

# Applying the Land Use-Transportation Integrated Model, Using the Most Effective Sustainable Urban Variables

## Case study: part of the district 22 of city of Tehran

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### Abstract

Land use planning is the main core of urban planning and one of the main components of an urban system. This element has close relation with transportation system of the city, so if their interaction becomes insufficient, deterioration and chaos would have an adverse impact on the urban system and would cause serious environmental issues.

The integrated land use-transportation models seem to be the ones that can help to create efficient interaction between land use and transportation systems. Since the introduction of sustainability to urban studies, urban researchers have tried to investigate and use the variables that will help to achieve urban sustainability in the models.

This analytical-documental research (with a quantitative approach), with emphasis on sustainability tries to verify the most effective variables in the above mentioned models, and then propose a process with a particular kind of analysis. The verified variables and the process are then examined in part of the 22<sup>nd</sup> district of Tehran as the case study. Our findings indicate that; applying the chosen variables in the model and simulation process will make significant reduction in energy use, pollution (MO<sub>2</sub>), and delay (direct effects on environment and economy). The indirect effect shows itself on social aspect since the mentioned changes are related to the citizens conveniences.

**Key words:** Urban land use- Transportation- Integrated model- 22<sup>nd</sup> District of Tehran

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### 1. Introduction

Land use and transportation with their close interaction are the two elements of a dynamic urban system. That is why if inefficiency happens in their relation, disorders will happen in different aspects in a city: for example, socially (inconvenience for citizens), economically (delay, congestion) and environmentally (pollutions) and many more disturbances. Occurrences of these represent a city far from being sustainable.

One of the ways to make land use-transportation interaction work efficiently is the application of integrated models. Although these models have been used since 1950, researches still try to make updated models, especially by using those variables which help to design sustainable urban indicators.

This research in this regard has carried out two main purposes.

First of all, to verify the most effective variables in an urban land use-transportation model and proposing a process for their use, with emphasis on moving towards sustainability.

Second is to verify the importance of land use and transportation interaction with aiming to bridge the gap between views of urban and transportation planners. This collaboration is important when development plans are under consideration; since these two groups of planners are often carrying their practices apart from each other and their plans are prepared independently without consultation with each other (even the feedbacks of land use and transportation networks are ignored), cases that happen very often in Iran.

### 2. Research method

This documental-analytical research has a quantitative approach and each part, due to its characteristic has been analyzed on basis of a particular method. The literature review is mainly done through the library and available urban studies. The theoretical framework was driven from these studies for verification the interactive land use-transportation variables and proposing how to apply the integrated model in order to move towards sustainability. The information for case study (part of the 22<sup>nd</sup> district of Tehran) was gathered from the detailed urban plans of this district and the other studies relevant to this research

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which have been done by the Tehran Transportation Comprehensive center.

### 3. Fundamental concept of the research

#### *Urban land use planning*

According to Chapin, urban land use planning is the spatial and local organization of the urban functions and activities which they should comply with the needs of an urban community. It is also considered as the main core of urban planning (Chapin & Kaiser, 1985). This definition has been used as the main step of the research.

#### Sustainable land use

The sustainable approach to urban land use means to make balance between economical, social and environmental components within the urban developing plans such that to respond the needs of people at present and future (Herber & Girardet, 1992).

#### Sustainable transportation

Transportation systems make easy access for the citizens to all directions but besides its benefit it has some disadvantages too (e.g. congestion, pollution, fume). The sustainable approach to transportation in this regard is to make a balance between advantages and disadvantages of transportation (Hitoshi, 2010 and Rodrigue, 2006).

#### Land use-transportation integrated models

Land use models were used since 1950 in the US but when the lack of transportation variables became obvious the Transportation-Land Use Models (TLUM) were prepared which also helped to predict the future urban patterns. These models include three sub-model as (1)land use, (2)spatial interactions and (3)transportation network (Rodrigue, 2006).

### 4. Literature Review

By the time sustainability paradigm was introduced to urban discussions some researchers (among them Newman & Kenworthy, Williams, Newton, Simonds, Steed & Titheridge), tried to verify those variables in land use-transportation models which could help gaining sustainability. In the present research these studies are reviewed in two groups; (A) studies before the year 2000 (1990-2000) and (B) studies after 2000

#### A) The studies between 1990-2000

These studies are mostly done by *Newman & Kenworthy, Newton, Steed, Williams and Titheridge*, in the UK and Australia. Their common results insist on the special effect of urban density, mixed land use, land use composition, modal split and use of energy on sustainability.

