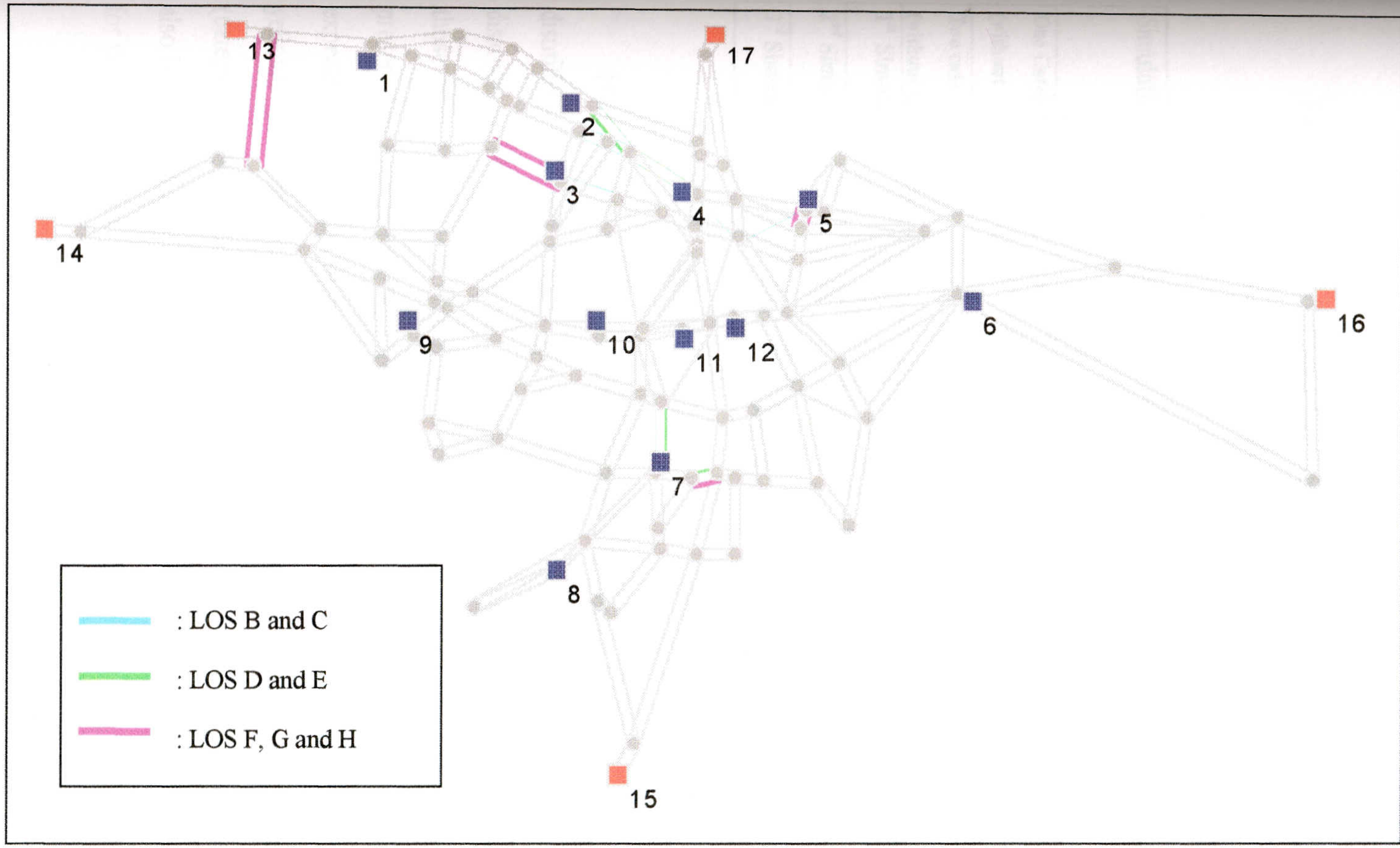


Figure 58. The LOS Levels of Simulation 3

* IMPTRA (general/summary results)
* MATS (display trips by mode and category)
* MATESP (detailed results)

The averaged statistical results of the simulations for disadvantaged category produced by the TRANUS are as in the comparison chart format in Table 39:

Table 39. The Averaged Statistical Results of the Simulations for the Disadvantaged Category

Simulations	**Distance**	**Cost**	**Travel time**	**Wait time**	**Disutility**	**# of best/ worst**
One Categ Base (Nor) (without extern trips)	1,70	43,58	0,17	0,03	80,69	**-/3**
Two categ. Base (without extern. trips)	1,73	43,47	0,17	0,03	71,31	**-/1**
1st Simulation	1,62	37,15	0,17	0,02	65,03	**1/1**
2nd Simulation	2,64	23,37	0,18	0,01	51,56	**3/2**
3rd Simulation	1,74	37,40	0,13	0,03	58,31	**1/2**

Here, those five evaluation criteria (distance, cost, travel time, wait time and disutility) that are readily given at TRANUS can be used as the measures of the disadvantagedness to some extent. The first hand evaluation can be the marking of those best and worst values across the simulations. On the chart, the yellow ones present the best results and the blue ones the worst, for each column. The results are expected to have the minimum values. The best simulation could be the one with many yellows but less blues. Among the simulations, second one seems to be the best (category specific policies) with 3 best values and 2 worst values. However, it should also be noticed that all simulations are better than the policy-off Base Year (ie, Model for normal) results.

As another evaluation, absolute changes of the simulations at the Mode Split By Category results from the Base Year results are summarized in Table 40. All change in positive direction are summed and subtracted from the negative direction change. Then absolute (positive) changes are regarded as the score of the simulation. According to that, the best simulation appears to be the third one with a total absolute change of 6,9%. Of all simulations, the best change occurred at the 'Public Trips of Advantaged' results (in the form of trip reductions) with 4% change (that of Private was so close, too, with %3,5 change):

Table 40. Summary Results of the Absolute Changes (as %) Observed in the Simulations at the Mode Split by Category

Mode Split Results	**Simul. 1**	**Simul. 2**	**Simul. 3**	**Improve?**
Public Trips of Advant.	3	-1	4	Yes
Public Trips of Disadv.	-	-	-	-
Private Trips of Advant.	3	-1	3,5	Yes
Private Trips of Disadv.	-	-0,5	-0,6	No
Total Absolute Change	**6**	**-2,5**	**6,9**	**10,4**

It would be the best if the results of simulation alternatives are evaluated in a pairwise fashion in cells of a matrix, which is many times called rank ordering technique (Papacostas and Prevedouros 1993, p.523) as offered in AHP (Analytical Hierarcy Process) method (Saaty 1980a). It may alternatively be more appropriate to use pairwise [simulationXsimulation] comparative evaluation tables for each criterion in two stages (also called Analytical Hierarchy Process – AHP, see Saaty 1980a, Nijkamp and Blaas 1994, Levine and Underwood 1996). Such pairwise comparisons are especially good for the unclear and qualitative situations. In a sense, this is a method of direct comparisons among themselves, at which comparison ends with clear elimination of one. But, they tell nothing about the weight of the criterion as the result of the scores collected. Such approach was also explained briefly in Elker's doctoral thesis (Elker 1981, pp.36-7.) It was also used in a recent Istanbul-based study for choosing the best alternative for Bosphorus crossing (Ülengin and Topçu 1997, p.1065). For each cell of this matrix, a positive or negative scoring, or 1 if one alternative is superior while other is 0, must be defined. For objectivity reasons, we prefer to assign no priority weight to the measures of disadvantagedness. Here, all simulation results will be evaluated in relation to each other.

Another set of evaluation will be in terms of the changes in trip numbers for advantaged-private/advantaged-public and disadvantaged-private/disadvantaged-public on the zone-to-zone basis (ie, Modal and Categorical Split stage). That also gives hint about the magnitude of change. But, the main attention must be paid to the trip exchanges for both (increase in) advantaged-public and advantaged-private, as well as the increase in disadvantaged trips. On the other hand, a clear decrease in the private trips of advantaged is expected. Because, the exchanges provide the most essential clue about the improvement level in disadvantagedness. However, it should not be forgotten that trip exchanges could only occur laterally (ie, in category): there can not be exchange between the two categories. For example, any trip change in the private trips of disadvantaged can only shift (add) to the public trips of the disadvantaged. That condition fairly restricts our expectations: Regarding the proportions of the public-disadvantaged and private-disadvantaged simulations at Mode Split trips becomes not meaningful for three reasons:

1- In the Base case (policy-off), the trips observed in private-disadvantaged are so less in number compared to those public-disadvantaged that any greater portion of change in private side does add very little (around 1%) to the public side.
2- The expectation was for increase in trips for both private and public trips of disadvantaged, and, it is understood that it is impossible for either when an increase is observed for one (for example, an expected increase in public trips will decrease the private trips)
3- It is observed that public trips of disadvantaged can not record a significant change at all even the private trips of disadvantaged are emptied in negative direction, which is not expected.

Therefore, it is rather suitable to look at the proportional changes in the trips of advantaged, when especially decrease in the private trips of advantaged is highly expected for. In any case, trip exchanges do not much provide information about the improvement of disadvantaged. They only show the affected modal preferences by the simulations. In terms of improvement, rather the disutility criteria should be regarded.

Third policy alternative is clearly the heading one. This is also obvious with the weighed results (Table 41). Thus, it is seen not necessary to apply more complicate methods. This is also because of the emphasis of the thesis not devoted to the subject of evaluation methods.

Table 41. Simulation Ratios as Weighted Scores and Rate of Impacts (Based on the Zone-pair Evaluations)

	SIMULATIONS/BASE YEAR RATIOS (%)				MODE SPLIT			weight	weighted
simulations	**Disutilities**	**Money Cost**	**Distance**	**Times**	Public	Private	sum	winned	sum
Sim 1	-6,7	14	4	-6	-4,5	18,7	19,5	0,3	**5,85**
Sim 2	-1	23	-60	-20	-6,4	28	-36,4	0,17	**-6,19**
Sim 3	-18	15	-1	16,5	-1	49	60,5	0,52	**31,46**
sum	-25,7	52	-57	-9,5	-11,9	95,7		0,99	
Aver. Impact	**-8,57**	**17,33**	**-19**	**-3,17**	**-3,97**	**31,9**			
dist. to average (of best sim)	7,57	5,67	23	19,67	2,97	17,1	**75,967**		
rate of impact	0,10	0,07	0,30	0,26	0,04	0,23	**0,9996**		

Note: Orange colored cell signifies the winning simulation in that criterion

In the Table 41, also the relative weight of the winning simulation to others, by proportioning of the score to the sum of the criterion (column), is provided for each criterion. That shows, to some extent, the relative size (importance) of the simulation for that particular criterion. We assume first five of criteria are exclusively mutual (independent from each other) as if an orange can not be compared to an apple: A situation can be evaluated within its context. Thus, in case if they are assumed to be mutually exclusive, the situation will turn out to be as in the Table 41 where weights are derived from distance of the best result to the average (impact) value for each simulation. Then, the individual weights of each indicator are found, which should be interpreted as the maximum magnitude of impact observed in that indicator, as these differences are summed and the individual differences rationed to this sum. In this approach for the zone-pair evaluations, the third simulation becomes significantly the best simulation in terms of the best impact. Similarly, even in Table 42, where exactly the same procedure is run for the criteria values as the per capita averages, again the third simulation is found succesful (see the "weighted sum" in the Tables).

Table 42. Simulation Ratios as Weighted Scores and Impacts (Based on Per Capita Averages)

	SIMULATIONS/ BASE YEAR RATIOS (%)					MODE SPLIT			weight	weighted
simulations	Disutility	Distance	Cost	Trav. time	Wait time	Publ. Trips	Priv. Trips	sum	winned	sum
Sim1	8,8	6,3	14,5	0	33	0,6	24,6	87,8	0,16	**14,05**
Sim2	27,7	-53	46,2	-5,8	66,6	1,3	-12,7	70,3	0,46	**32,34**
Sim3	18,2	-1	14	23,5	0	1,3	57	113	0,37	**41,81**
sum	54,7	-47,7	74,7	17,7	99,6	3,2	68,9		0,99	
Goal:	reduce	reduce	reduce	reduce	reduce	increase	reduce			
Aver. Impact	18,23	-15,90	24,90	5,90	33,20	1,07	22,97			
dist. to average (of best simul.)	9,47	22,20	21,30	17,60	33,40	0,23	34,03	**138,2**		
rate of impact	0,07	0,16	0,15	0,13	0,24	0,00	0,25	**1,002**		

Note: Orange colored cell signifies the winning simulation in that criterion

On the basis of cells, the simplest calculation technique to find the net change (or, difference) would be used for the first five criteria: just subtracting the Base year values of disadvantaged groups from the values of the simulation, which can be denoted as:

$$C = \text{Base}_{dis} - \text{Sim}_{dis}$$

C is found for each cell. General results can be sought in:

$$\Sigma C = \sum_{i} (\text{Base}_{dis} - \text{Sim}^{i}_{dis}) / (\text{Base}^{8}_{norm} - \text{Base}_{dis})$$

Then, $C = Sim^{i}_{dis} / Base_{dis}$ can be possible

Then the proportions of values to the Base year values can be taken since these are all independent criteria. In this case, then the calculation is:

$$P = (Base_{dis} - Sim_{dis}) / Base_{dis}$$

Here, superscript i represents the criteria evaluated. Then, the general average of all proportions found fore each cell is obtained which is single value peculiar to the criterion and the simulation stage evaluated just as in the Table 41. Consequently, the evaluation of findings can be organized under four points of reference:

5.3.4.1. Results pertaining to the situation of zones (or, zone-pairs)

In Modal Split cases, the private trips are regarded to see the impact of changes. There are positive but minor shifts in general by the simulation's policies in the expected direction. That is, almost (except one or two cells) all cells reported increments in public trips (but, very low) and correspondingly reductions in private trips (as far as 18,7%, 28% and 49% respectively for simulations).

In the first simulation, as of zone specific scenario, the weakest effects appear in the public trips (-4,5). Only Zone 12 reports a considerable effect both in productions and attractions of the Public trips. From the point of private trips, purposefully, the zones 7, 10, 11, 12 are more benefited from the policy.

In the second simulation, as of the category specific scenario, private trip productions and attractions benefit from the Zones 1, 2 and 6, 8 (Northwestern). For the private attractions, again Zones 1, 7, 8 and 11 are the most affected by the policy application.

---

[8] Base results of the model run for Normal should be without external trips.

In the third simulation, as of variable-based scenario, Zones 2, 5, 11, 7 and 8 are the most impacted towards benefit both in terms of attractions and productions for the Private trips.

From the point of other five criteria based on the general cost situation to travellers, in which there is no categorical and modal results, usually 6, 7, 8, 9, 11 and 12 are the zones where the most successful results are obtained. The conclusions below are drawn. Only, the situation of public trips are held for the comparison:

5.3.4.1.1. Costs

In the first simulation, especially zones 11 and 12 (both from productions and attractions) benefited from the policy package. In the second simulation, especially 1, 6, 8 and 9 were advantaged. In the third simulation especially 7 and 11 benefit from the policies. Thus, second simulation is especially becomes the most fruitful approach.

5.3.4.1.2. Distance

Zones 6, 7, 8 and 12 benefit from the policy application for the first simulation. Only, Zones 6 and 9 become advantageous in the second simulation. For the third simulation, 7 are relatively better. Here, the first simulation comes front.

