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ROAD TRANSPORTATION PLANNING OPTIMIZATION WITHIN LOGISTIC SYSTEM

Summary of Doctoral dissertation

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RIGA TECHNICAL UNIVERSITY
Faculty of Engineering Economics and Management
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DOCTORAL DISSERATION

PROPOSED TO THE RIGA TECHNICAL UNIVERSITY FOR THE PROMOTION TO THE SCIENTIFIC DEGREE OF DOCTOR OF ECONOMICS (Dr.oec.)

The Doctoral dissertation has been developed at the Department of International Business, Transport Economic and Logistics, Faculty of Engineering Economics and Management of Riga Technical University (RTU). The defending of the Doctoral Dissertation will take place during an open meeting of the Promotion Council "P-09", Faculty of Engineering Economics and Management of the RTU on 28 October, 2011, Riga, 1/7 Meza Street at 10 a.m. in the room 309.

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CONFIRMATION

I hereby that I have worked out this Dissertation that has been submitted for review to Riga Technical University for the promotion to the degree of Doctor of Economics (Dr.oec.). This Dissertation has not been submitted to any other university in order to receive any scientific degree.

Pavels Patlins..

The Doctoral Dissertation has written in Latvian. The total page count is 160 p. Dissertation consists of introduction, 3 parts, conclusions and proposals, 23 tables, 54 figures, 42 formulas and 8 annexes. The Bibliography consists of 130 sources and references.

The Doctoral Dissertation and Summary are available at the Scientific Library of Riga Technical University, Kipsalas Street 10. To submit reviews please contact Secretary of the RTU Promotion Council "P-09", professor, Dr.habil.oec. Anatolijs Magidenko; 1/7 Meza Street, Riga, LV-1007, Latvia. E-mail: rue@rtu.lv. Fax: +37167089324

GENERAL REVIEW

Topicality of theme

Logistics importance nowadays increases due to modern international market development; the long distance between different trading process participants, and manufacturing specialization as well. Often it creates various difficulties to organize material flow management in an optimal way. On the one hand, it is necessary to improve the level of the customer service – provide high-quality deliveries in time; on the other hand, it is necessary to minimize logistic service costs. When planning consumer products delivery, it is significant to note both delivery duration and accuracy factors.

Economics globalization allows saving up manufacturing resources as well as optimizing resources location. The assortment of goods is growing; quality of goods is improving especially in national markets. Recently transition from regional to international economy came together with global logistics development. As a result, the distance between manufactures and customers increased and also informational flow organization and data transmissions systems changed. A great part of the world finished goods are produced by enterprises of Eastern Asia, satisfying worldwide demand. It is topical to appreciate- what mode of transport or which combination are appropriate to provide high-quality delivery of finished goods, for instance from Shanghai to Riga.

When planning road transportation and routes within a big city it is important to note the level of traffic intensity on particular roads. This problem is very important for route planning specialists of the EU big cities with intensive traffic. Traffic intensity (road overload) influences both the delivery time and costs. Traffic intensity may change depending on hours of a day or days of a week. As a result, the total costs and time of delivery depend on delivery's hours of a day.

In the real situation often it is impossible to plan routes efficiently, using simple mathematical operations or people experience. Mathematical model – is only an abstract reflection of the real process, using mathematical symbols. Traditional mathematical methods help to reduce, for instance, the total distance of route, but do not provide accurate time of delivery for customers.

The topicality of the Doctoral dissertation theme is ensured by economical significance of effective transportation system as well as high requirements for delivery accuracy and route total time minimization. Accuracy of delivery and route total time minimization are the main characteristics of efficient transportation system.

Accurate deliveries as a requirement of modern logistics allow harmonization of both goods receiving and consignment processes as well as minimize warehousing space and reduce the level of unsatisfied demand. Many enterprises nowadays have additional requirements for delivery accuracy and delivery time.

Efficient transportation system allows not only to provide high-quality service to enterprises' customers delivering them needed goods in time, but also using enterprises' resources in an optimal way, minimizing operations costs when the quantity of demand changes. Delivery accuracy and delivery time planning problem is especially important for transport companies, that provide transportation in cities with unstable traffic as well as for wholesalers who serve retailers, for express post companies, garbage collector companies, internet shops, pizzerias that deliver production to customers in a particular moment of time and other companies which use circular routes principles and consolidate many customers within one route. It is important that enterprises ensure delivery accuracy as well as provide customers with high level of logistics service, reducing the total time of delivery and lead time in general.

It is important to use transportation optimization methods when planning transportation and routes. Usually transportation optimization methods provide the optimal solution to the problem in general, but do not provide the optimal result for the real situation because transportation (moving) time as well as vehicle's loading time change. To achieve accurate delivery planning it is necessary to use traditional optimization methods in combination with other methods, which provide higher level of delivery accuracy. Traffic constraints in cities, unstable and intensive traffic, loading time changes for particular objects make transportation planning process difficult especially for routes with multiple recipients.

Therefore **the goal of the Doctoral dissertation** is to work out cargo auto transportation methodology which takes into consideration goods delivery timetable as well as logistics' requirement to organize just in time delivery in unstable traffic conditions for different route segments.

Tasks to achieve the goal are:

1) To estimate the role of the delivery lead time as well as the delivery accuracy factor in the logistic system; to define the main elements of the delivery lead time.
2) To investigate constraints of traditional routing methods in real circumstances as well as both international and local auto transportation planning specification and differences between them, analyzing just in time delivery requirement.

3) To look into the problem of transport company and distribution centre location; to define, how it influences the final production and raw material delivery lead time in the logistic channel;
4) To analyze both international and local types of routes planning and just in time delivery requirements for these routes.
5) To estimate pendulum and circular routes planning methods from the just in time delivery requirements aspect.
6) To study auto transportation planning specifics and problems into intensive traffic conditions.
7) To evaluate the opportunities to use micro-elements methods to improve transportation time planning process for cities with intensive traffic, as well as to analyze the opportunities to use micro-elements methods for vehicle loading process time standardization in auto transport.
8) To work out auto transportation planning and optimization algorithm in order to improve route planning process into intensive traffic circumstances.
9) To develop suggestions how to optimize auto transportation planning into the logistic system.

The Object and Subject of the Research

The object of the research is cargo auto transportation into the modern traffic conditions.

The subject of the research is planning and optimization of the cargo auto transportation routes into the unstable traffic circumstances.

Research methods

In the elaboration of the Doctoral dissertation the generally accepted quantitative and qualitative method of economical science, system analysis, mathematical, expert estimation, statistical and micro-elements methods as well as traditional optimization methods of transportation planning has been applied.

The methodological basis of the research

The methodological basis of the Doctoral dissertation:

1) Scientific reports and investigations about transportation planning specifics in Latvia and other countries as well as about the current situation and development perspective of Latvia’ economy (especially transportation sector).

2) The European Union documentation, data base of Central Statistical Bureau, Riga Municipal Department of Transport, Ministry of Transport information as well as information from other state organizations.
3) The theoretical and practical findings of Latvian and foreign authors (J.Antes, P.Ballou, J.Beļčikovs, J.Bockertette, J.Belovs, J.Coile, I. Gutāne, F.Hičkok, N.Krūmiņš, V.Nešpors, J.Niedrītis, R.Počs, N.Sprancmanis, A.Urbahs, B.Turton etc.) in the field of transportation planning.
4) Information from internet resources about auto transportation planning and optimization into the logistic system.
5) Doctoral dissertation author's experience from international scientific conferences, seminars, courses and contacts with other logistic specialists of Latvia and other countries.

The scientific novelty of the Doctoral dissertation

1. International auto transportation planning cumulative algorithm has been worked out. The algorithm allows choosing of the most expedient transport modes combination as well as port to make cargo transportation, for example, from Western Europe to Latvia' regions.
2. Unstable traffic parameters within auto transportation process, especially for large cities, analyzing circular route unstable traffic as well as unstable level of customers' demand are investigated and elaborated.
3. The necessity to use traffic element standardization principle to improve auto transportation planning nowadays is justified.
4. Automobile speed changes differences planning principle for particular street segments and different periods of time are worked out.
5. A method for crossing time differentiation depending on route direction at uncontrolled crossroads has been worked out.
6. Correction of driving time planning changes method for different road segments and hours of a day as well as time of crossroad passing which allows precise planning of a real driving time between the customers served as well as the total vehicle's working time in the route and the arrival moment to a particular object been worked out.
7. The unloading time divided into separated micro-elements, such as driving up to the customer served, manoeuvring, cargo moving from the vehicle to object, leaving object and signing documents, observing the fact that the vehicle unloading

time share is very high in the total vehicle working hours. These process elements are divided depending on its outside features and the standardization data base has being created. This method allows calculating precise total time needed for unloading process near particular customers served depending on the quantity of cargo.

8. The optimization methodology for complex circular route planning, combining traditional route planning method with micro-elements standardization methods for precise calculation of both vehicle moving time and unloading time to realize "just in time" deliveries has been worked out. The methodology includes city routes planning improvement algorithm within the logistic system.

The theses presented for the defence:

1. It is necessary to increase either driving time or delivery lead time planning accuracy in unstable traffic conditions. This aspect is the key stone for the participants of traffic as well as cargo recipients. It is possible to provide it, using cargo transportation planning methodology, worked out by the Doctoral dissertation author.
2. Traditional route optimization methods do not take into account independent traffic speed changes for different hours of a day or the real time needed to unload production; so it is necessary to use defined methods, that take in account these factors.
3. Replacing the traditional route optimization methods with micro-elements standardization method, it is possible to provide optimal planning of changes of particular time elements of the route as well as additional time savings.

