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METODE MJERENJA I PROGNOZIRANJA PROMETA NA AUTOBUSNIM KOLODVORIMA

SAŽETAK

Da bi se prometni poremećaji sveli na najmanju mjeru i predvidivu razinu, u radu su predočene metode za mjerenje i prognoziranje putnika na autobusnim kolodvorima. Posebna pozornost usredotočena je na prognoziranje prometa metodom korelacijske analize. Ispitivanje pokazatelja, koeficijent korelacije, kao i trend vrijednosti, potvrdili su adekvatnost primjene Gompertzovog trenda osobito važnog u prognozi buduće potražnje za prometnim uslugama.

1. UVOD

Jedno od obilježja cestovnog prometa je i njegova neravnomjernost koja kulminira naročito u linijskom prijevozu putnika. Posljedica neravnomjernosti je pojava "navala" i gužvi tzv. "*rush time*", vršnih opterećenja koja se pojavljuju tijekom dana u godini (petak i subota kada je promet putnika povećan i do 30%), u ljetnim mjesecima (sezonska neravnomjernost), te posebno zbog udvostručenog broja putnika u vrijeme blagdana.

Podaci o broju putnika u sustavu autobusnih kolodvora mogu se dobiti mjerenjima prometa. Povećani broj putnika determinira troškove djelovanja kolodvora, kao i njegove fizičke i kadrovske kapacitete. Kolodvorski sustavi obično se dimenzioniraju za svladavanje satnih ili dnevnih opterećenja.

Posljedice "rush time" su zagušenja sustava, što se reflektira na urednost odvijanja prometa. Da bi se poremećaji sveli na najmanju mjeru, provode se mjerenja prometa nekom od sljedećih metoda:

- brojenjem, tj. utvrđivanjem kvantitativnih značajki odabranog uzorka
- anketiranjem određenog uzorka
- intervjuom također odabranog uzorka, koji može dati dostatno stručne i argumentirane odgovore.

2. METODE MJERENJA PROMETA NA AUTOBUSNIM KOLODVORIMA

U svijetu su poznate različite metode za mjerenje i opisivanje prometnog opterećenja, a najpoznatije su:

- metoda standardne razine opterećenosti
- metoda prosječne opterećenosti
- metoda satne razine opterećenosti
- metoda prosječnog "rush hour".

METHODS OF MEASURING AND FORECASTING TRAFFIC AT BUS STATIONS

SUMMARY

In order to have fluctuations in traffic reduced to the minimum and on to a predictable scale, the paper deals with the mesuring and forecasting of passenger flows at bus stations. Particular attention has been fixed on traffic forecasting by the method of correlative analysis. The examination of respective indices, coefficient of correlation, and value trend have all confirmed the adequacy of the Gompertz trend, being of particular importance for the projections of future demand for traffic services.

1. INTRODUCTION

One of the features of road traffic refers to its fluctuations especially culminating in passenger transport services. Fluctuations result in jams and crowding at 'rush time' and general problems in peak hour traffic, particularly pronounced on certain days of the week (on Fridays and Saturdays, when passenger trafic reports an as high as 30% increase), in summer season (seasonal fluctuations) and at the time of holidays, when the number of passengers usually doubles.

Respective information on the number of passengers to be accommodated in the system of bus station(s) can be obtained by measuring traffic. Increased number of passengers shall inevitably determine the costs of operations of a bus station as well as its fleet, facilities and manpower. Bus stations systems are usually capacitated for adequate meeting of hourly and daily peak periods.

Consequences of the 'rush time' traffic are experienced as saturation of the system affecting the regular aspect of the operation of services. In order to have fluctuations reduced to the minimum, traffic is measured by one of the following methods:

- counting, i.e. establishing qualitative aspects of a selected sample
- sample group polls
- interviewing a selected sample group, able to furnish competent and valid arguments.

