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COOPERATION MODELS OF CITY LOGISTICS

KOOPERATIVNI MODELI CITY LOGISTIKE

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Abstract: *City logistics is the notion that attracted a lot of particular attention of numerous scientific and expert forums during the last decade. Researches of problems of urban environments logistic, particularly of big cities, give different results and practical solutions. City logistics flows are characterized by partiality, spatial dispersion of generators, diversity of logistic chains structure, frequency of large number of smaller deliveries, dynamics, stochastic etc. The major part of these flows in the city area is realized independently and without coordination by logical systems of shipping, commercial, service, industrial and other firms. Problems and complexity of logistics in urban area caused the development of different conceptions of city logistics. In the first part of this paper you can find analysed different interprets of notion of city logistics, problems and different solutions of systems and processes of logistics of urban areas. Different cooperation models of city logistics and some results of their applications are shown in the second part of this paper.*

Key words: *city logistics, cooperation, consolidation, logistic terminal.*

Apstrakt: *City logistika je pojam koji u poslednjoj deceniji privlači posebnu pažnju mnogih stručnih i naučnih foruma. Istraživanja problema logistike urbanih sredina, posebno velikih gradova, daju različite rezultate i praktična rešenja. City logistički tokovi imaju obeležja parcijalnosti, prostorne disperzije generatora, raznolikosti u pogledu strukture logističkih lanaca, učestalosti većeg broja manjih isporuka, dinamičnosti, stohastičnosti, itd. Najveći deo ovih tokova na području grada realizuju logistički sistemi špediterskih, trgovačkih, uslužnih, industrijskih i drugih firmi. Problemi i kompleksnost logistike u gradskim sredinama uslovili su razvoj različitih koncepcija city logistike.U prvom delu ovog rada analizirana su različita tumačenja pojma city logistike, problemi i različita rešenja sistema i procesa logistike urbanih sredina. U drugom delu rada prikazani su različiti kooperativni modeli city logistike, kao i neki od rezultata njihove primene.*

Ključne reči: *city logistika, kooperacija, konsolidacija, logistički terminal.*

1 INTRODUCTION

Problems of supplying a city with goods and extracting materials from the city environments have been present and solved according to different level of economic, cultural, technological and other aspects of social progressing. Delivery of goods is the primary condition for keeping urban life and business activities that make fortune and develop city environments. Efficient transport of goods can have significant role in competing between

1 UVOD

Problemi snabdevanja grada robom i izvlačenja materijala iz gradskih sredina su prisutni i rešavani u skladu sa različitim stepenom ekonomskog, kulturnog, tehnološkog i drugih aspekata razvoja društva. Dostava robe je preduslov za održavanje urbanog života i poslovnih aktivnosti kojima se ostvaruje bogastvo i razvoj gradskih sredina. Efikasan robni transport može imati značajnu ulogu u

urban areas and that is the reason of its being the part of city economics. It supports employment and produces income, but also it causes some negative influences on all important city functions.

A great deal of goods flows ends or begins within the city. The importance of the goods transport is also presented by the results of some researches which show that two thirds of the total amount of goods costs have the source or destination within the city centre zones. The closest city center (CBD-Central Business District) in the European metropolies with approximately 1-2% of the total city area initiate one third of the total cargo flow, which is several dozen thousands of vehicles within a day. Urban freight transport has continual growth, and there are expectations that the trend will continue in the future. The reason of greater participation of freight transport in the city are trends in production and distribution based on the low stock and the deliveries that are precisely defined in time (JIT, Just In Time strategy),as well as the trend of growth of electronic trade and the delivery to the home address (B2C, Business to Customer). The goods transport in the city produces great expenses and time loss in logistic systems. Goods and freight flows in the city are realized by all means of transport on disposal. Road transport attracts special attention because of its dominant role in the realisation of these flows and the problems it causes. It becomes more expensive because of permanent decrease of factors of loading vehicles, and more frequent deliveries in order to satisfy permanently growing customers' demands. These problems initiate the development and applying of all other means of transport, especially intermodal transport logistic solutions in the cities.

The problem of planning of goods transport and goods moving to and through the cities in general, was solved partially and one by one in many cities, according to the demands and characteristic of firms which were covered by the research and which ordered it. The most suitable solutions were looked for single economic entities, rarely for one of economic groups or more of them, and it could be said, never for all others who were involved in the social and economic life of the city.

Cooperation in the area of city logistic for different participants under certain circumstances

konkurentnosti urbanih područja i zbog toga je sastavni deo gradske ekonomije. On podržava zaposlenost i stvara prihode, ali izaziva i niz negativnih uticaja na sve bitne funkcije grada.

Veliki deo robnih tokova završava ili počinje unutar grada. Važnost robnog transporta u gradu pokazuju i rezultati nekih istraživanja da dve trećine ukupnih robnih tokova ima izvor ili destinaciju unutar centralnih gradskih zona. Najuži centar grada (CBD-Central Business District) u evropskim metropolama sa oko 1-2% ukupne površine grada inicira trećinu svih teretnih tokova, odnosno nekoliko desetina hiljada teretnih vozila u toku dana. Urbani teretni transport ima kontinuiran rast, a očekivanja su da će se taj trend nastaviti i u budućnosti. Razlog sve većeg učešća teretnog transporta u gradu su tredovi u proizvodnji i distribuciji bazirani na niskom nivou zaliha i vremenski precizno definisanim isporukama (JIT, Just In Time strategija), kao i trend rasta elektronske trgovine i isporuke na kućnu adresu (B2C, Business to Customer). Robni transport u gradu stvara velike troškove i velike vremenske gubitke u logističkim sistemima. Nosioci realizacije robno teretnih tokova u gradu su svi raspoloživi vidovi transporta. Zbog svoje dominantne uloge u realizaciji ovih tokova i problema koje stvara, drumski transport privlači posebnu pažnju. On postaje sve skuplji zbog stalnog opadanja faktora tovarenja vozila i frekventnijih isporuka u cilju zadovoljenja sve šireg spektra kupčevih zahteva. Ovi problemi iniciraju razvoj i primenu svih drugih vidova transporta, a posebno intermodalnih transportnih rešenja logistike u gradovima.

Problem planiranja transporta robe i kretanja robe do i kroz gradske oblasti i kroz gradove uopšte, u mnogim gradovima je rešavan parcijalno i pojedinačno, u skladu sa zahtevima i karakteristika preduzeća na koja se istraživanje odnosilo i za čije potrebe je bilo rađeno. Tražena su najpovoljnija rešenja za pojedine privredne subjekte, retko kada za jednu od njihovih grupacija ili više njih, a može se reći nikada za sve grupacije, za sve učesnike društveno privrednog života grada.

Kooperacija na području city logistike za različite učesnike u određenim situacijama daje različite

gives different results. In the city logistic area companies of the same but also from the different work fields join together, according to a certain aspect of homogenity of demands, considering collecting in time and space (homogenity looking from the aspect of technology, size and packaging of goods, relation, delivery zones, time of delivery, means of transport, etc.). Different forms of cooperation are modelled and tested very often. Effects given by different models of cooperative forms show significant possibilities of rationalization considering the size of drive parks, total length of transportation, usage of freight space on the transportation device, emmission of contamination, etc.

2 CITY LOGISTICS

Regular interpretation of certain item can influence significantly on the quality of planning activity, modelling, optimization of logistic processes and systems. Different interpretation of the city logistic can be seen best in definitions given by various authors:

- City logistics, based on economical end ecological goals, represents organized planning, managing and control of logistic processes in a united business logistic system. The task of City logistic is cooperative production of logistic service during the supplying and removing of goods and materials from a city or a town. (*Isermann*) [4]
- City logistics is the process for totally optimising the logistics and transport activities by private companies with the support of advanced information systems in urban areas considering the traffic environment, its congestion, safety and energy savings within the framework of a market economy. (*Taniguchi*) [11]
- City logistics ... means nothing else but connecting, connecting, and one more time, connecting. (*Ewers*) [3]
- City logistics includes all strategies, technologies and all logistic solutions which support all participants and functions of urban space, regardless their size and number, area and boundaries, and according to their individual and general interests and goals. (*Zecevic*) [15]

rezultate. Na području city logistike udružuju se firme iz istih, ali i iz različitih delatnosti, a na osnovu nekog aspekta homogenosti zahteva u pogledu sabiranja u vremenu i prostoru (homogenost sa aspekata tehnologije, pojavnog oblika robe, relacije, zone isporuke, vremena isporuke, transportnog sredstva i sl.). Različite forme kooperacije se često modeliraju i testiraju Eefekti koje daju različiti modeli kooperativnih formi pokazuju značajne mogućnosti racionalizacije u pogledu: veličine voznih parkova, ukupnog transportnog puta, iskorišćenosti tovarnog prostora transportnog sredstva, emisije štetnih gasova, itd.