5.3.4.1.3. Disutilities

Interestingly, almost all zones are worse in terms of disutilities. The success is very low for this criterion for unknown reasons. Only seventh zone is better-off in the first simulation and the second zone in the second simulation. But, no zone is better-off in the third simulation.

5.3.4.1.4. Monetory Costs

Relatively Zones 11 and 12 get more benefit from the application of first simulation. Zones 8 and 9 benefit from the application of second simulation. For the third simulation, especially 7 and 11 are the best. Interestingly, every zone benefits in greater shares from the applications of the third simulation except 1 and 9. The second simulation looks the best.

5.3.4.1.5. Times

Actually all simulations worked successfully and all times were reduced in almost equal shares for all zones. Especially, 9, 11 and 12 in the first simulation, 9 and 11 in the second simulation, and 2, 8 and 12 in the third simulation were the most benefiting zones. The third simulation records the best results.

5.3.4.2. Results from the perspective of the criteria (Based on Per Capita Averages)

As can be inferred from the Table 41 in Section 5.3.4, the weighted sum of the indicators show that the most elastic indicators in terms of the impact are the reductions in distance (%30) and the times (%25). The most inelastic but the highest level of impact occurred in the public trips indicator (%0,9). In the Table 42, for the per capita averages, the most elastic impacts were with the wait time and private trips (24% for both). Adverse impacts occurred in 'disutilities' for all simulations.

5.3.4.3. Results pertaining to the situation of two categories in general

Average impact ratios, or the average amount of shift by the policy applications, for all simulations are around: -8,5% for disutility, -19% for distance, -3% for times, and -4% for public trips, which are all adverse impacts, and 17,3% for money cost and 32% for private trips, which are positive. But, the results for per capita evaluations are quite different: 18% for disutility, -16% for cost, 25% for distance, 6% for travel time, 33% for wait time, 1% for public trips and 23% for the private trips, which are almost all positive. That is to say, the disadvantaged could be improved well, commonly in all simulations, in especially the fields of times (travel, waiting, etc.), cost and the private trips (reductions). For the positive results (per capita), the plain average of all, without taking weights into consideration, makes around 13% (which is net 2,4%, and absolute average change is %14, for zone-pair evaluations) improvement (as output), although around, at best, 50% (actually 63%) input changes were aimed at the simulations.

Regarding the per capita criteria averages, the efficiency of simulations in gross, expected to be 1.00, thus:

E = 13% / 50% = 0,26

Which is actually far from the efficiency.

However, when the total average impact of the only <u>best</u> simulations are regarded, which is 32%, almost a significant efficiency appears[9]:

E = 32% / 50% = 0,64

That is to mean, in real life, improvement efforts to help improve the conditions of those disadvantaged are costly, inefficient and burdensome. Yet, the efficiency ratio can be increased with some more strategic scenario simulations. It is admitted that, in this study, the focus was not on finding the best policy packages and the simulations were just heuristic trials.

5.3.4.4. Results from the Point of Traffic Assignments

Although it is apparent that the third simulation is the best policy alternative for the disadvantaged in terms of all criteria mentioned, it is the worst one in terms of the LOS levels and there appear the links where the traffic might severely be restricted. This situation does not devalue the simulation' significant success but such information reminds the planner to take necessary action to eliminate the capacity related problems on those links.

[9] However, in this case of efficiency calculation, the best simulation is different at each criterion.

Chapter 6

CONCLUSION

6.1. The main conclusion on the thesis

The hypothesis, as stated at the Introduction of this study is that, **first**, it can be possible to define those disadvantaged groups in an objective manner, as could well be subjectively, and they can be treated to greater extent at the transportation planning and the modelling stages. **Second**, it is possible to model for disadvantaged and compare the results with that of the Normal (conventional) modelling, as far as the comparability is sustained. And, **third**, it is possible to deploy "relevant" policies based on modelling results (The Evaluation stage) to recover the disadvantageous conditions that those disadvantaged fall into, although still many ambiguities (uncertainty) rules out there. The uncertainty appears at (1) which policy action causes (2) what sort of impact, that can be covered to some extent by the sensitivity analysis in policy impact analysis stage, but may have required some additional and exhaustive effort. This study lacks sensitivity sort of analysis.

This study was to form a methodological guideline to accomplish all the statements said above. This study was not to properly excel with the finer procedings and to cover all details in the steps of a typical transportation planning study. . This study has showed the short-cut definition of handling such models about the disadvantaged. However, it is believed that, pursuing further studies in this direction, there might be invented more simplistic and easier ways to accomplish all these procedures, especially that could be utilized in the evaluation process and city planning. Thus, TRANUS was majorly utilized in order to speed up the processes. Since, this study does not certainly offer a separate handling of the disadvantaged but seeks its integration to those conventional models, using a reputed transportation planning software (TRANUS) is the search for this kind of integration.

This thesis began with a theoretical discourse, a problem definition; modelled it and used real data to validate it. That is, it has been a deductive approach. It proposed a modelling approach, not only descriptive but rather a normative one. The model approach described here could not be meaningful without the evaluation part at the end, the equalization effort of the disadvantaged to the normality.

The approach is raised basically from the simple logical assertion that there exists the mutual relation between the inequity in the existing situation and the policy measures in the ideal state. The idea is inspired from, but not copied, the principles of measuring equity. There are few equity measure indices among which Gini index being the most well known (Mandell 1991). The model here, inspired from the index, did not follow its special methodology, but offered a new measure of equity and a way to eliminate the inequity.

In existing situation: $(\text{disad} + \theta) / \text{Norm} = 1$

where, that the equation has to be 1 is imperative for logical consistency

similarly, in ideal state: $(\text{disad} + \vartheta) / \text{Norm} = 1$

where Norm = disad + adv, which is same for both equations

The values of the equations probably belong to different valuation realms: Indeed, θ represents the defect parameter of existing transportation situation, while ϑ represents the "means" parameter to overcome this defect. Thus, practically the logic let θ and ϑ be the equals not in terms of "value" but in terms of the "content" that maintains the two equations. That is, **whatever the values and the units that θ and ϑ may take independently from each other, it must be maintained that the equations always be equal to 1.** For example, θ can be 5 "kg" of defect and ϑ can be 30 "unit" of policy measure at which, only when 5 kg defect can be overcome by 30 units of policy measure, both equations can become equal to 1. This condition makes the parameters "equals" in terms of the content.

Based on this seducing idea, as defined largely at the Introduction and at the very beginning of Chapter 4 , the thesis was three-fold:

a) There is so-called a "transportation disadvantaged" that can be identified (distinguished) from the rest,
b) the identified transportation disadvantaged should be treated separately in a separate model, as of the requirement of **equity** principle, but be integrated to the generic models,
c) as of the process defined in (b), the neediness level, and thus, policies addressing to the improvement of the disadvantaged can be defined (measured) by simply developing a set of methods in interpreting the differences between the model output of disadvantaged and model output of Normality.

For the first one (a), there are these sub-statements (maintaining hypotheses) as:

1-Existing (status-quo) transportation system is an ill-defined system that continuously creates those disadvantaged unattended and transportation problems, for short term solutions,

2- And, what is worse, existing (conventional) models support this status-quo. Therefore, they are not normative (solution-oriented) and are not helping those disadvantaged,

3-There arises need for rectifying the system (ie, normative approach) integrated to the status-quo models that continuosly correct their ill structure, and its problem-generating features, updating the awareness for the situation of those disadvantaged.

Because of the complexity of the identification of the disadvantaged in real life, and its multi-criteria nature, the identification procedure needed to be as possible as simplistic and objective in model validation that can be performed well by multi-variate cluster analysis method. Since the disadvantaged can not be signified person by person, which would not be meaningful either, only the socio-economic and geographical (zones) transportation categories to which they are affiliated could be identified meaningfully as the disadvantaged.

For the second statement (b), the same principles and procedures of modelling was to be applied for both the case disadvantaged and the case of Normal (that might be called "Base case").

For the third (c), the nature of differences was learned. The difference between the situation of disadvantaged and the normality should provide information-basis for formulating the policies to help improve the disadvantaged. As known, the ideal condition where the needs of disadvantaged is completely met is the Normality.

Therefore, the modelling approach here is called the 'ideal' model. The policies must be defined on the basis of the information obtained from the differences and be applicable to the identifiable socio-economic (and demographic) groups and the geographical areas (zones in the study) seen in real life (Category Analysis or "Matching Process" in the study) to be realistic. The application is tested in the simulation environment, and the best one is nominated. The aim of the thesis is not actually achieving the best solution, but the learning from the results. The simulation results, and other results, will give idea about the policy types we have to choose.

The reader should be warned that this study is based on many axioms (assumptions) inescapably assuming to be true even if they are not in reality. Thus, the model run outputs in this respect may not be one hundred percent fitting the reality[1]. Therefore, the study presented here within the limited resources provides results of neither truth (accuracy) nor reality, but serve to an understanding of a phenomenon and processing (methodology) of handling of the issue.

6.2. The general conclusion on the findings

In the literature, those transportation disadvantaged have been strongly felt to exist, but neither scientifically determined as who they might be nor deserved a special treatment among the modelling studies. The disadvantaged is especially relieved by the strong existence of those advantaged (usually automobile owners) in the Western societies. When the car owners heigtened their positions, relatively that of rest got degraded: those transit users, pedestrians, disabled, old and poor, and those inaccessible, center city dwellers in the Western societies, etc., thus, not only fell into disadvantageous position in terms of travel conditions but also in terms of access to job opportunities, and other locational and social advantages. Differently, in this study the phenomenon is examined empricically in their daily trips and experienced on a case study, for the first time, heavily with the emphasis on the travel conditions.

This study is, thus, about the search of an objective way of determining the disadvantaged. It is not, however, meant that automobile owners, short trip makers, or even non-trip makers are definitely advantaged. Likely, it is not either intended to call public transport users, for example, definitely as disadvantaged. The disadvantaged must be the result of an objective evaluation process without the interference of subjective criticism but under the defined set of criteria or correspondence, which is *raison d'etre* of the cluster analysis technique. After objectively defined, how far those objectively defined category(ies) matched with those subjectively defined categories of disadvantaged is one of the second major concern of this study.

The **general conclusion** of this study can be stated as: all thesis statements and promises mentioned in "main conclusion on the thesis" are proved to be true and applicable to some extent: All steps and processes are designed and realized within the limits. The disadvantaged **could be defined, treated and analysed, at least, in three steps of the four (ie, except Traffic Assignment) transportation planning** as could be done for Normality. **The policies could be derived** from the differences between the model output for disadvantaged and for Normality (Base case) and the policies were tested on the simulation environment that yielded some meaningful and positive results (will be largely explained later). Thereby, it is argued that the differences, thus policies, can be defined for each planning stage as well as for general, yet are not tested firmly for all stages. That is, in the absence of data of disadvantaged, it is possible to apply a special "disadvantagedness coefficient, Dx (or, factor)" found previously, to be used in similar studies as an "export" coefficient for each stage, which would give idea about the disadvantaged when planner handles the issue at a specific stage (for example only at Trip Generation stage). Yet, defining a firm Dx ratio could only be obtained by frequent tests (ie, many studies in many different areas).

[1] According to Kurt Gödel's famous argument ('Incompleteness Theorem'), any scientific study based on set of axioms will reach the statements within the system governed by those axioms (ie, consistency) that can neither be proved or disproved on the basis of those axioms. Hence, every mathematical system will **always** have unsolvable paradoxes.

What sort of differences exist between the two categories? What are their nature? At what stages do the differences become more significant? Do they mean parametric differences, the structural differences, or the differences coming from the data facts? Can we arrive at a summarizing conclusion such an overall "disadvantagedness Ratio" (Dx), which is sort of friction of being disadvantaged?

It is observed to exist at least two sorts of Differences (Dx): One is the difference at the level of parameters or coefficients. "Parametric" type of difference can naturally bring change in the modelling structure (additional or different coefficients, calibration parameters, or even change in the variables themselves) and thus, in the results with different parameters peculiar to the disadvantaged. The other type is the change observed in the (total) result itself and called the "structural" difference that does not change the model structure but the results. Yet, it is definitely true that "structural" difference is largely the product of the population difference between the two categories: when supposed the number of the disadvantaged is equal to the number of Normality, the structural difference would then approach zero, and the parametric difference is almost trivial. "Parametric" change occurred significantly at the Trip Production stage (due to different variables used), while the same "structural" change is valid for all stages. The Dx (structural) is 0,63 for Aydın.

Special D_{ij} values are found for the Trip Distributions as well. Further, A general Dx can be defined at the Mode Split in place of modal choices (between public and private) as well as D_{ijk} for each zone-pairs by mode. Because, the parametric difference is heavily influenced by the utility based mode choice parameters besides the transportation and network system characteristics that affect the mode choice of users. The difference between the normality and the disadvantaged was minor.

When the variables 'DEPEND' (dependency level in the household), 'INC.PER' (income per capita) and 'statu.edu' (educational level), which are generally income related, could be the explanatory variables in the Trip Generation stage of the Normal Model, these turned out to be 'DEPEND', 'PUB.COM' (perceptional comfort parameter for transit system) and 'VEH.COM' (comfort parameter for the vehicle) for the model for disadvantaged, which are generally the perceptional variables about the travel conditions. Of those, only the variable 'DEPEND' co-exists in both models. As can be noticed, all variables except 'statu.edu' are the major (function) variables. That proves the utility of major variables.

Finally, how can we use differences in the evaluation of the results and the policy-making stage? The differences can best be evaluated as the material in measuring the efficiency of output/input balance when policy-making. For example, if the planner knows the impact (output) change occurred around 50%, for efficieny, the input must be maximum 50%, too, which can be expressed as:

If Efficiency (E) is trying to get maximum output given minimum input:

$E = \text{Output} \;/\; \text{Input}$

Then, $E \geq 1$ (should be)

Then, it can be assumed either that since 'input' change, here, is around 50%, the output must also be expected, at least, 50% to be E=1. However, this may not be so in real life and output may require three or four times more input. In this study, <u>any</u> change will be welcome as improvement, not as efficiency but sufficiency.

Indeed, there occurred "some" change as the result of the simulations, which is unfortunately not very efficient: 26% (ie, E is not even closing to 1). But, it is increased almost to total efficiency when the average of all the <u>best</u> simulations at each criterion of evaluation is regarded: 64%[2]. Alternatively, when solely taking the average of all changes (ie, 16%) of the best simulation chosen, which is the third simulation, all throughout the criteria, the efficiency ratio becomes approximately 32%. That is, we need more input for obtaining a considerable amount of output. In other words, supplying the very best results to improve the disadvantaged, to make it almost equal to Normality, or acquiring a *total* equity, can be obtained only after very

[2] When calculating the efficiency ratio of this, 50% (between Normal and the disadvantaged) is taken instead of the net difference, 63%.

expensive policy implications and investments. Yet, as mentioned before, cost criteria is ignored in this study. Sort of a series of sensitivity analysis studies would be helpful in identifiying the exact amount of input for the full satisfaction of equity.

However, it is also strongly emphasized and advised that the issue of coefficient for disadvantaged is still a virgin area and can be handled from various perspectives. There can be, for example, various forms and approaches of defining the "disadvantagedness coefficient" (which will be proposed in the 'Further Research' at the end) and there are many ethical dimensions to explore. Still, many aspects and situations of disadvantaged are ignored in this study. after this introduction, it is believed, such studies will contribute much to the literature on the transport disadvantaged.