The practical application of the results of the research.

The results of the research have been presented into international scientific conferences in Latvia, Cyprus, Slovenia and Russia as well as scientific discussions and seminars. Results of research are used in the lecture courses "Entrepreneurship logistics", "International transportation organization" and "Transportation commercial operation" – at the RTU. The results of the research are published in scientific journals of Latvia and other countries.

Scientific Publications

Results of Doctoral dissertation are presented in 14 scientific publications:

1. Patļins P. Delivery time factor for city routes // Proceedings of the 50th RTU Scientific Conference on Economics and Entrepreneurship (SCEE'2009) 15-16 October 2009, Riga. - pp.464-470. ISBN 978 -9984-32-173-8 (CD).

2. Patļins P. Delivery problems solution for small-cargo physical distribution control// Proceedings of the 8-th International scienntific Conference: Engineering for Rural Development, 28- 29 May 2009, Jelgava.- Jelgava: Latvia University of Agriculture, Jelgava 2009.– pp. 365.-371. ISSN 1691-5739 (CD).
3. Patļins P. Drivers working hours standardization within planning of local deliveries for cities with heavy traffic // Proceedings of the 49th RTU Scientific Conference on Economics and Entrepreneurship (SCEE'2008) 9-13 October 2008, Riga. – pp.271-276. ISBN 978-9984-32-567-5 (CD).
4. Patļins P. Vehicles discharging processes control optimization within planning of local deliveries // Proceedings of the 7-th International scienntific Conference: Engineering for Rural Development, 29-30 May 2008,- Latvia University of Agriculture, Jelgava 2008. – pp. 165.-169.pp. ISSN 1691-3043.
5. Patļins P. Local deliveries time optimization for cities with unstable traffic // Proceedings of the 22nd European Conference on Modelling and Simulation, 11-13 June 2008, Nicosia Cyprus.- Germany, Sbr.-Dudweiler, Digitaldruck Pirrot GmbH, 2008.- pp. 399.- 402. ISBN: 0-9553018-5-8.
6. Sprancmanis N., Patļins P. Loģistikas kvalitātes problēmas mazumtirgotāju apkalpošanā no vairumtirdzniecības sadales centra // RTU Zinātniskie raksti, 3. sērija. Ekonomika un uzņēmējdarbība. 16. sējums.– Rīga: RTU, 2008.– 97.-105. lpp. - ISSN 1407 – 7337.
7. Patļins P. Circular routes optimizations for cities with intensive traffic // Proceedings of the 6-th International Scienntific Conference: Engineering for Rural Development, 24 -25 May 2007, Jelgava.- Jelgava: Latvia University of Agriculture, 2007. – pp.340-344. ISSN 1691 – 3043.
8. Sprancmanis N., Patļins P. Preču fiziskās sadales organizēšana intensīvas satiksmes apstākļos // RTU Zinātniskie raksti, 3. sērija. Ekonomika un uzņēmējdarbība. 12. sējums. – Rīga: RTU, 2006. – 125.-132. lpp. ISSN 1407 -7337.
9. Patļins P. Universal routing algorithm for cities and other built-up areas // Proceedings of the 8th International Symposium on Operational Research, 28-30 September 2005, Slovenia, Nova Gorica.- Slovenia, Ljubljana: Slovenian Society Informatika, Section for Operational Research, 2005.- pp.247 – 252. ISBN 961-6165-20-8.

Other publications:

10. Patļins P. Piegādes laika faktors pilsētas maršrutos // RTU 50.Starptautiskās zinātniskās konferences tēžu krājums, 2009.g.15.-16. oktobrī.- Rīga: RTU, 2009.- 68.lpp.ISBN 978-9984-32-173-8.
11. Patļins P. Drivers working hours standardization within planning of local deliveries for cities with heavy traffic // Conference proceedings of the 49th RTU Scientific Conference on Economics and Entrepreneurship (SCEE'2008) 9-13 October 2008, Riga. – pp.123. ISBN 978-9984-32-567-5.
12. Patļins P. Lokveida maršrutu optimizācija intensīvas satiksmes apstākļos // Semināra materiāli: Satiksmes Departamenta zinātniski-praktiskais seminārs „Satiksmes drošības problēmas Rīgā, risināšanas ceļi, 2007.gada aprīlī.- Rīga: RDSD, 2007. – 81-86. lpp.
13. Patļins P. Latvijas vietējo kravas pārvadājumu tirgus cenu veidošanas problēmas, to pamatojums un atrisinājums // Grāmatvedība un Ekonomika: I Zinātniski-praktiskā

konference, 2006.gada jūnijā.-Rīga: Grāmatvedības un finanšu koledža, 2006.- 85.-90.lpp.

14. Патлинс П., Спранцманис Н. Нормирование рабочего времени водителей при развозе грузов в условиях интенсивного сообщения // Конференция ”Актуальные вопросы соцэкономики в 21 веке.” Российский Государственный Унивеситет Туризма и Сервиса. Публикация в сборнике материалов Конференции, 2008 февраль.-Москва: РГУТС, 2008. – 256-263 с.

The results of the Doctoral dissertation have been presented at the following international scientific conferences:

1) 50th RTU Scientific Conference of Economics and Entrepreneurship: „The Problems of Development of National Economy and Enterpreneurship”, Riga, Latvia, October 15-16, 2009. Title of the report: „Delivery time factor for city routes”.
2) 49th RTU Scientific Conference of Economics and Entrepreneurship: „The Problems of Development of National Economy and Enterpreneurship”, Riga, Latvia, October 9-13, 2008. Title of the report: „Drivers working hours standardization within planning of local deliveries for cities with heavy traffic”.
3) 22nd European Conference on Modelling and Simulation, Cyprus, Nicosia, June 11-13, 2008. Title of the report: „Local deliveries time optimization for cities with unstable traffic”.
4) 8-th International Scienntific Conference of Latvia University of Agriculture: „Engineering for Rural Development”, Jelgava, May 28-29, 2009. Title of the report: „Delivery problems solution for small-cargo physical distribution control”.
5) 7-th International Scienntific Conference of Latvia University of Agriculture: „Engineering for Rural Development”, Jelgava, May 29-30, 2008. Title of the report: „Vehicles discharging processes control optimization within planning of local deliveries”.
6) Tūrisma un Servisa Krievijas universitātes Starptautiskajā zinātniskajā konferencē: „Актуальные вопросы соцэкономики в 21 веке”, Maskava, Krievija, 2008.g.16-18. februārī. Title of the report „Нормирование рабочего времени водителей при развозе грузов в условиях интенсивного сообщения”.
7) 7-th International Scienntific Conference of Latvia University of Agriculture: „Engineering for Rural Development”, Jelgava, May 24-25, 2007. Title of the report: „Circular routes optimizations for cities with intensive traffic”
8) Grāmatvedības un Finanšu koledžas I zinātniski-praktiskajā konferencē „Grāmatvedība un Ekonomika”, Rīgā, Latvijā, 2006.g. 29 martā. Title of the report: „Latvijas vietējo kravas pārvadājumu tirgus cenu veidošanas problēmas, to pamatojums un atrisinājums”,
9) Baltic Tangent Final Conference, Rīga, 2007. g. 22-25 maijā. Loģistikas centra izveides iespējas Valkas/ Valgas reģionā.
10) Satiksmes Departamenta zinātniski-praktiskais seminārs „Satiksmes drošības problēmas Rīgā, risināšanas ceļi”, Rīga, 2007.g. 30.martā. Title of the report „Lokveida maršrutu optimizācija intensīvas satiksmes apstākļos” .

The volume and content of the Dissertation

The Doctoral dissertation is an independent scientific research, written in the Latvian language and it consists of introduction, main body, conclusions and proposals, list of bibliography and appendices. The main body consists of 3 chapters:

1. TIME FACTOR IMPORTANCE FOR TRANSPORTATION AND LOGISTICS.
2. ROUTE PLANNING OPTIMIZATION METHODS AND THEIR EVALUATION.
3. TRANSPORTATION OPERATIVE PLANNING OPTIMIZATION OBSERVING TIME MOMENTS OF VEHICLES MOVING AND UNLOADING PROCESSES.

The first chapter includes general time-factor importance analysis for transportation, and other logistic processes; customers' main requirements about delivery lead time are evaluated; the influence of distribution centre and transport company's location on the total time of delivery as well as the factor of accuracy. Driving time uncertainty in cities and other built-up areas is evaluated too. The author justifies why traffic intensity is an unstable factor for different road segments, days of the week as well as hours of a day.

The second chapter includes different route planning analysis depending on the type of the route. Both international and local transportation planning problems are investigated; traditional route planning methods are evaluated. It is possible to use these methods in real circumstances to reduce vehicle's run and total transportation costs, though it does not minimize delivery time or provide precise deliveries. Also time factor standardization and control necessity to plan circular route with a huge amount of customers served are founded.

In the third chapter the author's auto transport operative planning improvement system is investigated, noticing different time periods and moments in vehicle's moving and cargo unloading processes. Delivery process planning improvement algorithm has been worked out; it is possible to use this algorithm into the modern circumstances of unstable and intensive traffic. Cargo distribution is quite a complex process especially due to intensive traffic in city roads. Traffic congestions are not stable; they change depending on hours of a day and days of a week. So it is necessary to use a special method to plan cargo deliveries in cities in an optimal way. The author recommends using micro-elements standardization principles in combination with traditional routing methods to plan deliveries in cities in an optimal way.

