Preface

During the last three decades, the use of computers has contributed a lot to the practice of transport planning. In addition to gaining the ability to build up more complex models in order to analyze collected data, some new approaches, which take human behavior into consideration, have been added to transport planners’ tools.

Increasing use of computers gives transport planners possibilities to handle much more data with increasing precision in very limited timeframes. This modern perspective in decision-making in transportation planning is mainly fed by scientific approaches of systems thinking, GIS, information systems and artificial intelligence. The results of any analysis regarding any transport decision can easily be visualized and presented to decision maker. A single solution is usually replaced by a set of solutions with a comparative list of advantages and disadvantages.

Use of decision support systems help mainly to professionals of transport planning, urban planning, public-policy planning, public transport operating, service industry and logistics but also individual users of transport systems. Monitoring of traffic conditions, listing all possible travel alternatives or calculating fares are now a part of transport users’ daily life. User friendly interfaces in web applications and smart devices in transport decisions not only help individuals but also pave the way for formation of smart societies. The decision support systems for transportation planners cover a wide perspective, ranging from traffic control centers, passenger movements, public transport management for the scheduling and routing of cargo, automated transport systems, etc.

This publication addresses transportation planning problem cases which are solved by decision support systems. The book is prepared for transportation planning professionals to extend their expert information and domain knowledge to drive decision support systems (DSSs). The principal audiences are transportation planning professionals and academicians who need expert information to handle their specific transportation-related problems. The book offers a broad range of subjects addressed in specific areas such as spatial planning, developing policies for PT, traffic information systems, handling of cargo, logistics, goods transport, and environmental issues in transport planning.

The submitted case studies, developed models and researched literature survey in 15 chapters show that modern transport planning professionals are no longer capable of solving ever developing problems by using traditional methods. Instead, contributions from other fields of science, such as artificial intelligence, optimization algorithms and some advanced statistical analyses, in addition to modern technologies, such as, GIS, ITS and smart solutions are the tools in modern transport planners’ hands.

The content of the book is organized into three headings: transport mode specific decision support systems, decisions in urban transportation and sustainability/environmental risks of transport.

Under the first heading (transport mode specific decision support systems) case studies related to different transport modes are presented in five chapters. A brief description of each of the chapters follows:
Chapter 1 presents an analysis of air transport mode. The addressed problem is airline crew scheduling, which is a part of airline schedule planning. Robust airline crew pairing process refers to the procedure of constructing anonymous crew pairings to cover the given flight schedule in near-optimal way that is less prone to disruptions (or at least easier to recover once disrupted). This process has to deal with complicated specifications of inputs and satisfy a number of different and often conflicting constraints. Also user inputs are often needed in several points in the process to obtain high quality and timely solutions. Bülent Soykan, and Serpil Erol present a model-driven Decision Support Framework (DSF) which combines an optimization algorithm and a simulation-based schedule evaluation scheme for automating real-world practical robust ACP problem. A Branch-and-Price (B & P) approach is utilized as a solution method in which column generation method is applied at each node of the B & B tree. The presented DSF can primarily assist airline crew schedule planners, who have to spend a lot of time and effort creating crew schedules taking into account non-linear cost structure, various amounts of constraints that affect cost and flight safety.

Chapter 2 presents an analysis of maritime transport. It proposes a typical investment planning problem with uncertainties and risk parameters that decrease the reliability of cost and income predictions, which coastal engineers are used to face. Can Elmar Balas presents a case study from the Iskenderun Pier of Turkey, which is under construction. The superiorities of this proposed simulation-ANN model to other classical investment planning methods were the inclusion of uncertainties in the investment parameters like the change of cargo and costs variables in time, and the determination of project benefit/cost with an improved accuracy. A feasibility analysis model was proposed in this chapter for ports. Three methods were utilized: 1) Artificial Neural Network (ANN) to determine the rates and capacity of cargo by considering the economic development of hinterland, 2) Queuing model to determine the waiting to service time and the berth occupancy ratios, 3) Importance Sampling Monte Carlo (ISMC) to simulate ship arrivals/departures from the quays. The required time to reach the operational capacity in various economic scenarios is determined by the cargo rate predictions of ANN, which is interrelated with ISMC simulation. The artificial intelligence methodology takes the economic developments of the region into account by defining the GNP as one of the input parameters of ANN structures.

Chapter 3 presents a comparison of three transport modes, road, airway and railway in a case study of Turkey’s transportation system’s efficiency. Adnan Sozen, and Fatih Cipil present Turkey’s situation in transportation compared to the EU member countries (23 countries whose data were accessed) through the approaches of Data Envelopment Analysis (DEA) and Malmquist Index (MI) as decision support models. The study determines Turkey’s position among EU member countries and defines its pros and cons in terms of road and railway transportation (safety) indicators. Within the scope of this study, relative performance evaluation was first performed by applying DEA approach so as to determine if 12 regions of Turkey were using their airline transportation effectively or not. Meanwhile, to monitor the variation of the performance with time, total factor change of the airline transportation was examined by MI approach. Using subjective calculation results, information on the strategies and targets to be followed are given so that the performances of the transportation indicators were maintained in their highest level.