2 CITY LOGISTIKA

Pravilno tumačenje određenog pojma može presudno uticati na kvalitet aktivnosti planiranja, modeliranja, optimizacije logističkih procesa i sistema. Različita shvatanja pojma city logistike se možda najbolje uočavaju u definicijama datim od strane različitih autora:

- City logistika je na ekonomskim i ekološkim ciljevima uređeno planiranje, upravljanje i kontrola logističkih procesa u poslovno objedinjenom logističkom sistemu. Zadatak City logistike je kooperativna proizvodnja logističke usluge pri snabdevanju i izvlačenju robe i materijala iz jednog grada ili naseljenog mesta. (*Isermann*) [4]
- City logistika je proces totalne optimizacije logističkih i transportnih aktivnosti pojedinačnih kompanija uz podršku naprednih informacionih sistema u urbanom prostoru uzimajući u obzir saobraćajno okruženje, gužvu i energetsku potrošnju u okviru tržišne ekonomije. (*Taniguchi*) [11]
- City logistika ... ne znači ništa drugo nego povezivanje, povezivanje i još jednom povezivanje. (*Ewers*) [3]
- City logistika obuhvata sve strategije, tehnologije i sva rešenja logistike koja daju podršku svim učesnicima i funkcijama urbanog prostora bez obzira na njihovu veličinu i broj, prostor i granice, a u skladu sa njihovim pojedinačnim i opštim interesima i ciljevima. (*Zečević*) [15]

Many pieces of work that dealt with the flow of goods, cargo and material in the city area, beside the term city logistics, also use terms such as urban freight transport, urban transport, urban logistics, etc. Considering the scope of the area, this term often underestimates the researches of central urban zones logistics. The dilemmas imbade whether city logistics means the logistics of inherited place, central zone, part of a city or the whole one, agglomeration or region. The real space that should be considered is the whole urban territory, and in certain cases, the suburban zones. There are rare authors who dealt with all activities and flows of goods and material that start, end or transit the city (supply flows, transit flows, flows of removing waste, raw and recycling materials, service flows, sales flows, etc.). Beside the goods flows in urban areas, there are also flows of different kinds of materials, and flows which are not only materials and things, but rather described as freight. Therefore, beside the goods there are flows of prospect material, billboard material, equipment for sports competitions, theatre stages, museum exhibition items, animals used for experimental research, etc. In the number of studies, urban and freight transport is defined as the transportation of the goods for mass consumption by freight (non passenger) vehicle and is mainly concentrated on the dominant road traffic. However, the flows of city logistics are supported by all means and technologies of transportation and means of carrying goods, material, freight. Very often the city logistics is inadequately identified only with conceptual solutions:concetration, cooperation, consolidation, intelligent transportation system, ecological vehicles, underground systems of transportation, etc. Disagreements about the task and the goal of city logistics are subsequences of its complexity, great number of participants and their different, most often conflict, goals. Goals setting of the city logistics in the domain of optimization of the transportation part only, and then the optimization of only the road transportation, are opposite to the basic items of LOGISTICS and its principles.

U mnogim radovima koji su se bavili tokovima robe, tereta i materijala na području grada pored pojma city logistika, pojavljuju se i pojmovi kao što su: urbani teretni transport, urbani transport, urbana logistika, i sl. U pogledu prostorne obuhvatnosti neretko se pod ovim pojmom sreću istraživanja logistike centralnih gradskih zona. Nameću se dileme da li city logistika podrazumeva logistiku naseljenog mesta, centralne zone, dela ili celog grada, aglomeracije ili regiona. Stvarni prostor koji se mora posmatrati je celokupna gradska teritorija a u pojedim slučajevima i vangradske zone. Rekti su autori koji su se bavili svim aktivnostima i tokovima roba i materijala koji počinju, završavaju se ili tranzitiraju grad (tokovi snabdevanja, tranzitni tokovi, tokovi izvlačenja otpada, sekundarnih sirovina i povratnih materijala, uslužni tokovi, komercijalni tokovi, itd.). Pored robe u urbanim sredinama, prisutni su i tokovi raznih vrsta materijala, ali i tokovi koji nisu samo materijali i stvari, već bi se mogli opisati kao tereti. Tako se pored robe pojavljuju tokovi prospektnog materijala, bilbord materijal, oprema za sportska takmičenja, pozorišne kulise, muzejski eksponati, životinje za eksperimentalna istraživanja, itd. U mnogim studijama, urbani teretni transport je definisan kao transport robe široke potrošnje teretnim (neputničkim) vozilom i uglavnom se ograničava na dominantan drumski vid saobraćaja. Međutim, tokove city logistike podržavaju svi vidovi i tehnologije transporta i oblici prenosa robe, materijala, tereta. Često se city logistika neadekvatno identifikuje samo sa koncepcijskim rešenjima: koncentracije, kooperacije, konsolidacije, inteligentnim transportnim sistemima, ekološkim vozilima, podzemnim sistemima transporta, itd. Nesuglasice oko zadatka i cilja city logistike su posledica njene kompleksnosti, velikog broja učesnika i njihovih različitih, najčešće konfliktnih ciljeva. Postavka ciljeva city logistike u domenu optimizacije samo transportnog dela, a onda i samo drumskog dela transporta je u suprotnosti sa osnovnim pojmovima o LOGISTICI i njenim principima.

3 PROBLEMS OF THE LOGISTICS IN URBAN AREAS

The tasks and the problems of logistics in urban areas are directly correlated with the state and trends of the development of cities. The problems

3 PROBLEMI LOGISTIKE URBANIH SREDINA

Zadaci i problemi logistike u gradskim sredinama su u direktnoj vezi sa stanjem i trendovima razvoja gradova. Problemi se razlikuju od grada

differ from city to city, but their dimension can be similar in many cities in the world. Rapid urbanization caused great problems. Heavily inhabited urban environments demand deliveries of greater quantities of goods and generate starting of larger number of vehicles, which influences negatively the living conditions, mobility and the environment. The annual generated quantity of goods and freight in Paris is approximately 15t per inhabitant. [2] Over 80% of road freight transportation in Europe is realised on the distances of 80km, which can be defined as urban or urban – regional transport. Researches undertaken by Iveco in nine European countries have shown that approximately 48% of vehicles circulate within cities and city centres, and approximately 32% of vehicles circulate in suburban areas. [1]. In Italy, over 70% of transported freight has the destination in the region of the source. Over 50% of goods is transported on the distances up to 50km, and 25% within the city itself [8]. In the realization of goods flows, the dominant place is occupied by the road transportation, which is over 80% of goods movement. Participation of freight transportation (trucks over 3.5t) in the total transportation in European urban areas is up to 10% (Germany – approx. 5%, England – up to 15%), and it is 35% in Japan and have the tendency of growth [6]. According to some researches, up to 2030, the growth of freight transportation is expected, realised in kilometres, for 40% approximately.

The importance of urban transport can be shown by distribution costs which make approximately 40% of the total costs of combined "door to door" transport. The importance of these costs will rise in the future, considering the tendency of reducing the stock, and smaller, but more often deliveries. Approximately 85% of delivered goods is realised with 5% starting the road freight vehicles, and the rest 15% of delivery is realised with 95% of starting [1]. In Genova, Italy, the amount of delivery in 40% of cases is less than 15kg, and the total length of road covered by freight vehicles within a day in Vaasa, Finland, is 51281km, that is, 0,9km per head. [2]

The problems of surviving of freight transportation in the cities have both local and global dimension. Looking from the aspect of the city – local dimension, goods transportation influences the lowering of accessibility especially in certain city parts and during a certain period of

do grada, ali njihova dimenzija može biti slična za mnoge gradove u svetu. Rapidna urbanizacija je izazvala velike probleme. Gusto naseljene urbane sredine zahtevaju isporuku veće količine robe i generišu pokretanje većeg broja vozila, što negativno utiče na uslove života, mobilnost i životno okruženje. Godišnja generisana količina roba i tereta u Parizu je oko 15 t po stanovniku. [2] Preko 80% drumskog teretnog saobraćaja u Evropi se realizuje na distancama do 80km koje se mogu definisati kao urbani ili urbano – regionalni transport. Istraživanja koja je sproveo Iveco u devet evropskih zemalja pokazala su da oko 48% vozila kruži unutar gradova i city centara, a oko 32% vozila u suburbanim područjima [1]. U Italiji preko 70% transportovanog tereta ima destinaciju u regionu izvorišta. Preko 50% robe se transportuje na distancama do 50km, a 25% unutar samog grada [8]. U realizaciji robnih tokova dominantno učešće ima drumski transport, preko 80% robnog rada. Učešće teretnog transporta (kamioni preko 3,5t) u ukupnom saobraćaju u urbanim sredinama Evrope kreće se oko 10% (Nemačka – oko 5%, Engleska – do 15%), a u Japanu oko 35% i ima trend rasta [6]. Prema nekim istraživanjima do 2030. godine očekuje se porast teretnog saobraćaja, izražen u pređenim kilometarima za oko 40%.