#### B) The studies after the year 2000

These groups of studies were mostly done by Giovanni (2001) and Kenworthy & Laube (2001-2005). Giovanni introduced a table containing 38 indicators in the macro groups of "activity composition", "population", "building supply", "transportation infrastructures", "modal split", "generated journey" and "pollutants" (Giovanni, 2001).

*Kenworthy & Laube* focused their study on 100 city (emphasizing on gaining sustainability at 2025) by dividing them into two groups of cities; high and low income. The result obtained 69 effective variables in the main groups of "land use", "transportation infrastructure", "traffic demand & supply indicators", "modal split", "environmental costs", "traffic congestion" and "pollution indicators" (Kenworthy and Laube, 2001).

The mentioned variables consist of a vast range that using all of them in a model makes it complicated (information complexity) and on the other hand it is costly and takes time and energy. Therefore this research has tried to verify the most effective variables with emphasis on sustainability.

### 5. Methodology

In order to investigate the most effective variables related to land use and transportation integrated model regarding urban sustainability, the following steps were taken:

- a. Identifying the common sustainable principles between land use and transportation. This step was done according to the sustainable land use-transportation principles of Calgary city (since it is a pioneer city in practicing the integrated land use-transportation sustainability).
- b. Identifying the most effective land use and transportation variables on sustainability investigated in the literature review.
- c. Identifying the most effective variable on achieving urban sustainability.

This step has been done by comparing two indicators: (1) Frequency of each variable in the literature review (2) Overlapping of each variable with the land use-transportation principles (interactive approach).

In this regard the most effective variables are (1) land use density, (2) land use composition (according to population and occupation density), (3) local access to transportation infrastructures and the moderate effect variables are (1) community size, (2) modal split, (3) energy use, (4) car ownership (Table 1).

The variables with high frequency and overlapping (more than 50%) were named the most effective variables and the ones with less effect (about 30%) were named the moderate effective ones.

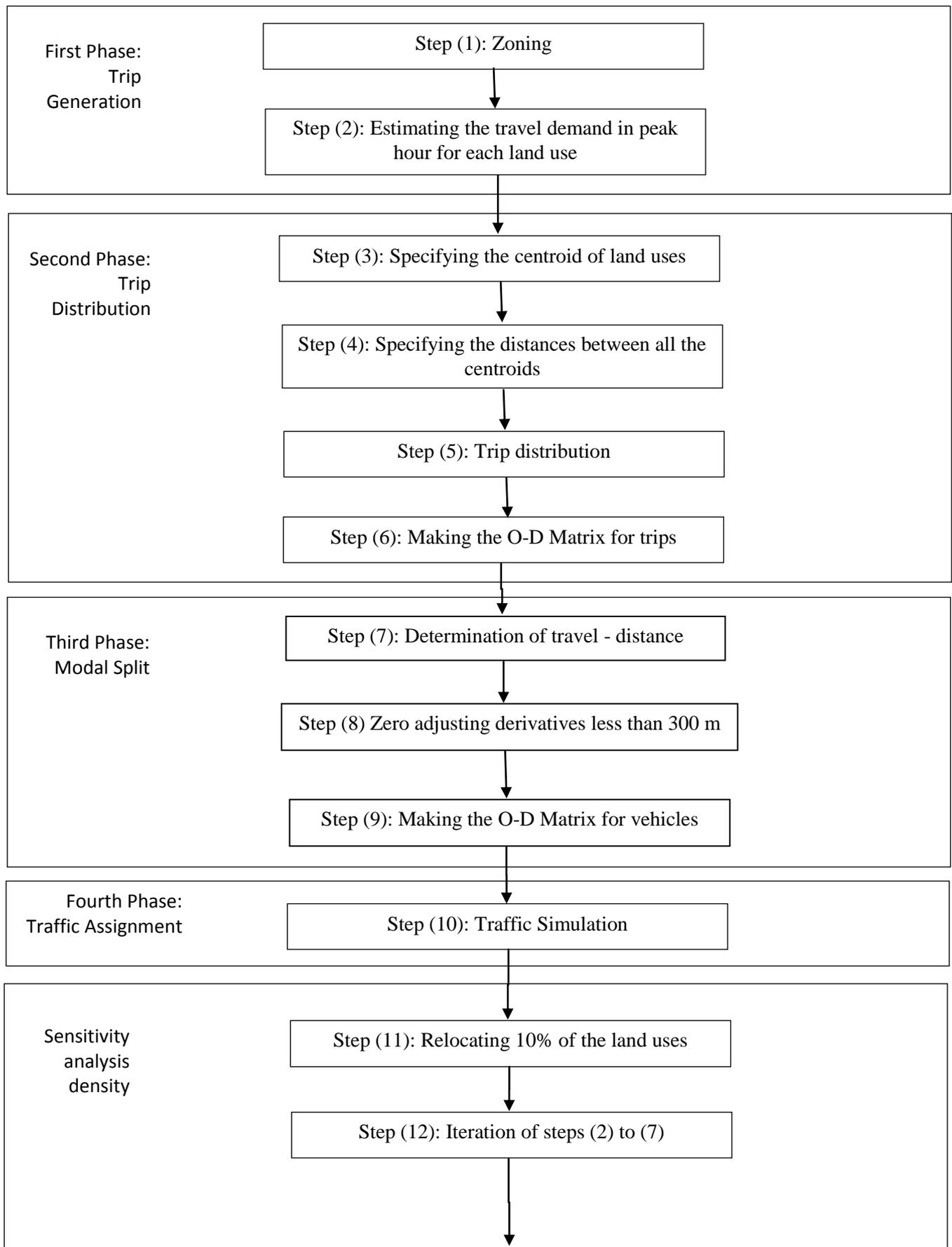
Table 1  
Effective variables on urban sustainability (Land use – Transportation interactive)

