CENTRE – PERIPHERY DISPARITIES IN AIR ACCESSIBILITY

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Abstract. The transport infrastructure has always been an important force in space. The global air transport has reduced the inhibitory role of the geographical and time barriers and close economic-, informational- and workforce flow became possible which resulted a global city network. This study aims to examine, the regional differentiation between the top and the bottom of the global city hierarchy, and how this global urban network shows the center-periphery separation concerning to air traffic data. The research lighted that the traditionally assumed center-periphery air routes are changing. In the case of the cheapest flights there for the traditional idea that London, New York and Tokyo have a central role, while the shortest flights are demonstrating a new Paris-based world order. A fourth centre is also emerging in the Middle East, in the area Doha and Dubai. However, China already has a significant role which was not common two decades before. Along the East Asian coast Shanghai and Hong Kong are the most influential, which, though have lower contact values, connection diversity has increasingly regarded as important feature

Rezumat: Disparități centru-periferie în accesibilitatea aeriană. Infrastructura de transport a fost mereu o important forță spațială. Transportul aerian global a redus rolul inhibitor al barierelor geografice şi temporale şi a devenit posibil fluxul economic, informaţional şi al forţei de muncă fapt ce a dus la formarea unei reţele urbane mondiale. Acest studiu doreşte să examineze diferenţele regionale dintre vârful şi baza ierarhiei urbane globale şi cum această reţea urbană globală ilustrează separarea centru-periferie în ce priveşte datele de trafic aerian. Studiul a ilustrat faptul că rutele aeriene tradiţionale dintre centru - periferie se schimbă. Pentru zborurile cele mai ieftine locul central îl au Londra, New York şi Tokio în timp ce rutele cele mai scurte au ca loc central Parisul. Un al patrulea centru se prefigurează în Orientul Mijlociu în regiunea Doha Dubai. Cu toate acestea China are deja un rol important care nu a fost observabil acum două decenii. De-a lungul coastei asiatice Shanghai şi Hong Kong sunt cele mai importante , la care, deşi au valori de contact mai scăzute, diversitatea legăturilor a fost tot mai mult considerată o caracteristică importantă.

Key words: *centre-periphery, air transport, world city network, airline network connectivity.*
Cuvinte cheie: *centru periferie, transport aerian, reţea urbană mondială, conectivitate reţelei aeriene.*

INTRODUCTION

In today's globalized world, the traditional center-periphery relationship is changing. The development of transport facilities and Information and Communication Technologies (ICT) resulted the shrinkage of the geographical space. The definition of distance had been replaced into another dimension, and the economic distance is to the fore instead of the

geographical distance. A good method of measuring it via studying air traffic data, because the fastest way to overcome long distances is using aircraft. Our study also based on the assumption that the cities located at the top of the city-hierarchy have intensive air relations.

Appropriateness of the study was that although more research (Grubesic, T.H. ET AL. 2008, Matsumoto, H. 2004.2007, Smith, DA - Timberlake, M. 2001, Zook, M. - Brunn, S. 2006) used air traffic data to examine the links between global cities, but out of these researches only a few have taken up the question of the changing effect of fares and flight time, on spatial relations. Thus the aim of the research was to examine whether, and if, how the fares and flight time change the established city-hierarchy pattern and relationship. Will the cheapest and shortest flight relations lead to the center-periphery situation in between the cities we have considered, or not. If it leads what pattern will appear on the world map?

During the research we were examining the 100 largest metropolis and the relationships between them. Using air traffic data, considering the cheapest and shortest flights we determined cities, and in between the cities the strength of the relationships they have via air. The role of air transport was tried to be defined by the number of transfers in the cities. We want to stress that this is a cross-sectional view of the world recorded that specific point in time.

1. CENTRE AND PERIPHERY IN AIR TRANSPORTATION

The center-periphery relationship theory (Wallerstein, I. 1974) was spread through the work of Wallerstein in the scientific world. The center-periphery thesis includes geographical and socio-economic components of a dual world pattern, and interdependency between them.

According to Wallerstein, the center is a socio-economic formation which is the most developed in that particular phase of the world economy, and the development of it is autonomous and organic, which originated from the system's internal structure and the motivation of the population. Continuous innovation is an important feature which ensures the role of center. Using continuously new resources results a higher quality of life and production compared to the previous phase of the economy.

The development of the periphery is much lower, which is mainly based on the adaptation of older technologies. Peripheries are economically subordinated to the center regions, and poverty is a serious problem in the collective society.