Doctoral dissertation's total volume is 151 pages without appendices. The dissertation involves 23 tables, 54 figures, 42 formulas as well as 8 appendices. 130 sources of information were used to complete the Doctoral dissertation.

The Doctoral dissertation is supported by the European Social fund project "RTU doctoral programme implementation support".

MOST RELEVANT SCIENTIFIC RESULTS OF THE RESEARCH

1. TIME FACTOR IMPORTANCE FOR TRANSPORTATION AND LOGISTICS

The chapter includes 40 pages, 19 figures and 5 tables.

The Doctoral dissertation's author has investigated and evaluated works of different authors as well as special reports and statistical information and concluded that stable trading routes and material flow have been created as a result of international trading development. These ways connect different participants of the logistic channel. Stable routes has been created for different modes of transport, because demand for transportation service increases today.

When analyzing material flows and trading routes it is obvious that these are different in different regions. For example, economic development level of European countries is different today; each country has particular needs for different resources; export and import also are different for each country.

Final production may be delivered to customers using transport today. This branch should be developed and improved, optimizing route planning process, improving logistic service quality, enhancing the quality of roads, railroads, and air and sea transport infrastructure, involving state, private and international investments to develop transportation system of different countries.

There is a time factor and place unity of international transportation service nowadays. The time factor is extremely significant, because specification of international transportation is as follow: if the transport enterprise does not satisfy the demands, it may lose customers. So, the transportation beginning should be precise. Also transportation finish should be precise. Only in this case both cargo consigner and recipient may be satisfied. One of the most important quality ratios of transportation process is the period of delivery. This is really very significant both for cargo and for passengers' international transportations, because time is money, but it is difficult to spend the transportation process time with use. So, fast transportation service normally is more expensive than large cargo transportation using slow modes of transport.

It is important to note that logistics creates an additional value (VA). It is significant for customers, for forwarders, for manufacturers as well as for trading enterprise shareholders or owners. The additional value of logistic process expresses itself as place and time factors. Goods and services have no value, if these are not located in the time and place where they can be consumed. If logistic system is developed, each additional operation provides increased added value. The more precisely the particular route is planned; the shorter is the process time without VA. For instance, if the enterprise reduce goods warehousing time, it is possible to improve VA in general. It is possible to use Just-in-Time system elements to improve logistic process planning.

If the particular logistic process element does not provide any added value, then it is necessary to evaluate, if this element is needed for the whole process at all. Anyway, the additional value exists when the customer is ready to pay additional money for product, more than the actual costs of the product and delivery.

Analyzing modern economy development circumstances, it may be concluded that there are some additional requirements for the transportation process, for instance, safety, regularity, continuity and rhythmical pace.

Delivery lead time uncertainty requires necessity to create additional guarantee inventory. The level of inventory is connected with the accuracy of a particular supplier’s operations in general and for particular process elements.

Too fast deliveries sometimes also provide a negative effect, so the company should find new ways how to reduce delivery lead time dispersion. Actually, both forwarder and cargo recipient enterprises should come to an agreement about requirements for precise delivery; what level of dispersion is not the critical one. Usually the cargo recipient company wants to reduce delivery lead time dispersion, but the forwarder or supplier wants to increase it.

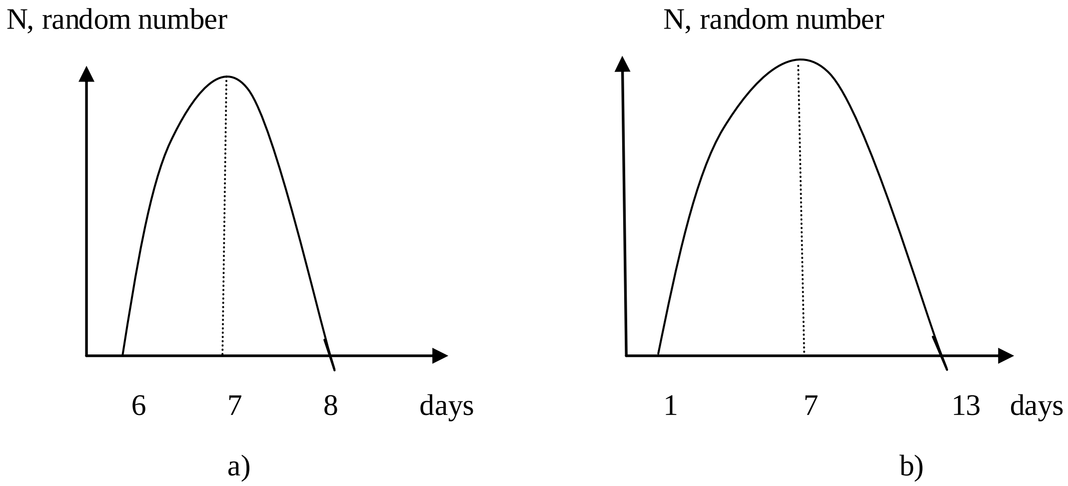


Figure 1.1. Evaluation of precise delivery from cargo supplier or forwarder (a) and the cargo recipient’s opinion.

Figure 1.1. provides information that the cargo recipient wants to conclude an agreement where precisely delivery is after 6 days from the moment of order with 7 days

dispersion (from 6 to 8 days) but cargo supplier or forwarder wants to raise dispersion to 6 days (between 1 and 13 days). According to the analysis, when an enterprise provides international transportation in a real life, delivery time dispersion may be more than 6 days, because delivery lead time consists of many elements, and each of them has its time dispersion. It is necessary to evaluate time uncertainty factor for each element of delivery to reduce the total delivery time dispersion.

When planning deliveries in cities, the delivery time dispersion measured using hours, not days; so it is necessary to plan delivery moments very precisely, to organize accurate deliveries and satisfy customers' demand.

The transportation process total time and accuracy are influenced not only by transport modes combinations, specification of route of factors connected with vehicles, but also specification of cargo flow, location of cross-docking places, distribution centres and forwarders. It is important to decide, if the company uses its own transport or buys transportation service from other enterprises. It is essentially important to organize fast and precise deliveries, because these criteria often are the main measure of delivery quality. Anyway, it is necessary to analyze all factors influencing delivery time; so the author investigates different factors and theories, which influence delivery accuracy and time, such as number and location of forwarders and suppliers in the territory served.

Non-compliance between the number of vehicles and the speed of infrastructure developments today creates vehicle moving speed irregularity, which is significant for different parts of roads, days of the week and hours of a day. Simultaneously development of trading within a city creates additional requirements to deliver goods to enterprises and retailers in time.

Actually, it is necessary to provide customers with high-level delivery service using forwarders' vehicles. To solve this task in an optimal way, it is important to investigate the city infrastructure in details. The forwarder should evaluate which methods are appropriate to use to plan routes both within cities and between cities.

Both local and international transportation in Latvia usually start and finish in Riga; that means that Riga region is good for different types of business locations, especially connected with international trade operations.

The intensity of traffic in particular streets of Riga city is changing too. There are approximately 100 bridges in Riga, as well as other infrastructure objects, from which 36 are in good condition, 46 – in satisfactory condition, but 17 - in unsatisfactory condition. During road work hours it is impossible to use these objects for transportation.

It is necessary to know the most problematic hours of the day when planning transportation process in a city, when the number of vehicles in a city is huge and traffic congestions are in many places. Usually traffic congestions are connected with population working day beginning and end. Working days are hard for route planning. For instance, traffic congestion hours in Riga centre usually are between 5.00 and 7.00 p.m. Similar situation is in the mornings.

When planning delivery time in a city, applying the usual route planning methods is not effective because of the city's traffic intensity specifics. Both computer programmes and mathematical and other methods may not provide the optimal planning result, because the intensity of traffic in Riga changes depending on the hours of a day, so the speed of vehicles is constant neither in the particular part of city nor for particular days of the week or hours of a day (see figure 1.2.).

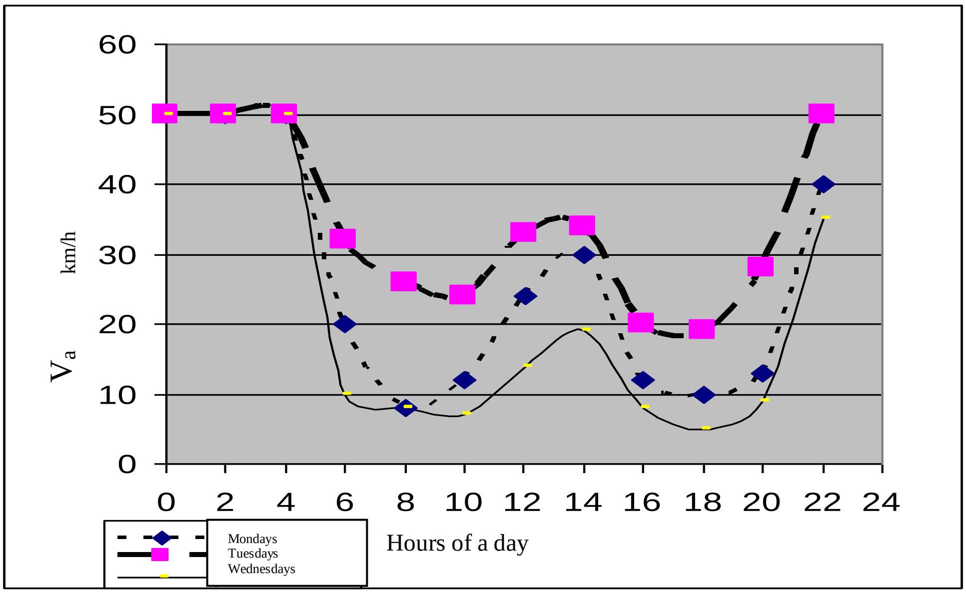


Figure 1.2. The Average Vehicle's Speed (Va) Variables For Particular Crossroads in Riga in Particular Day's Hours (on Monday, Tuesday and Friday).