| Indicator                                      | Type of effect on sustainability   |   |   |                                     |                                 |
|--|--|---|---|-------------------------------------|---------------------------------|
|  | Traffic reduction  | Improvement in air and sound quality                      | Reduction in Car usage                      | Reduction of movement costs         | Access to Infrastructures       |
| <b>High Effect</b>                             |  |   |   |                                     |                                 |
| Population and activity density                | Giovanni, 2001, Williams, Newton, Masnavi, Kenworthy, Newman, 1995, 1999 | Giovanni, 2001, Titheridge, Banister, Hall, 1995, 1999    | Masnavi, 1997, 1998                         | Kenworthy, Newman, 1995, 1999       | Masnavi, 1997, 1998             |
| Land use Composition (Mixed)                   | Giovanni, 2001, Williams, Newton, Masnavi, 1995, 1997, 1998, 1999        | Giovanni, 2001, Newton, 1995, 1999                        | Masnavi, Senior 1997, 1998                  | Titheridge, 1999                    | Masnavi, 1997, 1998             |
| Local access to transportation infrastructures | Titheridge, Steed, 1999  | Titheridge, 1999  | Titheridge, 1999                            | Titheridge, 1999                    | Titheridge, 1999                |
| <b>Moderate Effect</b>                         |  |   |   |                                     |                                 |
| Population density                             | Giovanni, 2001, Newton, 1995, 1999                                       |   | Steed Williams, Banister, 1999              |                                     |                                 |
| Modal split                                    | Giovanni, 2001, Steed, Williams, Banister, 1999                          | Giovanni, 2001, Steed, Williams, Banister, 1999           | Steed, Williams, Banister, 1999             | Steed, Williams, Banister, 1999     | Steed, Williams, Banister, 1999 |
| Energy use                                     |  | Kenworthy, Newman, 1995, 2001, Banister, Titheridge, 1999 |   | Kenworthy, Newman, 1995, 1999, 2001 |                                 |
| Car ownership                                  | Steed, Williams, Banister, Titheridge, 1999                              | Steed, Williams, Banister, Titheridge, 1999               | Steed, Williams, Banister, Titheridge, 1999 |                                     |                                 |

### 6. The proposed process for applying the integrated model

The main aim of this research is to introduce a new way to apply the identified variables in an integrated model with a sustainable approach. This process consists of two main parts: (1) using the 4 step land use-transportation model

(2) sensibility analysis and simulating .These all contain 14 steps (the process is completely shown in Fig. 1).