Chapter 4 presents an important maintenance problem in road transport. Sangeeta Roy, Jagan J, and Pijush Samui review work zones. A work zone is the area of a highway where construction, maintenance, or utility work activities that can be identified by warning signs/signals/indicators, including those on transport devices. Work zones also include roadway sections where there is on-going, moving (mobile) work activity such as lane line painting or roadside mowing only if the beginning of the on-going, moving (mobile) work activity is designated by warning signs or signals. The various problems which presaged the increased number of work zones in today’s date also created a myriad of complicated challenges for
the various traffic agencies involved in work zone management and estimation. The creation of a work zone changes the road user conditions which then lead to increased number of accidents. The placement, duration and maintenance of work zones are a multi-faceted problem. The highway is not closed thus work zones can be defined as spatial and temporal restrictions on the roadway which negatively impacts traffic flow conditions. The major concern of most traffic management and planning agencies is the placement of long term. This article describes Extreme Learning Machine (ELM), Minimax Probability Machine Regression (MPMR) and Gaussian Process Regression (GPR) for prediction of work zone capacity.

Chapter 5 discusses logistic hub optimization in a transportation network. Serpil Erol, and Aykut Sureyya Duyguvar review a background which classifies the considered literature using three criteria relevant for the aforementioned topic: a literature review, the list of mathematical models/algorithms and the solution approaches which are optimizing logistics services. Some applicable algorithms, namely greedy heuristic algorithm, genetic algorithm, and benders decomposition method, are presented as decision support systems for hub location problems (HLP). The submitted future research directions also give good hints for researchers who have their own HLPs of people, commodities and data.

The second heading is specially been defined for decisions in urban transportation. Transport planning is basically studied in varying scales. The largest scales cover global, intercontinental, international and national transport of people, goods, information and energy. The smallest scales deepen in intraurban relationships, among districts, dwelling units, working places, point destinations, etc). Urban transport planning requires a specialization different from other scales of transport. By planning for urban transport, in addition to aggregates, special arrangements are done for any individual demand. Thus, four chapters related directly with urban transportation are grouped separately. A brief description of each of the chapters follows:

In Chapter 6, I, as author, present a case study example to a web based Decision Support System (DSS) for individuals’ urban travel alternatives. The case study is from a project prepared for Ankara (Turkey) Municipality, which aims to give individuals the opportunity of choice among all travel alternatives under different criteria, both for public transport riders and car users. A literature survey gives background information from fields of applications of Intelligent Transport Systems (ITS), shortest path problems and web based DSSs. Special emphasis is given to Floyd-Warshall algorithm which is used to solve the shortest travel time between all pairs of points in the case specific problem. In the case study part, the design of the proposed system, its capabilities and examples with screenshots are submitted, to help other researchers design their projects according to the requirements specific for their own cities. The proposed ideas can be applied to the transport net of another city.

Chapter 7, written by Darcin Akin and Serdar Alasalvar, presents a study on modeling the change of urban spatial structure. The purpose of this chapter is to model urban growth and expansion based on observed and modeled travel patterns in a study area. In the analysis of interzonal trips using hierarchical cluster analysis (HCA) for 2012 and 2023 as a case study of the province of Sakarya (Turkey). The modeling in this study made possible to analyze the urban structure for different time horizons when O/D travel data are available to understand the interactions over the spatial structure of an urbanized area. The achieved results are useful tools for planners, administrators and policy makers as decision maker to understand the interactions over a spatial structure, and to plan for creating efficient subcenters with more balanced distribution of travel patterns over urban agglomerations. The approach also helps to chose potential areas for future developments.

Chapter 8 presents an example to use of analytical hierarchy process (AHP) as a decision support system in the case of Denizli (Turkey) for intersection type selection in urban areas. Yetis Sazi Murat, Turan Arslan, Ziya Cakici, and Cengiz Akcam review also many other applications related to the given
one. This chapter is related to higher construction cost of at-grade intersections. The authors gave emphasis on “not signalized intersections”, as the minimum interruptions in traffic flows, average delays, fuel consumption, operating cost and CO emission rates are lower than the others. The analyses that consider operating cost show that preference of at-grade intersections is in the second order. Results of the AHP analysis support also the findings obtained for signalized intersections. Signalized intersections with left turn bay and signalized intersections are also discussed in the chapter. Left turn bays provide an extra space, thus possibility of an accident occurrence can be reduced and also capacity of the adjacent lane can be improved by this way.

Chapter 9 presents a detailed review of the literature about definitions of accessibility, usage areas of accessibility, components of accessibility, GIS based accessibility modeling techniques, and role of Geographical Information Systems (GIS) in accessibility modeling. Accessibility measures are generally concerned with equity and a better distribution of services and help to evaluate the proximity/availability of several public, commercial and emergency services by considering one or more modes of transportation. By referring numerous accessibility measures, Kivanc Ertugay, and Sebnem Duzgun illustrate the need of GIS-based analyses in assessing the justice in the distribution of public services for plan evaluations.