Figure 1.2. provides information about the average speed of vehicles, which is the highest before 5.00 a.m., between 12.00 and 2.00 p.m., but minimal between 6.00 and 8.00 a.m. and 4.00 and 6.00 p.m.. According to the information in the figure, the highest number of vehicles is in the streets on Monday and Friday (when the average speed of vehicles often does not exceed 5 km/h), but on Tuesday traffic is not so intensive. The situation is not similar for all streets of the city; there are some "hot places" in Riga – places, where traffic intensity changes very fast, depending on the hours of a day. For instance, some problematic

places are streets going in/out of the city; main bridges in the city as well as main streets in the centre of Riga.

It is possible to make the delivery planning process easy, if the person who plans route knows all these factors.

The time for cargo unloading process also influences the total delivery lead time. This ratio may change not only depending on the particular object's capacity, but also on the quantity of cargo, number of forwarders near the object (in the queue) as well as the serving hours of the object.

Inaccurate deliveries stimulate customer dissatisfaction and provide idle time (if deliveries are too late) and too high costs for the manufacturer and other objects. Too early delivery also is connected with a negative effect, for example, if a company uses some principles of JIT system, it requires frequent deliveries of small quantities of goods, and if production is delivered too early, there may be not enough place to put it.

After evaluation of modern logistic requirements for transportation, it may be concluded that delivery planning between cities as well within cities is a complex process. It is necessary to generalize information about traffic intensity in streets, the average speed of vehicles in streets depending on days of the week and hours of a day, to divide “hot places” - where the intensity of traffic is very unstable, so the author has analyzed information about that in this chapter.

Transportation efficiency improvement in the conditions of economic globalization is the main direction of logistic development. It is possible to realize it by minimizing blocked funds amount during transportation process as well as by providing JIT deliveries. Different factors such as traffic intensity increase, infrastructure development level and others influence delivery time minimization as well as precise delivery planning. As a result, the intensity of traffic is a changeable ratio for different streets, days of the week and hours of a day.

2. ROUTE PLANNING OPTIMIZATION METHODS AND ITS EVALUATION

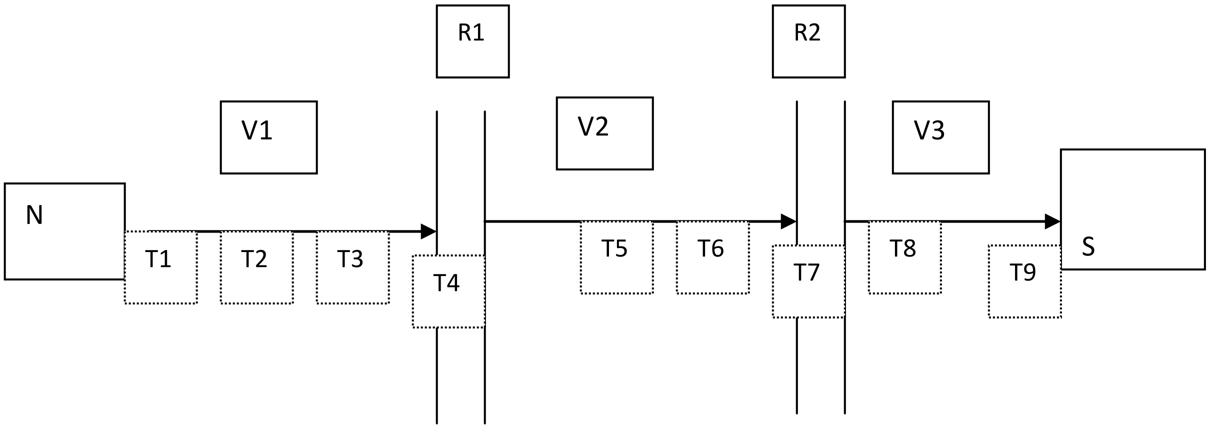
The chapter includes 48 pages,16 figures and 6 tables.

From the author's opinion the keystone of transportation planning is transport analysis. The goal of analysis is to improve vehicles efficiency, planning the route as well as creating transportation schedule and organizing drivers' working hours to satisfy customers' needs in an optimal way. Planning specialists make decisions when planning transportation processes in order to realize their plans. Transportation decisions may be either strategic or tactically operative. Strategic goals are good for a long period of time, more than one month, but tactical operative decisions set down resources allocation for a short period of time – days or weeks. The task of transportation analysis is to find the optimal solution for transportation process, to minimize transport costs, delivery time and distance.

It is necessary to choose the optimal mode of transport and analyse many special factors when planning international transportations (see figure 2.1.).

According to the information in figure 2.1, transportation time consists of nine time elements. In some cases this number may be more than nine. It is possible to forecast easily some of these elements (T2, T5, T8), but others are not easy to forecast, they depend on different factors (T3, T6, T4, T7).

It is significant to note that it is necessary to use local transportation when planning cargo deliveries from the manufacturer to the final customer (if they are located in the same state) or international and local transportation combination (for instance, using “hub and spokes principle”), when the manufacturer and the final customer are located in different countries.



legend:
N – cargo consigner warehouse,
S – cargo recipient warehouse,
T1 – loading time,
T2, T5 , T8 - vehicle’s moving time,
T3, T6 – waiting time near the border (in a queue),
T4, T7 – border crossing time,
T9 – unloading time,
R1, R2 – borders,
V1, V2, V3 – countries.

Figure 2.1. Possible scheme for international auto transportation.

Local transportation specifics are connected with the fact that small-quantity loading and transportation management is different from full-cargo transportation. Local transportation often may be planned using circular route scheme. Circular routes connect more than 2 points within one route, namely, the forwarder should take cargo from the consigner and deliver small quantity of cargo to a great number of recipients (multi-drop route). In other situations the forwarder collects cargo from many consigners and delivers it to one recipient (multi-pick route). It is possible also to combine both types of routes.

It is necessary to evaluate two main optimization criteria (the shortest time and the shortest way) to plan efficient circular routes. Different planning methods and methodology may also be used to improve delivery time planning process.

The main task of route planning for the forwarder is the total time minimization as well as efficient run improvement: first, route system optimization planning for full-cargo transportation, second, traffic organization to design multi-drop, multi-pick and combined routes.

Mathematical methods may be used as an information instrument or technological tools to make quantitative analysis in the economics theory. Analysis may reduce the possibility of subjective conclusions and manufacturing forecast errors; improve planning and projecting quality, for instance, when there are insufficient resources.

It is possible to find the information needed for decision making process, with the help of computer programmes and mathematical methods.

Very popular mathematical methods are optimization methods (operation investigation methods), especially linear programming methods.

Linear programming is a mathematical branch, where minimization or maximization methods of linear functions for many variable values are investigated (efficiency function), , if it is necessary to optimize variable value condition system, created by linear equalities and inequalities.

Functionally it is possible to divide transport optimization models using the following classification:

a) Transportation problems:
- classic transportation problem;
- open model of transportation problem;
- transport mode problem;
- cargo processing and delivery problem;

b) Transport network optimization:
- the shortest way problem;
- the maximal flow problem.

There are many special methods and algorithms to optimize circular route planning and reduce delivery costs as well as vehicle‘s run and transportation costs. Often it is impossible to provide the needed result, because use of these methods is connected with the following problems:

- using the method is work-consuming;
- it is impossible to provide precise result;
- it is impossible no satisfy customers' individual needs;
- it is impossible to take into account traffic intensity changes depending on days of the week and hours of a day.

The author concludes that computer programs often provide non-optimal solution to transport problem due to different restrictions; on the one hand, it is possible to use only these programs to solve theoretical problems. On the other hand the real situation is changing daily, because demand is not stable, it is possible to use heuristic methods. But in a real life computer programmes are used in combination with heuristic method to achieve the optimal result. Because of lack of information, criteria of optimization used in practical conditions often are vehicle's run and transportation costs, not delivery time factor.

The author has summarized also different researchers' information about the non-linear problem that may be formulated as non-linear programming optimization problem. Transport problem is a well-known network optimization problem, first created by F.Hitchkok (1941). The goal was to find the optimal costs of distribution plan for one product delivery, multiplying it with quantity of product to find each channel and source capacity for each recipient.

When transportation costs of the given route are non-linear dependent on the quantity of production for transportation, this problem becomes a non-linear transportation problem. To find the optimal solution for this problem (NTP), it is necessary to make many investigations in logistic management. Many heuristic methods as well as mathematical program methods are created to solve NTP problems.

Many authors and researchers have worked out different methods and algorithms to solve NTP. As regards approximate heuristic optimization methods, genetic algorithms (GA) by Holland (1975), tabu search (TS) by Glover (1977), particle swarm optimization (PSO) by Kennedy and Eberhart (1995).

Many specialists solve NTP, using also linear programming models. For instance, Cao (1992), Dangalchev (1996), Bell et al. (1999), Kuno and Utsunomiya (2000), Dangalchev (2000) and Nagai and Kuno (2005). However, research effort has been also devoted to nonlinear programming (NLP) techniques for the optimum solution of the NTP. For instance, Michalewicz et al. (1991) have applied the reduced gradient (RG) method to obtain the optimal solution of the NTP.