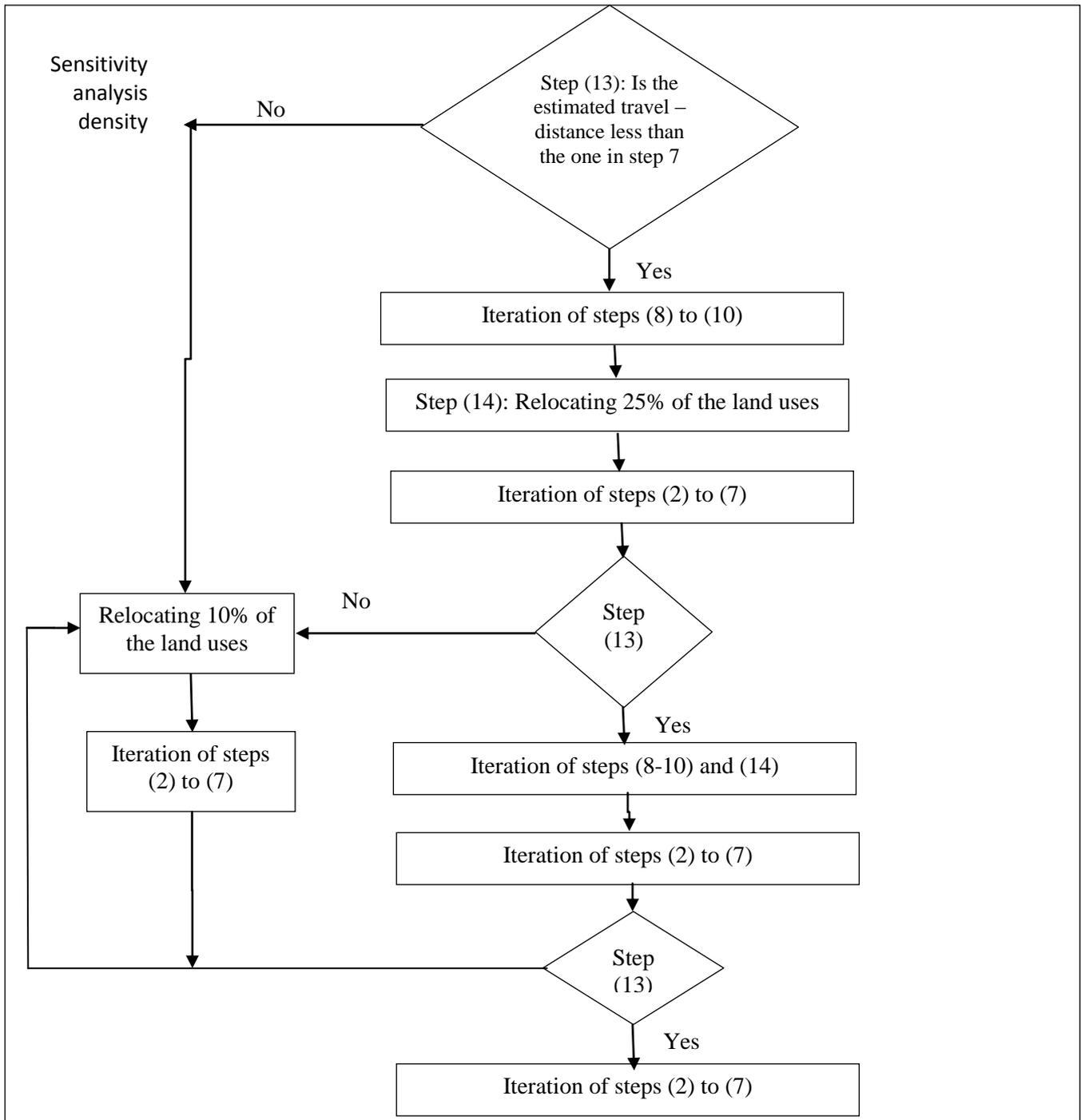


Fig. 1. Model application and Simulation Process

## 7. Case study

The proposed method is examined in part of the 22<sup>nd</sup> district of Tehran (Fig. 2). The reason for choosing this district was its being pioneer in achieving the sustainable urban indicators. The boundary of the selected area is *Shahid Kharazi Exp.* way in north, *Azadegan Express* way in east, *Havanerooz Blvd.* in south and *Arghavan Blvd.* in west. As mentioned before the information was gathered from the detailed urban plan of this district. According to the detailed plan, land uses in this district are categorized

in four groups: (R) Residential, (S) Commercial & Official (M) Mixed and (G) Green Space (Fig. 3).

The application of the model was done by using the district information (as mentioned in Fig. 1) and then the simulation process through using the AIMSUN (Advanced Interactive Microscopic Simulator for Urban & Non-Urban Networks) software. The outcome was 549 alternatives which due to their huge amount, 18 alternatives were chosen with the least distance-journey

(the result of changes in the variables after simulating is shown in Table 2).

Analysis of Table 2 shows that alternative no. 407 is the best one between the simulated alternatives. In this alternative most of the mixed land uses were relocated and they were located far from the high buildings. This alternative has the most reduction in energy use and pollution (MO2), so it plays an important role to achieve urban sustainability. According to Table 2 the conclusion is that those verified variables that show improvement after this application are "energy use", "time delay", "pollution (MO2)" and "distance traveled (km)".

