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PRESENTATION OF LAND-USE AND TRAFFIC EFFICIENCY ASSESSMENT

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Abstract. Extensive research has shown that land use and transportation features are linked by a complex, yet identifiable, set of relationships, hence, in order to interpret this link and relationship, there are just a few investigations and models, especially in IRAN. Nowadays, Transportation Plans rarely acknowledge any feedback effects from transportation improvements on land use, and thereby ignore these effects in plan evaluation. This omission has the potential consequence of exaggerating mobility and environmental benefits of transportation projects and undervaluing the potential benefits of land use or transportation policies.

This paper uses the main concepts of transportation efficiency of metropolitan transportation systems. It offers a neural model to measure and assess land use and transportation system efficiency. Besides the fact that many different factors work simultaneously, shaping our land use and its transportation efficiency, such as agricultural features, socioeconomic parameters, environmental parameters and so on, but in order to evaluate land use-transportation efficiency, it is useful to consider just transportation infrastructure parameters. As long as through a region, land use conditions (especially transportation facility efficiencies) results in different travel behaviors, the region were divided into zones and are defined by individual or combinations of land use and transportation variables, such as network connectivity, pedestrian environment, density of activities, and other transportation infrastructure attributes. This neural-based model uses GIS-based data for each parcel of land use to evaluate its transportation efficiencies and result in percent of SOV (Self Occupancy Vehicle) trips through the region. SOV trip rates serve as a tool currently used for the evaluation of any land use and transportation efficiency through the region. The main concept of such an evaluation index is based on the fact that in a region, fulfilling the transportation accessibility needs will result in less use of SOV trips and vice versa.

The model was calibrated and validated in neural network based on Tehran city's GIS data and evaluated. In order to increase the accuracy of the results, the AHP Model was applied to operationlize various effects of input parameters into the neural model.

The aim of this study was to increase acknowledgement of any feedback effects of transportation improvements on land use and providing such a tool for Transportation departments at state, federal and local levels. This model is a powerful tool to guide decision-makers about whether to build new transportation facilities or maintain or improve the existing ones, evaluation of the land-use efficiency and also comparing regions by some transportation facilities.

Keywords: traffic assessment, land-use, accessibility, transportation efficiency, neural network, AHP.

1. Introduction

Land-use planning is the central core of urban planning. Land use is a general term that encompasses not only land utilization – by function or activity – but also acts as a proxy for characteristics of urban and suburban development patterns. In land-use systems as well as transportation systems, the relationship between different classified and located land-use and the existing transportation systems will be assessed and studied by land-use systems.

Land-use planning models can have different goals and objectives among which are land-use prediction, land-use future changes and land-use assessment, considered in the present paper. The land-use assessment model as a sub-classification of the land-use system in general can include a group of various factors taken from social parameters to environmental and hemispheric ones. In the present investigation, a land-use traffic efficiency model has been presented based on traffic factors. This assessment model enables the urban traffic planners to investigate different urban zones and conduct a comparable assessment in terms of transportation parameters and variables.

Transportation is considered one of the paramount infrastructures of any society. Transportation needs meticulous planning in its sub-classification; on the one hand this is due to its relationship with other factors and on the other hand, due to its role in human activities. One of the most important roles of transportation can be considered its socioeconomic role which includes the land-use and its planning. In fact, land-use planning is the pivot of urban planning. It classifies and locates different types of land-use. In addition, in the land-use plan it specifies the type of land-use in cities, organizes city spaces, determines the manner of constructing and compatibility of constructions with each other and urban transportation systems.

Land-use-transportation systems can be simply demonstrated through the plans, which present the transpor-

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tation system network with the area's land-use. In this plan, different land-use systems such as residential, business, etc. are demonstrated. Access to transportation has a very fundamental relationship between land-use and transportation. According to its definition it is the ease of transportation and moving between places in which the access increases by reduction of the cost or time of transportation (New Urbanism … 2004).

Access in land-use systems is only one of the different fields of a region or area which can be investigated along with many other factors such as the geological aspects and the type of soil, economy, value, price, social, architectural and weather conditions. Among these, in the investigation of land-use-transportation systems there is a great need to consider the transportation background in general and land access in particular. This is in fact the most significant transportation parameter in relation to land use.

Extensive research has shown that land use and transportation features are linked by a complex yet identifiable set of relationships, hence, in order to interpret this link and relationship, there are some attempts but they are insufficient. In Australia development of the land gaming-simulation model by Young and colleagues at Monash University in Melbourne (Gu *et al*. 1992), and the proposed PIMMS (Pricing and Investment Model for Multi-Modal Systems) model, described by Hensher (Hensher *et al.* 1993) at the University of Sydney. In Canada, initial progress in the development and empirical application of an integrated land-use-transportation model to the Hamilton Consolidated Metropolitan Area is reported by Anderson (Anderson *et al.* 1994; Kanargolou *et al.* 1995). Here the early focus has been placed on simulating automobile fuel consumption and emissions. In Japan, integrated urban modeling includes the CALUTAS model (Computer-Aided Land Use Transport Analysis System) (Nakamura *et al*. 1983) and the Osaka model (Amano *et al*. 1985). In the work of Wegener (1994), brief references and other recent Japanese developments. Other studies include modeling of the Eindhoven urban area (van Est's 1979); modeling of Turin and Rome in Italy (Bertuglia *et al.'s* 1981); and a number of modeling applications to the city of Stockholm in Sweden, including application of the Transportation and Location.