Značaj urbanog transporta može se prikazati i troškovima distribucije koji čine oko 40% ukupnih troškova kombinovanog transporta "od vrata do vrata". Značaj ovih troškova u budućnosti će rasti s obzirom na trend smanjenja zaliha, manjih, a češćih isporuka. Oko 85% isporučene robe realizuje se sa 5% pokretanja drumskih teretnih vozila, a preostalih 15% isporuke sa 95% pokretanja [1]. U Đenovi, Italija, veličina isporuke u 40% slučajeva je manja od 15kg, a ukupna dužina koju pređu teretna vozila u toku jednog dana u Vaasi, Finska je 51.281km, odnosno 0,9km po stanovniku. [2]

Problemi održivosti teretnog transporta u gradovima imaju lokalnu i globalnu dimenziju. Sa aspekta grada - lokalna dimenzija, transport robe utiče na smanjenje pristupačnosti posebno nekim delovima grada i tokom određenog perioda dana (zakrčenost ulica, regulacija vremena pristupa, itd.)

a day (crowded streets, regulation of the time of approach, etc.) and also have the influence on the decreasing the quality of life in the city (air pollution, noise, traffic security, occupies significant parts of the city, etc.). Urban freight transportation contributes the global problem of surviving, especially through its negative influence on the environment (emission of contamination, spending natural resources, waste it makes, etc.). Consequences of road freight transportation on the environment in the urban overcrowded areas are enormous. One freight vehicle equals 20 passenger ones looking from the aspect of emission of contaminated air, and 10 – 20 passanger ones when considering noise. Lowering freight road transportation for 4% has the same effect as lowering the passenger transportation for 50%. In Bremen, city of 500 000 inhabitants, 500t of fuel a day is spent for transportation, which causes the list of emmission of air pollution: CO – 34, NOx – 18, CH – 8 and small particles 0.16. One third of inhabitants in Zurich live in the area where the level of noise is on the very edge with the one permitted by law [13].

Problems with approaching are mainly connected to the limitations of the size of a vehicle and of the freight for the goods transportation which introduce city authorities in order to improve the quality of city life, especially in certain city zones during certain period of time. However, the problems of availability could be the result of overcrowded parts in city centre, inadequate traffic infrastructures, etc. These problems have influence on the efficiency and performances of goods transportation in the city (costs of transportation increase, fuel consumption, they cause the stress of drivers which increases probability for accidents), on economical development, and, indirectly, on the city structure. Overcrowded area, and building cities, limited spatial possibilities, and conditions of life surrounding represent big problems which possibilities. Traffic infrastructure is overloaded, and the possibilites for its widening are limited by the lack of free space. Because of difficult approaching and wrong parking of vehicles during unloading 10 to 20 automobiles are stopped. Annual stops in the USA because of unloading of goods produce loss of two billion hours and $16 million.

i opadanje kvaliteta života u gradu (aero zagađenje, buka, bezbednost saobraćaja, zauzima značajne površine grada, itd.). Urbani teretni transport doprinosi i globalnom problemu održivosti, posebno preko negativnog uticaja na životno okruženje (emisije štetnih gasova, potrošnja prirodnih resursa, otpad koji stvara, i sl.). Posledice drumskog teretnog saobraćaja na životnu sredinu u urbanim i gusto naseljenim područjima su velike. Jedno teretno vozilo je kao 20 putničkih sa stanovišta emisije štetnih gasova, a 10 – 20 putničkih vozila sa stanovišta emisije buke. Smanjenje teretnog drumskog transporta za 4% ima isti efekat na smanjenje buke u gradu kao i smanjenje saobraćaja putničkih automobila za 50%. U Bremenu, gradu sa oko 500.000 stanovnika, za saobraćaj se dnevno troši preko 500t goriva što izaziva listu emisija aero zagađenja: CO – 34, NOx – 18, CH – 8 i čestice 0.16. Jedna trećina stanovnika Ciriha živi u prostoru sa bukom koja je na granici zakonom dozvoljenog nivoa [13].

Problemi pristupačnosti uglavnom se vezuju za ograničenja veličine vozila i tovara za robni transport koja uvode gradske vlasti u cilju poboljšanja kvaliteta života u gradu, posebno u određenim gradskim zonama tokom određenog vremenskog intervala. Međutim, problemi pristupačnosti javljaju se i kao posledica gužve u centralnim delovima grada, neadekvatne saobraćajne infrastrukture, itd. Ovi problemi utiču na: efikasnost i performanse robnog transporta u gradu (povećavaju se troškovi transporta, potrošnja goriva, dolazi do stresa vozača i povećava se verovatnoća nezgoda), ekonomski razvoj i indirektno na strukturu grada. Velika gustina naseljenosti i izgradnje gradova, limitirajuće prostorne mogućnosti i uslovi životnog okruženja predstavljaju velike probleme sa kojima robni transport mora da se izbori. Saobraćajna infrastruktura je preopterećena, a mogućnosti njenog proširenja su ograničene nedostatkom slobodnog prostora. Zbog nemogućnosti prilaza i nepropisnog postavljanja vozila prilikom istovara zaustavlja se od 10 do 20 putničkih automobila. Godišnji zastoji na ulicama SAD-a zbog istovara robe stvaraju gubitak od dve milijarde sati i 16 miliona $.

4 CONCEPTUAL SOLUTIONS

Parallel with historical development of functions and physical structures of the cities, logistic problems have appeared and have been partially solved. Significant researches and innovations in the area of logistics of urban area have begun during seventies, last century, and the last 15 years they match modern interpretation of city logistics. Turnpoint, and in some cases, limiting factor when defining conceptions and introducing certain measures of city logistics is represented by sociological, cultural, demographic characteristics of the city, architectural heritage, customs and perception of population. The complexity of this problem and the nature of the city logistic system dictate that certain concepts in cities should appear in different combinations [16]. Up to now more concepts for solving the problem of city logistics have been developed:

- Cooperative logistic systems
- Logistic centres
- Concept of concentration of information flow
- Concept of controlling the degree of usage of load space (load factor control)
- Underground systems of goods transportation
- Concept of orientation to ecological vehicles
- Concept of logistic associations
- Regulatory concept of city administration
- Etc.

Among the variety of different conceptual solutions there are two of them which stand out and which are often appled, and these are cooperative logistic systems and logistic centres. The concept of logistic systems is based on consolidation of goods flows and the cooperation between transportation companies, goods deliverers or recipients. Within cooperative systems more objects possessed by different companies are serviced by one mutual or manifold integrated logistic system. The cooperation and consolidation can be done without diverting of flows on to the logistic centres. Such work can be done by more independent companies or by one independant logistic provider. Logistic providers, beside transportation, offer the services of storing, sorting, packaging, etc. (fig. 1).

4 KONCEPCIJSKA REŠENJA

Paralelno sa istorijskim razvojem funkcija i fizičkih struktura gradova pojavljivali su se i delimično rešavali problemi logistike. Značajnija istraživanja i inovacije u oblasti logistike urbanog prostora počela su sedamdesetih godina prošlog veka, a zadnjih 15-tak godina ona odgovaraju sadašnjem tumačenju city logistike. Presudan, a u nekim slučajevima i ograničavajući faktor pri definisanju koncepcija i uvođenju određenih mera city logistike predstavljaju sociološke, kulturološke, demografske osobenosti grada, arhitektonsko nasleđe, navike i shvatanja stanovništva. Kompleksnost problematike i priroda sistema gradske logistike uslovljavaju da se pojedini koncepti u gradovima pojavljuju u različitim kombinacijama [16]. Do sada je definisan veći broj koncepcija za rešavanje problema gradske logistike:

- Kooperativni logistički sistemi
- Logistički centri
- Koncept koncentracije informacionih tokova
- Koncept kontrole stepena iskorišćenja tovarnog prostora (load factor control)
- Podzemni sistemi transporta robe
- Koncept orjentacije na ekološka vozila
- Koncept logističkog udruženja
- Regulativni koncept gradskih uprava
- Itd.

U mnoštvu različitih koncepcijskih rešenja izdvajaju se a često i integrisano primenjuju kooperativni logistički sistemi i logistički centri. Koncept kooperativnih logističkih sistema bazira se na konsolidaciji robnih tokova i saradnji transportnih kompanija, pošiljaoca ili primaoca robe. U kooperativnim sistemima veći broj objekata različitih kompanija opslužuje se jednim celovitim ili višestruko integrisanim logističkim sistemom. Kooperacija i konsolidacija se mogu izvesti sa i bez usmeravanja tokova na logističke centre. Ovaj posao može obaviti više nezavisnih kompanija ili jedan nezavisni logistički provajder. Logistički provajderi pored transporta, pružaju i usluge skladištenja, sortiranja, pakovanja, itd. (slika 1).

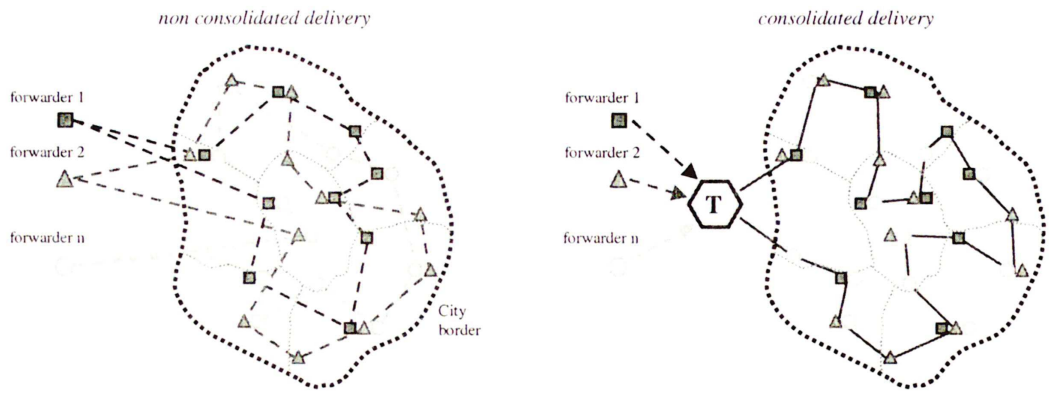

Figure 1 Cooperation in the distribution of goods [9]
slika 1 Kooperacija u distribuciji robe [9]