Many authors offer to use VRP (vehicle route problem) system to optimize vehicle usage and to minimize delivery costs. It is necessary to group objects in the particular territory depending on the distance between them, as well as their location and address, serving customers with one vehicle in the particular territory. VRP solutions may be used if the route connects not so many objects; usually specialists use a combination of graphical and heuristic methods to avoid routes crossing in the system as well as other methods and optimization's restrictions.

The Street Routing Problem (SRP), as a problem of servicing a large number of customers in a city zone, is often a part of many logistics. In the SRP category, we can include such problems as postal service delivery, commercial freight delivery, meter reading, newspaper delivery and waste removal. It is possible to use SRP also for situations when road network is developed and traffic is intensive.

After evaluation of traditional route planning methods usage for delivery optimization, the author concludes that usage of mathematical methods allows minimizing of vehicles' run and transportation costs, but may not provide the optimal result when planning delivery time for a real situation. Traditional methods allow making transportation planning process easier, but these methods may not provide precise auto transportations route time planning, especially for cities with unstable and intensive traffic.

It is necessary to justify labour working hours management to make working process more efficient. On the one hand, labour management requires maximal productiveness, maximal volume using the existing resources; on the other hand, maximal usage of labour is needed to reduce manufacturing costs. It is important to find the optimal time period to complete each operation or to define the quantity of production to produce per a period of time.

Labour standardization methods as well as work physiology, psychology and management investigations may provide advisable result for the company's administration – it is possible to define technological process minimal time utilization before its starting; that is necessary to complete particular work operations and provide high working speed maintenance for a long period of time. But use of these methods ignores the negative influence of high-speed work on a person's organism.

After analyzing standardization methods, the author may conclude that standardization is the definition of a time period needed for particular work process realization. If it is assumed that particular cargo quantity delivery to the customer is a standardization problem, than this agrees with the optimal transportation planning problem, whose optimization criteria are delivery time or total route time, vehicle's run, transportation costs, vehicle's unloading time and work intensity. It is possible to minimize these criteria, using standardization methods.

Traffic intensity uncertainty does not allow using traditional route planning and optimization methods, based on vehicle's run or transportation costs minimization, assuming that vehicle's speed is fixed or constant. So, it is necessary to use also standardization methods, connecting the result of work with a lead time to optimize the time factor planning for the vehicle's movement.

3. TRANSPORTATION OPERATIVE PLANNING OPTIMIZATION OBSERVING TIME MOMENTS OF VEHICLES MOVING AND UNLOADING PROCESSES

The chapter includes 38 pages, 21 figures and 12 tables.

According to the investigation, traditional routing methods may not provide the optimal result when planning delivery lead time for circular dropping route, so it is necessary to use also other methods or combinations of methods.

In cities it is often necessary to solve the following task: delivery of particular amount of goods Q through the known-before route with n roads' segments, providing particular m objects with the needed q_j units of cargo. All cargo should be delivered.

$$\sum_{j=1}^{m} q_j = Q \tag{3.1}$$

Restriction of the model:

1. Each road segment distance is known before, but the speed of a vehicle in each road segment *i* may be different depending on the day of the week or hour of a day;
2. Amount of cargo *qi* may change for objects *m*; unloading processes labour-intensity also changes as a result of the different objective circumstances;
3. Vehicle's driver provides all unloading processes without additional equipment;
4. Daily route may change for the particular region served.

It is necessary to notice the moment of cargo delivery for each route object *j*; it is also important to calculate the total time of the route:

$$T_m = \sum_{i=1}^{n} T_i + \sum_{j=1}^{m} T_j \tag{3.2}$$

n – the number of road segments in the route;
Ti – particular segment's *i* driving time;
m – the number of objects served on the route;
Tj – time used in unloading operations of the particular *j* object.

So, for the whole day:

(3.3)

$$T_m = \sum_{i=1}^{n} \frac{l_i}{V_i} + \sum_{j=1}^{m} T_j$$

l_i – distance of particular road segment's;
V_i – moving speed of vehicle.

It is necessary to take value l_i from the road map of the region served, but value V_i - from the prepared data base depending on the day of the week and hours of a day for the particular route.

Micro-elements standardization concept for vehicle's moving time planning.

Depending on the total period of time over the route, it is necessary to divide it into average speed elements V_1, V_2, $V_{3,}$... V_i,..., V_n (see figure 3.1.), assuming that depending on the route's road segments the average speed does not change.

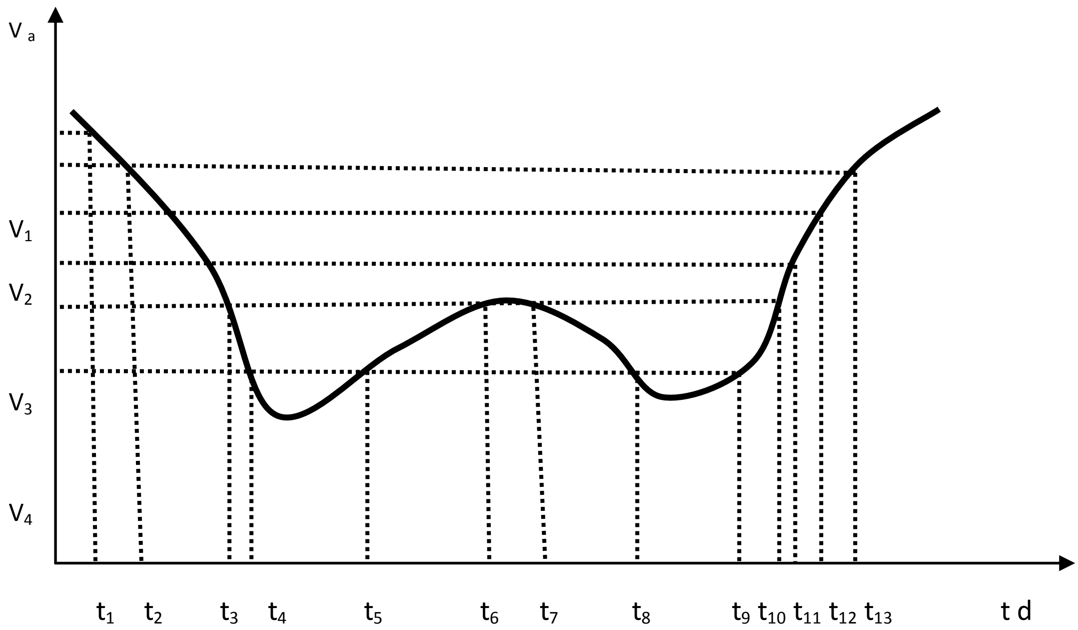


Figure 3.1. The average speed in the city streets at the particular moment of time.

legend:
td – hours of a day
V_a – average speed of the vehicle.

According to figure 3.1., the average speed in the city streets changes at different moments of time. It is very difficult to plan delivery lead time in these circumstances using traditional routing methods only, so it is necessary to make the following operations using micro-elements standardization method:

1. divide route traffic into separate segments V1 – Vn – depending on the traffic intensity changes specifics (figure 3.1.);
2. create "road passport" for the whole region served. The "road passport" includes the routes starting point (enterprise's warehouse) and objects served. The road

connecting the objects should be divided into particular segments, using different principles of division, for instance, from crossroads to object, from object to object etc.;

3. correction of vehicle moving time depending on hours of a day, passing that for particular route road V_i = const (see formula 3.4.).

$V_i/l_i = t_i$

where:

V_i – the average speed after the division by hours;

l_i – distance of road segment (from the roads map)

4. using $t_i = V_i/l_i$ after the correction it is possible to use also traditional route planning methods, depending on the vehicles moving time in the city streets.

The result of standardization: low labour input, but delivery planning accuracy is improved.