For the Middle East, Garnett (1980) reports a planning model and policy application for Tehran, Iran, and it was the last attempt to clarify the relationship of the transportation and land-use effects in Iran.

Land-use models

As it was discussed earlier, one of the pivots of the process of urban transportation planning is using the land-use planning models. These models can have a wide range of different goals and objectives. Among these objectives are land-use prediction, land use future changes and land-use evaluation (Moudon and Kavage 2005). In the present paper, land-use assessment models are to be considered. As mentioned before, the land-use assessment model as a sub-classification of land-use models can include a broad spectrum of variables such as social, environmental and weather parameters. In the present study, transportation parameters have been taken into account. This model enables urban transportation planners to assess the conditions and prepares the ground for comparative analyses and studies of different urban areas and zones.

There are sets of parameters which are considered in the assessment and indexing of land use. These parameters are considered as the performance measures and For each, a measure of effectiveness was considered as well.

2. Model-developing procedure

Two steps have been taken to develop the assessment model. The process description, calibration and validation of models are proposed in the following section.

2.1. Variable identification and selection

In the present investigation, a Land-use Assessment Model is presented which is able to evaluate land use through transportation parameters. Two simplifications have been done through the scope of the Model: the type of land use and also the type of evaluation model.

The type of land use is clearly different classifications of land use. Each of these classifications has its own essentials and unique features in terms of traffic and transportation. For instance, a residential type of land use is different from business land use in terms of its minimum requirements and needs. This further complicates the job. Accordingly, in this model only commercial land use has been regarded in an urban area. The pertinent parameters for a commercial land use will be selected from several existing parameters. Table 1 presents a set of influential and selected parameters considered by the Model-makers in many investigations. In this Model and in the process of selection of influential variables a group of people have been consulted through different measures, including: a survey to learn about public opinion involved in the area, the experts, officials and authorities, laws and regulations, urban issues and points of views, the neighboring multimodal transportation factors, etc. Accordingly, the parameters most pertinent to the current country's condition and the immediate area were selected. Table 2 presents a set of these parameters besides their descriptions that have been applied in the former investigations.

As mentioned earlier, some contributing factors, which could affect locating land use, have been eliminated. On the other hand, the analyst will be able to observe these factors in the follow-up studies and make sound decisions about them. These sets of factors in addition to traffic and transportation factors include such factors as land earthquake likelihood, flood, type and texture of the area's soil, wind speed and many others.

2.2. Model architecture

There are different types of models which have operationalized the relationship between land-use and transportation systems and tried to indicate and prove this relationship.

Table 1. Domains or groups of variables used to measure the impact of land use on travel (Moudon and Kavage 2005)

Domain variables	Descriptions
Density	Site intensity Gross population, household density Net household density Employment density Retail, service employment density
Mix of uses	Percent floor space in office, retail use Ratio of on-site employees to housing units within 3 miles Entropy variables (land use balance) Dissimilarity variables (land use mix) Buildings with mixed office and retail vs. buildings with only office Retail, residences, offices within ¼ mile Convenience services within ¼ mile Number of land use changes along a route Fraction of population within ¼ mile of neighborhood shopping Employment density of residential zones Commercial or other non-residential buildings within 300 ft of residence Proportion of commercial parcels with vertical mixed use Proportion of residential units within ¼ mile of convenience retail Distance to nearest grocery store, gas station, park Retail, office, dominance
Connectivity of networks	Access to regional centers, commercial employment within a zone Employment accessible within 30 min. By car, transit Proportion of commercial jobs within ¼ mile of bus tsop or within zone Distance to CBD, activity center(s) Presence of continuous sidewalks or pedestrian paths Density of census block Proportion of residential areas with gridded streets Road density per household; Road network by type Number of street intersections, dead-end streets Gridded street patterns; Discontinuous street pattern Proportion of four-way intersections
Parking supply and availability	Parking supply Number of parking spaces per employee Proportion of commercial parcels with paid off-street or abutting on-street parking
Pedestrian environment	Number of residents, employees within ¼ mile of bus stop Various variables measuring urban design characteristics (Cervero and Kochleman 1996) Presence of sidewalks or pedestrian paths Proportion of street frontage with sidewalks; without buildings; or with trees; of blocks with sidewalks Number of signalized crosswalks, striped crosswalks Sidewalk width; Width of widest sidewalk Number of sidewalk benches Presence of bike paths; Length of arterials Distance between overhead street lights Absence of vacant lots, graffiti
Affordable housing	Various variables measuring job/housing balance