2. METHODS OF MEASURING TRAFFIC AT BUS STATIONS

Various methods of measuring and defining busy traffic periods have been applied in the world, most well-known among them being:

Metoda standardne razine opterećenosti koristi se za mjerenje prometa na parkirališnom prostoru, na način da se opterećenost sustava ustanovi tako da se svi sati u promatranoj godini poredaju prema količini prometa, i to od najviše do najslabije opterećenog sata. Odabere se od gore na niže trideseti najjače opterećeni sat i on predstavlja standardnu opterećenost. Ovom se metodom kapaciteti dimenzioniraju prema tom opterećenju, a eventualna odstupanja na više se zanemaruju.

Metoda dopušta da se razina standardne opterećenosti odredi i prema najviše opterećenom satu u godini, ali uz primjenu korekcijskog faktora. Izabrano satno opterećenje pomnoži se s faktorom čija je vrijednost od 1.1 do 1.9, ovisno o veličini kolodvora. Za veće kolodvore uzima se manji korekcijski faktor.

Metodom prosječne opterećenosti dobivaju se odstupanja od postojećih kapaciteta tako da se sati u kojima je putnički promet bio veći dijele s normalnom opterećenošću.

Metoda satne razine opterećenosti pojačanog prometa uzima onaj sat godišnjeg opterećenja kod kojeg veličina prometa predstavlja zadnji član u nizu najopterećenijih sati.

Metodom prosječnog "rush houra" izračunava se opterećenje iz najfrekventnijeg mjeseca u godini tako da se ustanovi opterećenje svakog sata u promatranom mjesecu. Ta metoda daje i relativne vrijednosti i stvarne vrijednosti satnog opterećenja.

Metode se temelje na realnim oscilacijama tokova putnika, a podaci se unose u algoritme za proračun potrebnih kapaciteta i njihova rada što omogućuje uredno odvijanje prometa, kao i mogućnost određenog stupnja fleksibilnosti i adaptibilnosti za svladavanje dnevnih pojačanih prometnih opterećenja.

3. METODE PROGNOZIRANJA PROMETA NA AUTOBUSNIM KOLODVORIMA

Za osiguranje neophodne kvalitete prijevozne usluge i racionalno korištenje sredstava nužno je utvrditi potrebne kapacitete i uspostaviti odgovarajuću organizaciju. Kako bi se postigli ovi uvjeti, valja raspolagati prognozom o količini prijevoza putnika.

Prognoze su ocjene pojave koja se s velikom vjerojatnoćom očekuje u određenom budućem vremenu i zbog toga su opterećene visokim stupnjem rizika. Na prognoziranje utječu mnogobrojni čimbenici od kojih je neke vrlo teško predvidjeti. Stoga se rade na osnovi kvantitativnog i kvalitativnog razvoja u pro-

- the method of standard level of traffic volumes
- the method of average loads
- the method of hourly loads, and
- the method of average 'rush hour'.

The method of standard level of traffic volumes is being used for measuring traffic at parking lots, establishing respective loads of the system by arranging all hours in the year being considered according to the level of traffic, from the busiest hour down to the least busy hour. Working from top to lower levels, the 30th busiest hour is selected to represent the standard load to be accommodated. By this method, the capacities are dimensioned on this load, while no allowances are made for possible deviations to higher values. The method provides for determining the level of standard load from the busiest hour in a year, however by application of a correction factor. The selected hourly load is multiplied by a factor whose value ranges from 1.1 do 1.9, depending upon the size of the bus station. For larger bus stations, a lesser correction factor is taken.

The method of average loads gives deviations from the available capacities, so that the hours of busier passenger traffic are devided by the value of normal loads.

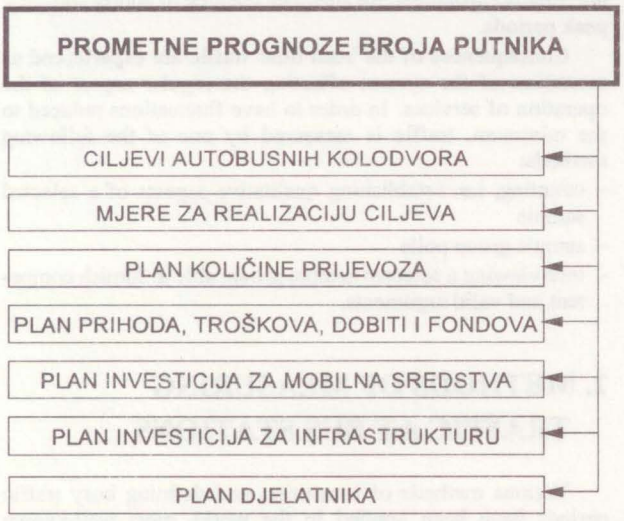
The method of hourly loads takes that hour of yearly load in which the volume of traffic makes the last member in a series of busiest hours.