Though, it is not intended to stress, in this thesis, which simulation was going to be successful, and why, the policy approach is captured through simulations that plays around the concept of benefitting those who are low income and the carless groups. Likely, transit operators ought to be attractive and comfortable as far as the private automobile to help reduce their being disadvantaged. **As the general finding drawn from this lesson, it was observed and verified not surprisingly once again that the disadvantagedness is largely the outcome of <u>income</u> and <u>automobile (or vehicle) ownership</u>. To prevent disadvantagedness, policies must be deployed around these parameters, thus, more palpable effects can be obtained in order to improve the conditions of the disadvantaged. In a sense, from the results of the simulations, vehicle ownership and income related policies are the "captured policies".** Yet, this does not mean the improvement in the form of monetory helps or distributing cars to people (well, maybe hypothetically), for example, but in terms of the qualitative conditions of travel. There are also other determinants but they are related to the income (such as accessibility) indirectly.

Probably, this conclusion was the fact not surprising, but the study has been a firm verification to that knowledge. What is additional to the verification, in this study, has been the finding of the "prescription out of the diagnosis" (ie, the problem that could be well defined and examined) as well, which constituted the basis of the policies for disadvantaged. In other words, the policies were drawn on the basis of the information of disadvantagedness levels of the various socio-economic groups (and zones as well). Thus, the model, in a sense, produced knowledge-based scenarios.

There are also auxiliary conclusions of the study: The study should be drawing attention to the special case of disabled and their mobility problems. One of the important stimuli of this study was that the obligation enforced by the Law to employ the disabled to a certain percentage, if ever applied, must be creating some transportation demand by those people. Now, those working-age disabled must not be sitting at home but participating to work force as normal people. There must be paralleling in the number of disabled employed and, thus, trip productions by disabled, and in the number of disabled who are abled to work (or, in the work age). In this case these issues appear, which are not effectively held in this study, as the immediate further search areas, whether:

- the working-age disabled are really employed in reality,
- they produce trips as far as the rate of their population to the rest of the population,
- they produce trips as far as the rate of their participation to work-force,
- they need a separate special transportation provision and extra facilities, or, services,
- or, they can be integrated to the current transportation system,
- if they can not be integrated, and transported, what will happen? (Will other <u>compensation</u> means be considered?)

As being the most serious, the disabled, not concerning here how they can be transported, was <u>not</u> actually found among the categories of the most disadvantaged since their very low representation power (ie, frequencies) in the sampled population. This can be the answer to the first question asked above: The participation rate of disabled to trip making was so low. That is also a partial answer to whether they contribute to labor force. It is strongly believed that they do not, as far as permitted in the Law that allocated job opportunites for handicapped. But, one of our scenarios for simulation is devoted to improve the conditions of the disabled and old, such as a separate paratransit solution but could get a partial success. This does not mean the problem is trivial and ignorable, but, cannot probably be handled this way in four steps of planning and with such a software which is not specifically designed to handle such "minor" considerations.

One another vital conclusion drawn from this study is that the behavioral difference between the Normality and disadvantagedness appears overwhelmingly at the patronage of the socio-economic variables (like car ownership, income, household size, educational status, etc.). This is probably the disadvantagedness is overwhelmingly the result of the socio-economic factors. This may also give idea about the ideal aggregation level, which is probably the household level, especially for the model for disadvantaged.

In the Trip Assignment stage, on the other hand, the emphasis was on the test of the viability of the model results and the monitoring whether the assignments at two modelling approaches (especially, the assignments at the model for Normal together with external trips) do not cause any dysfunctioning of the links rather than measuring the disadvantagedness at this stage[3]. This is because practically measuring the disadvantagedness on the links is hard and not very meaningful among the content of this thesis. But, in a separate study, this can be done on the links basis as well as zone basis. On the other hand, the traffic assignment results of the simulations (especially the winning third simulation) create serious capacity problems that need to be solved separately, or, a modified alternative simulation considering these additional capacity problems should be offered.

6.3. Conclusion on the Modelling Approach

In this study, modelling in transportation planning is used as a helpful instrument in order to construct and re-address the planning policies to ameliorate the situation of the disadvantaged groups in terms of their travel conditions. In other words, it is argued and testified, the policies to improve the conditions of the

[3] Yet, it should not be forgotten that the assignments on the links were the modelled results, but not calibrated. If calibrated, highway results must have been divided by traffic adjustment factors which are found specific to link types, the volumes, thus LOS levels, would be different, yet proportional to the non-calibrated results.

disadvantaged can even start from the four-step planning model. The three utilities of doing that were:

1. The model gives information about the nature of "disadvantagedness"
2. The model also prescribes the necessary steps
3. The model enables continuous monitoring and test of the policy application results by simulations

By the "category" property of TRANUS package, it is deemed that it could be possible to adopt such an equity-based normative model in the form of two basic categories. However, still many shortages were encountered that prevented one-to-one fit of our model's proceedings to that of the package, simply because the package had not been designed for such a consideration: Though few parameters were adoptable, many were absent or irrelevant to what we aimed to in our model.

Since the approach described in this thesis is not the offering of totally a new model, it does not require to apply best model check criteria. However, some attributes of the approach can be discussed. The model approach may, at first sight, look scaringly complicated. The complication is rather in its processing, indeed. It is so in terms of conducting a series of data aggregation process, which, in fact, may not be necessary if the data is already available for the process, and of the evaluation (equalization) process, which is also comprised of a set of processes. It is rather simple in terms of mathematical sense and conceptualization in terms of the integration. Furthermore, if all four steps of planning are done through a sophisticated user friendly software, the only difficulty might be reduced to interpreting the results of model runs. Since the evaluation process, or at least the logic, is already described in detail here, it does not require a re-definition of the processes in future studies using this model. The user of the model is advised to follow through the steps described in this study, as the guide, which is less difficult than following the technical manuals. Further, after the logic is understood, some new personal methodologies can be even invented at will.

The model is consistent and accurate as far as the data collected is consistent and accurate. Yet, it is admitted that, in the case study proposed, where data collection and aggregation was not ideal, many defects could be observed. However, this does not devalue the role and logic of the model. It is predominantly assumed that the model *is* consistent and provides the expected results, then it is run to make it work and produce expected results, which proves that it works.

The model is sensitive and flexible to changes means that if any change in the structure of the conventional model, or, if some new elements are added to it, the system described here, as being just an integration to the base model, will not collapse as far as the robustness of the Base model.

As mentioned before, the idea of model integration that handles the situation of disadvantaged is a realist one in terms of the fact that it is a reality that there are disadvantaged persons in their urban travels, and their complaints are real that must be addressed within a systematic approach. The findings that those sub-categories low income groups and people without cars are truly the disadvantaged, which is expected, mean the modelling approach is representative of the real life facts.

The model is decisive since, as the result of the model outcomes, targeted outcomes nearly came true, that is the ultimate purpose of this study.

6.4. About the Methods Used

A series of methods, or data processing techniques, most of which are peculiar to this study and are all interdependent, were applied to achieve the goal of this thesis work:

- First of all, it was important presumably to know about who (or, which socio-economic and demographic groups) might be disadvantageous, or subject to disadvantageous positions. Thus, as far as followed from the literature, some basic categories are generically pre-defined as "might-be" disadvantaged groups. This is a subjective classification based on the common knowledge. The reason in doing this is to later associate (match) those pre-defined groups to the disadvantageous positions and variables used in the model. So that , these variables could be named as "disadvantaged-related variables" after they are associated with the categories as a result of the correlation process. There are, of course, uncertainties in this area and the reasons of correlations are not very readable. But, using some quantification techniques, the ambiguities were to be reduced.

- Being the essential part of the thesis, to find out whether the society can be non-presumably (ie, objectively) be divided into two basic categories as those advantaged and disadvantaged in terms of the transportation conditions exposed, the study used sort of "self-organizing" cluster analysis technique to identify the disadvantaged, and inevitably the advantaged, in an objective manner. This study, in a sense, is to test whether this segregation can be done and the partitions can be treated in the modelling. It was important to apply the same modelling rules (or, approach) for both groups. It is not, however, inquired here whether the technique is properly used or the disadvantaged was rightfully determined. To compare the results of the two partitions, it is essential that the summation of advantaged and disadvantaged be (nearly) equal to those of Normal's. The results obtained are assumed to be correct. The population ratio of disadvantaged (K^p) is found to be almost **2/3**, which is, of course, peculiar to Aydın City. If this ratio is to be multiplied by the "parametric ratio" (δ_x), it must give the "structural" Disadvantagedness Ratio (Dx - general coefficient for the disadvantaged) for the modelling stage considered:

$$Dx = K^p \,.\, (1 \pm \delta_x)$$

- Another method, which is quite peculiar to this thesis work, is the clustering (reduction) of the minor variables to Major function variables. So, there are both Major (function) variables and Minor (individual) variables at hand. Major variables are composed of the minor ones in the form of functions. The purpose in doing that is, first, to <u>reduce</u> the number of variables (out of 100 variables) that are to measure the qualitative aspects of travel behaviors. Thus, the minor variables are formed in meaningful clusters (by looking at the correlation values). The colinearity was avoided in these correlations. Second, it is thought especially in the social sciences that individual (minor) qualitative variables measuring comfort or impedance related parameters would be inadequate in explaining the behavior. To avoid this weakness, group of variables are thought to have more impact as the impact of one giant variable. Yet, this time there has been the danger that those strong minor variables in the function would loose its strength. Indeed, this is observed: many major variables had lower correlation values with others such as the impedance (general cost) type variables (IMPED1, IMPED2, IMPED3)[4], etc.. Third, as a by-product, we could be able to know whether the Major variables are more effective than the minors especially in forming the Regression model in Trip Productions. Indeed, it was observed that major variables are more effective while some minor variables can also be effective.

Besides this complexity, there were both the variables when their value increase the situation of the person ameliorate and also the variables when the value increases, the situation gets worse. For the comparability requirement, first of all, those ameliorating-value variables and also those worsening-value variables are grouped separately. Then, all "worsening-value" variables were converted to ameliorating ones subtracting from 1 if the values are rate type, and from 100 if the values are between 0 and 100. Thus, the first step for the comparability of variables is sustained for especially the clustering process.

- Additional complexity was the scaling problem. Scaling of the variable values is also necessary for comparability of the variables: Values of some variables were between 1 and 4, some between 1 and 5, some were 1 and 8, etc.. For the standardized scaling, all values were turned to the scale between 1 and 100, not including the Minors, in the functions as well: (1) Major variables are enriched in value range compared to the Minor variables. (2) Variables are scaled for the comparability. (3) The variables became more representative of the reality. Finally, all variables are converted to sort of **ameliorating-value variables** and **between 1 and 100** values, which is what can be called standardization, or normalization process. Thus, all variables were measurable, and precisely quantifiable parameters.

[4] See the note in Imperfections section at the end of this chapter

- Another useful technique used in the study is the correlation matrix. The correlation matrix including all variables but with the emphasis on the Major (function) variables served basically two purposes: (1) the definition of the Multi-variate Linear Regression Model that was used to find the trip productions (ie, the first step of the transportation planning process). This is one of the weakest points of the model constructed in this thesis work, which maintained artificially increased R^2 value: Out of 12 zone-aggregated samples, 3-variable ragression model is constructed. (2) the definition of the related variables, especially between the transportation categories and the home interview variables. Latter is used especially in determining the policy areas to be used in the scenarios.

- One another accomplishment peculiar to this study, which is actually the ultimate goal of the thesis, is the definition of the policies from the differences between the Normal model run and the model run for the disadvantaged. It is argued that ideally the Rate of Disadvantagedness should be read for each four stages and be addressing again to these steps. But, in this study, the differential rate (D_{ijk}) could only be aggregated up to Mode Split stage due to the restrictions mentioned. It is found that, such an overall "disadvantagedness coefficient" (or, factor) can be 63% for Aydın case. But, this is the rate observed in total output (structural), affected heavily by the population factor of disadvantaged, nearly 2/3, therefore, only the parametric difference, which is minimal, should be ragarded as the genuine factor of disadvantagedness. This is important conclusion in the sense that, in similar cases, and when the data for disadvantaged are absent, we can apply such a disadvantagedness factor to find out the approximate number of disadvantaged, at least, for Trip Distributions.

Since the "Disadvantagedness Coefficient" is in terms of "structural" difference, and it is rather the factor (as percentage) of the disadvantaged population, after the "structural ratio" is known (or, calculated) for each stages for each zone-pair, such a stepwise estimation of the disadvantaged trips can be tried for any i^{th} stage of planning, without going far into the details:

Estimation at the Trip Generation Stage:

The aim is to define $\mathbf{o}_i^{dis} = T_i^{dis}$,for each zone

Yet, $\mathbf{o}_i^{dis}$ can be roughly determined assuming all $\mathbf{o}_i$ are multiplied by the general ratio of disadvantagedness Dx (or, $\sum D_i/n$) for the initial process. Alternatively, if we already know D_i, only at the level of Trip Generation we can find the trip productions of a zone:

$$T_i^{dis} = T_i \ . \ D_i$$

Estimation at the Trip Distribution Stage:

$$T_{ij}^{dis} = \mathbf{o}_i^{dis} \ . \ d_j \ f(c_{ij})^{dis} / \textstyle\sum_i d_j \ f(c_{ij})^{dis}$$

,where k_{ij} can be ignored and if A_j's (Attractions) are also defined for the disadvantaged d_j can be known, otherwise they can be iteratively be found through the calibration process. $f(c_{ij})^{dis}$ is determined after β parametric value is known for the disadvantaged by the calibration.

Alternatively, if the D_{ij} is known somehow (emprically found, or, imported value for each zone-pairs). This is also practically true:

$$T_{ij}^{dis} = T_{ij} \ . \ D_{ij}$$

,or, if D_{ij} rates for disadvantaged are not known but only $\mathbf{o}_i^{dis}$ values are known (or, obtained):

$$T_{ij}^{dis} = [(T_{ij} \ . \ Dx) \pm \mathbf{o}_i^{dis} \ (T_{ij}/d_j)(\ T_{ij}/\mathbf{o}_i)] \ . \ (1 \pm \varepsilon_{ij})$$

, where $(\varepsilon_{ij}) = (\varepsilon_i) \ . \ (\varepsilon_j)$ discrepancy from the reality, which is unknown

Alternatively another simple method could be:

$$T_{ij}^{dis} = T^{dis} \ (\mathbf{o}_i^{dis} \ / \ T^{dis})(d_j \ / \ T)$$

However, this method requires its validation (sort of calibration) (For validy of this method, $T_{ij}^{dis}/T_{ij} = D_{ij}$ and $d_j^{dis}/d_j = D_j$ rates should be checked whether new ratios obtained as the result of the formula are equal to the known D_{ij} and D_j ratios, where T_{ij}^{dis} and d_j^{dis} are new values found by the formula above). If the values do not converge we should iterate the proces with the new values correcting the most deviant d_j^{dis} values (and even o_i^{dis} values). (Here, it is best to check the convergences of the $\sum D_{ij}/n$ and also $\sum D_j/n$. They must provide the overall Dx value, which is known to be 0,63.).

This formula is tried and a matrix of closer results to that of the real disadvantaged trips are obtained. However, the accuracy decreases with the cells with low values. Because, the unknown value (ε_{ij}) might be much greater in the cells with small amounts. (ε_{ij}) value also contains the extraordinary disadvantagedness situations for some special zone-pairs. For example, with this formula above, the estimates for special zones will be unrealistic such as: highly attracting zone's figure might be away from the estimated value. Thus, instead of unknown value, a special K constant may be placed at will.