Numerous researches of cooperative transportation systems have shown that the number of drivings for collecting or delivery of the same quantities of goods is decreasing, which underestimates the decrease of transport costs and also the negative influence on the environment. The examples of mutual goods distribution within the city are noted in the cities of Germany, Japan, etc. Logistic centres are formed on locations convenient for traffic, in the suburban parts of the city or in the city area. They connect input and output flows, coordinate the goods flow during supplying and driving away from the city area. They are formed in all cities larger than 300 000 inhabitants. Accordingly, big cities have special settings for logistic terminals for the domain of city logistics, so that the centres become central element of the system for the goods supplying and removing the waste material. Depending on the size and characteristics of cities, the number, size and location of logistic centres may differ. Therefore, for example, when the cities of the population number up to one million are considered, there is one goods transportation centre settled on the edge of the city. The question of building and functioning of more centres in this case, depend on organizing and the size of transportation flows in the city. In the big cities, the population number of which is between 1 and 2 million, beside the centres settled on the edge of the city, additional centres of specific structure (subcentres) are defined for providing services within the city area. The cities of more than two million inhabitants are provided the network of logistic centres, which underestimates the

Mnogobrojna istraživanja kooperativnih transportnih sistema su pokazala da se smanjuje broj vožnji za sakupljanje ili isporuku iste količine robe, a samim tim i troškovi transporta i negativni uticaji na okruženje. Primeri zajedničke distribucije robe unutar grada sreću se u gradovima Nemačke, Japana, itd. Logistički centri se osnivaju na saobraćajno povoljnim lokacijama na obodu gradova ili u samom gradskom području i povezuju ulazno izlazne tokove, koordiniraju protok robe pri snabdevanju i odvoženju iz gradskog područja. Formiraju se u svim gradovima većim od 300.000 stanovnika. Pri tome, veliki gradovi imaju posebne postavke logističkih terminala za domen city logistike tako da centri postaju centralni element sistema za snabdevanje robom i izvlačenje otpadnih materijala. U zavisnosti od veličine i karakteristika gradova različit je broj, veličina i lokacija logističkih centara. Tako, na primer, za gradove do milion stanovnika postavlja se jedan robno transportni centar na obodu grada. Pitanje izgradnje i funkcionisanja više centara u ovom slučaju zavisi od uređenja i veličine robnih i transportnih tokova u tom gradu. Kod velikih gradova, sa 1 do 2 miliona stanovnika, u funkciji opsluživanja gradskog područja pored obodnih centara definišu se i dopunski (subcentri) određene strukture. Za gradove sa više od dva miliona stanovnika, mreža logističkih centara podrazumeva kombinaciju velikih centara na obodu grada, uz lociranje jednog ili više city logističkih

combination of large centres on the city edge, and location of one or more city logistic centres in the inner city. Defining the network for every city, apart from the number and location schedule for the posts, also means defining of their mutual connection.

5 COOPERATIVE MODELS

Cooperation in the area of logistics, i.e. city logistics, can be analysed from more aspects, which contributes sistematic and understandable approach to the creation of cooperative models of city logistics. Mutual work of many different logistic structures could be defined with the cooperation of the same or similar activities, then with the cooperation of different activities, as well as non-profitable and profitable logistic systems. (fig. 2)

Horizontal forms of cooperation in city logistics most often underestimates mutual work of freight forwarder firms. Vertical cooperation in city logistics underestimates cooperation of industrial, trade and transport firms. Specific forms of cooperation are done between logistic non-profitable systems (logistics of industrial, trade, service firms) where logistics is not the primary activity, and profitable logistic systems, on the other hand (transport, freight forwarder firms and agencies) where logistics represents the primary activity.

Functional logistic areas where cooperation could be initiated are the following: transport, storaging, stock, package, ordering, etc. As far as transport is considered, two or more companies use the same transport system, which could be defined as transport system of a neutral service provider, or as a part of transport system of the companies that enter the cooperation. According to the same principle, both storage and stock systems can cooperate for multiple customers. Thus, in the stock area, two or more companies which use the same materials for their production (eg. sheet metal of different width – car industry, industry of agricultural machinery) can join together with a trade firm with wholesale and retail trade, which has the turnover of the same materials. The area of cooperation is the stock, which can be positioned in one or several places, and all the companies that have entered the cooperation and perform their activities in the urban areas, use it according to their demands.

centara u unutrašnjosti grada. Definisanje mreže za svaki grad pored određivanja broja i lokacijskog rasporeda terminala, podrazumeva i definisanje njihovog međusobnog povezivanja.

5 KOOPERATIVNI MODELI

Kooperacija na području logistike, odnosno city logistike može da se analizira sa više aspekata što doprinosi sistematičnom i razumljivom prilazu kreiranja kooperativnih modela city logistike. Zajednički rad više različitih logističkih struktura može biti definisan kroz saradnju istih ili sličnih delatnosti, zatim kroz saradnju različitih delatnosti, kroz saradnju neprofitnih i profitnih logističkih sistema. (slika 2)

Horizontalne forme kooperacije u city logistici najčešće podrazumevaju zajednički rad špediterskih preduzeća. Vertikalna kooperacija u city logistici podrazumeva saradnju industrijskih, trgovačkih i transportnih kompanija. Posebne forme kooperacije nastaju između logističkih neprofitnih sistema (logistika industrijskih, trgovačkih, uslužnih kompanija) kod kojih logistika nije osnovna delatnost i profitnih logističkih sistema (transportne, špediterske, agencijske kompanije) kod kojih je logistika osnovna delatnost.

Funkcionalna područja logistike na kojima može doći do kooperacije su: transport, skladištenje, zalihe, pakovanje, poručivanje, itd. Na području transporta dve ili više kompanija koriste isti transportni sistem koji može biti definisan kao transportni sistem neutralnog davaoca usluge ili kao jedan deo transportnih sistema kompanija koje ulaze u kooperaciju – jedan od kooperanata svojim voznim parkom realizuje transport na području grada za sve kompanije koje su ušle u kooperaciju. Po istom principu, i skladišni sistemi i sistemi zaliha mogu da budu u kooperaciji za više korisnika. Tako i na području zaliha, dve ili više kompanija koje u proizvodnji koriste iste materijale (npr. limove različitih debljina - automobilska industrija, industrija poljoprivrednih mašina) mogu se udružiti sa trgovačkom kompanijom na veliko i malo koja ima promet istih materijala. Zalihe predstavljaju područje kooperacije i mogu se nalaziti na jednom ili na različitim mestima, a po potrebi se koriste od svih kompanija koje su ušle u kooperaciju i koje svoju delatnost obavljaju na području urbanih sredina.

Transport and storage systems in city logistics are the most common areas where cooperation is established. In the realization of city logistics flows, all means and technologies of transport are present: starting from the road, railway, water and tube transport, to the different conveyer systems and technologies of vertical transport (elevators, cable railway, etc.). In transport, there can be formed the cooperation between the systems of distant and loco transport, between different transport technologies or performers of transport task. Mutual work of transport systems which can belong to different systems produces specific form of cooperation, so called diagonal cooperation. The example of such cooperation is mutual work of underground (UT) and road goods transport (freight vehicles-RT, city bicycle-CB).

Transportni i skladišni sistemi u city logistici su najčešća područja na kojima dolazi do zajedničkog rada. U realizaciji tokova city logistike prisutni su svi vidovi i tehnologije transporta: od drumskog, železničkog, vodnog i cevnog transporta do različitih konvejerskih sistema i tehnologija vertikalnog transporta (liftovi, žičare, itd.). U transportu može doći do kooperacije između sistema daljinskog i loko transporta, do kooperacije između različitih tehnologija transporta ili izvršioca transportnog zadatka. Zajedničkim radom transportnih sistema koji mogu pripadati različitim sistemima i tehnologijama nastaje poseban oblik kooperacije, takozvana dijagonalna kooperacija. Primer ovog oblika kooperacije je zajednički rad podzemnog (UT) i drumskog sistema transporta robe (teretna vozila-DT i city bicikl-CB).