Table 2. Land use and network variables tested in research

Variable indexes	Land Use Domains	Description
1	Network Connectivity	Accessibility to the roadway
2	Environment & Mix of Uses	Distance to CBD, activity center(s)
3	Environment & Mix of Uses	Number of integrated cells
4	Network Connectivity	Distances from equal land use
5	Network Connectivity	Distances from Transit network
6	Parking Supply and by parking lots Management	Parking existence
7	Environment & Mix of Uses	Views and Distance to nearest grocery store, gas station, park
8	Pedestrian Environment	Slopes & Presence of sidewalks or pedestrian paths
9	Density	Retail, service employment density
10	Network Connectivity	Road network by type

But the intention of all these land use-transportation systems is based on two fundamental issues: first, prediction of urban area activity and second, allocating these activities to a determined category. There are two techniques in land-use models: statistical models and discrete models. In statistical methods, for each area different land-use distributions, dependent variables, and independent variable values, such as population, employment, soil conditions, slope and weather conditions, are used. Then, for each land use, a multi-regression is determined based on dependent variables. In discrete models, each type of land use will be determined as a function of a couple of characteristics. Then for each area, utility and unutility of land use will be assessed as a function of these characteristics. After that, the likelihood of the selection of one land use in the area will be assessed as a function of the utility and unutility of land use. In the majority of land-use models, mitigated models have been used which are categorized based on the mitigation technique used in them. These classifications include linear models, dynamic programming and bi-level programming. On the other hand, in Iran, very few investigations have been conducted in this field. Due to the fact that the issue of land use and its models are based on the utility and unutility, it includes many qualitative judgments and assessment, which lead to many public opinions, which are against the urban planning and regulations. Accordingly, the present investigations, the initial steps have been taken to develop efficient land-use models aiming to create a good relationship between land-use models and transportation in Iran considering the conditions and behavior of trip-takers. Having taken these steps, developing and utilizing complete models, determining, predicting as well as locating different types of land use in future, other steps could be taken much faster in future. The developed Model in the present study is considered as a discrete model and will be a base for developing a mitigated model.

2.3. Introducing neural networks

Among different modeling methods, naturally-inspired models like neural networks, Genetic Algorithm, Ant Colony, etc. are widely used in transportation planning. There have been many uses of neural networks in different fields of transportation planning and civil engineering thanks to their efficient capability in prediction, classification, data association, data conceptualization as well as data filtering (Behbahani and Haghighi 2003).

Neural networks are broad parallel processors, which are made of simple processing units called neurons, which have the capacity to save the empirical knowledge and prepare that for future application and use. The neurons are classified into different layers called Input Layer, Output Layer and Hidden Layer. The Input Layer as the entrance gate of the network receives the input, then the processing is done in the Hidden Layer, and after that, in the Output Layer, the output is ousted. Each neuron has some input signals, output signals, transfer function, summation function and connection weight. The activation model can be that of sigmoid functions, step function, linear, etc. In addition, the summation function can be a kind of linear function or other functions. In order to utilize the neural network composed of some neurons, which are located in different layers and are related with each other, the network should be trained. There are different training methods such as Supervised Network and Unsupervised Network.

Supervised Network is a network, which is trained by a training group including the desired input and outputs. This is trained by a training and education pattern in a manner that after having some inputs produces the best and most desired outputs.

Unsupervised Network is a network, which is trying to get to the objectives of the planner and designer through only one training group. Understanding the procedure of unsupervised networks is more difficult. Also, they act in a more complicated manner. It has always been a difficult and far-from-reality issue for a human to think of developing a robot or a machine, which can make sound decisions by itself.

In reality, the use of supervised networks is more common. There are many different supervised networks such as Back Propagation-Network, and ADLINE and MADLINE; The Back Propagation-Network is one of the most frequently used neural networks which are used in many different applications of neural network.

The normal process runs this way that at first, the INPUT vector is applied into the neural network and in the input layer, after being multiplied in Weighting Vector values, the sum of the values will be measured by one of the summation functions and then is sent to transfer function. In the transfer function, comparing this value with the initial value of transfer function, the output is created and sent to the other layers. In the hidden layers also this processing is conducted until the product of the processing reaches the output layer. In the output layer, the values undergo scaling and limitation to create the most desired scope. Finally, the output is produced as a real output of neural networks and will be compared with the equivalent desired output and a value called Error is measured. Up to here, nearly in all of the supervised neural networks a similar approach has been taken, such a procedure has been depicted in Fig. 1.