Estimation at Mode Split Stage:

$$T_{ijk(publ)}^{dis} = T_{ij}^{dis} \, . \, (\pm \, \delta_{ijk})$$

($\pm \, \delta_{ijk}$) can be replaced by the modal choice constant.

,where $P(U)_{ij}^{dis}$ is the probability of choosing the public mode for the specific zone-pair. However, if we have no idea at the zone specific level, then we will have to apply general $P(U)^{dis}$ ratio found for the disadvantaged.

In the case of private trips:

$$T_{ijk(priv)}^{dis} = T_{ij}^{dis} \, . \, (1 - P(U)_{ij}^{dis})$$

Yet, if the specific D_{ijk} rates are already known (or, imported) , such practical calculation is also probable:

$$T_{ijk(publ)}^{dis} = T_{ijk}^{nor} . D_{ijk}$$

While in all these calculations, the D_{ijk} or $\pm \delta_i$ can be found interchangibly when one of them is known:

$$D_i = K^d (D_i^p)$$

where, D_i is the structural difference for the stage of planning

K^d is the ratio of disadvantaged population, which is a constant, at least for Aydın case, of 2/3 (or, 0,66)

D_i^p is the parametric change (from the previous stage) of disadvantaged from the Normality in the model of that peculiar stage , and can be described as $(1 \pm \delta_i)$ and the $\pm \delta_i$ is usually in negative direction. It provides the deviation from the population rate of disadvantagedness by the parametric change.

Especially, finding of the real parametric change for <u>each cell</u> is important when population factor K^p_{ij} is known:

$$\delta_{ij} = [T_{ij}^{dis} - (T_{ij} . K^p_{ij})] / T_{ij} . K^p_{ij}$$

can be obtained from the known results of the current study[5].

For example, if D_{ijk} is 0,8 for the public and 0,2 for private trips and the population constant (K^d) is 2/3, then overall $\pm \delta_{ijk}$ is;

$0{,}8 = 0{,}66 (1 \pm \delta_{ijk})$ for public, $0{,}2 = 0{,}66 (1 \pm \delta_{ijk})$ for private

$\delta_{ijk} = \pm 0{,}21$ (mean value for public trips)

$\delta_{ijk} = \pm 0{,}69$ (mean value for private trips)

- In the Cluster Filter at the Equalization stage, where filtering property of Excel was used conforming to the purpose, those who are under the threshold values of disadvantagedness for a specific category and the objective variable are determined out of the general group of disadvantaged, which is similar to conditional probability but where events are not mutually exclusive. This method is applied to both the data of Normality and disadvantaged to observe the difference between them.

- Finally, the model for disadvantaged, what is called alternatively 'ideal' model, was run and one simulation's policy impacts was found more successful under the shedlight of screening criteria (indicators) that can be manipulable in TRANUS. In fact, such further supply indicators could have been involved among the criteria: frequency, reliability, security/safety, technology, etc.. Nevertheless, TRANUS does not handle those indicators in the categoric separation and does usually on the links basis, which is difficult to aggregate. The purpose of simulations in this study is rather for "learning" about what type of policies would be effective.

6.5. TRANUS' pros and cons

TRANUS simulation package is found not really so flexible in simulating decisions taken in all terms of planning applications. TRANUS-defined parameters have to be used as the simulation media. It would be better if a sophisticated simulation package that can be compatible with TRANUS is used for the simulation and evaluation of results. There should be some more qualitative parameters contained in TRANUS about the travel conditions such as comfort, reliability, penalty of disadvantagedness. Although there is "categories" property in TRANUS, the categorical assessment (especially visually) and evaluation for each zone are weak. Most of the tasks could not be realized because of the software restrictions. Therefore,

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[5] This formula can be replaced by $\delta_{ij} = (D_{ij} - K^{p}_{ij}) / K^{p}_{ij}$ when D_{ij} are known.

based on such normative principles, as a suggestion of this thesis, there has to be further a new package developed that address to these issues.

In the simulation packages, also those special parameters addressing to various categories and various policy variables should be further developed. TRANUS is found weak at this point. Additionally, TRANUS is also weak in handling the planning tasks at zone by zone basis. Zone based aggregations in TRANUS ignore the individual level data variations (or, deviations).

6.6. Conclusion for Aydın

There are also the special results as by-products of the study such as the specific averages peculiar to Aydın. The study is not done for Aydın *per se*, but done *in* Aydın, thus, that the data may not be so accurate should not be disappointing. Yet, even if the accuracy of the data would be low, the data is still reliable and proportional to accuracy expectation when interpreted correctly. The study still provides the pattern about Aydın. That is, the study still talks about Aydın and gives valuable summarizing information rather than accuracy of results, which is the most preferred. Additionally, the graphical information such as Trip Assignment results as volumes or LOS levels provide the preliminary information about the existing situation of Aydın. For the current situation, Aydın seems not having a serious transportation problems but has the signals for the future.

As relating to the disadvantagedness, the geographical information such as disadvantaged zones would be helpful in identifying the problem areas.

6.7. Efficiency of the Simulations

The simulations are produced from the Knowledge-based (KB) policy package scenarios each reflecting the three different dimensions of disadvantagedness: Spatial (zone-based), socio-economical (category-based) and the policy application area (objective variable).

Geographically, the most impacted areas by the simulations converged on these zones: 6,7,8,9,11 and 12. Of those, 6, 7 and 8 had already been nominated among disadvantaged zones. Yet, zones 11 and 12 are not of disadvantaged.

The parameters of TRANUS were the keys for converting the policy implications to create the expected impacts. The related keys were, as the principle, introduced as far as around 50% (actually 63%, which is the structural difference between Normal and the disadvantaged) change in impact. Yet, the expected output was far less than expected.

Relatively the third simulation came forward as the best one under the three evaluation steps conclusively: One evaluation was based on the comparison of the Mode Split Trips (by Category) results of the three simulations with the Base Year results. In this evaluation, the third simulation was the best with 6,9% absolute change from the Base Year. Second was the evaluation based on the TRANUS' summary criteria composed of five cost indicators as per capita averages: Travel time, cost, distance, wait time and disutility. Here, the second simulation looked the best. Alternatively, in the comparative evaluation with the weights, which is the third evaluation method[6], the third simulation was found apparently to be the best one, that was based on the wealth related parameters.

Unfortunately, since the simulations were solely random trials based on expectations, though Knowledge Based, none of the simulations posed the ideal result: There could either be better simulation (or, scenario) designations with better results, or, there can not be any 100% efficient policy package that exists to invent.

6.8. Imperfections

One of the drawbacks of this study is that there may be concluded many category based policies (especially pricing) solely towards to improve the conditions of the disadvantaged, but, their applicability in real life is suspected. In the study, the

[6] The evaluation with the weights is done for the criteria both as the zone-pair results and as the Per Capita averages: the zone-pair results were far from the expectation and, thus, dropped from the further

policies were applied in the virtual reality of simulation. However, these may appear much complex and even inapplicable in real life, or, even if applicable, bear costly consequences.

Unfortunately, TRANUS does not provide category-based graphical assignments. It is also offered here that the assignments must be provided on the basis of transportation category so that we could have seen the differences between the two categories (advantaged and disadvantaged) visually. And, this would much contribute to the explanation of the modelling approach described in this study[7].

As of imperfections, some major unfavorable situations are recorded in the study:

- The use of IMPED (1, 2 and 3) variables would not be so proper because those variables were of the weakest ones in effect among all variables in the correlation matrix. They are used in the utility functions of the Mode Split Stage as the impedance (generalized costs) factor.
- Dx values are derived from the output results (in this study, for Trip Distribution and Mode Split stages). Dx are the differential parameters that are derived directly from the proportions between the model for disadvantaged and Normal model. When this parameter is added in all normal models (for all four stages), it should be converting the values of normality, in a short-cut manner to the values of disadvantaged, or vice versa. However, focus here was not still on finding finer values by this property of the modelling approach described here.
- Unfortunately, in Trip Generation stage, the Regression Model was not ideal than expected due to the limited number of samples (zones) taken. On the other hand, the reliability for household and person based regression models was low.

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evaluation. The zone-pair results for simulations 1, 2 and 3 were as respectively: 5.85, -6.18 and 31.46. The Per Capita results were as: 14, 32.34 and 41.8.

[7] Model designers of TRANUS in Venezuela were contacted and requested whether category-based displays on the screen will be available in the future. The reply was that this consideration was already in line.

- Disadvantagedness levels in the Cluster Filtering studies in Section 5.2: Correspondence Module could only be measured as the number of individuals who are disadvantaged. Yet, this way of measuring may not provide an effective measure about the real disadvantagedness. For example, disabled persons are under-represented.
- The Trip Distributions derived from the original OD survey may not be so accurate because of two basic reasons:

  1. Very low population/sample ratio
  2. The OD querry was not asked for each trip in a day, but for general in a day.

  In this case, a special "trip rate factor" is introduced to rectify the trip distribution values obtained after the introduction of population sample ratio. Additionally, distance decay $f(c_{ij})$ was defined as the function of solely distance that should be instead travel time. The β values, then, of both normal and disadvantaged population would be quite different realistically.

- In the calculation of link capacities, there may be imprecise findings due to the scarce data for calibration and inadequate methodology for urban streets that can comply with the TRANUS data requirements.

Additionally, many restrictions followed through the study and affected the accuracy of the results. Although the results of this study are expected to approximate reality, it should be kept in mind that they should <u>not</u> be trusted as accurate results as the product of a typical four step planning model. This study focused on the understanding and teaching a methodological approach rather than accomplishing a true planning procedure. But, still many lessons can be derived for both the general knowledge and for the applications in Aydın for the future because of the truistic results of the study. One of the main reasons that might be keeping the results a little away from the reality is that study was realized under restricted conditions and resources. This also caused the reduced sampling size and restricted cordon traffic counts. Probably, the aggregation of the individual-based data to the zone level also caused some little shift in the accuracy of the results, finally led by misunderstandings of the questions by respondents when interviewing plus miscalculations when data processing may have also caused some distortions from the reality. Since it is assumed forthcomingly all data obtained are accurate, not much room (only correlation study and R^2) is reserved for the statistical methods that were to validate the accuracy of the data. On the other hand, the accuracy of some data is cross-checked by the observations or interviews.

6.9. Further studies

Based on such an introduction called "special planning model for transportation disadvantaged", many related studies can be conducted and new methodologies be invented to elaborate on this issue. The methodology described here is not the finite but the leading one towards new horizons. Upon this study, for example, can be constructed a new one showing more definite, clear and practical ways of handling the issue.

The study had many incomplete and imperfect parts. Further reseach can be devoted to complete these parts. For example, the disadvantagedness in Traffic Assignments was not dedicated full attention. A further study can elaborate on this largely. Another reason for not considering the disadvantagedness at the Assignments stage is that, in reality, there can not be special assignments for disadvantaged on the links. Even if there is (at least in the modelling), it can hardly be represented on the links. At least, TRANUS does not handle this way.

Second, as the continuation of this study, a further study can be the dedicated to sensitivity analysis which is to measure the wide range of effects (impacts) per unit of input change of a single parameter. What parameters in the model (or package) cause what sort and amount of changes must be scanned. That was impossible in this thesis work for basically three reasons:

- The main goal (focus) of the thesis is not about that,
- There is not much room and time, resource and within the contend of the thesis. It requires a laborous and patient work of scanning

- In the study, three scenarios were used each containing mix of parametric changes of which the results could be inseparable. That is, we can only observe the results jointly of one set (combination) of parameters that are formulated as a scenario. Thus, the input-output interactions are multi-variate.

It is proven in this study that, under the restricted conditions due to the model-package misfits, the disadvantagedness based simulations measured at the Mode Split level yielded, at least, positive results in the direction what is desired to see: By applying disadvantagedness derived policies, there observed a move towards the amelioration in the situation of the disadvantaged. In the trips, the disadvantaged shifted the modal preference towards to the public one. This is similar for the advantaged, too. The amount of shift is small but the thesis was already about the recording of "any shift" (partial) in the desired direction. Now, that actually means "we can use the transportation planning models as the policy determination tools".

Another advantage of this modelling approach in eliciting the disadvantaged from the Normal is that it can enable us to monitor the changes in the events in the separate observation of disadvantaged and advantaged. Then, planners can act and make policies accordingly using this "monitor".

A further study may search and utilize other softwares that may bring some other contributions to the exploration of transport disadvantaged.

One important point missing in this study was the estimation of future transportation needs. The subject of future estimations was not deliberately considered for basically three reasons, which are obligatory:

- The study is not truly a real planning study but only the validation of a modelling approach. Estimating of future trend and planning for future in transportation studies is always a secondary concern after the model establisment for the base year. When a model is to be tested, first concern is the validity of the base year results. Thus, in this model, only the base year results and the simulation (scenario) results, that have no time dimension, are handled.

- Estimating future trends is necessary but quite complicate and time consuming subject that could not be involved in the limited scope of the study
- Estimating the future requires the collection of much elaborate and accurate data of usually the land use developments and also about their future trends. For this study, probably insufficient and the unhealthy results about future land use would further blurr and jeopardize the accuracy of the model, that instead needs even more simplicity.

However, estimation of future is the essential part of transportation planning studies. Thus, suggesting as a further study, this issue should broadly be enhanced for the modelling studies devoted to disadvantaged groups as natural process of the models. Such models involving time dimension should also scan through the disadvantagedness trend in time: With what tools the disadvantagedness can be elicited. The "time" notion in this study is perceived as "stages" to success, and, the "target future" is replaced by "ideal state" where disadvantagedness is totally removed (ie, total equity).

A further study should be devoted to finding out whether disabled and elderly groups contribute to work force, and thus, to the trip making for going to work place as far as the rate allowed in the related Law designated for the employment consideration of disabled, which could not be well handled in this study.

Another methodological approach would be devoted to finding of the disadvantaged-specific Impedance values to be used in Modal Split stage such as:

1- Finding the rate of transit use by comparing the two models:

% of transit trips (for disadvanatged) = $1 / [1 + (I_{transit} / I_{auto})$

% of transit trips (for Normal) = $1 / [1 + (I_{transit} / I_{auto})$

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APPENDICES

Appendix A

THE LIST OF HOME INTERVIEW ADDRESSES RANDOMLY CHOSEN

AYDIN BELEDİYESİ
Rayiç Değerler Dökümü (1998 Yıl

GÜZELHİSAR MAH.