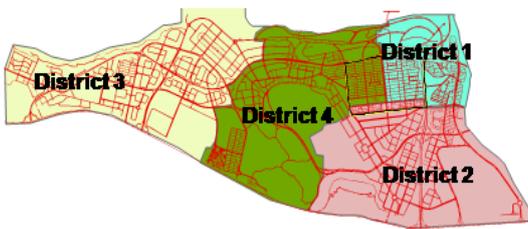


Fig. 2. Tehran 22<sup>nd</sup> District and the selected area



## 8. Conclusion

Fig. 3. The selected area of study and its boundaries

Efficient Land use-transportation interaction models have always been an important part of the urban planner's discussions. Also it was claimed that the integrated models can help to achieve both efficiency and sustainability. This study has tried to verify the most effective variables on gaining sustainability and it was applied in the proposed method.

The most effective variables were divided into two groups with high and moderate effect and they were applied and examined in part of the 22<sup>nd</sup> district of Tehran as the case study. It came to the conclusion that some alternatives could play a better role in gaining sustainability than the accepted locations in the district detailed plan. This is worth paying attention that while preparing the plans both land use and transportation studies must have close interaction together and their feedbacks to be considered in their part carefully.

Table 2  
Changes in the interactive variable of chosen alternatives (Comparing with the base alternative) %

|  |        |       |        |        |
|--|--------|-------|--------|--------|
| 198  | -11.32 | 4.96  | -13.30 | -13.23 |
| 583  | -9.21  | 3.27  | -10.33 | -9.84  |
| 572  | -12.34 | -0.84 | -14.06 | -12.53 |
| 561  | -13.31 | -0.74 | -14.13 | -12.88 |
| 539  | -10.83 | 1.85  | -12.12 | -11.53 |
| 541  | -13.51 | 3.74  | -14.11 | -14.65 |
| 528  | -12.11 | 2.48  | 13.37  | -12.88 |
| 517  | -11.76 | 1.42  | -14.00 | -12.57 |
| 100  | -11.17 | 4.28  | -13.44 | -13.09 |
| 495  | -11.43 | 2.32  | -12.61 | -12.40 |
| 484  | -12.64 | -1.58 | -13.78 | -12.55 |
| 473  | -14.44 | 2.77  | -15.09 | -15.27 |
| 462  | -14.58 | 0.37  | -14.30 | -15.24 |
| 451  | -10.58 | 3.90  | -12.54 | -12.35 |
| 440  | -12.02 | -0.74 | -13.71 | -12.44 |
| 429  | -10.76 | 1.53  | -11.99 | -11.30 |
| 418  | -11.93 | 1.21  | -12.33 | -12.16 |
| 407  | -15.97 | 3.22  | -16.20 | -16.58 |
| <b>Changes Comparing with base alternative (%)</b> |        |       |        |        |
| <b>Energy use</b>                                  |        |       |        |        |
| <b>Delay</b>                                       |        |       |        |        |
| <b>Pollution (Mo<sub>2</sub>)</b>                  |        |       |        |        |
| <b>Vehicle kilometer traveled</b>                  |        |       |        |        |

## References

- 1) Banister, D., 2005. *Unsustainable transport; city transport in the new century*", Rutledge.
- 2) Chapin, F. S., Kaiser, E., 1978, 1985. *"Urban land use planning*, Illinois Press.
- 3) Giovanni, F., 2001. *Conceptual modeling of the interaction between transportation, land use and the environment as a tool for selecting sustainability indicators for urban mobility*.
- 4) Herber, G., 1992. *New direction for sustainable urban living*, Gaia Books, London.
- 5) Idea, H., 2010. *Sustainable urban transport in an asian context*, Springer.
- 6) Kaiser, E. J., Godschalk, D. R. and Chapin, F. S., 1995. *Urban land use planning*, University of Illinois press.
- 7) Kenworthy, J. and Laube, 2001. *A submission to the house of representative standing committee on environment and heritage inquiry into sustainable cities 2050*.
- 8) Newman, P. and Kenworthy, J., 1999. *"Sustainability and cities; overcoming automobile dependence"*, Island press.
- 9) Rodrigue, J. et al, 2006. *The geography of transport systems*, Routledge.
- 10) *Tehran 22nd districts detailed urban plan*.
- 11) Williams, K., 2000. *Achieving sustainable urban form*, translated by Moradi Masihi