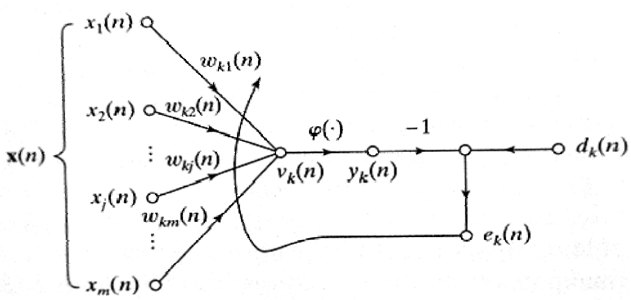

Fig. 1. Stages of error reduction and adjusting the connecting weights

In the back propagation method trained network is able to produce the outputs with all of the equivalent inputs and enjoys very desirable qualities such as fault tolerance, adapting with new changes, general data treatment, even analyses and measurement.

In the present investigation, the neural network has also been used. This network has the capability of learning the current trend and registering inputs to outputs. In order to expedite the network, the supervised training neural networks with back propagation method were used. The back propagation networks have shown high capability in learning the data trend and communicating inputs and outputs in the passage of time.

3. Results

3.1. The architecture of neural networks

In order to develop a neural network, it is required to train the network through the existing data. To do this, the acquired data from city transportation were used. So, an area of the city was selected as a sample. Then it was classified into different areas on a checked basis. To do this, the cells' area was considered to be as big as the area of the smallest proposed urban planning unit. In this sample the dimensions of each cell was considered to be 100 square meters. Consequently, this area was divided into 50 cells. So according to the model parameters, the input data for the neural network were prepared.

According to above mentioned explanations, the under-study area consists of 50 cells with each of them having 1 hectare area. According to the regional observation of a bus terminal in the east, a commercial center and a public utility in the west each with an area of 2000 square meters. There are two arterial roads, one in the east and one in the west. The general configuration of the under-study area, its classification and networking and other characteristics as well as cell numbering are presented in Fig. 2.

The most important thing about the Supervised Neural Networks is the possibility of training data using the pair of input/output data. For each of these cells, therefore, we need to assess the traffic using some criterion, and then the results are given to the network. This way, the network, after being trained, will be able to assess each cell with parameters and register its assessment mark.

Transportation efficiency is a key concept behind assessing the effects of land use on transportation (Moudon and Kavage 2005). Generally, transportation efficiency is blind to travel mode, with mode considered as only a means to travel and not an end. In metropolitan areas, where the majority of population lives in relatively compact and often dense settings, however, the focus of transportation efficiency is typically on decreasing or even eliminating Self Vehicle Occupancy travel. Urban Self Vehicle Occupancy travel (SOV) consumes too much space and an over-reliance on automobile travel leads to high levels of congestion. In the present model, the assessment criterion chosen is SOV.

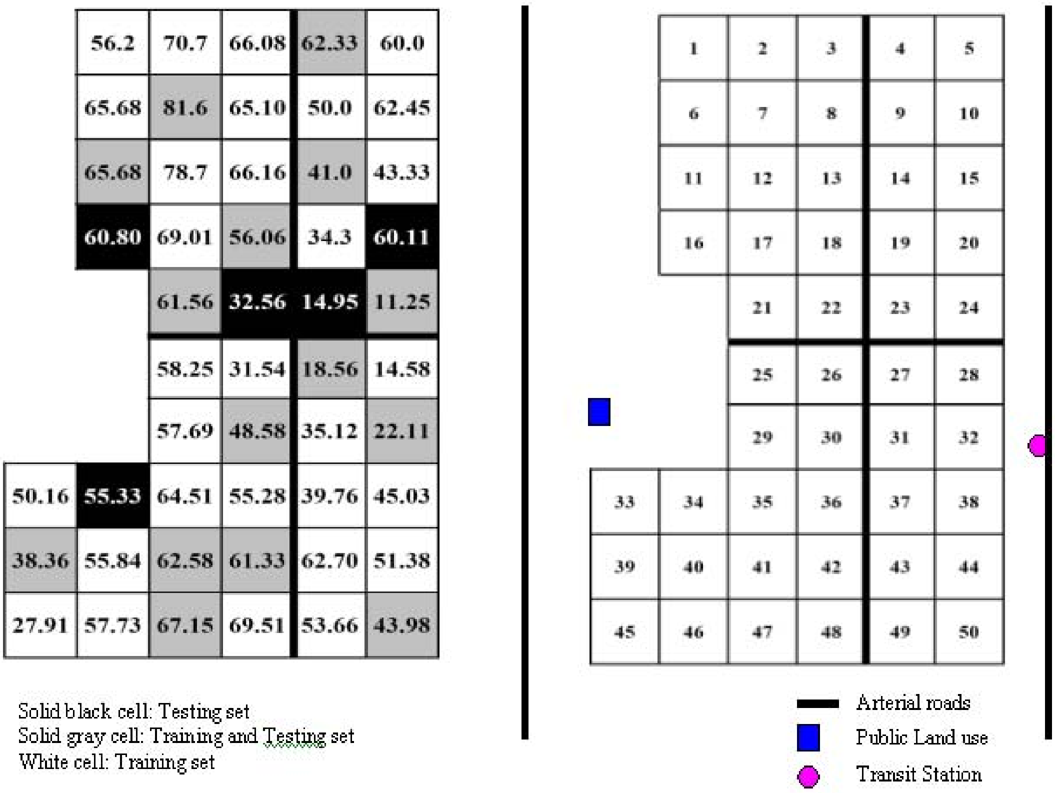

Fig. 2. General configuration of the under-study area, networking and other characteristics (right) –results of neural network traffic analysis (left)