Mahalle	Cadde	Sokak	Açıklaması	Rayiç Degeri
7	0	0	GÜZELHİSAR MAH.	
7	1	0	ADNAN MENDERES BUL.(A.MEND.BL.	10.000.0
7	2	0	A.MENDERES BL.1 SK.(MEN.B.2 SK	7.000.0
7	3	0	A.MENDERES BL.3 SK.(MEN.BL.4 S	7.000.0
7	4	0	A.MENDERES BL.5 SK.(MEN B.6 SK	7.000.0
7	5	0	A.MENDERES BL.7 SK.(MEN.B.8 SK	7.000.0
7	6	0	A.MENDERES BL.9 SK.(MEN.B.10.S	7.000.0
7	7	0	A.MENDERES BL.11 SK.(MEN.B.12S	7.000.0
7	8	0	A.MENDERES BL.13 SK.(MEN.B.16S	6.000.0
7	9	0	A.MENDERES BL.15 SK.(MEN B.18S	6.000.0
7	10	0	A.MENDERES BL.17 SK.(MEN.B.20S	4.000.0
7	11	0	A.MENDERES BL.19 SK.(ÇIKMAZ 2S	5.000.0
7	12	0	A.MENDERES BL.21 SK.(ÇIKMAZ 3S	5.000.0
7	13	0	A.MENDERES BL 23 SK.(ÇIKMAZ 5S	5.000.0
7	14	0	A.MENDERES BL.25 SK.(ÇIKMAZ 6S	5.000.0
7	15	0	ATATÜRK MEYDANI SK.(MEN.B.1 SK	8.000.0
7	16	0	İSTİKLAL CAD.(TÜRKOCAĞI CD.)	9.000.0
7	17	0	7 EYLÜL CADDESİ (7 EYLÜL CAD.)	7.000.0
7	18	0	ALBAYRAK CADDESİ(A.ŞEFİK CAD.)	7.000.0
7	19	0	ALBAY.ŞEFİK CADDESI.(A.ŞF.C.1S	7.000.0
7	20	0	TÜRK OCAĞI CADDESİ	6.000.0
7	21	0	TÜRK OCAĞI 1 SK.(SABUNHANE 1.G	2.500.0
7	22	0	TÜRK OCAĞI 2 SK.(SABUNHANE 1/2	2.500.0
7	23	0	TÜRK OCAĞI 3 SK.(SABUNHANE 2.G	2.500.0
7	24	0	TÜRK OCAĞI 4 SK.(SABUNHANE 3.G	2.500.0
7	25	0	TÜRK OCAĞI 5 SK.(TÜRKOC.CD.4 S	2.500.0
7	26	0	KIBRIS CADDESI.(A.MEN.B.14.SK.	8.000.0
7	27	0	ULUBATLI CADDESİ.(ARAPKAH.SK.)	2.500.0
7	28	0	OZAN SOKAK.(ARAP SOKAK)	2.500.0
7	29	0	ÖRGÜ SOKAK.(A.ŞEFİK CD.GEÇIDİ)	3.000.0
7	30	0	ARAP SOKAK	3.000.0
7	31	0	HUZUR SOKAK	4.000.0
7	32	0	ONUR SOKAK.(ÇİLINGIROĞLU SK.)	5.000.0
7	33	0	SAMUR SOKAK.(SERVER SOKAK)	2.500.0
7	34	0	SERVER SOKAK.(7 EY.CD.1/3.SK.)	1.500.0
7	35	0	PIYADE SOKAK	3.000.0
7	36	0	ÇEVRE SOKAK.(ÇİLINGİROĞLU SK.)	1.500.0
7	37	0	ÇİLİNGİR SOKAK.(7 EY.CD.1/2.SK	1.500.0
7	38	0	PIRAMİT SOKAK.(GÜZELHİSAR GEÇİ	2.000.
7	39	0	BARIŞ SOKAK.(ZÜBEYDEHANIM CD.)	7.000.
7	40	0	SANCAK SOKAK.(7 EY.CD.1.SK.)	3.000.
7	1	0	DENİZLİ BUL.(AYDIN-DENİZLİ K.Y	12.000.
7	42	0	CAMİ GEÇİDİ	2.000.
7	43	0	KAYNAK SOKAK	2.500.
7	44	0	EGEMENLİK BULVARI (SABUNHANE S	4.000.
7	45	0	ÇİLİNGİR SOKAK (7 EYLÜL 1 ÇIKM	1.500.
7	46	0	7 EYLÜL CADDESİ (7 EYLÜL 2 ÇIK	7.000.
7	47	0	7 EYLÜL CADDESİ (7 EYLÜL 3 ÇIK	7.000.
7	48	0	7 EYLÜL CADDESİ (7 EYLÜL 4 ÇIK	7.000.
7	49	0	7 EYLÜL CADDESİ (7 EYLÜL 5 ÇIK	7.000.
7	50	0	7 EYLÜL CADDESİ (7 EYLÜL 6 ÇIK	7.000.
7	51	0	ÇİLİNGİR SOKAK (TÜRKOC.CD.5 SK	1.500.
7	52	0	TÜRK OCAĞI 4 SK.(SAB.S15.F.A.Y	2.500.
7	53	0	ULUBATLI CADDESİ (ARAPKAV.1 ÇI	2.500
7	54	0	ULUBATLI CADDESİ (ARAPKAH.4 ÇI	2.500.
7	55	0	ÇEVERE SOKAK (ÇİLİNG.SK.ÇIKMAZ	1.500.

ad-mend		ata		Cuma		cumhur		efeler		girne		guzelhis		hasanef		ılıcabaş	
sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina
1	6	54	10	3	25	24	3	10	58	47	11	5	9	24	42	1	4
1	3	47	14	18	6	25	7	19	30	47	11	46	86	11	17	15	17
12	3	42	18	5	12	32	14	61	60	47	11	35	22	10	5	1	1
2	3	57	42	5	36	10	47	61	5	47	11	5	21	5	6	3	1
13	11	7	36	8	2	6	7	41	17	47	11	44	37	17	32	5	5
8	27	36	1	4	20	36	20	64	9	47	11	39	4	23	1	9	14
18	16	8	8	8	5	33	6	67	7	47	11	38	2	23	20	7	11
8	16	54	28	1	34	42	29	66	13	47	11	46	48	11	30	4	26
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37	1	41	68	23	33	3	7	35	2	47	11	12	29	23	12	4	12
10	11	43	9	1	1	30	6	16	8	47	11	38	9	20	13	4	23
15	32	32	26	8	3	27	6	50	11	47	11	14	3	5	5	7	10
6	4	75	31	2	4	32	39	15	3	47	11	14	56	17	23	1	2
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19	12	17	3	4	29	10	48	31	21	47	11	46	111	22	29	8	3
2	8	37	2	23	28	10	9	10	66	47	11	46	43	20	70	4	19
7	11	56	4	5	49	10	29	37	24	47	11	11	25	19	41+	4	7
34	10	13	6	7	13	14	7	20	46	47	11	20	8	18	12	7	11
30	1	41	154	3	41	30	19	56	9	47	11	46	34	24	39	15	10
32	16	52	9	3	41	6	26	21	5	47	11	21	4	24	45	2	6
34	17	50	3	4	2	32	32	46	17	47	11	14	37	4	10	7	4
37	6	1	6	4	25	2	8	10	7	47	11	46	1	13	38	1	4
8	29	66	18	17	36	44	29	10	29	47	11	9	55	20	65	11	5
15	22	27	1	21	9	10	5	19	35	47	11	9	55	6	4	9	19
37	2	41	13	21	19	39	23	62	46	47	11	14	18	20	31	2	9
34	23	34	25	17	22	32	47	47	3	47	11	9	62	13	19	4	1
35	23	34	7	8	35	36	35	46	14	47	11	36	12	7	11	4	18
34	8	46	8	10	5	36	53	49	26	47	11	46	77	14	5	4	23
15	35	47	21	1	22	30	4	47	4	47	11	12	11+	11	21	4	21
25	3	27	21	2	41	31	4	47	11	47	11	9	1	17	15	5	9

istiklal		kemer		köprülü		kurtulus		mesudiye		meşrutiy		mimar-sin		orta		osman-yo	
sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina
12	3	55	32	3	15	24	35	10	82	18	2	4	3	33	58	67	13
2	3	29	4	1	98	3	9	29	17	11	49	10	10	16	124	80	6
24	8	27	2	13	19	24	44	18	4	40	37	10	5	15	3	14	16
5	8	7	1	16	30	25	27	4	192	24	12	10	18+	4	51	59	24
27	20	34	6	12	2	17	51	34	80	22	22	9	7	42	6	22	8
1	9	20	17	1	110	28	14	16	26	29	16	6	2	39	9	32	6
7	2	14	4	5	53	23	4	11	69	25	12	6	3	14	11	47	13
27	13	56	20	21	4	4	24	12	9	4	19	9	2	5	73	74	7
28	8	9	16	24	1	28	15	34	25	24	24	12	10	10	9	58	6
23	22	31	5	1	116	23	39	2	30	14	8	6	6	4	53	17	19
				+													
25	14	14	14	19	1	30	30	15	3	33	44	12	1	30	3	48	19
27	19	46	45	5	19	27	42	32	9	32	24	10	4	5	62	43	14
21	12	29	108	7	14	5	9	10	130	9	19	11	8	45	22	59	13
11	1	28	103	13	15	25	5	32	16	28	19	9	4	33	83	7	53
30	8	11	9	19	12	29	60	19	94	17	15	6	3	7	61	67	2
21	4	32	64	11	29	4	51	10	128	12	32	3	4	30	40	76	3
21	29	51	21	4	38	8	1	2	18+	3	84	11	5	5	113	55	5
20	6	34	13	17	8	4	40	2	25	39	57	9	9	27	23	16	10
22	5	54	8	22	1	24	82	11	112	31	14	12	9	30	26	3	55
11	6	56	41	20	13	18	18	29	25	40	6	6	4	40	7+	21	15
21	3	22	19	15	8	12	2	4	28	38	22	6	11	15	6	3	51
6	19	28	66	2	19	21	10	12	23	39	13	2	8	45	50	34	17
30	17	13	29	13	17	6	5	34	31	22	20	5	3	6	129	3	29
3	10	4	23	8	2	22	12	31	10	3	3	13	2	29	11	80	2
6	3	12	90	17	15	1	11	35	14	40	3	14	1	30	43	17	12
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27	13	36	7	7	12	14	4	27	9	33	39	14	1	34	52	57	10
4	14	29	119	11	29	10	40	24	4	8	25	13	3	18	7	34	29
13	6	56	11	21	15	27	21	35	9	13	10	7	6	44	22	24	11
6	10	56	83	15	10	7	15	4	8	39	25	9	7	14	16	3	28

ramazanp		veysi-pas		yedi-eyl		zafer		zeybek	
sokak	bina	sokak	bina	sokak	bina	sokak	bina	sokak	bina
10	33	8	6	26	15	20	53	8	55
1	1	22	42	35	9	7	8	6	5
5	44	7	6	9	20	8	12	20	64
1	15	8	6	44	6	14	67	1	61
14	11	21	38	30	35	30	17	15	19
6	25	25	9	35	7	8	23	14	3
17	1	5	7	18	10	21	48	15	19
10	36	16	34	51	11	10	70	15	22
3	13	21	18	10	5	2	9	4	72
6	33	20	31	25	28	10	4	5	63
22	12	9	7	28	1	22	8	1	20
8	17	1	7	31	18	2	33	21	33
13	2	20	8	44	61	1	6	5	13
5	41	22	38	55	27	21	68	8	31
22	16	20	8	45	48	22	19	1	6
23	4	8	23	14	29	23	73	11	41
15	14	20	18	10	13	23	75	21	23
21	2	18	1	14	35	14	40	15	6
7	11	16	8	3	20	7	5	6	31
6	1	20	63	17	29	8	31	8	40
8	9	21	35	31	16	20	58	1	12
9	26	2	1	27	24	18	14	21	6
20	6	22	37	10	10	26	15	1	59
6	8	15	15	9	10	24	19	5	38
23	26	5	1	57	29	3	13	3	52
20	11	20	54	31	13	21	18	5	22
23	22	14	9	2	17	8	26	20	3
22	13	20	37	40	7	4	6	11	58
3	18	16	3	14	33	29	6	15	18
22	19	21	34	13	3	23	67	8	33

Appendix B

THE PERMISSION FOR THE HOME INTERVIEW SURVEY AND ORIENTATION TEXTS FOR INTERVIEWERS AND INTERVIEWEES

T.C.
AYDIN ILI
BELEDIYE ENCUMENI KARARI

Karar Tarihi	: 25-06-1998	Özü	: PERSONEL HK.
Karar No	: 2799	Ilgili	: İzm.Yüks.Tek.Ens.

K A R A R

İzmir Yüksek Teknoloji Enstitüsü Mühendislik ve Fen Bilimleri Enstitüsünün ilişikte sunulan 18.06.1998 tarih ve B.30.2.İYE.0.02.00.00./342 sayılı yazılarıyla şehir ve bölge planlama anabilim dalı öğretim görevlilerinden Yavuz Duvarcının doktora tezi kapsamında, Aydın Kentinde; ev anketi, trafik sayımları, güzergah incelemeleri, araç doluluk oranları gibi çalışmaarı yapabilmesi için gerekli izin ve tam gün çalıştırmak üzere ankötör olarak çalıştırmak üzere dört adet personel talebinde bulunulduğu, söz konusu talep hakkında karar alınmasını muhtevi 25.06.1998 tarih ve 1128 sayılı Trafik İşleri Müdürlüğü yazısı Encümende okunarak gereği düşünüldü;

Her nekadar İzmir Yüksek Teknoloji Enstitüsü Mühendislik ve Fen Bilimleri enstütüsünün müracaatla, şehir ve bölge planlama anabilim dalı öğretim görevlilerinden Yavuz Duvarcının doktora tezi kapsamında, Aydın kentinde, ev anketi, trafik sayımları, güzergah incelemeleri, araç doluluk oranları gibi çalışmaları yapabilmesi için gerekli izin ve tam gün ankatör olarak çalıştırmak üzere dört adet personel talebinde bulunmaktalar isede; yapılan incelemede, mezkür çalışmaları yapabilmeleri için gerekli iznin verilemsine, ancak personel tahsisinin mümkün olmadığına oybirliğiyle karar verildi.

BAŞKAN	AZA	AZA	AZA	YAZI İŞ.MD.
HÜSEYİN AKSU	M.S.YARIMCA	O.ARSLAN	A.ÖZTÜRK	H.ARIKAN
HESAP İŞL.MD.	SAĞLIK İŞLERİ MD.	VETERİNER	FEN İŞL. MD.	M.AVUKAT
M.GÖR	D.GÖLGÖN	A.DEMİREL	A.AKTAŞ	M.KALLEMOĞLU

ANKET GİRİŞ ve TANITIM

Konu: Anket, yeni bir ulaşım modelinin Aydın kenti üzerinde test edilmesi amacıyla kullanılacak veri tabanını oluşturmak için yapılmaktadır. Anket sonucunda kentlinin ulaşım davranışları ve sosyo-ekonomik veriler elde edilmiş olacak, hangi grupların ulaşım sisteminden yeterince yararlanıp yararlanamadığı ortaya çıkarılmış olacaktır. Burada amaç Aydın için bir planlama çalışması yapmak değil sözkonusu modelin test edilmesi olduğundan, elde edilen verinin doğruluk derecesinin çok yüksek olması beklenmese de gerçeğe yakın olması önem arzetmektedir.

Bu amaçla örnekleme çok yüksek tutulmamıştır. Fakat, anketlerin mümkün olduğunca sağlıklı yapılması gerekmektedir. Bu amaçla anketörün anket yaparken ekteki anket uygulama rehberini göz önüne alması gerekir. Bu, anketin hızlı ve eksiksiz yapılmasını sağlayacaktır.

Anketör, yalnızca sorumlu olduğu bölge ve sokaklarda, belirlenen uygun zamanlarda anket yapacaktır. Anket ücreti anket başına 400 000 TL olup, anket yapılan hane sayısına (A1 formu sayısı) göre ödeme yapılacaktır.