The third heading of the book is devoted to decision support systems related with sustainability and environmental risks of transport. While approaching to three decades after Brundtland Commission’s Report of the United Nations, the increasing awareness and concern on environmental matters today better evaluate the human interventions on earth’s resources. Transport, despite its all positive effects, e.g. combining role in society, increasing mobility, supporting economic activity, can also be a major threat against social, environmental and economic sustainability if not examined and managed well. Thanks to decision support systems, environmental risks of transport are better evaluated and reflected to decisions in transport planning now. The six chapters in this section provide information on sustainability, dangerous aspects of transport and suggestions for solutions, including smart applications. A brief description of each of the chapters follows:

Chapter 10 presents a model of a sustainable transport system, the transport on-demand model, for making public transport sustainable. After reviewing the use of various definitions, examples and scenarios, Maria Spichkova, and Margaret Hamilton develop a methodology to provide smart solutions for sustainable outcomes, so that a transport system becomes a part of a ‘smart city’. In this chapter DSSs are viewed as a special way of partially designing humans out of the main system actions, particularly if it is assumed that the human will follow the decision recommended by the support system. The proposed web-based DSS, which can be a part of a smart city, is designed for the public transport driver, where the request information for the route is collected from the passengers dynamically in real time. The model can help enabling the reduction of greenhouse gas emission and noise pollution, as well as the saving of fuel costs for the public transport service company. Having a more flexible/dense timetable and possible longer routes as well as subjective shorter travelling times are other possible outcomes of the model.

Chapter 11 presents a discussion of challenges and future options for using smartphones, social networking and the position of disadvantaged groups in sustainable mobility. Ozge Yalciner Ercoskun presents a comprehensive literature survey on the emergence of easy mapping tools, widespread cellular network, declining costs of smartphones and increasing internet use by public agencies, which provide new opportunities towards the betterment of public transport management. The chapter, focusing mainly on spatial DSSs and communications-driven DSSs, aims to explore how GIS and ICT can be used for more eco-friendly public transport and improved sense of community. Some success stories from different countries are also given as examples to the use of mobile systems in public transport.
Chapter 12 presents a case study from Romania for integrating spatial planning of protected areas and transportation infrastructures. For the case study, Mihai Răzvan Niță and Mihăiță Iulian Niculăe analyse the connectivity of the Natura 2000 protected areas network for terrestrial mammals in the Alpine Biogeographic Region from Romania by evaluating the spatial distribution of Sites of Community Importance in the Region and assessing the functional connectivity of the protected areas network on two scenarios: with and without the impact induced by the roads network. The analysis includes a number of 125 sites and the distribution of 17 species of terrestrial mammals, protected under the Habitats Directive, each having different dispersion distances and different home-range sizes. The protected areas crossed by the transportation infrastructure are considered to be disconnected. The achieved results for the case study area opens a horizon in discussions about the adverse effects of transport on environment.

Chapter 13 presents a multi-objective optimizer for multimodal distribution networks. Mauro Gamberi, Marco Bortolini, Francesco Pilati, and Alberto Regattieri discuss the effective design of multimodal distribution networks (DNs) from a multi-objective perspective. Three of the most relevant optimization drivers are jointly considered looking for the multi-objective optimal network configuration. The operating cost function stresses the importance of effective DNs to save money making the retailer/end-user full price convenient, the carbon footprint looks for environmentally sustainable DNs able to mitigate the impact on the climate change and to reduce emissions due to production, storage and shipment activities. Finally, the delivery time function forces to speed the distribution process to promptly supply the market demand. The tri-objective model is behind an optimizer decision support system (DSS) supporting the planner in the steps to design an effective supply chain network. The application is exemplified through a case study taken from the fresh food industry. Particularly, the peculiarities of food produces are considered to update the general multi-objective model, e.g. produce perishability. The data are from Italian producers distributing products to multiple European countries. Short and long shelf life products are studied to highlight differences in the most effective shipping strategies. The key outcomes stress opposite trends between operating cost and environmental impact on one side and the time objective function on the other.

Chapter 14 presents a literature survey, which is a collection of many DSS applications, for hazardous materials (hazmat), also known as dangerous goods transportation. Serpil Erol, and Zafer Yilmaz draw our attention to issues which are well-studied by many researchers and the ones underestimated so far. The researchers give the clues for developing new DSSs in transportation of dangerous goods on road by underlying the underestimated issues and possible research areas.

In Chapter 15 Serhan Karabulut, and I present a tool for GIS based risk analysis for transportation of dangerous goods on road (the RAGISADR). The proposed model has been developed to evaluate the environmental risks of transportation of dangerous goods on road. In this chapter a risk based decision support model is used as a tool for route decision making of fuel products. The relevance of the model as a decision support tool is demonstrated through a case application to a road network in a region in western Turkey. The priority weights of each environmental criterion are calculated by using Analytical Hierarchy Process (AHP). The most convenient route according to the criteria set is determined after assessing the outcomes of the risk analyses models.

Ebru V. Ocalir-Akunal  
Gazi University, Turkey