In commercial land use, in fact, the level of access to the public transportation system is a determining factor, which plays a considerable role in the commercial desirability of the area. Having chosen the mentioned factor, the more (SOV) self vehicle occupancy rate is, the less commercially desirable the area is in terms of traffic factors. The increase of density and self vehicle high density and environmental factors all in all have a negative effect on the commercial desirability of the area. In the present model, each of the under-study areas was divided into 3 levels of efficiency: high (SOV < 30%), medium (30% < SOV < 60%) and low (SOV > 60–65%). It means that if 30% or more of trips made in a commercial area are done by self vehicles, the area has a low traffic efficiency and is grappling with the traffic issues and its problems.

In fact, in this part, the neural network was applied to use GIS-based data for each parcel of land use to evaluate its transportation efficiency and result in percent of SOV trips through the region. The model was calibrated and validated in neural network based on Tehran city's GIS data and was evaluated.

The above mentioned statistical group has 50 cells. Among these, 45 cells were utilized in training set and 5 cells were used in the test of the network. A network with 10 neurons in the input layer and in 5 layers was designed. Finally, a neuron in the output layer would register the final measurement of the function. This network had fully connected layers and back propagation training mode that have been developed *in MATLAB 6.5.* After training the network, the weights of the network were saved and studied with the 5 cells, which remained from the statistical cells. Fig. 3, on the right, shows the error in network training. The same figure on the left shows the adaptability of the Model results with the real results. Accordingly, the trained neural network is able to assess different traffic zones or areas based on the effective parameters in land use such as motorist access, distance from the city center, under influence area, distance from similar land use, distance from public transportation, the existence of public parking, natural factors, slope, employed density, etc.

3.2. Modifying the neural model

As it was explained earlier, the training process of neural networks is based on updating the connecting weights of neuron in different layers. This weight updating and adjusting would result in some mathematical relations, which are eventually called network training. In fact, network training is applying coefficients with specific weights in the inputs of the model X which by itself produces the output according to equation (1). In 'i^{th}' layer, these outputs will be considered the inputs for the next layer neurons $(i + 1)^{th}$, which have been presented as mathematical phrases.

$$OUT = f\,[\Phi(WX) + b], \tag{1}$$

$$NETi = (XW),$$

$$OUTi = F(NET_i),$$

$$NET_{i+1} = OUT_i,$$

$$OUT_{i+1} = F(NET_{i+1}). \tag{2}$$

There are different methods of updating the methods, that back propagation is one of the most frequent and quickest methods. The mathematical structure of this model is based on error measurement and its back propagation mentioned in equation (3).

$$\delta_{qk} = F'(NET_{qk})\,(Target_{qk} - OUT_{qk}). \tag{3}$$

In equation (3), the value of δ_{qk} equals the amount of the error obtained through the first round of inputs and the comparison of the neural network model with the real model. Accordingly, (NET_{qk}) would be the quantity of the input for the neural cell q from layer k. ($Target_{qk}$) and