Hane ziyaret edildiğinde, ciddi bir görüntü vermeye çalışmalıdır. Temiz, sade bir kılıkla ve kibar bir tavırla hitabedilmelidir. Unutulmamalıdır ki, kişiler soruları cevaplandırıp cevaplandırmamakta serbesttir. Ayrıca, anket sorularının amacı konusunda bilgilendirilmeye hakları vardır. Bu amaçla, çok bağlayıcı olmamakla beraber, aşağıdaki GİRİŞ'te verilen açıklamanın yeterli, öz ve etkili olacağı kanısındayız. Anketör bu açıklamayı baz alıp, duruma göre, ek bilgi istenmesi durumunda, vs. ekleme veya daha iyi sonuç alacağını düşündüğü biçimde ifade tarzında değişiklik yapabilir:

GİRİŞ ve TANITIM CÜMLELERİ:

> **"İyi günler, rahatsız ediyoruz.. Biz Aydın Belediyesi işbirliği ile Üniversiteden (gerekirse hangi üniversite olduğu açıklanacak) geliyoruz. Sizinle ulaşım konusunda bir anket/(araştırma) yapmak istiyoruz. Bu anketin amacı karşılaştığınız ulaşım problemlerini anlamak ve ona göre size daha iyi bir ulaşım hişzmeti sunmak için gerekli tedbirleri almaktır.. Vereceğiniz bilgiler sadece anket çalışmalarımız için kullanılıp, kayıtlarımızda gizli tutulacaktır.."**

Bu girişten sonra anket yapmayı kabul ederse, adres ve telefon numarası gibi bilgiler alınıp, sorular anlaşılır bir biçimde sorulacaktır. Anketör, kişilerin ekonomik ve psikolojik yapısını anlamaya ve ona göre yaklaşım tavrı belirlemeye çalışmalı, fakat verilen cevapları yorumlamamalıdır. Sorunun anlaşıldığından emin olmalıdır. Gerekirse soru tekrar izah edilmeli.

Aşağıda ismi bulunan anketörler, verilen ücret karşılığında anketin gerçekleştirilmesinde emeği olduklarını kabul ederler:

İsim: **imza:**

ANKET UYGULAMA REHBERİ:

<u>A1 formları için:</u>

1. Ortalama anket süresi 15 dk'dır. Adres arama ve yolda geçen sürenin ortalama 15 dakika alacağı kabul edilmiştir.
2. Anket yapacağınız adreslerin sırasını size en uygun olacağını düşündüğünüz biçimde yapınız ve buna göre en uygun yerden başlayınız.
3. Anket mümkün olduğunca hızlı yapılmalı, gereksiz sohbetlere girilmemelidir.
4. Ankete başlamadan önce anketör kibarca kendisini tanıtmalı ve anket konusuna giriş yapmalıdır*. Anketin amacı kısa ve öz biçimde açıklanmalı.
5. Anketör, herhangi bir nedenle ankete katılmamakta kararlı olan kişileri zorlamamalı, gereksiz tartışmalara girmekten kaçınmalıdır. Ankete hemen yan komşudan devam etmeli (bir numara üstü veya bir numara altı), eğer bunlardan da bir sonuç alamazsa sonuç alınıncaya kadar komşu numaraları ziyaret etmeye devam etmelidir.
6. Anketör sorulara başlamadan önce hanenin adresini, anket yapılanın adını ve (varsa) telefon numarasını ilk sayfanın üstüne kaydetmelidir.
7. Mümkünse, A1 anketleri içeri girmeden kapıda yapılmalıdır. Eğer ortam müsaitse ısrar üzerine içeri girilebilir. Varsa, aile reisi soruları yanıtlamalıdır.
8. Sorulardan anlaşılmayan varsa, sadece sorunun "ne anlama" geldiğini örnekler vererek açıklayınız, fakat anket yapılan kişiyi yönlendirebilecek açıklamalardan kesinlikle kaçınılmalıdır (gerekirse anladığı kadarıyla cevap vermesi ile yetinilmelidir).
9. Tüm sorular mutlaka cevaplandırılmalı, bir şekilde eksik soru kaldıysa soru yanına (E) işareti konulmalıdır.
10. Form kağıtlarının zımbalı halde olmasına dikkat edilmelidir.
11. Anketör, cevaplandırılmış her formun üzerine adını yazmalı, saat, tarih atmalıdır.
12. Anketörlere, üzerinde anketin yapılacağı sokak ve adres yerleri kırmızı (*) asteriks işareti ile işaretlenmiş haritalar verilecektir. Eğer anket değişik bir sokakta yapıldı ise Anketör değişikliği, yuvarlak içinde asteriks ile (*) göstermelidir.
13. Anketör kendisine tehlike gelebileceğini düşündüğü ortam/muhitten kaçınmalıdır. (örn. başıboş köpeklerin yoğun olduğu ve tenha mahaller, havanın kararması, vs.) Mümkünse adres daha sonra ziyaret edilmeli, yahut bu durum anket yöneticisine rapor edilmelidir.
14. Adres ararken veya anket yaparken çevreden ilgilenenler olabilir ve çeşitli sorular sorulabilir. Bu kişilere kısaca ve kibarca anketin mahiyeti açıklanabilir, fakat değerli vaktinizi harcamamaya çaba gösteriniz.
15. Anket bitiminde kibarca teşekkür ederek vakit geçirmeden diğer en yakın adrese geçiniz.

* Anket giriş ve tanıtım kısmını inceleyiniz.

A2 formları için:

1. A2 formları ortalama bir hanede (ailede) 4 kişi yaşadığı, bunlardan birinin 6 yaşın altında olduğu kabulüyle, ve A1 formlarının sayısının 3-4 katı olması gerektiği kabulüyle çoğaltılmıştır.
2. A2 formları hanedeki tüm bireylerin tek tek **kendi başlarına** dolduracakları formlardır.
3. Anket yapmaya gittiğiniz haneye A1 anketi bitiminde, 6 yaş ve üzerindeki kalıcı hane halkı üyelerinin sayısından emin olunuz (ya da A1 formu 4.sorusunun c şıkkından çek ediniz) (Örn: anketi yaptığınız anda hanede 4 kişi varsa, bunlardan biri 5 yaşında ve biri de misafir olarak kalıyorsa, demekki sadece 2 adet A1 formu bırakacaksınız). **A2 formlarının mutlaka 6 yaş ve üzerindeki bireylerce doldurulması gerektiğini, 6 - 13 yaş arasındaki kişilerinse ebeveylerinin veya büyüklerinin yardımıyla doldurması gerektiğini hatırlatınız.** Formların 2-3 gün sonra geri toplanacağını, bu nedenle **kaybetmemelerini hatırlatınız.**
4. A2 formları için hane başına tek zarf bırakınız. Formların doldurulduktan sonra katlanarak zarfa konulmasını ve zarfın sıkıca kapatılarak en kısa sürede **ödemesiz** olarak postalanmaları gerektiğini hatırlatınız.
5. Boş bir sayfaya hane numarası karşısına kaç adet A2 formu olduğunu liste şeklinde not ediniz Her mahalle için mutlaka ayrı bir sayfa düzenlenmiş olmalıdır. (Bu liste, zarflar açılırken yararlı olacaktır.
6. A2 formu için belirlenen kişi sayısı (6 yaş ve üstü) A1 formu üstünede de teyid edilmelidir (ya da A1 formunda 4. Soru c şıkkı yanına çentik işareti ile konfirme edilmelidir).
7. (Eksik olan anket formları sonradan tamamlanmaya hanenin telefon numarasını almak önem arzetmektedir. Fakat, telefon numarasını vermek istemezlerse ısrar etmeyiniz.
8. A2 formları verilmeden önce üzerine kodları ve adresleri eksiksiz olarak kaydedilmeli, tıpkı A1 formlarında olduğu gibi anketörün doldurması gereken yerler doldurulmalıdır.
9. Hane içinde kendisine anket yapılmasını istemeyen olursa ikna etmeye çalışınız. Sonuç çıkmazsa rapor edip, hangi hane olduğunu elinizdeki listeye **"biri katılmadı"** biçiminde işaretleyiniz. Eğer hane üyelerinden biri ankete katılamayacak kadar uzun süreli olarak hanede bulunamıyorsa "**biri** (veya 2 kişi ise, ikisi..) **dışarda"** diye işaretleyin. Kişi ankete katılamayacak derecede özürlü veya hasta, vs. ise **"biri mazeretli"** yazınız.

NOT: anketlerin doldurulmasında bu rehbere uyulması önem arzetmektedir. Anketlerin gerçek adreslerden yapıldığı bazı adreslerin ratgele seçimi ile telefon edilerek teyid edilecektir. Anket bitiminde (gün ya da hafta sonunda) anketler derlenmiş biçimde anket yöneticine teslim edilecek, karşılaşılan problemler bildirilecek, tartışılacaktır.

Katkılarından dolayı tüm anketörlere teşekkür ederiz.

Appendix C

HOME INTERVIEW SURVEY FORMS FOR BOTH A1 AND A2

AYDIN BELEDİYESİ ve

İZMİR YÜKSEK TEKNOLOJİ ENSTİTÜSÜ

ULAŞIM PLANLAMASI ANKET SORULARI

Form no: A1

Saha Kontrolü:__________
Büro Kontrolü:__________
Bilgi Kontrolü:__________

Bu anket size daha iyi bir ulaşım hizmeti sağlama amacıyla hazırlanmıştır. Soruların bu nedenle dikkatle doldurulması önem arzetmektedir. Tüm bilgiler yalnızca çalışmalarımızda kullanılmak üzere gizli tutulacaktır.

Bu ankette "yolculuk"tan kasıt, kent içinde bir yerden belli bir amaçla, araçla veya yaya olarak, bir başka noktaya durmaksızın yapılan yolculuk hareketidir.

Anket yapılan kişi:

Konut adresi:________________

____

____

Telefon no:________________

Anketi uygulayan:
Tarih:
saat:

Mahalle Kodu :
Sokak Kodu :
Hane Kodu :

☐☐ **I. BÖLÜM: HANE BAZINDA SOSYO-EKONOMİK VERİ**

1. Hanedeki toplam kişi sayısı (Misafir ve geçici olarak kalanlar sayılmaz),______

2. Oturduğunuz konutta kirada mı kalıyorsunuz? Evet ☐ Hayır ☐

3. a) Hane halkı içindeki ulaşım aracı sahipliği : Var ☐ Yok ☐

Yok ise dördüncü soruya geçiniz,

b) Aracınız varsa, kutucukların içine kaç adet olduğunu belirtiniz;

otomobil ☐

ticari araba ☐

minibüs ☐

motosiklet ☐

traktör ☐

bisiklet ☐

diğer ☐ ,__________ (belirtiniz)

c) Hane halkı arasında sürekli olarak araçla yolculuk eden kaç kişi,_______

---

4. Hanede istihdam ve nüfus durumu;

a) Hane halkından çalışanların (veya gelir getirenlerin) toplam sayısı,_____

b) Çalışmak isteyip de işsiz durumda olan varsa, kaç kişi,____

c) Hanede 6 yaşında ve daha küçük olanlar kaç kişidir,____

d) Hanede 65 yaşında ve daha üstünde olanlar kaç kişidir,____

e) Hane halkı arasında herhangi bir engelliliği (ortopedik, görme engelli, işitme engelli, zihinsel engelli, ileri derecede görme bozukluğu, ileri derecede duyma zorluğu, dilsizlik ve konuşma/ iletişim kurma güçlüğü, otizm, erkeklerde 120 kg'dan fazla kadınlarda 100 kg'dan fazla kilosu olanlar, zaafiyet, sara, kan düşüklüğü, parkinson, astım, vb., kalıcı ve/veya bulaşıcı bir hastalığı olmak..) olan kaç kişi,_____

Not: Bilindiği gibi engellilik veya özürlülük hali doğuştan ya da sonradan ortaya çıkabilen, kişinin vücut fonksiyonlarının kullanımında engel teşkil edici fiziki bir kısıtlılık ve kayıptır.

---

5. Sokağımızda (ya da mahallemizde) en az 2m genişliğinde yaya kaldırımı..

☐ var ☑ yok

6. Hane halkının aylık toplam **net** geliri aşağıdaki seçeneklerden hangisine uygun düşmektedir?

100 milyon TL altında ☑

100 - 300 TL milyon arası ☐

300 milyon TL'den fazla ☐

7. a) Hanede en son eğitim seviyesine sahip kaç kişi varsa aşağıdaki kutucuklara rakamla yazınız.

Üniversite (veya yüksek okul)......... ☐

Lise ve dengi.......................... ☐

Orta okul ve dengi.................... ☐

İlkokul................................ ☐

Çeşitli kurslar....................... ☐

b) Hane halkı arasında okuma/yazma bilmeyen varsa kaç kişi,____

(yoksa boş bırakıp diğer soruya geçiniz)

8. Evinize son gelen elektrik faturasının yaklaşık ne kadar tuttuğunu belirtiniz,

5 milyon TL'dan az ☑

5-15 milyon TL arası ☐

15 milyondan çok ☐

9. a) Şu anda hane halkından lise ve üstü (üniversite) okula gidenler kaç kişi,______

b) Hane halkı arasında ilköğretim çağındaki (7 - 15 yaş arası) kişilerin sayısı,____

c) İlköğretim okuluna gidenler **genelde** aşağıdaki durumlardan hangisine uygundur (ilk kutu yaşca en küçük çocuk, son kutu en büyük için işaretlenecek);

okula giden çocuklar					
1.	**2.**	**3.**	**4.**	**5.**	
☐	☐	☐	☐	☐	Okula servisle gidiyor
☑	☑	☐	☐	☐	Yakındaki (en çok 500m) okula yürüyerek gidiyor
☐	☐	☐	☐	☐	Çocuğu okula kendi arabamızla, ya da bir yakının, komşunun, vs. arabasıyla bırakıyoruz.
☐	☐	☐	☐	☐	Çocuk uzaktaki okuluna (500m'den fazla) **yürüyerek** gidiyor,
☐	☐	☐	☐	☐	üstelik **ana caddeyi** geçmek zorunda kalıyor
☐	☐	☐	☐	☐	Okuluna, taksi, dolmuş, veya belediye otobüsü ile gidiyor

10. Oturduğunuz yerin aşağıdaki aktivitelere olan yaklaşık uzaklıklarını işaretleyiniz (en yakında varsa işaretleyiniz).

	500m içinde	1.5 km içinde	1.5 km'den fazla
İş yeriniz	☑	☐	☐
Okulunuz (ilköğret.)	☑	☐	☐
Sağlık merkezi	☑	☐	☐
Büyük market veya pazar	☑	☐	☐
Oyun alanı, spor veya park	☑	☐	☐
Sosyal, kültürel veya dini (veya idari, kamu kurumu)	☑	☐	☐

□□ II.BÖLÜM: KİŞİ BAZINDA SEYAHATLER (bu kısımda tek tek hanedeki bireylere, hafta içi yolculukları sorulacak)

Form no: A2

Mahalle kodu :	
Sokak kodu :	bu kısım anketör tarafından doldurulacak
Hane kodu :	

Birey no: **yaş:** **cinsiyet:**

(Not: bu form 6 yaş ve altındakilere uygulanamaz. 13 yaşına kadar olanlar anket formunu büyükleri/ebeveyni ile birlikte doldurmalıdır.)