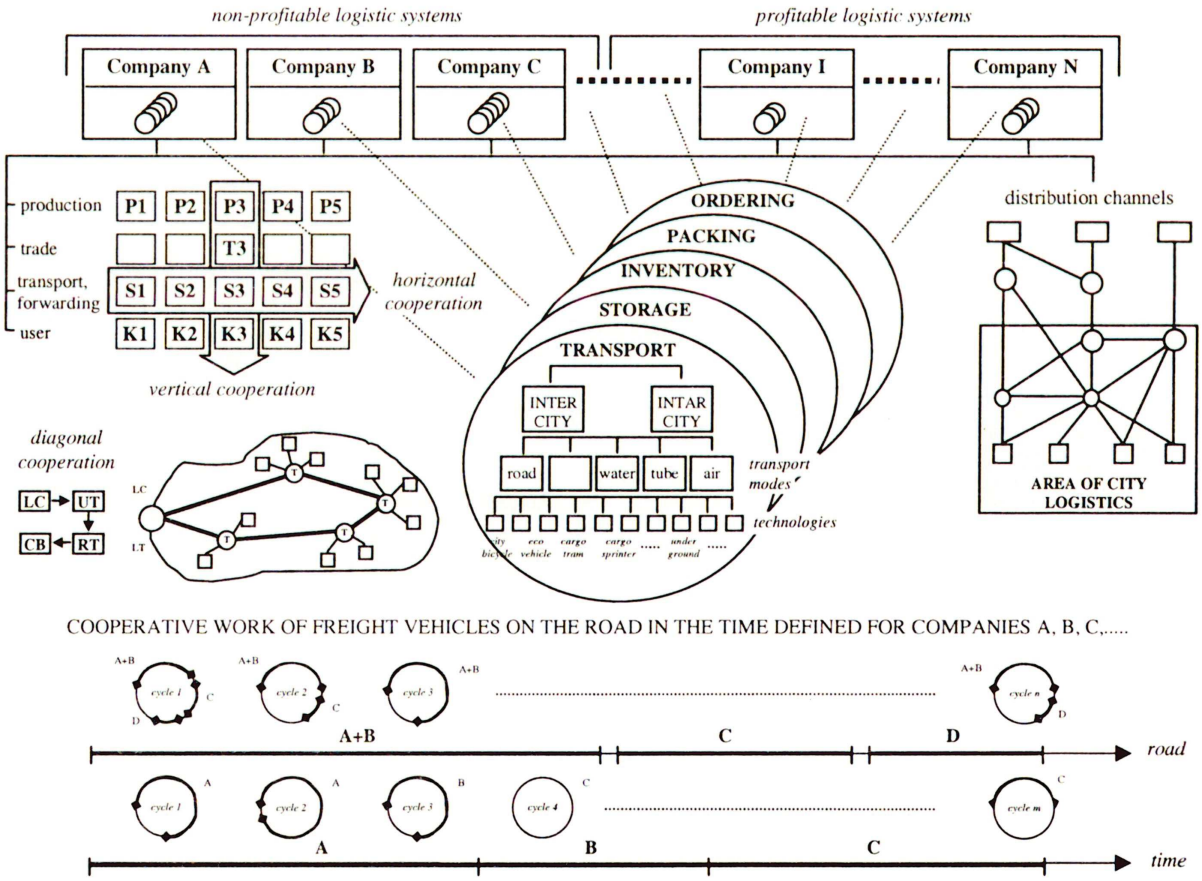

Figure 2 Areas and forms of cooperation within city logistics
slika 2 Područja i oblici kooperacije na području city logistike

Logistic terminals play important part not only in the supplying chain, but also in planning of logistics and transport of the city as a whole, and their location that have significant influence on

Logistički terminali imaju važnu ulogu ne samo u lancu snabdevanja već i u planiranju logistike i transporta grada kao celine, a njihova lokacija ima značajan uticaj na raspoređivanje

the ordering transport flows in the city traffic network. From the social point of view, locations of logistic terminals are particularly important, especially when planning public logistic terminals which could represent an efficient initiative for solving the problems of city logistic. These terminals are built in the surrounding area of big cities, in order to solve problems and create the unique, efficient logistic system for all firms and whole community. Via these consolidation terminals, the implementation of progressive informational and cooperative transport systems has its practical use. Public logistic terminals can be used by 3PL companies, or those which made cooperative contracts. The concept of public logistic terminals and cooperative systems is relatively new and demands intensive researches in the domain of the structure of functions, size, location, and organization of terminals and cooperative transport on one side, an on the other, in the domain of the role and function of public sector for promotion of these systems. There are different cooperative models which basically have two forms of consolidation: the consolidation of goods flow via terminals (centres) – centralized system, and the consolidation of flows on the transport road of a vehicle (decentralized system). (fig. 3)

transportnih tokova na gradskoj saobraćajnoj mreži. Sa društvene tačke gledišta, lokacije logističkih terminala su od posebnog značaja posebno pri planiranju javnih logističkih terminala koji mogu predstavljati efikasnu inicijativu za rešavanje problema city logistike. Ovi terminali grade se u okolini velikih gradova sa ciljem rešavanja problema i stvaranja jedinstvenog efikasnog logističkog sistema za sve kompanije i za celokupnu zajednicu. Preko ovih konsolidacionih terminala, implementacija naprednih informacionih i kooperativnih transportnih sistema ima svoju praktičnu primenu. Javni logistički terminali mogu se koristiti od strane 3PL kompanija ili kompanija koje imaju sklopljene kooperativne ugovore. Koncept javnih logističkih terminala i kooperativnih sistema je relativno nov i zahteva intenzivna istraživanja u pogledu strukture funkcija, veličine, lokacije i organizacije terminala i kooperativnog transporta, ali i u pogledu uloge i funkcije javnog sektora u promovisanju ovih sistema. Postoje različiti kooperativni modeli koji u osnovi imaju dve forme konsolidacije: konsolidacija robnih tokova preko terminala (centara) – centralizovani sistem i konsolidacija tokova na transportnom putu vozila (decentralizovan sistem). (slika 3)

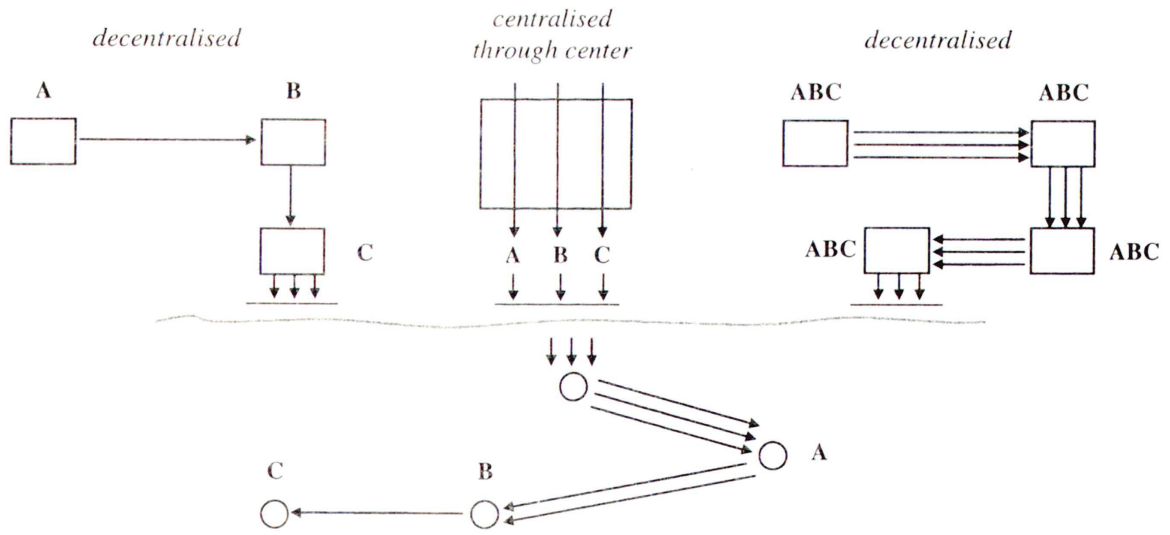

Figure 3 Consolidation forms
slika 3 Forme konsolidacije

Based on these forms of flows consolidation, it is possible to define eight basic cooperative models of city logistics:

Na osnovu ovih formi konsolidacije tokova moguće je definisati osam baznih kooperativnih modela city logistike:

Model 1: Large number of freight forwarders deliver goods to the city and to the city terminals. A neutral carrier deliver the shipment to the recipient – retail objects – by own vehicle. (fig. 4)

Model 1: Veći broj špeditera nezavisno doprema robu do grada i do city terminala. Neutralni prevoznik sopstvenim vozilima vrši isporuku do primalaca – maloprodajnih objekata. (slika 4)

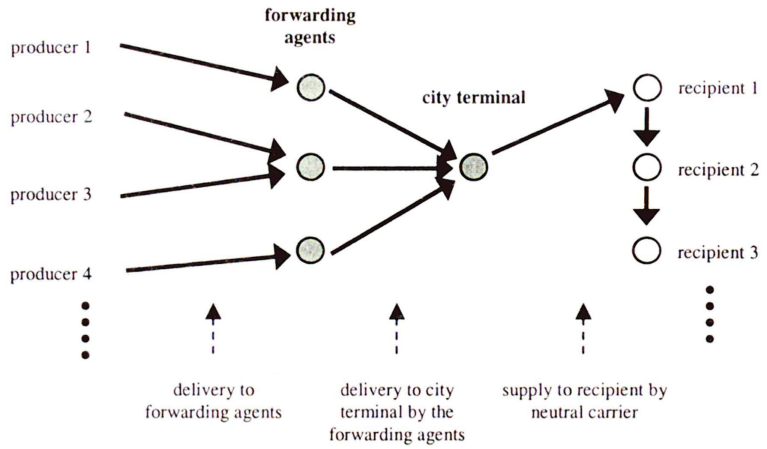

Figure 4 Cooperation model 1
slika 4 Kooperativni model 1

Model 2: The city area is divided into supplying zones, and every freight forwarder is responsible for the goods delivery in a certain zone. This model is based on the spatial cooperation, where every freight forwarder gathers the goods from other freight forwarders with own vehicle and supply one part of the city. (fig. 5)

Model 2: Gradski prostor je podeljen na zone snabdevanja, a svaki špediter je zadužen za isporuku robe u određenoj zoni. Ovaj model je baziran na prostornoj kooperaciji, u kojoj svaki od špeditera sakuplja robu od drugih špeditera sopstvenim vozilima i vrši snabdevanje jednog dela grada. (slika 5)

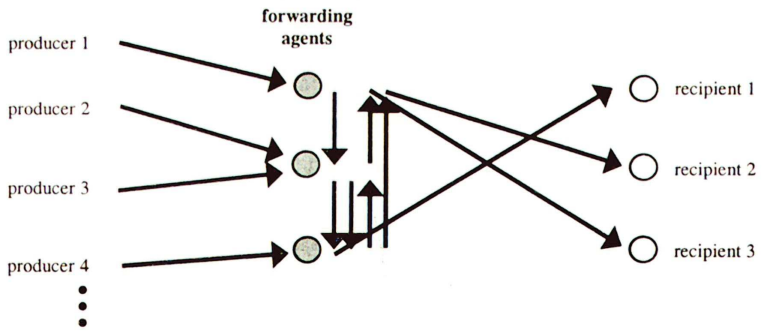

Figure 5 Cooperation model 2
slika 5 Kooperativni model 2

Model 3: This model is based on the time engagement of one of the freight forwarders, which are elected and changed among themselves, for supplying the whole city area during the time specified (ex. one month). Chosen carrier takes the goods from the cooperators and delivers it by own vehicles. After the prescribed time period, another freight forwarder from the cooperative group undertakes the supply of the city.