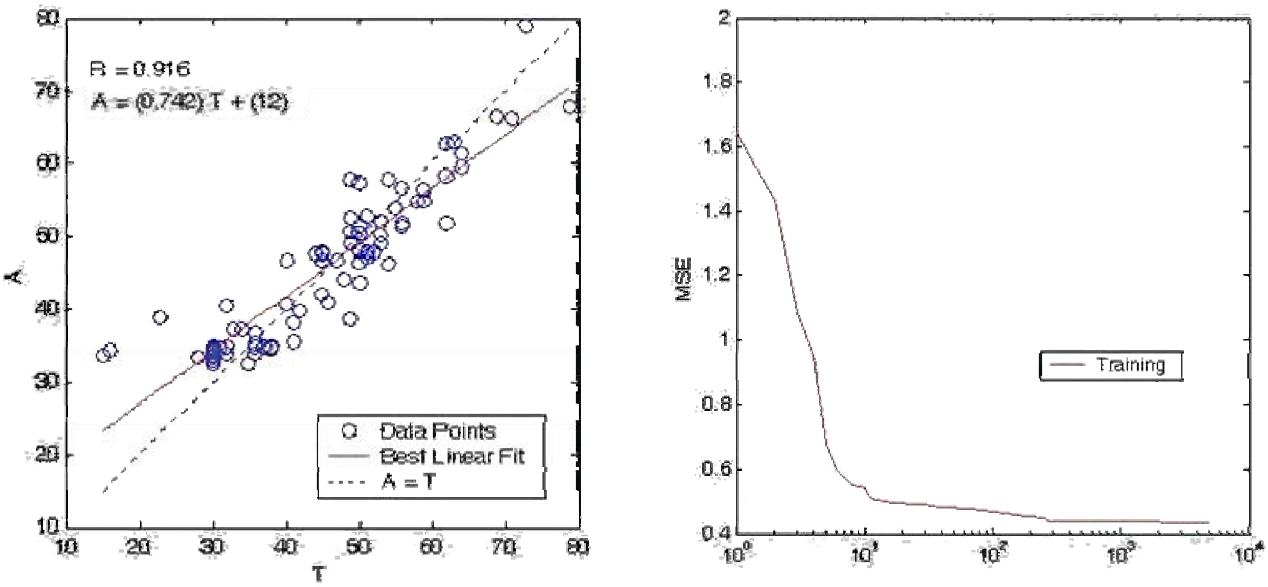

Fig. 3. Right: error in network training; left: adaptability of the model results with real results

(OUT_{qk}) are, respectively, the desired output of neural cell q out of layer k and the real output of neural cell of q out of layer k. The trend of the performance of the network would be this way that according to the feedback the amount of error based on equations (4) and (5), will be divided according to the connectivity weights of the neurons, and lead to updating the initial connectivity weights $W_{pq.k}(n)$ in the next stage $W_{pq.k}(n+1)$.

$$\Delta W_{pq.k} = \eta\ \delta_{qk}\ OUT_{pj}. \tag{4}$$

$$W_{pq.k}(n + 1) = W_{pq.k}(n) + \Delta W_{pq.k}\,, \tag{5}$$

where $W_{pq.k}(n)$ is the initial weight before updating which is selected and implemented by the network itself. Hence, in the initial stages, some desired weights could be given to the network, which is more homogenous with the real weights of the model parameters; it will lead to the increase of learning the speed of the network. In the present case, also, considering the fact that, among the effective parameters in the model, not all the parameters have an equal effect in the transportation assessment, so, it was decided to consider these effects in the neural network modeling. Therefore, in the relationship between the input layer and hidden layer, initial weights were introduced into the model, according to which the network was to be trained.

Applying weight to the variables should be done according to their effect. There are different methods for doing this. In the present model, using AHP method and surveying the urban and transportation planning, experts were selected. Table 3 summarizes the relative importance derived from the neural network. For determining the relative importance between the transportation efficiency and the variables concerned in the model based on a neural network, a heuristic approach was applied according to interpreting the neural network connection weights. Readers can refer to "Interpreting neural network connection weights" by G. David Garson for any further information.

Table 3. Level of significance of model variables

Variable indexes	1	2	3	4	5	6	7	8	9	10
Land Use Domains	Network Connectivity	Environment & Mix of Uses	Environment & Mix of Uses	Network Connectivity	Network Connectivity	Parking Supply and by Parking Lot Management	Environment & Mix of Uses	Pedestrian Environment	Density	Network Connectivity
significance	25	3	4.6	4.9	17.6	16.5	2.5	2.5	5.4	18

4. Conclusions

4.1. Discussion

This paper has focused on the need to integrate land-use parameters in making decisions about metropolitan transportation systems. It covers investigation findings on the relationships between land use and travel demand. The prepared model somehow indicates the feasibility of the use of neural networks in land-use planning. Based on the investigation experiments and results the following conclusions can be drawn:

1. Due to the variety of effective factors and their role in land use, the traditional models are slow and low-efficient. Working with neural networks would provide higher speed and power in analysis and possibility of including a greater number of variables into the model.

2. In the present study, a land-use assessment model was developed based on neural networks for assessing different commercial land-use types. Considering the parameter of the number of trips made by private vehicles in relation to the rest of all the trips made in the area, the efficiency of public transportation systems in the area will be assessed. Here we used the neural network and its capability in developing land-use models. In fact, the methodology of the procedure was developed and its feasibility was investigated which, of course, requires generalization and application.

3. Using the developed assessment models, one can easily make decisions in terms of different factors such as: determining desired residential, commercial areas, recognition and assessment of different urban areas, determining the lacks and shortages and developing desired criteria for each urban area, determining the level of the efficiency of future measures and operations, determining the most important parameters in the assessment of urban areas in terms of transportation, determining the level of the effectiveness and weights of all the variables. Table 4 illustrates the collection of all the applications mentioned above.

4. In addition, the obtained results can prepare a base for the start of many future investigations which could include parameters other than transportation parameters such as the price and value of land-use types, environmental issues, etc. in order to make the model transferable, in a particular case, we can collect the information of one of the big cities which is under comprehensive transportation investigation, in a broad range and a certain network.

5. As it was mentioned before, all of the conducted investigations have taken place in foreign countries, and considering the fact that many cases have effective parameters used in the investigations, there is a need for these studies to be conducted in Iran and its specific situations regarding the behavior of trip-makers.

6. Considering the fact that there are many contributing factors in peoples determining where to live such as housing cost and land price, but there are other hidden factors such as weather, different types of land use, urban density, the type of urban areas and many other factors.