1. a) Günde **düzenli** olarak yaptığınız ortalama yolculuk sayısı aşağıdakilerden hangisidir; (bunlar hergün **aynı saatlere rastlayan** genelde iş veya okul amaçlı yolculuklardır, **not:** gidiş-dönüş ayrı ayrı iki yolculuktur, hiç yolculuk yapmıyorsanız işaretlemeden diğer soruya geçiniz)

1□ 2☑ 3□ 4□ 5□ 6□ çok□

b) Düzenli yolculuklarınızı genelde hangi semte ve sokağa (veya hangi kuruma) yapıyorsunuz?,_______________, _____

2. İş veya okul **haricinde**, günde diğer , sosyal, gezme, eğlenme, spor, alış veriş, dinlenme, veya bir faaliyete katılmak için yaptığınız araçlı yolculukların sayısı (hafta sonunu dikkate almayınız);

1□ 2□ 3□ 4□ 5□ 6□

3. Günde **tüm** yolculuklar için ortalama olarak harcadığınız süre ne kadardır? (sadece yolculuk ettiğiniz süreler düşünülecek);

- □ 15 dakikadan az
- □ 15-30 dakika arası
- ☑ 30-60 dakika arası
- □ 1 - 2 saat arası
- □ 2 saatten fazla

4. Evden durağa, ya da otopark yerine varış süreniz ne kadar;

☑ 5 dakikadan az

☐ 5-10 dakika arası

☐ 10-20 dakika arası

☐ 20 dakikadan fazla

5. Ortalama bir günde yolculuk için harcadığınız para ne kadardır? (özel araç kullananlar, yakıt ücreti, park ücreti, vs. göz önüne almalıdır)

☐ 0 TL

☐ 0 - 100 bin TL arası

☑ 100 bin - 500 bin TL arası

☐ 500 bin - 1 milyon TL arası

☐ 1 milyon TL'den fazla

6. **a)** Ortalama bir günde kaç kere aktarma yapıyorsunuz (örneğin, işe ya da okula gidip gelirken),______

b) Toplu taşım araçları kullanırken ortalama bir günde **aktarma için** harcadığınız toplam süre ne kadardır? (aktarma yapmıyorsanız cevaplamadan diğer soruya geçiniz.)

☑ 5 dakikadan az

☐ 5-15 dakika arası

☐ 15-30 dakika arası

☐ 30 dakikadan fazla

7. Toplu taşım aracı kullanırken ortalama durakta bekleme süreniz ne kadar oluyor? (Toplu taşım kullanmıyorsanız işaretlemeyiniz)

☐ 5 dakikadan az

☑ 5-15 dakika arası

☐ 15-30 dakika arası

☐ 30 dakikadan fazla

8. Yolculuk amacı ve türü,

a) İş veya okul amaçlı **yolculuğa çıkış saatiniz** nedir?,___:____

b) İş ya da okul amaçlı yolculuktan eve **dönüş saatiniz** nedir?,____:____

c) İş ya da okul amaçlı yolculuğa çıkılan **araç türü** aşağıdakilerden hangisidir?

(toplutaşım ise): **Otobüs☐, Dolmuş☐, Minibüs☐, Tren☐,**

Servis☐, Diğer☐

(özel taşım): Özel araba☐, Ev halkından birinin arabası ile☐,

Yakının arabası ile☐, Taksi☐, Motorsiklet☐,

Bisiklet☐, Traktör☐, Diğer☐, _______

Yaya☐, engelli için özel ulaşım aracı ☐

d) Alışveriş ve diğer amaçlı yolculuklar için ayırdığınız günlük ortalama süre,

1 saatten az ☐ 1 - 3 saat arası ☑ 3 saatten fazla ☐

---

9. Ulaşım ALTYAPISI ve TOPLU TAŞIM hizmetleri hakkında sorular :

a) (Son üç-dört gün içindeki durumunuzu değerlendirerek) yolculuk ederken oturma imkanı bulabiliyor muydunuz?

sürekli	çoğunlukla	arada bir	çok az	hiç oturamıyordum
☐	☑	☐	☐	☐

b) ayakta iken..

çok sıkışık	sıkışık	normal	rahat	oldukça rahat
☐	☐	☐	☑	☐

10. Eğer engelli iseniz, günlük yolculuğunuzu yaparken..

☐ Biri (yakınınız veya bakıcı) size eşlik ediyor veya yardımcı oluyor

☐ Engelliliğim için yardımcı araç/gereç kullanıyorum

☑ yolculuklarımı özel bir servisle yapıyorum

11. Yolculuk yaptığınız taşıtların içinin genel kalitesini değerlendiriniz:

	İyi	Orta	Kötü
ışıklandırma	☐	☐	☑
koku	☐	☐	☑
sıcaklık ayarı	☐	☐	☑
gürültü	☐	☐	☑
koltuk rahatlığı	☐	☐	☐
sürüş kalitesi	☐	☐	☐
genel temizlik/bakım	☐	☐	☐
havalandırma	☐	☐	☐

12. Evinize en yakın durak (veya eve dönerken sıkça kullandığınız bir durak) koşullarına aşağıdakilerden hangisi uyuyor? **Özellikle trafiğin zirve saatlerinde (sabah 7 - 9 arası, akşam 5 - 7),**

- ☑ durakta çok yığılma ve karmaşa oluyor,
- ☑ araç çok geride veya ileride durup kapıyı açıyor
- ☑ durak tamamiyle (üstü ve yanları) açık
- ☑ durakta otobüs'ün (veya minibüs) yanaşacağı bir cep yok
- ☐ durak yeri bana göre çok ters, (örn; ana caddenin karşısında)
- ☐ durakta bilgilendirme levhası, açıklamalar, şemalar yok
- ☐ durakta bakımsızlığın ve tahribatın izleri var.
- ☐ durak eğimli bir yere konumlanmış
- ☐ durakta oturma yeri yok

Anket bitmiştir. Katılımınız için teşekkürler.

Appendix D

THE COORDINATES OF THE CENTROIDS AND NODES

COORDINATES of CENTROIDS and NODES

NODES	Y	X
Centroid 1	**47931**	**51158**
101	47961	51266
102	48201	51188
103	48428	51110
104	48536	51116
105	48668	50985
106	48770	50915
107	48404	50613
108	48063	50643
109	48033	50116
110	47650	50146
111	47332	51326
112	48320	50565
113	47033	50553
Centroid 2	**49160**	**50900**
201	49285	50883
202	48960	51115
203	48812	51242
204	48859	50877
205	49380	50655
206	49524	50600
207	49925	50660
208	49980	51206
Centroid 3	**49080**	**50488**
301	49105	50422
302	49213	50720
303	49057	50165
304	49045	50075
305	48680	50630
Centroid 4	**49842**	**50370**
401	49937	50350
402	49919	50170
403	49710	50242
404	49445	50326
405	49385	50140
406	49950	50583
407	50087	50517
408	50177	50104
409	50170	50320
Centroid 5	**50596**	**50326**
501	50584	50260
502	50692	50248
503	50782	50553
504	50555	50140
505	50536	49960
506	51303	50128
507	51513	50206
Centroid 6	**51595**	**49715**
601	51513	49763
602	52460	49912
603	53627	49715
604	53657	48643
605	50956	49026
606	50788	49344
607	50855	48390
Centroid 7	**49705**	**48757**
701	49686	48691

702	49900	48660
703	50057	48697
704	50340	48655
705	50267	49068
706	50087	49020
707	49937	48206
708	49705	48242
709	49704	48367
710	49380	48697
711	49465	49145
712	48728	48895
713	49190	49272
714	48870	49200
715	50160	48212
716	50656	48637
717	50165	48673
Centroid 8	**49090**	**48122**
801	49255	48290
802	49550	47085
803	48596	47900
804	49340	47930
805	49410	47875
Centroid 9	**48177**	**49595**
901	48207	49500
902	48410	49673
903	48338	49710
904	48315	48996
905	48368	48810
906	48960	49390
907	48572	49780
908	48350	49840
909	48380	50098
910	47555	50020
911	46200	50135
912	48010	49853
913	48020	49373
914	48716	49487
915	48350	49450
Centroid 10	**49327**	**49600**
1001	49340	49505
1002	49003	49577
1003	49584	49510
1004	49596	49560
Centroid 11	**49848**	**49487**
1101	49830	495553
1102	50003	49590
1103	49608	49092
1104	49925	50000
1105	49926	50055
Centroid 12	**50165**	**49560**
1201	50147	49613
1202	50475	49643
1203	50542	49212
1204	50297	49650
EXTERNAL CENTROIDS		
Ext 13	**47141**	**51362**
Ext 14	**45980**	**50145**
Ext 15	**49470**	**46900**
Ext 16	**53735**	**49720**
Ext17	**50033**	**51350**

Appendix E

THE FIVE MINUTE TRAFFIC COUNT FORMS, AND THE 15-MINUTE COUNTS

AYDIN KENTİÇİ TRAFİK SAYIMLARI
(özel ve ticari araçlar)

Form: **B2**
Sayım yeri:
Yönü:

Hava Durumu:
Sayım yapan:
Saat: Tarih:

		15 – 20 dk	20 – 25 dk	25 – 30 dk	toplam
Otomobil & küçük minibüs	1				
	2				
	3				
	4				
	5				
taksi	1				
	2				
	3				
	4				
	5				
Motorsiklet & bisiklet	1				
	2				
	3				
	4				
	5				
Kamyon Kamyonet pikap	1				
	2				
	3				
	4				
	5				
İş makinası & treyler	1				
	2				
	3				
	4				
	5				
Diğer	1				
	2				
	3				
	4				
	5				
toplam					

6 Kasım 1998

	araç sayısı					insan sayısı				
Private Modes	**15**	**30**	**45**	**60**	**Toplam**	**15**	**30**	**45**	**60**	**Toplam**
Oto-min	21	32	36	25	114	32	58	52	42	184
taxi	1	1			2	4	4			8
mot-siklet	4	6	4	14	28	5	8	4	20	37
Kamyo-pikap	10	11	12	14	47	13	21	21	21	76
işmak-trey	1		2	1	4	1		5	1	7
diger		2	1		3		4	2		6
Toplam	37	52	55	54	198	55	95	84	84	318
Public Mod					**Toplam**					**Toplam**
Minibüs	3	1	2	2	8	41	14	34	31	120
Midibüs		2			2		52			52
Servis-Çevr(ex)	35	38	42	34	149	215	168	250	174	807
Şehara-Oto(ex)										
Toplam	38	41	44	36	159	256	234	284	205	979
GEN TOP	75	93	99	90	357	311	329	368	289	1297

	araç sayısı					insan sayısı				
Private Modes	**15**	**30**	**45**	**60**	**Toplam**	**15**	**30**	**45**	**60**	**Toplam**
Oto-min	33	30	36	25	124	57	49	62	46	214
taxi		1	1		2		1	4		5
mot-siklet	14	7	9	14	44	14	7	10	15	46
Kamyo-pikap	7	12	8	15	42	9	19	11	29	68
işmak-trey										
diger			1		1			1		1
Toplam	54	50	55	54	213	80	76	88	90	334
Public Mod					**Toplam**					**Toplam**
Minibüs	1	1	2	1	5	5	17	20	5	47
Midibüs	3		1	1	5	46		7	15	68
Servis-Çevr(ex)	35	41	44	34	154	263	357	334	234	1188
Şehara-Oto(ex)										
Toplam	39	42	47	36	164	314	374	361	254	1303
GEN TOP	93	92	102	90	377	394	450	449	344	1637

Appendix F

THE MOST CORRELATED VARIABLES AND CORRELATION RESULTS

rrelations

Correlations

		Variables2				
ariables	Statistics	REG#TRP	SOC#TRP	TYPE#MOD	F(vehic)	f(inc#re
EG#TRP	Pearson Correlation	1,000	,007	,174**	,043	,107**
	Sig. (2-tailed)	,	,829	,000	,187	,001
	N	929	929	929	929	929
OC#TRP	Pearson Correlation	,007	1,000	,114**	,086**	,054
	Sig. (2-tailed)	,829	,	,000	,009	,102
	N	929	931	931	931	931
YPE#MOD	Pearson Correlation	,174**	,114**	1,000	-,075*	-,011
	Sig. (2-tailed)	,000	,000	,	,021	,747
	N	929	931	932	932	932
F(vehic)	Pearson Correlation	,043	,086**	-,075*	1,000	,457**
	Sig. (2-tailed)	,187	,009	,021	,	,000
	N	929	931	932	932	932
f(inc#re	Pearson Correlation	,107**	,054	-,011	,457**	1,000
	Sig. (2-tailed)	,001	,102	,747	,000	,
	N	929	931	932	932	932
f(veh#av	Pearson Correlation	,059	,081*	-,102**	,929**	,473**
	Sig. (2-tailed)	,074	,013	,002	,000	,000
	N	929	931	932	932	932
f(access	Pearson Correlation					
	Sig. (2-tailed)					
	N					
f(imped1	Pearson Correlation	,297**	,253**	,301**	,059	,003
	Sig. (2-tailed)	,000	,000	,000	,072	,939
	N	929	931	932	932	932
f(depend	Pearson Correlation	-,053	-,031	,006	-,110**	-,204**
	Sig. (2-tailed)	,104	,345	,856	,001	,000
	N	929	931	932	932	932
f(edu#1	Pearson Correlation	,014	-,008	,025	,149**	,362**
	Sig. (2-tailed)	,672	,800	,438	,000	,000
	N	929	931	932	932	932
f(ilko#t	Pearson Correlation	-,025	-,065*	-,060	,187**	,143**
	Sig. (2-tailed)	,440	,048	,066	,000	,000
	N	929	931	932	932	932
f(inc#pe	Pearson Correlation	,111**	,065*	-,022	,428**	,853**
	Sig. (2-tailed)	,001	,046	,506	,000	,000
	N	929	931	932	932	932
f(imped3	Pearson Correlation	,080*	,307**	,675**	,009	,058
	Sig. (2-tailed)	,015	,000	,000	,786	,078
	N	929	931	932	932	932
f(veh#co	Pearson Correlation	,095**	,046	-,054	-,085**	-,040
	Sig. (2-tailed)	,004	,159	,099	,009	,227
	N	929	931	932	932	932
f(imped2	Pearson Correlation	,154**	,188**	,204**	-,011	-,017
	Sig. (2-tailed)	,000	,000	,000	,731	,598
	N	929	931	932	932	932
f(pub#co	Pearson Correlation	-,107**	-,072*	-,129**	,004	-,015
	Sig. (2-tailed)	,001	,028	,000	,899	,657
	N	929	931	932	932	932

Appendix G

THE REGRESSION ANALYSIS RESULTS

The information include:

The Best Regression Trial for Trip Productions

Stepwise Regression for Trip Production

The Best Regression for Trip Productions of Disadvantaged

Stepwise Regression for Trip productions of Disadvantaged

The Regression for Mode Utility for Normal

The Regression for Mode Utility for Disadvantaged

The Regression for Beta Estimation for Normal

The Regression for Beta Estimation for Disadvantaged

gression of Trip Productions for All

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	STATU#EDU, f(depend, f(inc#pe[a]	,	Enter

a. All requested variables entered.

b. Dependent Variable: REG#TRP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,886[a]	,785	,704	,1631

a. Predictors: (Constant), STATU#EDU, f(depend, f(inc#pe

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,775	3	,258	9,713	,005[a]
	Residual	,213	8	2,659E-02		
	Total	,988	11			

a. Predictors: (Constant), STATU#EDU, f(depend, f(inc#pe

b. Dependent Variable: REG#TRP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3,131	,494		6,345	,000
	f(depend	-3,933E-02	,011	-,722	-3,615	,007
	f(inc#pe	-4,046E-02	,013	-,847	-3,051	,016
	STATU#EDU	2,022	,455	1,076	4,446	,002

a. Dependent Variable: REG#TRP

Appendix H

CALIBRATION OF EXTERNAL TRAFFIC (COMPARISON WITH THE HIGHWAY DIRECTORATE RESULTS AND ZONE-TO-ZONE EXTERNAL TRAFFIC)