The method of average 'rush hour' uses the busiest month in a year by establishing respective volumes accommodated in each an every hour of the observed month. This method does not only provide the relative values of hourly volumes or loads but also the actual values.

These methods are based upon the actual or realistic fluctuations of passenger flows, their respective data being included in the algorithms for the calculation of the needed capacities and their operation, enabling normal proceeding of traffic, as well as a given degree of flexibility and adjustment for overcoming daily increased traffic volumes.

3. METHODS OF FORECASTING TRAFFIC AT BUS STATIONS

For purposes of ensuring the necessary quality of transport service(s) and rational utilization of the fleet/facilities, it is necessary to define the needed capacities and introduce appropriate organization. To be able to reach such conditions, one



Slika 1. Osnovice za prometne prognoze

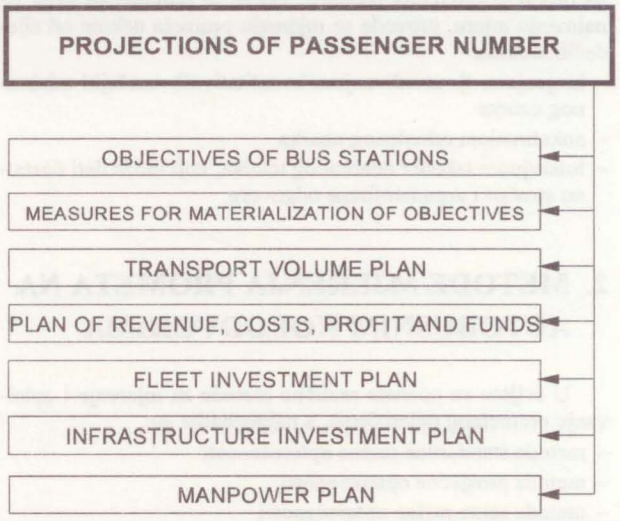


Figure 1. Basic Elements Used in Traffic Projections

teklom razdoblju. Osnove na kojima se temelje prognoze u autobusnom prijevozu putnika pokazane su na slici 1.

3.1. Podjela prognoza i ocjena točnosti

Prometne prognoze uglavnom ovise o cilju prognoziranja, a najčešće se primjenjuje sljedeća podjela:

1) Prema *prirodi* prognoziranja, razlikuju se:
   - kvalitativne prognoze o budućim kapacitetima
   - kvantitativne prognoze o broju prevezenih putnika
2) Prema *vremenu* prognoziranja, dijele se na:
   - kratkoročne prognoze (za mjesec, tromjesečje ili godinu)
   - srednjoročne prognoze (za razdoblje do 5 godina)
   - dugoročne prognoze (razdoblje dulje od 5 godina)
3) S obzirom na *područje* prognoziranja, mogu biti:
   - globalne prognoze za cestovni putnički prometni sustav
   - prognoze za pojedine autobusne kolodvore
4) Prema općim postavkama *planiranja*, razlikuju se:
   - prognoze u kojima se uzima u obzir promjena prometnih kapaciteta
   - prognoze u kojima se ne uzima u obzir promjena prometnih kapaciteta
5) Prema *primjeni postupka* prognoziranja, postoje:
   - individualne prognoze, koje se temelje na stečenim iskustvima i moći prosudbe prognozera
   - prognoze temeljene na primjeni matematičko-statističkih metoda od kojih su najpoznatije ekstrapolacija trenda, regresijsko-analitičke polazne osnove i ekonometrijski model
6) Prema *načinu prognoziranja*, razlikuju se:
   - izravne, u kojima prognoza ne ovisi o nekom drugom parametru (npr. broj putnika koji će se prevesti u 2000. godini s autobusnoga kolodvora u Zagrebu iznosit će 18 tisuća na dan)
   - posredne, u kojima prognoza ovisi o drugom pokazatelju (npr. ako grad Zagreb bude 2000. godine imao 1,5 milijun stanovnika, dnevni će intenzitet otputovalih putnika s autobusnoga kolodvora iznositi 20 tisuća na dan)
7) Prema *broju vrijednosti* prognoze mogu biti:
   - prognoza neke vrijednosti; grafički to je točka koja predstavlja približnu vrijednost planiranog pokazatelja što se dobiva u obliku fiksnog parametra
   - prognoza intervala vrijednosti u kojemu se sa zadanom vjerojatnošću očekuje planirani pokazatelj.