7. Results of the present investigation can be used by urban planners in assessment of different urban areas and development patterns, for city officials and investment contributors in prioritizing different urban areas, for transportation model-developers in determining trip effective parameters, production poles as well as trip attraction.

PAPER REVIEWS

Table 4. Use of traffic efficiency (TE) models for planners, etc. (Moudon and Kavage 2005)

DESCRIPTIVE AND EXPLORATIVE MODELING	PRESCRIPTIVE MODELING
Establish existing Lands Use Levels of Service . Identify locations/zones/areas at different levels of TE, with a focus on latent ("almost good") . Explore and test different thresholds of each domain or variable based on available travel	. Identify locations/zones/areas where TE levels must or can be increased . Identify which domain or land use variable of needs to be changed in order to reach better TE levels
RESULTING IMMEDIATE ACTIONS	**Resulting future actions**
Maintain transportation service to areas that have high TE . Concentrate investments in new transportation systems to areas that have latent TE	Overall, funnel new development (growth) to areas that have latent good TE levels . Ensure that target TE level can be achieved . Specifically, target domain or variable most effective in affecting TE levels

4.2. Hypotheses and delimitations of the Model

The collection of the hypotheses in the process of developing the model includes:

1. Among different parameters in the type of land use, effective transportation parameters are a key element in evaluating land-use traffic efficiencies.
2. There is a mutual relationship between land use, its type, intensity and the trend of changes, on the one hand, and a transportation system, on the other hand.
3. Selecting the commercial location as an example and in general regarding commercial land use has been on the account of transportation facilities related to this use. In this regard, other factors such as the price and value of land, weather, neighboring land use, etc. These factors could be overlooked in the transportation assessment of land use.

The developed Model also has some delimitations, namely:

1. The Model evaluates only commercial land use and is not applicable for land-use selection or planning. For areas without any land-use patterns, this Model only specifies possible commercial land use in terms of transportation parameters.
2. The scope of statistics for determining the relative significance of the variables and the number of variables are, respectively, 30 people and 10 variables. It is needed to have a wider sampling and more variables to make the Methodology more and more comprehensive.

References

Behbahani, H.; Bargi. 2004. *Lan- use model for rural and road side areas.* PHD thesis, Iran University of Science and Technology.

Behbahani, H.; Haghighi, F. R. 2003. *Developing a neural-based traffic signal control*. Msc thesis.

Congress for New Urbanism, Land Development Regulations. 2004. Available from Internet: <http://www.cnu.org/pdf/ code_catalog_8-1-01.pdf>.

Dunphy, R. 2003. *Making for better neighbors*. Urban Land, p. 34-37.

Federal Highway Administration. 1999. Guidebook on methods to estimate nonmotorized travel: Supporting Documentation. U.S. Department of Transportation.

Frank, L. D.; Stone, B.; Bachman, W. A. 1999. *Land-use impacts on household travel choice and vehicle emissions: lessons learned from a study of the Atlanta Region.* The Turner Foundation.

Implementing Transportation-Efficient Development: A Local Interview, Phase I of Integrating Land Use and Transportation Investment Decision-Making. 2004. WSDOT: Olympia, WA.

Kloster, T.; Daisa, J.; Ledbetter, R. 1999. *Linking land use and transportation through street design*. Metro: Portland. Available from Internet: <http://gulliver.trb.org/ publications/circulars/ec019/Ec019_b4.pdf>.

Kulash, W. M. 2001. *Residential streets.* Urban Land Institute: Washington, DC.

Moudon, A. V.; Hubner, M. 2000. *Monitoring urban land supply with gis: theory, practice, and parcel-based applications.* New York: John Wiley & Sons, Inc.

Moudon, A. V. *et al.* 2002. Pedestrian location identification tools: identifying suburban areas with potentially high latent demand for pedestrian travel, *Transportation Research Record,* 1818: 94–101.

Moudon, A. V.; Kavage, S. 2005. *Land use and transportation: operationalzing the relationship with a transportation-efficient land use mapping index.* Department of Urban Design and Planning, TRB annual meeting.

Pisarski, A. E. 2002. *Testimony for "Mobility, congestion and intermodalism",* in United States Senate Committee on Environment and Public Works: Washington, DC. Available from Internet: <http://epw.senate.gov/107th/Pisarski_031902.htm>.

Ross, C. L.; Dunning, A. E. 1998. *Land use and transportation interaction: an examination of the 1995 NPTS data*. Georgia Institute of Technology, Prepared for the U.S. Department of Transportation, Federal Highway Administration: Washington, DC.

Steiner, R. L. 1994. Residential density and travel patterns: review of the literature*, Transportation Research Record* 1466: 37–43.

Strategies and tools for transportation-efficient land use and development practices: a reference manual. 2003. WSDOT: Olympia, WA.

Traffic engineering for Neo-traditional neighborhood design. 1994. Institute of Transportation Engineers, ITE: Washington, DC.