Model 3: Ovaj model se bazira na vremenskom angažovanju jednog od špeditera koji se međusobno biraju i smenjuju za snabdevanje celokupne gradske teritorije u određenom vremenskom periodu (npr., mesec dana). Izabrani prevoznik sakuplja robu od kooperanata i isporučuje je sopstvenim vozilima. Nakon isteka vremenskog perioda drugi špediter iz skupa špeditera koji su uključeni u kooperaciju preduzima snabdevanje grada

Model 4: Collecting goods from freight forwarders, work in terminal and delivery of goods to customers is done by neutral service provider. Neutral carrier takes the goods from the freight forwarders during the night and brings it to the city terminal. After sorting and commissioning the goods should be delivered to the recipient in CBD (fig. 6)

Model 4: Sabiranje robe od špeditera, rad u terminalu i isporuku robe do korisnika obavlja neutralni davalac usluga. Neutralni prevoznik tokom noći sakuplja robu od špeditera i doprema je do city terminala. Nakon sortiranja i komisioniranja roba se isporučuje do primaoca u CBD-u (slika 6).

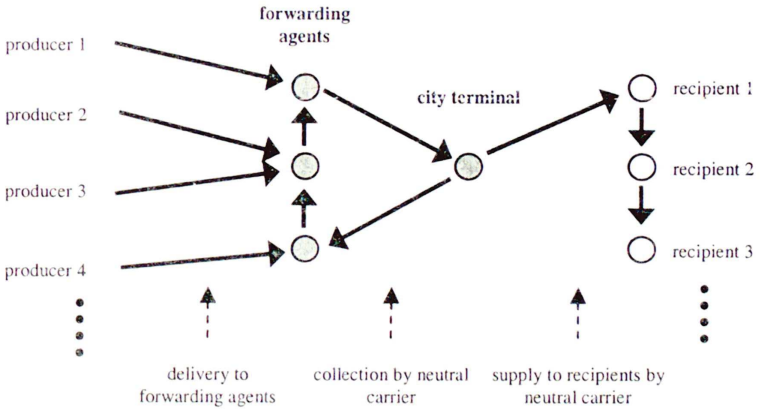

Figure 6 Cooperation model 4
slika 6 Kooperativni model 4

Model 5: This model represents integration of supply and return flows, as well as home delivery flows. Consolidation of flows is taken via freight transportation centre where there are systems of freight forward firms and city terminal of a neutral logistic provider. (fig. 7).

Model 5: Ovaj model predstavlja integraciju snabdevačkih i povratnih tokova, kao i tokova isporuke na kućnu adresu. Konsolidacija tokova se obavlja preko robno transportnog centra u kome se nalaze sistemi špediterskih kompanija i city terminal neutralnog logističkog provajdera (slika 7).

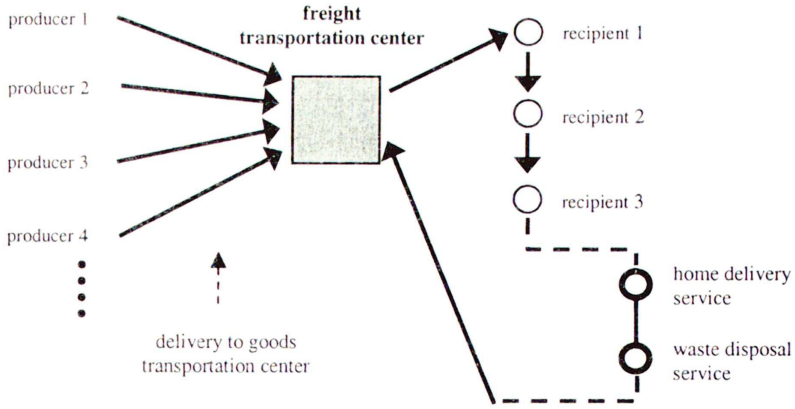

Figure 7 Cooperation model 5
slika 7 Kooperativni model 5

Model 6: Freight forward firms are concentrated at the area of freight transportation centre and deliver goods to the city terminal by themselves, where from the neutral service provider makes deliveries to the central city zones by electrical vehicles. This model also combines goods delivery with home delivery, collecting recycling materials and packages from the city objects. (fig. 8)

Model 6: Špediterske kompanije su skoncentrisane na području robno transportnog centra i samostalno isporučuju robu city terminalu odakle neutralni davalac usluge elektro vozilima vrši isporuku u centralne gradske zone. I kod ovog modela sa isporukom robe se kombinuje isporuka na kućnu adresu, sakupljanje povratnih materijala i ambalaže iz objekata u gradu. (slika 8).

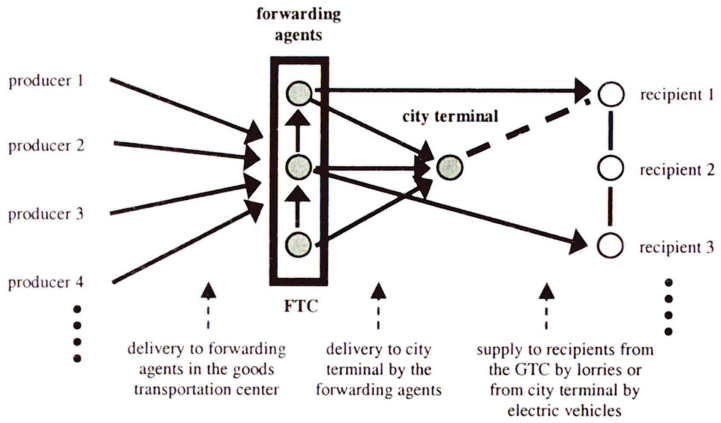

Figure 8 Cooperation model 6
slika 8 Kooperativni model 6

Model 7: Goods is exchanged among the storage systems of companies, and every company is responsible for the delivery of goods to the clients in certain area. By introducing this cooperative transport system of the company, the distances for goods delivery to the clients have been reduced, and the clients have the advantage of receiving goods of different companies at the same time. Such type of cooperation is made among trade companies which possess large selling systems. (fig. 9)

Model 7: Roba se razmenjuje između skladišnih sistema više kompanija, a svaka kompanija je odgovorna za isporuku robe do klijenata na određenom području. Uvođenjem ovog kooperativnog transportnog sistema kompanije smanjuju distance isporuke robe do klijenata, a prednost za klijente je to što jednovremeno primaju robu od više kompanija. Ovaj tip kooperacije uspostavlja se između većih trgovačkih kompanija koje imaju velike prodajne sisteme. (slika 9).

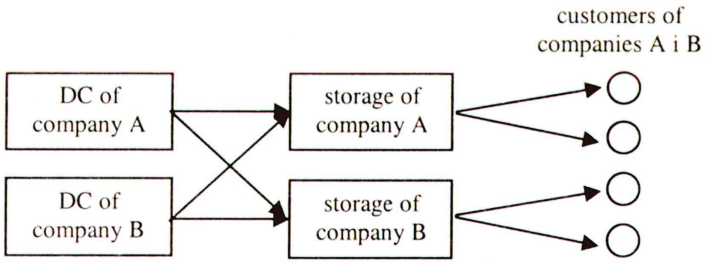

Figure 9 Cooperation model 7
slika 9 Kooperativni model 7

Model 8: This cooperative model underestimates use of the part or whole loading space of a vehicle in return drive after the delivery has been finished. The model is applicable for the companies which are dislocated, and within the location zone of the system there are clients of another company. (fig. 10)

Model 8: Ovaj kooperativni model podrazumeva korišćenje dela ili celog tovarnog prostora vozila kojim je izvršena isporuka u povratnoj vožnji. Model je primenjiv za kompanije koje su prostorno dislocirane, a u zoni lokacije sistema jedne kompanije nalaze se klijenti druge kompanije. (slika 10).