Krivulja p(x) označuje gustoću raspodjele vjerojatnosti prognoziranog pokazatelja u intervalu (x_1, x_2) (sl. 2.).

Kriterij za dobru prometnu prognozu je njegova točnost, tj. minimalna pogreška. Vrijednost koeficijenta pogreške može se pri prognoziranju odrediti sljedećim matematičkim modelom:

$$\eta_p = \left(\frac{P_p - P_s}{P_s} \right) 100[\%] \qquad (1)$$

η_p - vrijednost koeficijenta pogreške

P_p, P_s - prognozirana i stvarna vrijednost pokazatelja

Točnost, odnosno pogreška pri prognoziranju može se utvrditi po ostvarenju događaja za promatrano razdoblje.

3.2. Vrste metoda za prognoziranje prometa

Metode prognoziranja omogućuju dobivanje kvantitativne značajke i povećanje kvalitete prognoziranja tako da kolodvorski sustavi pravodobno planiraju kapacitete i obave odgovarajuće pripreme.

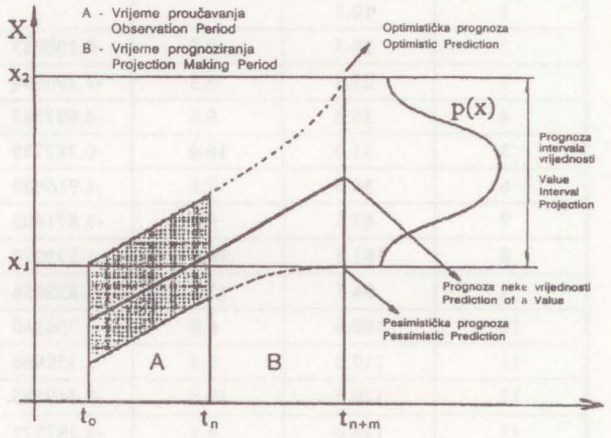
must have available the projection(s) of the scope of passenger service.

Projections are estimates or predications of an event that is highly probable in a given future period of time and therefore involves a high degree or risk. Forecasting is affected by a number of factors, of which some are rather difficult to anticipate. For this reason they are elaborated based upon the quantity and quality aspected developments in the preceding period. The elements projections are based upon in bus transport of passengers are given in Figure 1.

3.1. Division of projections and accuracy evaluation

Traffic projections mainly depend upon the objective of projection making, and most ferquently the following division is applied:

1) According to the *nature* of projection making, we discriminate:
   - quality-aspected projections of future capacities, and
   - quantity-aspected projections of passenger load.
2) According to the relevant *period* covered, we discriminate:
   - short-term projections (month, quarter, or year)
   - medium-term projections (for a five-year period), and
   - long-term projections (for a period of more than five years).
3) According to a relevant *segment* covered, we discriminate:
   - global projections for passenger road transport system, and
   - projections designed for individual bus stations.
4) According to general *planning* precepts, we discriminate:
   - projections taking into account the change of transport capacities, and
   - projections not taking into account the change of transport capacities.
5) According to the *method* of projection making, we discriminate:
   - individual projections based upon the experience acquired and power of reasoning of the originator, and
   - projections based upon the application of mathematical and statistic methods, of which most well-known are trend extrapolation, regression/analytical points of departure and econometric model.