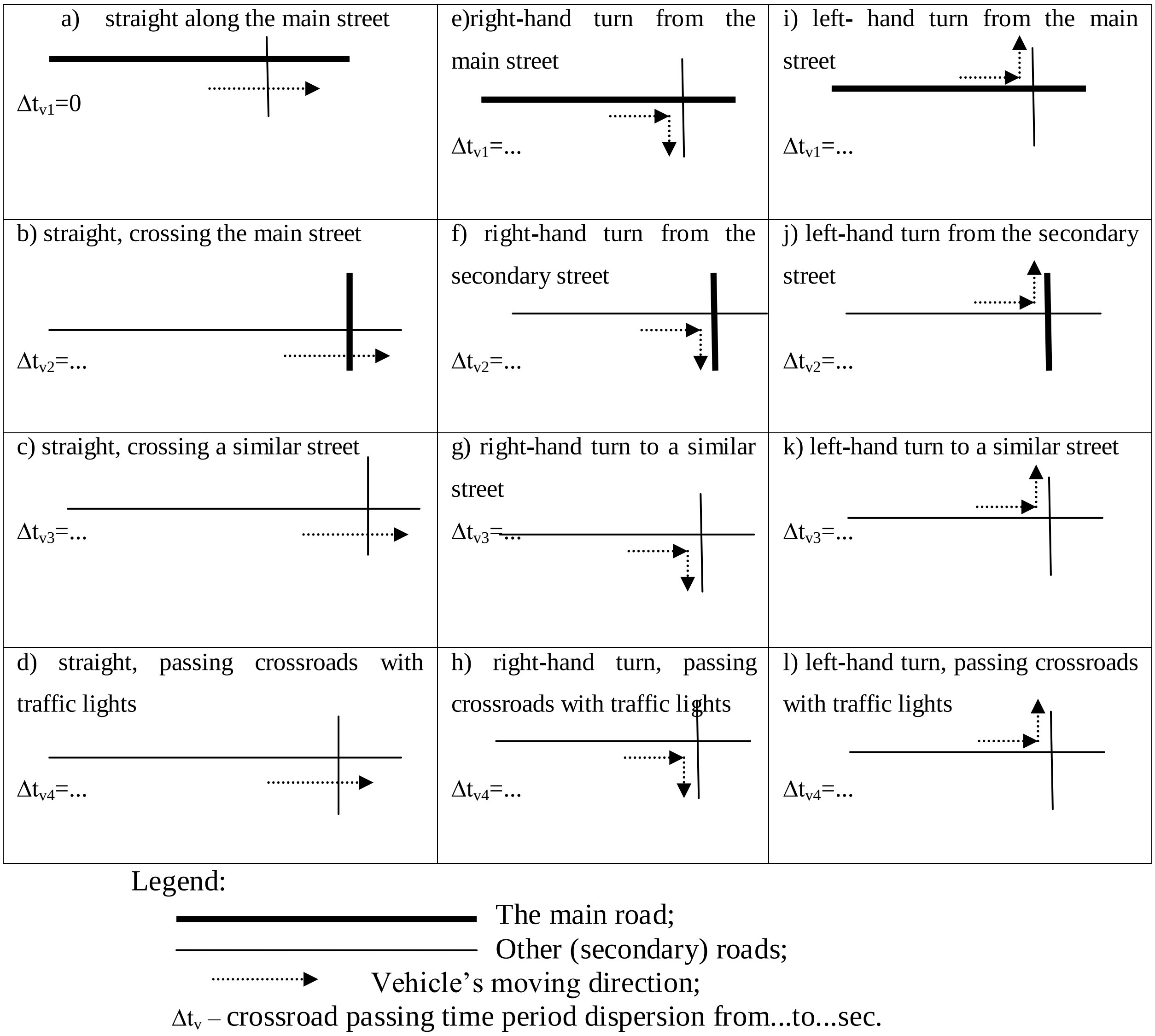


Figure 3.2. Crossing time division for crossroads with or without traffic lights

The author concludes that for successful route planning in cities, it is important to analyze not only the segments of city roads from crossroad to crossroad, but also to evaluate periods of time needed to go through crossroads. The author has worked out planning (figure 3.2.) model for passing uncontrolled crossroads (without traffic lights).

The passing time of crossroads depends also on the type of crossroad and vehicle's destination. Of course, unstable traffic intensity influences the passing time of crossroads.

The author establishes the fact that the passing time of uncontrolled crossroads consists of the time, which is necessary for the driver to evaluate the situation (traffic signs), waiting time till the moment, when it is possible to pass the crossroads and waiting time in the vehicle's queue.

According to the statistical information to make time planning for crossroad passing, easier it is important to create time grouping for the local route (see 3.3. figure).

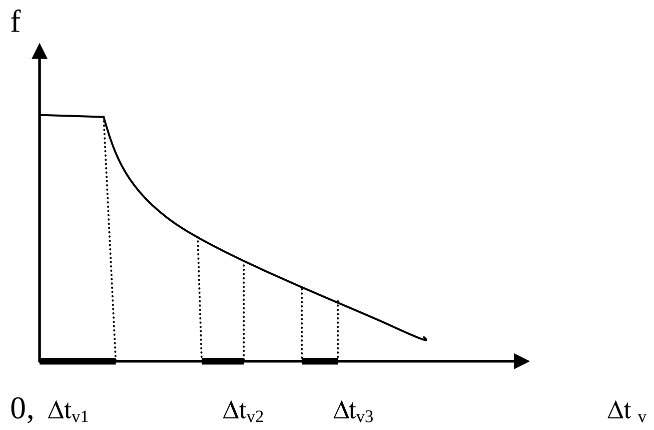


Figure 3.3.. Time grouping for crossroads passing

where: Δt_v – passing time of crossroad: dispersion from...to...sec.;

Δt_{v1} – dispersion from...to...sec.; Δt_{v2} - dispersion from...to...sec.; Δt_{v3} - dispersion from...to...sec.

According to figure 3.3., groups Δt_{v2} and Δt_{v3} dispersion includes the time period physically needed for the driver to complete manoeuvring operations, using MTM-2 methods principles as well as possible waiting time, giving way to other vehicles or pedestrians and possible detention of the controlled crossroad (this problem is not solved within the Doctoral dissertation). It is assumed that while going straight along the main street the speed is constant $\Delta t_{v1} = 0$.

So, the total time that vehicle spends between two objects served is:

$$t = \sum L_i/V_i + \sum \Delta t_{vi} \qquad (3.5.)$$

If a person who plans the route knows the distance of each road segment, it is useful to create a data base, which characterizes the vehicle moving time for each particular segment of road depending on the hours of a day.

The scheme of figure 3.4. provides summarized information about vehicle's moving time planning for cities, using micro-elements standardization method. In this scheme (also in the Doctoral dissertation in general) controlled crossroads passing problems are not investigated in detail; only moving time between crossroads, traffic lights and objects served.

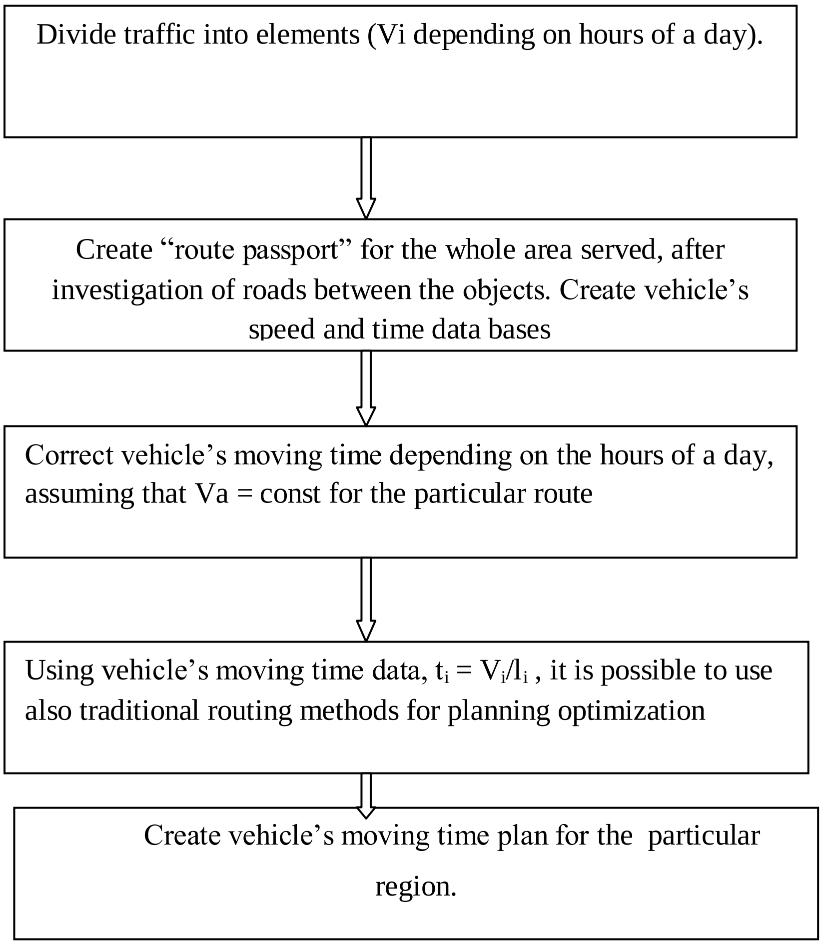


Figure 3.4. Vehicle's moving time planning scheme, using micro-elements standardization method.

It is possible to calculate precisely the time needed for a particular route for different hours of a day as well as other routes serving time.

The author concludes that it is useful to use micro-element method to plan efficient routes in cities to reduce vehicle's moving time planning uncertainty. To achieve it, it is necessary to divide the area served into many separate segments. It is important to complete both the vehicle moving speed data base and moving time data base for road segments with unstable traffic. It is possible to reduce the total moving time planning uncertainty, using these data bases.

The author has investigated that it is very important to plan also unloading time in an optimal way to optimize the route planning in cities and other built-up areas. Often the share of unloading operations time when serving customers is more than a half from the total route time. The standardization of the unloading time near a particular object using micro-elements methods, on the one hand, makes the total standardization process easier, on the other hand it is significant, because this is the only standardization method good for using in real circumstances (other methods are too labour-intensive or not precise).

Micro-elements standardization concept for vehicle's unloading time planning.

The author is sure that insufficient accuracy of loading and unloading time regulations especially negatively influences small parties' delivery process optimization. If a specialist optimizes the route for many times, the number of objects served increase in the route. As a result, traditional mathematical methods lose sense, because it is impossible to precisely evaluate more than 50% of the total routeing time.

Vehicles unloading time for small objects consists of the direct unloading time, which depends on the amount of production needed for the customer, as well as the distance over which the driver should carry cargo from the vehicle to the customer's warehouse and time of other process elements which does not depend on the amount of production needed for the customer. These time elements consist of the manoeuvring time approaching to the customer and going away from it and realization time for additional operations.