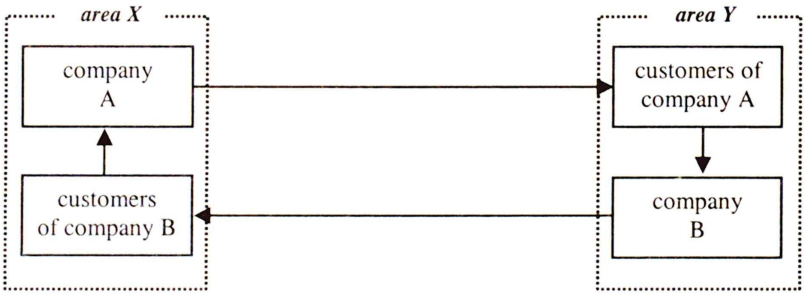

Figure 10. Cooperation model 8
Slika 10. Kooperativni model 8

The above mentioned models do not cover all variants of cooperation in the area of transport systems and logistic centers. Specific form of cooperation considering mutual use of freight vehicles by many companies, is achieved by applying progressive information and communication systems. This idea has been tested in Osaka, Japan, for the goods distribution by using 28 electrical vehicles, equipped with progressive information systems that enable following and navigation of a vehicle. Basic idea of the system is that sufficient number of electrical vehicles, used in cooperation of 79 companies from different economic branches, is supplied on different parking places [10]. Companies can make the reservation of the time for exploiting electric vehicle via Internet. The driver goes to the parking place of electrical vehicles on foot, or by public transport, and there he starts the commercial driving, directing to the place for loading goods first. After the delivery has been finished, the vehicle is parked on the closest parking place, out of eight defined, considering the distance of the place of the last delivery. This system reduces the number of kilometres driven without cargo, and in that way it influences on the improving conditions in environment. The companies involved into this form of cooperation can also expect reducing of operational costs for freight vehicles.

Cooperative models with more logistic terminals belong to the solution group called "Gate Conception" which can be defined as the conception of concentration and addition goods flows. Goods flows of the remote transport are stopped at several entering city gates (Gateways), where their spatial and time connection is undertaken. The key function in this concept has freight transportation centres, as technological links of the transport chain between macro and micro distribution. Their significant function is connected with spatial and time separation of goods flow in macro distribution and the unique providing services to urban environments in micro distribution. Remote distance of freight transportation centre from the citi have great influence on on the supply function, and it brings increase of transport costs. Practically, this problem is solved by building of city logistic centres – satelite of goods and transport centre, which is, according to its location, closer to inner city center. In order to obtain economical efficiency of the cooperation concept via logistic centres, it is necessary to reduce the costs of reloading and deconsolidation of the cargo, which make 1/3 of the total goods delivery costs. Thus, small containers and new technologies of reloading are applied, its equipment occupies a little space, and they are efficient even for the little

Pomenuti modeli ne pokrivaju sve varijante kooperacije na području transportnih sistema i logističkih centara. Poseban oblik kooperacije u pogledu zajedničkog korišćenja teretnih vozila od strane većeg broja kompanija postiže se primenom naprednih informaciono komunikacionih sistema. Ova ideja je testirana u Osaki, Japan, za distribuciju robe korišćenjem 28 elektro vozila opremljenih naprednim informacionim sistemima koji omogućavaju praćenje i navigaciju vozila. Osnovna ideja sistema je da se na različitim parking prostorima obezbedi dovoljan broj elektro vozila koja se kooperativno koriste od 79 kompanija iz različitih branši [10]. Kompanije preko Interneta mogu rezervisati vreme korišćenja elektro vozila. Vozač se peške, javnim prevozom upućuje do parking prostora elektro vozila i započinje komercijalnu vožnju upućivanjem na mesto utovara robe. Nakon izvršene isporuke vozilo se ostavlja na najbližem od osam definisanih parking prostora u odnosu na lokaciju poslednje isporuke. Ovaj sistem smanjuje broj pređenih kilometara vozila bez tereta i na taj način utiče na poboljšavanje uslova u okruženju. Kompanije uključene u ovu formu kooperacije takođe mogu očekivati smanjenje operativnih troškova teretnih vozila.

Kooperativni modeli sa većim brojem logističkih terminala pripadaju grupi rešenja "Koncepcija kapije" koja se može definisati kao koncepcija koncentracije i sabiranja robnih tokova. Robni tokovi daljinskog transporta se zaustavljaju na nekoliko ulaznih kapija grada (Gateways), gde se vrši njihovo vremensko i prostorno povezivanje. Ključnu funkciju u ovom konceptu imaju robno transportni centri, kao tehnološke karike transportnog lanca između makro i mikro distribucije. Njihova značajna funkcija vezana je za prostorno i vremensko rasčlanjivanje robnih tokova u makro distribuciji i jedinstveno opsluživanje urbanih sredina u mikro distribuciji. Veća udaljenost robno transportnog centra od grada značajno utiče na funkciju snabdevanja, pri čemu dolazi do povećanja troškova transporta. Ovaj problem se u praksi rešava izgradnjom city logističkog centra - satelita robno transportnog centra, koji je po lokaciji bliži užem centru grada. Radi ekonomske efikasnosti koncepta kooperacije preko logističkih centara potrebno je smanjiti troškove pretovara i dekonsolidacije tereta koji čine 1/3 ukupnih troškova isporuke robe. U tom cilju primenjuju se mali konteneri i nove tehnologije pretovara čija oprema zauzima mali prostor, a efikasne su i za manje obime rada. Sa druge strane,

work scope. On the other hand, the concentration of goods flows enables the application of intermodal transport systems among the centres. Therefore, in Berlin, the connection between freight transportation centres on the city edge, and city terminals in urban zone is realised by shuttle trains. In Vienna, the concept of shuffle trains is defined among three city terminals in the city. Remote transport is realised by railways, and distribution within the cities is realized by small trucks. Shuttle train circulates among terminals, and the goods are transported in small containers in order to fasten the process of reloading.

Depending on the city structure, structure of functions, profitable and non-profitable logistic systems in the cities, the structure of generators of logistic flows, different forms of cooperation are modelling and applying. One of significant activities in the process of planning can also be application of simulation models which describe different cooperative models of the city logistics. The aim of these models is defining performances of the logistic system for different types of initial figures (number of cooperators, quantity of delivery, size of drive park, number of places for delivery, etc.). Here are presented the results of the simulation model which describes the cooperation of freight forwarder firms via city terminal, and consolidated delivery in the city area by engagement of the neutral logistic provider (model 1) [9]. The model has been tested in the example city which, according to spatial, transport and logistic characteristics can be seen as a system with nine supply zones. In this model there is described nonconsolidated delivery and consolidated delivery via terminal for four cooperators. Cooperators have larger number of objects with different demands about the size (from 0.01 to 5 m^3) and frequency of the delivery (from 0 to 7 deliveries a day). Simulation experiment is made for dynamic-scholastic conditions of providing services to the objects in the period of 12 years. During that period of time, the total number of objects, generators of city logistic flows, was changing within the interval from 300 to 600 objects. The influence of consolidation of goods flows for four cooperators was analysed by the number of daily vehicle entries into the specified city zones. The simulation results obtained represent distribution of probabilities for the number of vehicle entries into the zones in nonconsolidated and consolidated delivery (fig. 11). Consolidated delivery generates less number of entries into the zones for 50% to

koncentracija robnih tokova omogućava primenu intermodalnih sistema transporta između centara. Tako se na primer, u Berlinu veza između robno transportnih centara na obodu grada i city terminala u urbanoj zoni grada ostvaruje shuttle vozovima. U Beču je definisan koncept shuttle vozova između tri city terminala u gradu. Daljinski transport se realizuje železnicom, a distribucija po gradu malim kamionima. Između terminala kružno saobraća shuttle voz, a roba se transportuje u malim kontenerima kako bi se ubrzao proces pretovara.

U zavisnosti od strukture grada, strukture funkcija, strukture profitnih i neprofitnih logističkih sistema u gradovima, strukture generatora logističkih tokova biraju se, modeliraju i primenjuju različite forme kooperacije. Jedna od značajnih aktivnosti u procesu planiranja može biti i primena simulacionih modela koji opisuju različite kooperativne modele city logistike. Cilj ovih modela je utvrđivanje performansi logističkog sistema za različite varijante ulaznih veličina (broj kooperanata, veličina isporuke, veličina voznog parka, broj mesta isporuke, itd.). Ovde su prikazani rezultati simulacionog modela koji opisuje kooperaciju špediterskih kompanija preko city terminala i konsolidovanu isporuku na području grada angažovanjem neutralnog logističkog provajdera (model 1) [9]. Model je testiran na primeru grada koji se prema prostorno saobraćajnim i logističkim karakteristikama može posmatrati kao sistem od devet zona snabdevanja. U modelu je opisana nekonsolidovana isporuka i konsolidovana isporuka preko terminala za četiri kooperanta. Kooperanti imaju veći broj objekata sa različitim zahtevima u pogledu veličine (od 0.01 do 5m^3) i frekvencije isporuke (od 0 do 7 isporuka na dan). Simulacioni eksperiment je izveden za dinamičko stohastičke uslove opsluživanja objekata u periodu od 12 godina. U tom periodu, ukupan broj objekata, generatora city logističkih tokova, se menjao u intervalu od 300 do 600 objekata. Uticaj konsolidacije robnih tokova za četiri kooperanta je analiziran kroz broj dnevnih ulazaka vozila u određene gradske zone. Rezultati simulacije su raspodele verovatnoća broja ulazaka vozila po zonama u nekonsolidovanoj i konsolidovanoj isporuci (slika 11). Konsolidovana isporuka generiše za 50% do 70% manji broj ulazaka vozila po zonama nego nekonsolidovana isporuka. Sa povećanjem broja objekata i pri većem prometu

70% than nonconsolidated delivery. With the increase of the number of objects and with larger turnover of goods within the years specified for observing the system, the effects of the cooperation increase. The simulation model was tested for four cooperators and for the city with traffical and spatial performances similar to Belgrade. The avarage number of daily vehicle entrances into one zone, within a year with the biggest number of objects (12th year, 111 objects in the supply zone) is reducing from 21 to 7. These results confirm the necessity for the development of cooperative logistic models.

roba po godinama posmatranja sistema povećavaju se i efekti kooperacije. Simulacioni model je tesiran za četiri kooperanta i grad sa saobraćajno prostornim performansama grada Beogradu. Prosečan broj dnevnih ulazaka vozila u jednu zonu se u godini sa najvećim brojem objekata (12-ta godina, 111 objekata u zoni snabdevanja) pri konsolidovanoj isporuci smanjuje sa 21 na 7. Ovi rezultati potvrđuju potrebu razvoja kooperativnih city logističkih modela.