Slika 2. Prognoza intervala vrijednosti
Figure 2. Value Interval Projection

juće tehnološke pripreme. U literaturi postoji veći broj različitih metoda za predviđanja budućih kretanja u cestovnom prometu putnika. Najprimjenjivije su sljedeće metode:

1) heuristička metoda prognoziranja
2) gravitacijski modeli
3) ekstrapolacija trenda
4) metoda stope rasta
5) metoda korelacijske analize.

U ovom je radu za prognoziranje broja prodanih karata korištena metoda korelacijske analize.

3.3. Metoda korelacijske analize

U teoriji i praksi u prognoziranju tokova putnika sve se više koriste statističke metode prognoziranja, i to uglavnom jednofazne i višefazne korelacije i regresije koje se odlikuju sljedećim svojstvima:

- relativno su jednostavne, jer je dobro razrađen matematički model kao i programi za računala
- dosta je visoka razina poznavanja ovih metoda
- lako se dobiju tražene ovisnosti i njihova primjena je jednostavna
- u kratkom roku postižu se parcijalna rješenja pri poznatim vrijednostima argumenta o kojima ovisi prognozirana veličina
- postoji mogućnost istraživanja utjecaja pojedinih čimbenika i njihovih veza na prognoziranu veličinu
- postoji mogućnost istraživanja ocjene izlazne informacije na stupanj točnosti prognoze
- visok stupanj objektivnosti.

Konstrukcija modela sastoji se od nekoliko etapa:

- izbor čimbenika koji utječu na prognoziranu veličinu
- izbor svrhovite funkcionalne ovisnosti.

Donošenje odluke o proširenju postojećih kapaciteta ili izgradnji novih, koji će zadovoljiti potrebe, ne može se prepustiti samo iskustvu. Analizom dosadašnjeg razvoja može se na temelju statističkih kriterija pretpostaviti trend razvoja, te dobiveni model koristiti za prognozu budućeg razvoja.

Tablica 1. Podaci za proračun koeficijenta korelacije
Table 1. Data for Correlation Coefficient Estimate

i	y_i	Δy_i	$\ln\left(\frac{\Delta y_i}{y_{i-1}}\right)$
1	10.5	–	–
2	20.5	9.5	-0.100083
3	25.5	5.5	-1.290894
4	35.0	9.5	-0.987387
5	51.0	16.0	-0.782759
6	58.5	7.5	-1.916923
7	67.5	9.0	-1.871802
8	81.5	14.0	-1.573070
9	94.5	13.0	-1.835654
10	100.5	6.0	-2.756840
11	110.0	9.5	-2.358866
12	120.5	10.5	-2.349105
13	125.0	4.5	-3.287572
14	130.0	5.0	-3.218876
15	135.0	5.5	-3.162786

6) According to the *method of projection* making, we discriminate:
   - direct methods, in which projections do not depend upon any other parameter (for instance: in the year 2000 the number of passengers starting their journeys from the Zagreb Bus Station will reach 18,000 a day).
   - indirect methods, in which the subject projection depends upon some other factor (for instance: if the city of Zagreb reaches 1.5 million inhabitants in the year 2000, then the daily volume of outbound passengers from the Bus Station shall reach 20,000).
7) According to the *value number*, we discriminate:
   - projection of certain value; in terms of graphic presentation this refers to a point representing the approximate value of the anticipated index obtained in the form of a fixed parameter, and
   - projection of value interval, in which we expect the planned indicator at a given level of probability.

Curve p(x) represents the incidence of distribution of probability of the anticipated indicator at interval (x_1, x_2). See Figure 2.

Major criterion for good or successful traffic forecasting refers to its accuracy, i.e. minimum error. The value of error coefficient can at the time of projection making be established by means of the following mathematical model:

$$\eta_p = \left(\frac{P_p - P_s}{P_s}\right) 100[\%] \qquad (1)$$

η_p – value of the coefficient of error

P_p, P_s – forecast and actual value of the indicator.