Trip generation. 1991. Institute of Transportation Engineers, 5th Ed.

ŽEMĖNAUDOS IR TRANSPORTO EFEKTYVUMO VERTINIMAS

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S a n t r a u k a

Išsamūs tyrimai parodė, kad žemėnaudą ir transportavimo ypatumus sieja visuma identifikuojamų sąsajų, vis dėlto, siekiant paaiškinti tas sąsajas ir jų santykį, bent Irane, yra mažai tyrimų ir modelių. Nūdienos transporto planuose retai kada atsižvelgiama į transporto patobulinimą, įtaką žemėnaudai. Perdėtai teigiama transporto projektų nauda mobilumui ir aplinkai, nepakankamai įvertinant galimą žemėnaudos arba transporto politikos naudą.
Straipsnyje remiamasi pagrindinėmis transporto efektyvumo didmiesčio transportavimo sistemoje sąvokomis. Siūlomas modelis išmatavus įvertinti žemėnaudą ir transportavimo sistemos efektyvumą. Kad būtų galima įvertinti transportavimo kiekviename žemėnaudos sklype efektyvumą ir nustatyti procentais privačių transporto priemonių reisus regione, naudojamasi *GIS* duomenimis. Pagal privačių transporto priemonių reisų dažnį pastaruoju metu vertinama žemėnauda ir transportavimo efektyvumas regione. Šio vertinimo esmė yra tai, kad regione, kuriame tenkinami transportavimo prieinamumo poreikiai, mažiau naudojama privačių transporto priemonių, ir atvirkščiai.
Modelis buvo kalibruotas ir patvirtintas remiantis Teherano miesto *GIS* duomenimis ir įvertinimais. Siekiant padidinti rezultatų tikslumą *AHP* modelis buvo pritaikytas modeliuojant įvairią įvesties parametrų įtaką.
Šio tyrimo tikslas – išryškinti transportavimo gerinimo žemės naudojimo atžvilgiu svarbą pristatant metodą valstybės, federalinės ir vietinės valdžios transporto departamentams. Šis modelis yra efektyvi priemonė, padedanti sprendimų priėmėjams nuspręsti, ar statyti naujas transportavimo infrastruktūras, ar atnaujinti, pagerinti esamas, jis paremtas žemės naudojimo efektyvumo įvertinimu ir leidžia palyginti regionus pagal kai kuriuos transportavimo ypatumus.

Reikšminiai žodžiai: eismo vertinimas, žemėnauda, prieinamas, transportavimo efektyvumas, nervų sistemos tinklas.

ОЦЕНКА ЭФФЕКТИВНОСТИ ЗЕМЛЕПОЛЬЗОВАНИЯ И СИСТЕМ ТРАНСПОРТИРОВАНИЯ

Г. Бегбагани, Ф. Гаггигги

Р е з ю м е

Исследования показали, что землепользование и особенности транспортирования тесно взаимосвязаны. Для объяснения этой взаимосвязи в Иране существует несколько моделей. В настоящее время транспортные парки редко учитывают возможное, более совершенное применение земельных территорий. Это преувеличивает значение транспортных проектов для мобильности и окружающей среды и недостаточно учитывает возможную пользу от землепользования и транспортной политики. В статье основывались на концепциях эффективности транспортных систем больших городов. Предложена модель для оценки эффективности землепользования и систем транспортирования. Несмотря на то, что эффективность землепользования и транспортирования формируется на основании нескольких различных факторов (особенностей сельского хозяйства, социально-экономических, природоохранных параметров и др.), для оценки эффективности землепользования и транспортирования целесообразно оценивать лишь параметры транспортной инфраструктуры. Условия землепользования в масштабе региона обуславливают разное поведение при передвижении. Регион был поделен на зоны и охарактеризован индивидуальными и общими переменными, а именно: густотой сети, условиями для пешеходов, частотой транспортной инфраструктуры и другими чертами. Эта модель, основанная на структуре нервной системы, для каждого участка земли применяет данные ГИС для того, чтобы оценить эффективность транспортной системы и в процентном отношении эффективность рейсов транспортных средств в регионе. Частота самоходных транспортных средств в последнее время является средством оценки эффективности землепользования для транспортных нужд в регионе. Суть такой оценки заключается в том, что в регионе, в котором удовлетворяются потребности в возможностях транспортирования, используется меньше самоходных транспортных средств и наоборот. Модель была калибрована и утверждена на основании данных ГИС города Тегерана и соответствующих оценок. Целью исследования было выявить возможности улучшения транспортных условий с учетом землепользования и представить метод государственным, федеральным транспортным департаментам и местным властям. Модель может служить эффективным средством при принятии решения о том, создавать новые транспортные инфраструктуры или совершенствовать имеющиеся на основании оценки эффективности землепользования и сравнения регионов по особенностям транспортирования.

Ключевые слова: оценка движения, землепользование, доступность, эффективность транспортирования, сеть нервной системы.

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