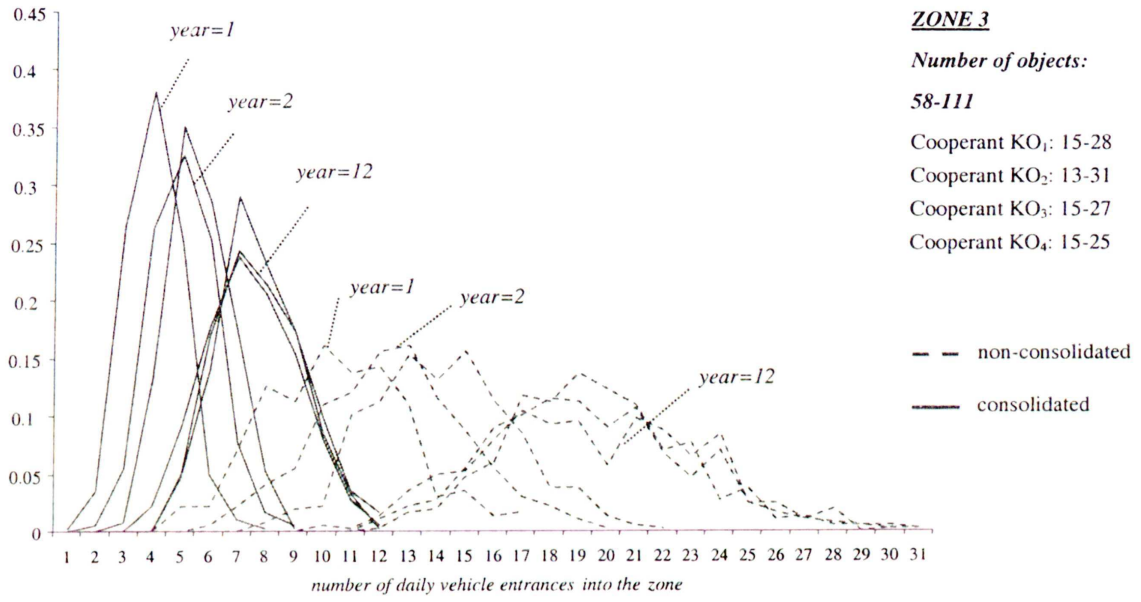

Figure 11 Distribution of probabilities for the number of vehicle entries into the city zone for the purpose of delivery [9]

slika 11 Raspodela verovatnoća broja ulazaka vozila u gradsku zonu radi isporuke [9]

6 CONCLUSION

A city is the biggest place where there are economic and social activities concentrated, while logistics is an important activity used for maintaining the city economics. The inhabitants want to be supplied adequately, and want to have the goods delivered on their doorsteps. Industrial as well as other economic systems cannot be imagined without the logistic flows of supplying and delivery of different kind of goods and materials on different levels of processing and finalization. Similar to economic, industrial, trade and service system, medical, cultural, sports, military, public, administrative and other objects, initiate the flows necessary for their functioning in the city area every day from 0 to 24 hours. The problems of logistics in urban environments

6 ZAKLJUČAK

Grad je najveće mesto koncentracije privrednih i društvenih delatnosti, a logistika je izuzetno važna aktivnost za održivost i ekonomiju grada. Stanovnici žele da budu adekvatno snabdeveni i da im po potrebi roba bude isporučena na kućnu adresu. Industrijski i ostali privredni sistemi su nezamislivi bez logističkih tokova dopreme i otpreme raznih vrsta roba i materijala u različitim stepenima obrade i finalizacije. Slično privrednim, industrijsko trgovačko uslužnim sistemima, medicinski, kulturno sportski, vojni, komunalni, administrativni, i drugi objekti svakodnevno od 0 do 24 časa na području grada pokreću tokove neophodne za njihovo funkcionisanje. Problemi logistike u urbanim sredinama iniciraju aktivnosti istraživanja,

initiate the research activities, finding optimal solutions, and, often, ad-hoc solving. Those changes in the systems of human activities on various areas, demand permanent researches and optimization of the problems in the scope of the city logistics.

optimalnog rešavanja, a često i ad-hoc prigodnog rešavanja. Promene u sistemima ljudskih delatnosti na različitim područjima zahtevaju stalna istraživanja i optimizacije problema u oblasti city logistike.

Recent researches and solutions of city logistics were focused on different areas. Many solutions have been present and they differ from city to city, which is the consequence of the line of factors such as historical components of urban development, cultural city attributes, preferable structures of the city functions, etc. Different conceptions have appeared independently on the first sight, as single or group solutions in the following forms: cooperative logistic systems, logistic centers, the concept of concentration of information flows, concept of control of the level of use load space, underground systems of transport, etc. By modelling cooperative solutions and experiments made on models, significant data have been obtained about the effects of cooperation. Those results are very often crucial for the decision maker, cooperators in city logistics: starting from the industrial, trade, freight forward firms to the specific logistic providers.

Dosadašnja istraživanja i rešenja city logistike su bila fokusirana na različita područja. Prisutna su mnoga rešenja i ona se razlikuju od grada do grada što je posledica niza faktora poput istorijske komponente urbanog razvoja, kulturnih atributa grada, preferentnih struktura funkcija grada, itd. Na izgled nezavisno, pojavljivale su se različite koncepcije kao pojedinačna ili skupna rešenja u sledećim formama: kooperativni logistički sistemi, logistički centri, koncept koncentracije informacionih tokova, koncept kontrole stepena iskorišćenja tovarnog prostora, podzemni sistemi transporta, itd. Putem modeliranja kooperativnih rešenja i eksperimenata koji su rađeni na modelima dobijeni su značajni podaci o efektima kooperacije. Ti rezultati su često presudni za donosioca odluke, kooperante u city logistici: od industrijskih, trgovačkih, špediterskih firmi do specijalnih logističkih provajdera.

The researches of some of the cooperative systems show that the larger numbers of firms decrease their costs from 5 to 20%. By applying these systems number of kilometres per vehicle within city areas is also decreased, up to 60%. The number of starting road freight devices is reduced in the interval from 30 to 60%, which directly influences the reducing of drive park for the same scope of working tasks. The size of the delivery is increased for 15%, and loading for over 100%. The number of vehicle entries into the certain city zones is reduced to 30 to 60%. By applying cooperative systems, the reliability of deliveries is increased, personnel needed is reduced, as well as the time of delivery, noise and contamination emission, etc. [5, 7, 9, 12, 14]

Istraživanja pojedinih kooperativnih sistema pokazuju da veći broj kompanija smanjuje svoje troškove od 5 do 20%. Primenom ovih sistema smanjuje se i broj vozilo kilometara u gradskim sredinama čak za 60%. Broj pokretanja drumskih tertnih sredstava smanjuje se u intervalu od 30 do 60% što direktno utiče na smanjenje voznog parka za isti obim transportnih zadataka. Veličina isporuke se povećava za 15%, a popunjenost vozila za preko 100%. Broj ulazaka vozila u pojedine gradske zone smanjuje se za 30 do 60%. Uvođenjem kooperativnih sistema povećava se pouzdanosti isporuke, smanjuje potreban personal, smanjuje vreme isporuke, emisija buke i štetnih gasova, itd. [5, 7, 9, 12, 14]

Cooperative models are, theoretically and practically, very attractive, however, there are sometimes difficulties in their application. Modelling, recording and tracking all expenses and benefits of these systems and their comparation with the system of single, independent deliveries, is extremely significant and it depends on the structure of urban

Kooperativni modeli su teorijski i praktično veoma atraktivni, ali ponekad postoje i teškoće u njihovoj primeni. Modeliranje, snimanje i praćenje svih troškova i koristi ovih sistema i njihovo poređenje sa sistemom pojedinačnih, nezavisnih isporuka je veoma značajno i zavisi od strukture sistema logistike urbanih sredina. Male i srednje kompanije mogu imati velike

environment logistic systems. Small and middle firms can obtain great benefits from the cooperation, and the factor of success often lies in the choice of the right variant of cooperative model of city logistics.

koristi od kooperacije, a faktor uspeha često leži u izboru prave varijante kooperativnog modela city logistike.

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