Respective accuracy i.e. error in projection making can be established when the event anticipated for the observed period happens.

3.2. Types of Traffic Forecasting Methods

Forecasting methods enable obtaining quantity-aspected characteristics and higher quality of projections for bus station systems to be able to timely plan their capacities and make relevant technological preparations. In the literature one may find examples of a variety of methods available for prediction of future trends or developments in road passenger transport. The following methods have the highest level of applicability:

1) heuristic method
2) gravitation model
3) trend extrapolation
4) growth rate method, and
5) correlation analysis method.

This paper has dealt with the method of correlation analysis for projections of the number of tickets (to be) sold.

3.3. Correlation Analysis Method

In the theory and practice of forecasting passenger flows, statistical methods have been increasingly used, mostly monophase and multi-phase correlations and regressions, exhibiting the following features:

- they are comparatively simple, because the mathematical model and relevant computer programs have been well-elaborated
- rather good knowledge of subject methods
- interdependent aspects are easily obtained and grant simple appliaction

Tablica 2. Parcijalne sume i trend vrijednosti
Table 2. Partial Sums and Value Trend

Vrijeme	Broj prodanih karata u 000		Parcijalne sume	Trend vrijednosti
Time	Number of Tickets Sold in 000		Partial Sums	Value Trend
t_i	y_i	ln y_i		$\langle y_i \rangle$
0	10.5	2.351375		11.5
1	20.0	2.995732		18.2
2	25.5	3.238678	S1 = 16.07296	26.6
3	35.0	3.555348		36.6
4	51.0	3.931826		47.1
5	58.5	4.069027		58.4
6	67.5	4.212128		69.8
7	81.5	4.400603	S2 = 21.840515	80.9
8	94.5	4.548600		91.5
9	100.5	4.610158		101.3
10	110.0	4.700480		110.1
11	120.5	4.791650		118.1
12	125.0	4.828314	S3 = 24.09695	125.1
13	130.0	4.867534		131.3
14	135.5	4.908972		136.6

Ako se raspolaže pouzdanim podacima o broju prevezenih putnika tijekom više godina ili o broju prodanih autobusnih karata, predlaže se primjena tzv. asimptotskih trendova pri predviđanju buduće veličine prometnog toka putnika.

Za prognozu buduće potražnje za prometnim uslugama korišteni su podaci o broju prodanih autobusnih karata na autobusnom kolodvoru u Karlovcu od 1980. do 1994. godine.

Identifikacija adekvatnog trenda provedena je ispitivanjem određenih pokazatelja za asimptotske trendove, te je za proma-

- in short time partial solutions are reached by having available the known values of arguments the forecast value depends upon
- there is a possibility of the study of impacts of individual factors and their relationships upon the forecast value
- it is possible to study the estimate or evaluation of the obtained information as related to the level of accuracy, and
- high level of objectivity.

Structuring of the model involves several stages:

- selection of elements of influence upon the forecast value, and
- selection of appropriate functional (inter)dependence.

Decision making on the issues of extension of the existing capacities or construction of new ones to meet the demand cannot be left only to experience. Analysis of the up-to-date developments can based upon the statistical criteria anticipate the trend of development while the obtained model can be used for future development projections.

In case reliable information is available on the number of passengers over a number of years or the number of sold bus tickets, we recommend the application of the so called asymptotic trends in the process of anticipation or forecasting the values of future passenger flows.