CALIBRATION of traffic counts of HIGHWAY DIRECTORATE (for Peak hours on Screen line counts)

		Izmir		**Mugla**	
		West	East	South	North
9583,333	15	322	301	209	192
	30	332	276	244	189
	45	378	383	275	198
	60	327	318	305	201
	sum	1359	1278	1033	780
	Gen.sum	2637		1813	
	aver	1318,5		906,5	
	daily factor	0,101538		0,225	0,257143
Ave/direc	Daily	12985,23		4028,889	
	extern traffic.	**5194** (5000-7000)		**1612** (1500-2000)	
	%	0,4		0,4	

(with the PCU values, Izmir exit gets 18000 and Muğla gets around 4000)

T.C. Karayolları Official Traffic Count Results (1/1/1998)
1997 AADT (Yıllık Ortalama Günlük Trafik)

observ. Area	Incirliova enviro	Nazilli environ	Çine environ	
volumes	Ayd-Izmir	Ayd-Denizli	Ayd-Muğla	
auto	8974	6830	2741	
bus	783	510	237	
lorry-truck	3742	2589	195	
heavy truck	212	127	32	
TOTAL	13711	10056	3205	
auto %	0,65	0,68	0,85	
bus %	0,057	0,05	0,074	
lorry-truck %	0,27	0,26	0,06	
heavy Truck %	0,015	0,013	0,01	
	0,992	1,003	0,994	
Vehicles with PCU	17961,41		4006,25	
PCU overall factor	0,31		0,25	calculated
		12972,24		assumed
		observation absent		
truncated	**18000**	13000	**4000**	

Appendix I

TRAFFIC ADJUSTMENT FOR THE SCREEN LINE STREETS BY THE MODELLED VALUES

Capacity Calculation Based on The Vehicular Composition on the Streets (Peak Hour)

	Atatürk Bulv.		AdnanMenderes Bul.		Egemenlik Bulv.		Izmir Yolu		Muğla Yolu		
	North	South	North	South	North	South	Doğu	Batı	North	South	PCU equiv's
car/min/ta	0,67	0,66	0,72	0,7	0,33	0,37	0,53	0,58	0,56	0,57	1
Mini/midi	0,09	0,1	0,09	0,09	0,43	0,42	0,15	0,12	0,15	0,16	1,2
Lorry/pik	0,17	0,13	0,12	0,1	0,15	0,12	0,27	0,24	0,25	0,21	1,5
Bus	0	0	0	0	0	0	0,01	0,01	0,01	0,005	2
Mot/bike	0,07	0,1	0,07	0,09	0,09	0,09	0,04	0,05	0,04	0,06	0,3
max.15m capacity	194	152	325	313	98	102	383	378	201	305	
car/min/ta	129,98	100,32	234	219,1	32,34	37,74	202,99	219,24	112,56	173,85	
Mini/midi	20,952	18,24	35,1	33,804	50,568	51,408	68,94	54,432	36,18	58,56	
Lorry/pik	49,47	29,64	58,5	46,95	22,05	18,36	155,115	136,08	75,375	96,075	
Bus	0	0	0	0	0	0	7,66	7,56	4,02	3,05	
Mot/bike	4,074	4,56	6,825	8,451	2,646	2,754	4,596	5,67	2,412	5,49	
	204,476	152,76	334,425	308,305	107,604	110,262	439,301	422,982	230,547	337,025	
	817,904	611,04	1337,7	1233,22	430,416	441,048	1757,204	1691,928	922,188	1348,1	
capacities	**818**	**611**	**1338**	**1233**	**430**	**441**	**1757**	**1692**	**922**	**1348**	
Average Capacity	**714,5**		**1285,5**		**435,5**		**1724,5**		**1135**		
max	800		1300		500		1800		1200		
# of lanes	2	2	3	3	1	1	3	3	3	3	
per lane	200	200	217	217	250	250	300	300	200	200	

Appendix J

CLUSTER FILTER ANALYSIS ACROSS THE TRANSPORTATION CATEGORIES AND ZONES (FOR BOTH NORMAL AND DISADVANTAGED)

uick Cluster

Initial Cluster Centers

	Cluster	
	1	2
VEH#AVA	3,97	56,34
ACCESS	28,93	52,50
IMPED1	60,00	96,67
DEPEND	8,79	69,70
EDU#FAM1	6,58	42,11
ILK#TRAV	,00	66,67
INC#PER	,00	94,11
IMPED3	78,57	64,29
VEH#COM	66,67	20,83
IMPED2	98,51	95,52
PUB#COM	80,00	80,00

Iteration History[a]

	Change in Cluster Centers	
Iteration	1	2
1	87,645	83,296
2	6,369	9,582
3	3,372	6,836
4	2,511	5,078
5	,864	1,680
6	,283	,535
7	,120	,229
8	,147	,280
9	,000	,000

a. Convergence achieved due to no or small distance change. The maximum distance by which any center has changed is ,000. The current iteration is 9. The minimum distance between initial centers is 158,838.

Final Cluster Centers

	Cluster	
	1	2
VEH#AVA	6,37	54,73
ACCESS	45,88	50,48
IMPED1	86,51	85,05
DEPEND	58,53	64,81
EDU#FAM1	36,68	43,41
ILK#TRAV	63,78	69,70
INC#PER	9,43	18,63
IMPED3	73,40	73,94
VEH#COM	37,59	38,41
IMPED2	95,89	96,07
PUB#COM	68,17	68,47

Number of Cases in each Cluster

Cluster	1	611,000
	2	321,000
Valid		932,000
Missing		,000

Appendix M

MODAL SPLIT OF TRIPS BY CATEGORY (ADVANTAGED AND DISADVANTAGED) PRODUCED BY TRANUS

TRIPS BY MODE AND TRANSPORT CATEGORY

Mode	Category	Iter	Area	Pol	Date/time simulation
1 Public	1 adv		13	AYD 98A	29- 7-1980 11:22

ZON	1 kem-gir	2 mes-k"p	3 MeŸru	4 oldcenter	5 cum-zaf	6 At-ort	7 adme-yed	8 Oyoz-ist	9 Ef-zey	10 Cumh	11 Kurtu	12 Ghis	13 Gir-ext	14 Izm-ext	15 Mug-ext	16 Den-ext	17 Nort-ext	
1 kem-gi	0	881	1163	2192	40	1275	41	40	39	40	42	309	1	1	1	1	1	6067
2 mes-k"	33	0	33	247	242	517	257	34	243	33	124	372	1	1	1	1	1	2140
3 MeŸru	33	244	0	33	505	524	34	263	246	253	125	33	1	1	1	1	1	2298
4 oldcen	35	33	495	0	491	33	382	34	489	33	122	493	1	1	1	1	1	2645
5 cum-za	68	65	502	1479	0	1001	67	69	1011	491	491	988	1	1	1	1	1	6237
6 At-ort	48	508	45	599	328	0	45	46	681	43	101	435	1	1	1	1	1	2884
7 adme-y	29	427	106	954	621	213	0	27	27	207	404	803	1	1	1	1	1	3823
8 Oyoz-i	23	23	173	342	23	23	22	0	23	23	22	22	1	1	1	1	1	724
9 Ef-zey	37	36	819	823	37	38	37	37	0	36	275	36	1	1	1	1	1	2216
10 Cumh	52	385	1540	1336	378	770	770	52	745	0	1412	757	1	1	1	1	1	8202
11 Kurtu	28	26	1164	726	575	602	190	26	26	27	0	711	1	1	1	1	1	4106
12 Ghis	32	30	436	442	220	30	432	30	220	29	616	0	1	1	1	1	1	2522
13 Gir-ex	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	16
14 Izm-ex	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	16
15 Mug-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	16
16 Den-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	16
17 Nort-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	16
TOT	423	2663	6481	9178	3465	5031	2282	663	3755	1220	3739	4964	16	16	16	16	16	43944

TRIPS BY MODE AND TRANSPORT CATEGORY

Mode	Category	Iter	Area	Pol	Date/time simulation
1 Public	2 disad		13	AYD 98A	29- 7-1980 11:22

ZON	1 kem-gir	2 mes-k"p	3 MeŸru	4 oldcenter	5 cum-zaf	6 At-ort	7 adme-yed	8 Oyoz-ist	9 Ef-zey	10 Cumh	11 Kurtu	12 Ghis	13 Gir-ext	14 Izm-ext	15 Mug-ext	16 Den-ext	17 Nort-ext	
1 kem-gi	0	1030	5141	2581	514	3099	95	95	513	772	258	95	1	1	1	1	1	14198
2 mes-k"	543	0	542	2176	1083	544	544	100	1083	1086	1898	1900	1	1	1	1	1	11504
3 MeŸru	53	857	0	1516	53	53	571	53	286	53	53	53	1	1	1	1	1	3606
4 oldcen	95	1031	1182	0	515	1539	771	95	668	154	514	2219	1	1	1	1	1	8788
5 cum-za	1421	471	87	2367	0	1895	2363	87	946	87	1180	2134	1	1	1	1	1	13043
6 At-ort	485	89	966	3371	967	0	967	89	484	480	1208	1691	1	1	1	1	1	10802
7 adme-y	55	55	295	3554	888	1721	0	54	296	296	1925	2363	1	1	1	1	1	11507
8 Oyoz-i	320	59	321	641	643	515	963	0	737	642	961	640	1	1	1	1	1	6447
9 Ef-zey	61	334	670	334	62	62	670	62	0	668	62	61	1	1	1	1	1	3051
10 Cumh	97	97	523	521	521	520	97	97	96	0	791	786	1	1	1	1	1	4151
11 Kurtu	65	350	65	1752	1052	65	64	350	350	354	0	889	1	1	1	1	1	5361
12 Ghis	412	410	75	1234	411	1231	75	75	205	205	1665	0	1	1	1	1	1	6003
13 Gir-ex	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	16
14 Izm-ex	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	16
15 Mug-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	16
16 Den-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	16
17 Nort-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	16
TOT	3612	4788	9872	20052	6714	11249	7185	1162	5669	4802	10520	12836	16	16	16	16	16	98541

TRIPS BY MODE AND TRANSPORT CATEGORY

Mode	Category	Iter	Area	Pol	Date/time simulation
1 Public	1 adv	13	AYD	98A	29- 7-1980 11:22

ZON	1 kem-gir	2 mes-k"p	3 MeŸru	4 oldcenter	5 cum-zaf	6 At-ort	7 adme-yed	8 Oyoz-ist	9 Ef-zey	10 Cumh	11 Kurtu	12 Ghis	13 Gir-ext	14 Izm-ext	15 Mug-ext	16 Den-ext	17 Nort-ext	
1 kem-gi	0	881	1163	2192	40	1275	41	40	39	40	42	309	1	1	1	1	1	6067
2 mes-k"	33	0	33	247	242	517	257	34	243	33	124	372	1	1	1	1	1	2140
3 MeŸru	33	244	0	33	505	524	34	263	246	253	125	33	1	1	1	1	1	2298
4 oldcen	35	33	495	0	491	33	382	34	489	33	122	493	1	1	1	1	1	2645
5 cum-za	68	65	502	1479	0	1001	67	69	1011	491	491	988	1	1	1	1	1	6237
6 At-ort	48	508	45	599	328	0	45	46	681	43	101	435	1	1	1	1	1	2884
7 adme-y	29	427	106	954	621	213	0	27	27	207	404	803	1	1	1	1	1	3823
8 Oyoz-is	23	23	173	342	23	23	22	0	23	23	22	22	1	1	1	1	1	724
9 Ef-zey	37	36	819	823	37	38	37	37	0	36	275	36	1	1	1	1	1	2216
10 Cumh	52	385	1540	1336	378	770	770	52	745	0	1412	757	1	1	1	1	1	8202
11 Kurtu	28	26	1164	726	575	602	190	26	26	27	0	711	1	1	1	1	1	4106
12 Ghis	32	30	436	442	220	30	432	30	220	29	616	0	1	1	1	1	1	2522
13 Gir-ex	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	16
14 Izm-ex	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	16
15 Mug-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	16
16 Den-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	16
17 Nort-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	16
TOT	423	2663	6481	9178	3465	5031	2282	663	3755	1220	3739	4964	16	16	16	16	16	43944

TRIPS BY MODE AND TRANSPORT CATEGORY

Mode	Category	Iter	Area	Pol	Date/time simulation
1 Public	2 disad	13	AYD	98A	29- 7-1980 11:22

ZON	1 kem-gir	2 mes-k"p	3 MeŸru	4 oldcenter	5 cum-zaf	6 At-ort	7 adme-yed	8 Oyoz-ist	9 Ef-zey	10 Cumh	11 Kurtu	12 Ghis	13 Gir-ext	14 Izm-ext	15 Mug-ext	16 Den-ext	17 Nort-ext	
1 kem-gi	0	1030	5141	2581	514	3099	95	95	513	772	258	95	1	1	1	1	1	14198
2 mes-k"	543	0	542	2176	1083	544	544	100	1083	1086	1898	1900	1	1	1	1	1	11504
3 MeŸru	53	857	0	1516	53	53	571	53	286	53	53	53	1	1	1	1	1	3606
4 oldcen	95	1031	1182	0	515	1539	771	95	668	154	514	2219	1	1	1	1	1	8788
5 cum-za	1421	471	87	2367	0	1895	2363	87	946	87	1180	2134	1	1	1	1	1	13043
6 At-ort	485	89	966	3371	967	0	967	89	484	480	1208	1691	1	1	1	1	1	10802
7 adme-y	55	55	295	3554	888	1721	0	54	296	296	1925	2363	1	1	1	1	1	11507
8 Oyoz-is	320	59	321	641	643	515	963	0	737	642	961	640	1	1	1	1	1	6447
9 Ef-zey	61	334	670	334	62	62	670	62	0	668	62	61	1	1	1	1	1	3051
10 Cumh	97	97	523	521	521	520	97	97	96	0	791	786	1	1	1	1	1	4151
11 Kurtu	65	350	65	1752	1052	65	64	350	350	354	0	889	1	1	1	1	1	5361
12 Ghis	412	410	75	1234	411	1231	75	75	205	205	1665	0	1	1	1	1	1	6003
13 Gir-ex	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	16
14 Izm-ex	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	16
15 Mug-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	16
16 Den-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	16
17 Nort-e	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	16
TOT	3612	4788	9872	20052	6714	11249	7185	1162	5669	4802	10520	12836	16	16	16	16	16	98541

Vita

- Born in Çorlu in 1966.
- Graduated from the Department of City and Regional Planning of Middle East Technical University in 1989.
- Experienced part-time work in a Planning Bureau (Epsilon Co.) between September 1989 and November 1990
- Earned Master's deggree in City Planning from the same department in 1992.
- Work experience as research assistant in the same department and entered the 2^{nd} year studios between January 1992 and August 1993.
- Earned Master's deggree from the Department of City and Regional Planning of the University of Pennsylvania (U.S.) on Transportation in May 1995.
- Currently entering to the courses: UD 653 – Simulation Techniques, CP 730 – Urban Transportation Planning and Policy, UD 572 – Urban Traffic Design in the Department of City and Regional Planning at Izmir Institute of Technology

Proceeding: "Elektrikli Arabaların Çevre ve Enerji Açısından Değerlendirilmesi" (The Evaluation of Electric Vehicles With Respect to Environment and Energy), Çevre ve Enerji Kongresi – 5 –7 June 1997, TMMOB, no. 192, Ankara, pp.395-409

Interested in the Science Fiction novels and painting.