It is possible to draw the following total unloading time formula for the particular object served:

$$T_{unl} = T' + n_{unl} * T_{unl}'' \qquad (3.6)$$

where:

T_{unl} - the total time the vehicle spends to serve the particular object;

T' - the sum of micro-elements, which depends on the circumstances where the vehicle approaches to the object;

n_{unl} * T_{unl}'' - manual labour used in the unloading process, which depends on the quantity of cargo and particular micro-elements (the distance between the stopped vehicle and the cargo receiving place of the client).

The fact that a routing time justified standardization does not exist, provides that drivers are uninterested so reduce the total routing time, because it is impossible to create material stimulation system without precise standards system. To improve vehicle unloading time planning using micro-elements, it is necessary to make the following operations:

1. Divide unloading process into basic complex elements and their variants, taking into account specifics of the transportation and unloading processes.

2. Evaluate basic complex elements or use timekeeping. It is necessary to divide variants into working processes and calculate the needed time period to complete each of them.
3. Real objects survey to get information about the objects' external features; after that it is possible to make basic complex elements planning.
4. Calculate the unloading time, as well as the period of time needed to complete other elements of the time, which the vehicle spends near the object served.
5. Calculate unloading time, evaluating the demand or cargo amount needed to serve the particular customer.

Observing necessity to improve unloading processes time standardization, the author has worked out the methodology based on the micro-elements standards. One of the most specific features of the unloading process near small objects served is: a great share of manual labour time, that makes precise planning of delivery lead time period difficult.

Manoeuvring facilities of the object as well as keeping cargo documents and cargo unloading circumstances characterise the unloading processes. Cargo types differ from each other in the necessity to recount and rescale them. So, with the help of micro-elements method, it is possible to calculate precisely the total time of each process as well as the total time of the whole route.

It is important to plan the total unloading process time for the particular object. The total unloading operations time for the particular object served *j* is equal to:

$$T_j = \sum_{1}^{k} T_{mj} + \sum_{1}^{k} T_h * q_i \qquad (3.7)$$

where:

k – breaking the unloading process into particular operations;
T_{mj} - manoeuvring time of the vehicle;
T_h - working time of operations made manually, carrying the cargo from the vehicle to the customer's warehouse.

Formula 3.7. illustrates the dependence of total unloading operations time on the particular route in the city, the object locations in the territory served, as well as manoeuvring opportunities and distance between the vehicle and the customer's warehouse. So, according to the micro-elements standardization method, it is necessary to break up cargo operations of the *j* objects into standard groups depending on the labour-intensity of the manoeuvring when arriving to the warehouse of the object served as well as manual operations. It is necessary to create a data base, describing unloading processes time for typical objects served.

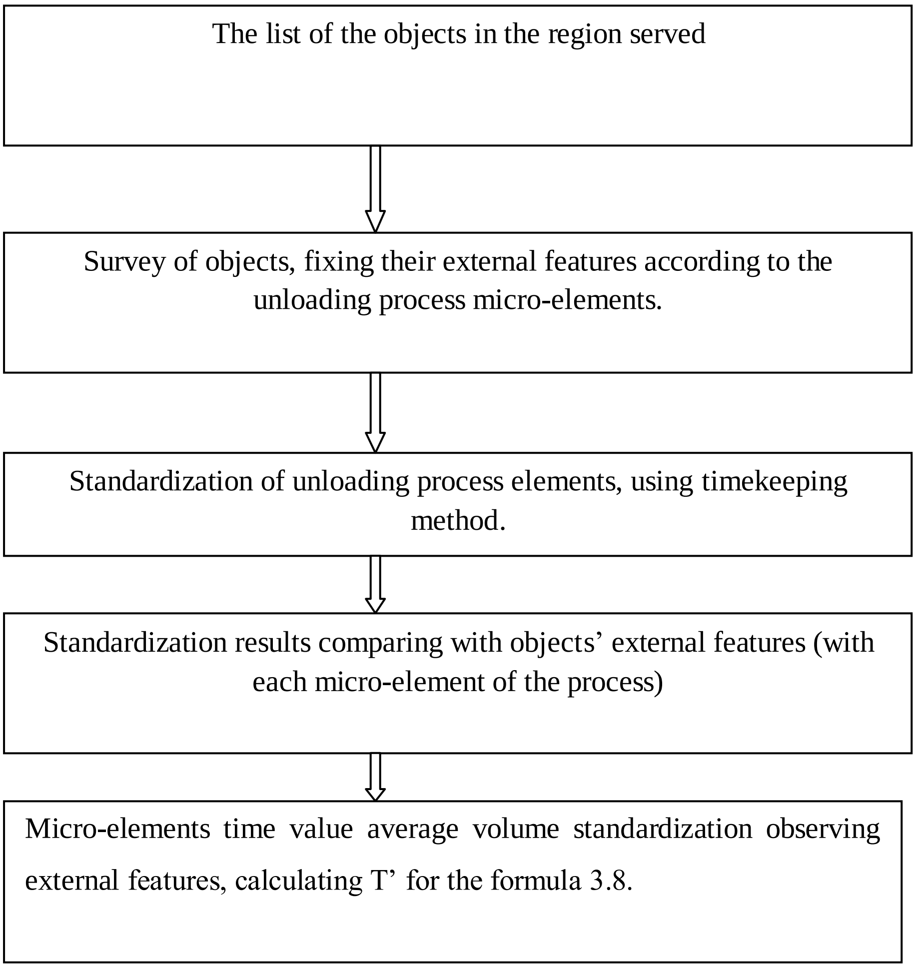


Figure 3.5. Data base creating process for the objects in the region served.

According to figure 3.5. micro-elements standardization operations help to improve unloading process planning when regularly serving small objects, for instance, retailers. Using data base, the external features of the objects served as well as the number of micro-elements of the whole unloading process are defined. Using micro-elements standardization method, micro-elements time for manual operations and the total time needed to serve an object are defined.

The author concludes that it is necessary to complement the micro-elements data base with time standardization when planning unloading process time. Standardization methods allow particular task adaptation to the needed period of time, so these methods provide an optimization of work-intensity. It is important to use micro-elements method when planning unloading time of objects in the region served; so it is possible to improve route planning process, precisely planning delivery lead time.

The author establishes the fact that there are many types of businesses in Latvia today, when enterprises' (which are located in Riga) main customers are located in the capital or near the capital of Latvia. In this situation it is important to use the combination of own transport and commercial transport to serve customers in an optimal way.

The customers' concentration is the largest near the company; the concentration is not so high in the bigger distance from the enterprise (figure 3.6.). It is possible to perform the following operations: to optimize delivery process: to create "2 drops" routing system, to calculate the optimal radius from the company where it is appropriate to use own transport. "Internal drop" customers are served by own transport, but "external drop" customers are served using commercial transport service. Figure 3.6. illustrates the "2 drops" model.

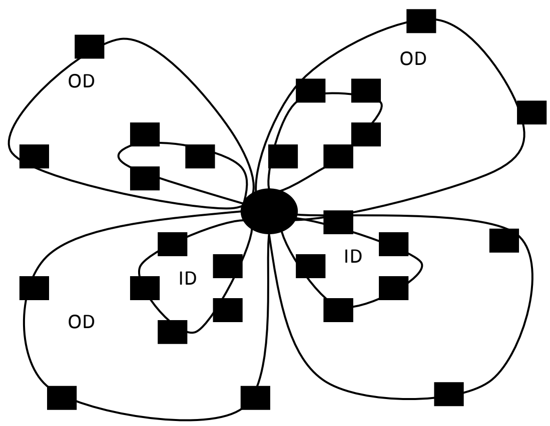


Figure 3.6. Wholesaler route planning scheme in cities

Legend:

⬤ Wholesaler located in city;

■ Customers (serving objects)

IP – "internal drop"

OP – „external drop".

According to the information displayed in figure 3.6., a wholesaler may use "2 drops" model, planning circular routes. It is possible to create routes, using "internal" and "external drop" principles. There are many advantages of using this principle in real circumstances, comparing with the situation when the enterprise uses only own transport.

It is recommended to use micro-elements standardization method in combination with other methods, to improve delivery time planning system in cities nowadays. One possible combination is the author's novelty – city routes planning improvement algorithm (figure 3.7).