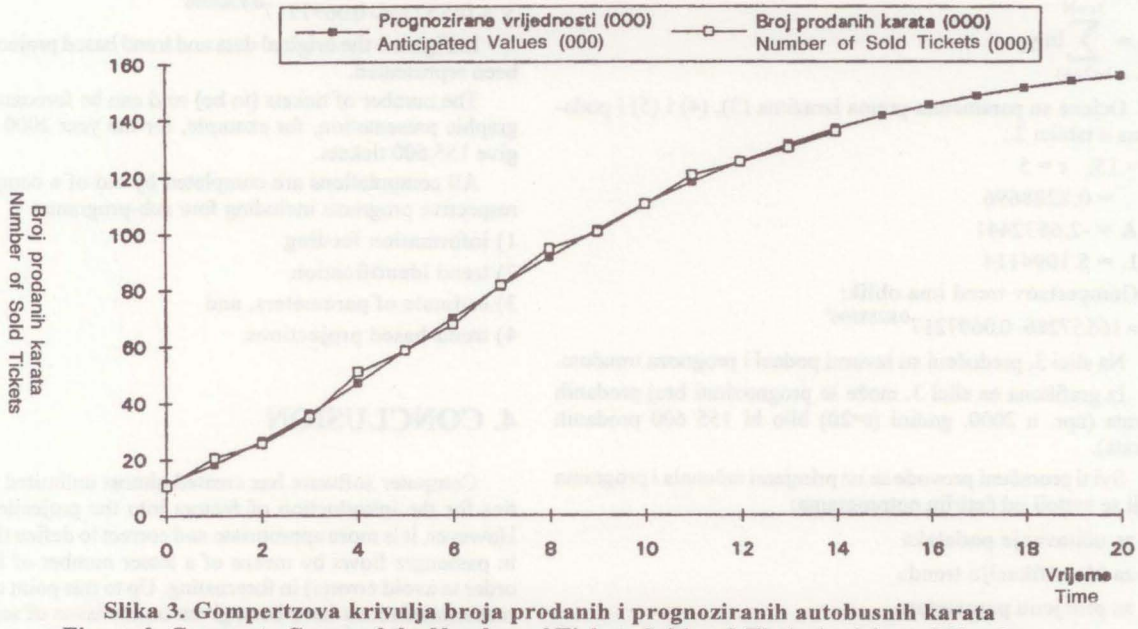
In projections of future demand for transport services information has been used on the number of sold tickets at the Karlovac Bus Station in the period of 1980 to 1994.

Identification of the appropriate trend or developments has been completed by means of examination of given indicators for asymptotic trends and the Gompertz trend has been established for the observed data.

Respective data for the computation of indicators are given in Table 1, where t_i is time and y_i is number of sold tickets. Time unit is one year, and the number of sold tickets is given in thousands.

By means of a computer the coefficient of correlation r = 0.93 has been calculated, and it has been established that the value

$$\ln\left(\frac{\Delta y_i}{y_{i-1}}\right)$$



Slika 3. Gompertzova krivulja broja prodanih i prognoziranih autobusnih karata
Figure 3. Gompertz Curve of the Number of Tickets Sold and Their Anticipated Number

trane podatke ustanovljen Gompertzov trend.

Podaci za proračun pokazatelja predočeni su u tablici 1. u kojoj je s t_i označeno vrijeme, a s y_i broj prodanih karata. Jedinica za vrijeme je jedna godina, a broj prodanih karata izražen je u tisućama komada.

Primjenom računala izračunan je koeficijent korelacije r = 0.93, a ustanovljeno je i kako je veličina

$$\ln\left(\frac{\Delta y_i}{y_{i-1}}\right)$$

linearna funkcija vremena što dokazuje da je primjeren Gompertzov trend.

Ocjene parametara u modelima obično se dobivaju metodom najmanjih kvadrata, no kako je ovo primjer modela nelinearnog u parametrima, primijenjena je jednostavnija metoda, metoda parcijalnih suma (tabl. 2.).

Parametri L, A, B u Gompertzovom trendu:

$$y = LA^{B^t} \qquad (2)$$

određeni su metodom parcijalnih suma prema formulama:

$$B = \sqrt[r]{\frac{S_3 - S_2}{S_2 - S_1}} \qquad (3)$$

$$\ln A = (S_2 - S_1)\frac{B-1}{\left(B^r - 1\right)^2} \qquad (4)$$

$$\ln L = \frac{1}{r} \cdot \frac{S_2^2 - S_1 S_3}{2S_2 - S_1 - S_3} \qquad (5)$$