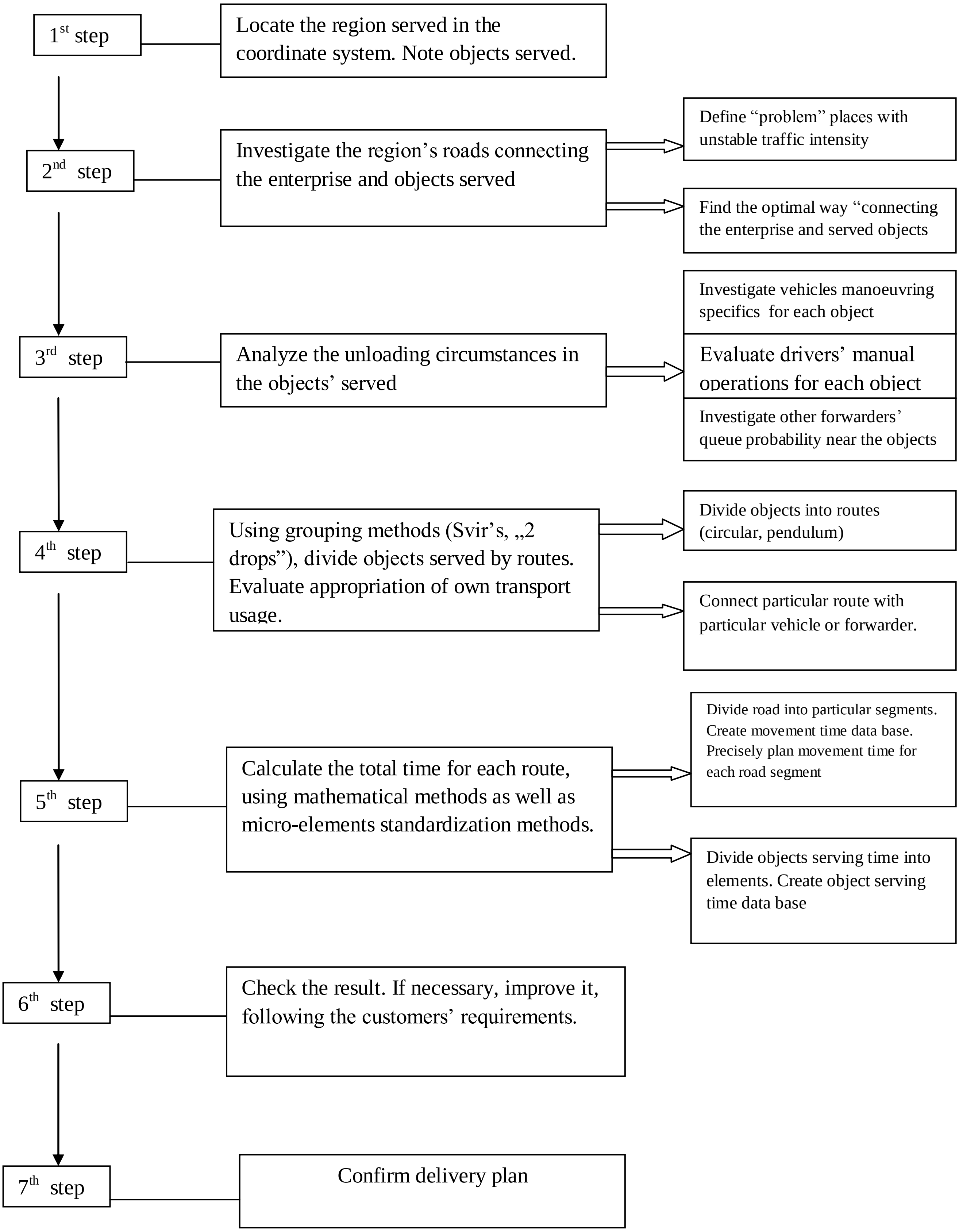


Figure 3.7. City routes planning improvement algorithm.

This algorithm combines vehicle's moving time planning scheme with unloading time planning scheme. Using the algorithm, it is necessary to make 7 steps.

First of all, it is important to investigate the infrastructure and the objects served; to analyze each object's location and find the minimal distance between customers as well as between the enterprise and each customer, observing the infrastructure specifics of the region served and general road configuration. Then it is necessary to create a "road passport" as well as data base of the objects served depending on unloading circumstances in objects.

It is possible to use mathematical method in combination with grouping and other methods to optimize the planning process of cargo auto transportation route; using of micro-elements method allow achieving the optimal result planning routes in real circumstances.

In contradistinction to traditional planning methods, the average vehicle's speed is not a basis of time planning. Dividing infrastructure into separate elements, calculate time intervals, when roads are maximally or minimally loaded. It is possible to precisely estimate vehicle moving time for a particular road segment.

Using city routes planning improvement algorithm allows to make planning delivery lead time for city routes easier and achieving precise result as well as combination of own transport with contract transport. Often own vehicles are used for goods distribution in cities with intensive traffic.

The author concludes that traditional route planning methods provide a good result only when vehicles moving time is constant; but does not provide the best result for separate road segments. These methods also may not provide the best result to unloading time fluctuations. Another method – standardization solves these micro-problems. So, observing modern business requirements and restrictions, the existing logistic routing methodology should be complemented with the optimal standardization method. Micro-elements method is the optimal standardization method; it may provide precise result, using separate time elements.

The author concludes that the micro-elements standardization method worked-out in the Doctoral dissertation allows improving route planning methodology, combining it with traditional planning methods.

CONCLUSIONS AND PROPOSALS

The following conclusions have been drawn during the elaboration of the dissertation:

1. Transport development has created objective traffic problems in cities, and their main reason is rapid increase in the number of vehicles. The overload of roads is the most important problem for planning vehicle moving time, because this problem influences both the total time of transportation and transport costs.
2. Efficient improvement of transportation in the conditions of economic globalization is one of the most significant logistic development courses. It is possible to achieve transportation efficiency reducing blocked funds value in transportation process as well as performing deliveries just in time. Traffic intensity growth is an objective restriction both for reducing transportation time and planning precise deliveries; infrastructure development speed is too low in comparison with the growth of the number of vehicles. As a result, traffic intensity has unstable values for different road segments depending on the days of the week and hours of a day.
3. It is necessary to choose the optimal mode of transport or transport modes combination; planning depends on the logistic system priority as well as criteria of optimization for particular transportation processes to plan international deliveries in an optimal way.
4. Operators often create circular routes when planning local deliveries. They consolidate many objects served within one route. It is significant also for international transportation (pendulum routes) optimization - to plan the total time of transportation precisely. The total time of international transportation consists of different elements and that may create difficulties in the planning process both for the vehicle's moving and unloading time.
5. After analyzing traditional route planning and optimization methods, the author concludes that these may not provide the optimal result for planning delivery and unloading time due to unstable and intensive traffic, because the standardization data base does not exist. Therefore it is necessary to complement traditional route planning methods with standardization methods for calculating both vehicle moving and unloading time in an optimal way.
6. The author has worked out methodology, which allows estimating precise vehicle moving time between the objects served, the total transportation time for the route

and the time of arrival to the particular object served. This methodology corrects vehicle's moving time changes for different segments of streets and hours of a day as well as time of crossroad passing.

7. The basis of micro-elements method is the break up of the analyzed process into microelements. When planning routes, it is necessary to divide transportation process into standard elements, because micro-elements standardization method intends to calculate the time period for minimal operation of each process, thus eliminating unnecessary movements.
8. Microelements standardization systems MTM-1 and MTM-2 consist of tables, which include the minimal working process movement lead time standards so that this information can be used for calculations without additional planning operations. Normally microelements methods MTM-1 and MTM-2 are used in the fields, where exist labour-intensive calculations; so it is impossible to apply the usual technical standardization methods especially if the human factor influences the working process results.
9. After analyzing standardization methods, the author chose micro-elements standardization methodology as a prototype for auto transportation standardization. The basis of this methodology is MTM-3 method, which has been worked out in order to improve the internal transport needs of manufacturers. The micro-elements standardization methodology has efficient structure; it allows achieving precise measurement in comparison with transport requirements of manufacturers.
10. The author has worked out auto transportation schedule planning methodology, which includes:
    - traditional route calculation, according to the demand and location of the objects served, using, for instance, the minimal growth method.
    - vehicles' moving time calculation for different road segments, taking into account the vehicles' speed changes depending on hours of a day;
    - route scheduling.
11. Loading and unloading operations are imperceptible and very significant parts of the total delivery process; so if these operations' time is not planed precisely, it especially influences the delivery process in small-cargo transportation, because the number of the objects served is large for these transportations. Therefore the forwarder or another company which arrange transportation should create the standard data base of unloading process for the objects of the region served.

12. The unloading process near little objects served may be divided into the following basic elements: manoeuvring, preparing for loading, unloading and movement processes, loading or unloading one unit of cargo, cargo transfer circumstances, signing cargo documents – to calculate each element’s lead time separately un improve standardization precisely.
13. The author has extracted five types of manoeuvring, because different types of working place organisation are possible, different objects have different location in regard to the street as well as unloading circumstances may be different; therefore it is necessary to use different automobile manoeuvring types.
14. The author has worked out the methodology for planning a complex circular route. It is necessary to consolidate traditional route planning methods with micro-elements standardization methods’ complex for both vehicle’ transfer and unloading time period calculations as well as to plan just in time deliveries in an optimal way.

Basing on the results of the research, the following proposals have been elaborated:

1. Ministry of Transport should provide not only investment for roads quality improvement, but also usage of progressive route planning methods to compensate the influence of objective unstable traffic intensity on the quality of transportation.
2. Forwarders should use the optimal route planning and calculation methods, improving their attitude towards time-factor consideration in transportation in order to satisfy cargo recipients’ requirements for precise delivery lead time.
3. Quantity surveyors should use micro-elements standardization method, dividing unstable elements of time in compliance with the created standardization micro-elements data base in order to improve the transportation quality and to plan precise deliveries within unstable traffic circumstances.
4. When planning circular routes for customers, forwarders should create a transportation process model, divide it into standard operations un create a standardization data base for these operations.
5. Quantity surveyors should choose the optimal standardization method to determinate both the vehicle moving and unloading time for each route’s element. In comparison with average statistical and timekeeping methods, the most appropriate is micro-elements principle used in planning manufacturing operations.

When creating circular routes for local city transportation, it is necessary to take into account not only changes of vehicle’s transfer time for each road’s segment, but also unloading time for particular objects.

6. Quantity surveyors should make the following operations in order to improve transportation planning process: to create “road passport” and to determinate what is the average vehicle’s speed for each road’s segment depending on hours of a day. To standardize transportation planning process, it is necessary to group road’s segments depending on the average transfer speed for different hours of a day.