Pritom je:

$$r = \frac{N}{3}$$

N - ukupni broj podataka

$$S_1 = \sum_{i=1}^{r} \ln y_i$$

$$S_2 = \sum_{i=r+1}^{2r} \ln y_i \text{ , i}$$

$$S_3 = \sum_{i=2r+1}^{3r=N} \ln y_i$$

Ocjene su parametara prema izrazima (3), (4) i (5) i podacima u tablici 2.:

N = 15, r = 5

B = 0.8288696

ln A = -2.6632441

ln L = 5.1094114

te Gompertzov trend ima oblik:

$$y = 165.57286 \cdot 0.0697217^{0.8288696^t}$$

Na slici 3. predočeni su izvorni podaci i prognoza trendom.

Iz grafikona na slici 3. može se prognozirati broj prodanih karata (npr. u 2000. godini (t=20) bilo bi 155 600 prodanih karata).

Svi ti proračuni provode se uz primjenu računala i programa koji se sastoji od četiriju potprograma:

1) za učitavanje podataka

2) za identifikaciju trenda

3) za procjenu parametara

4) za prognoziranje trendom.

makes a linear function of time enabling adequate Gompertz' trend.

The evaluation of the parameters in models is usually completed by methods of smallest squares, however, as this is an example of non-linear parameter model, a simpler method has been applied: the method of partial sums (Table 2).

Parameters L, A, B in the Gompertz trend:

$$y = LA^{B^t} \qquad (2)$$

have been determined by means of the method of partial sums from equations:

$$B = \sqrt[r]{\frac{S_3 - S_2}{S_2 - S_1}} \qquad (3)$$

$$\ln A = (S_2 - S_1)\frac{B-1}{\left(B^r - 1\right)^2} \qquad (4)$$

$$\ln L = \frac{1}{r} \cdot \frac{S_2^2 - S_1 S_3}{2S_2 - S_1 - S_3} \qquad (5)$$

This gives:

$$r = \frac{N}{3}$$

N - total number of data

$$S_1 = \sum_{i=1}^{r} \ln y_i$$

$$S_2 = \sum_{i=r+1}^{2r} \ln y_i \text{ , i}$$

$$S_3 = \sum_{i=2r+1}^{3r=N} \ln y_i$$

Estimates of parameters from equations 3,4 and 5 and information in Table 2:

N = 15, r = 5

B = 0.8288696

ln A = -2.6632441

ln L = 5.1094114

so that the Gompertz trend has the form:

$$y = 165.57286 \cdot 0.0697217^{0.8288696^t}$$

In Figure 3 the original data and trend based projection have been represented.

The number of tickets (to be) sold can be forecast from the graphic presentation, for example, for the year 2000 (t=20) to give 155,600 tickets.

All computations are completed by aid of a computer and respective programs including four sub-programs:

1) information feeding

2) trend identification

3) estimate of parameters, and

4) trend-based projections.

4. CONCLUSION

Computer software has created almost unlimited possibilities for the introduction of factors into the projection model. However, it is more appropriate and correct to define the change in passenger flows by means of a lesser number of factors, in order to avoid error(s) in forecasting. Up to this point of time no recommendations have been given on the issue of selection of permanent model factors, except for the coefficient of correla-

4. ZAKLJUČAK

Računalska tehnika otkrila je neograničene mogućnosti uključivanja čimbenika u model prognoze. Međutim, pravilnije je opisivati promjenu tokova putnika manjim brojem čimbenika, jer se smanjuje pogreška u prognozi. Do danas nema preporuka za izbor čimbenika koji su stalni u modelu osim na osnovi koeficijenta korelacije. Ako uključivanjem čimbenika koeficijent korelacije raste, tada se tvrdi da taj čimbenik treba egzistirati u modelu, i obratno. Unošenjem novih veza u model statističkog prognoziranja polučuje se dugoročno poboljšanje pokazatelja djelovanja prometnog sustava.

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tion. If by inclusion of factors the coefficient of correlation rises, then it is claimed that this should exist in the model, and vice versa. By introduction of new relations in to the model of statistic predictions, a long-term improvement of the factors or indicators of operation of the transport system is obtained.

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