Semi-peripheral position is somewhere between the periphery to the center area. This term is used especially on the former socialist countries. It can be marked as limited decision-making centers (mainly the capital city) in the global economy, third and fourth ranked cities in the global city-hierarchy. But the role of semi-peripheral countries is not only fulfilling the raw material and workforce needs of the center areas. In innovation semi-periphery is an early adaptor, which helps to fall into the line with centre areas.

In this case those cities and their surroundings, which were preliminary out selected due to low-rank in the GAWC-list, urban and agglomeration population and airport passenger traffic have not been included in the study considered as periphery. In between the cities are selected into the study adverted as peripheral cities while they have low transit and/or relationship values. A common feature is that the contact value, and thus availability is low, so in the global competition they are more and more tailing off, while the key of the

rapid, predictable and easy accessibility is crucial in this globalized world. By contrast, central cities considered with major transit and connection values, which are easily accessible and thus more integrated into the global competition.

Examination of the connections between cities three strong link-types (Fig. 1.) can be defined. The first is the *bilaterally subordinate relationship* (e.g. Johannesburg - Cape Town), where Cape Town is only available via Johannesburg, therefore, the situation of this city is extremely peripheral. The second of the contact type is the *multilaterally subordinate relationship* (e.g. Johannesburg ← Dubai, Frankfurt, Hong Kong) which is also accessible by air, from more cities, but access is still peripheral, in spite of it's less peripheral than the previous instances. The third connection type is *even relationship* (New York - London), where the cities are not subordinate to the other, the relationship between them is intensive and not the only one.

Criticism may arise, on the ground of that study areas are not containing the traditionally held periphery, as they had been dropped out of the 100 examined in the pre-collation. Despite we can say focusing on the air transport sector, which is utterly concentrating sector, those settlements that do not have adequate population, hinterland, and especially appropriate number of passengers, are not eligible to participate in world competition, and the research on air traffic is irrelevant of these areas. Dissolving doubts, it is worth noting that the 100 cities includes Nairobi, Lagos, Kiev, Karachi, Bangalore, etc. which are all traditionally peripheral and half-peripheral cities.

Fig. 1. Hierarchical air connections types between cities
/ Tipuri de legături ierarhice între oraşe
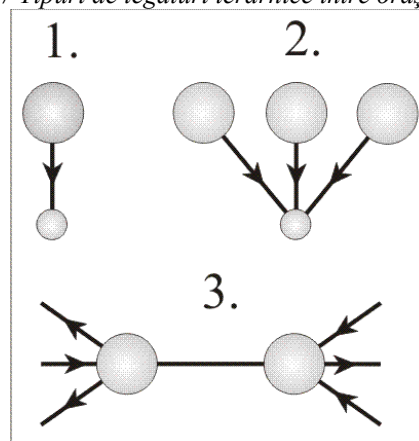
Source: edited by authors

2. METHODS AND DATA

We started our study with the selection of our analytical units (world cities). First of all we compiled our primary database, which contained 177 cities that we kept as important

world cities. Then we reduced the number of these cities to 100 using four different factors. During this selection the population of the cities, and its agglomerations (www.population.de), the ranking of Globalization and World Cities (GAWC 2008), the passenger traffic of the cities' airports (ACI 2006) were taken into account. Then set the priorities among the factors, which is the basis of the weighting. The passenger traffic - through the examination is about transport - got a prominent role, so during the selection the data about passenger traffic were 2.5 times taken into account. The population had been included in the study while the urban population generates the bulk of passengers of the airport.

Wherefore the city can not be assessed without the surroundings, so the population of the agglomeration is also had been taken into account. Thus population became overrepresented, and resulted distortion, especially in the case of populous cities of developing countries. Therefore, the two population data had been pooled and average was counted, so the combined population of the agglomeration and the core counts equally in the research. The last factor is the GAWC ranking, which lists 10 categories of cities according to economic power, decision-making centers number, etc. and the cities were given ranks according to the position in the GAWC list. The aggregation of the indicators resulted a rank between 177 cities, and the best 100 were chosen into the research.

On the basis of previous literature (ZOOK, M. - BRUNN, S. 2006), seven-seven city were selected from the three centre region (TÓTH, J. 2001), and according to the geographical position and four more cities were picked from each peripheral continents. So defined the following 25 special cities: New York, Tokyo, London, Shanghai, Beijing, Paris, Hong Kong, Moscow, Chicago, Madrid, Los Angeles, Singapore, Bangkok, Seoul, Atlanta, Toronto, Dallas, Washington DC., Rome, Frankfurt, Amsterdam, Mexico City, Sydney, Sao Paolo, Johannesburg.

In the next phase of the research already existing ticket-price-databases (BURGHOUWT, G. ET AL. 2007) were examined, however, we found that they are not freely available to researchers and does not contain sufficient information and are also incomplete. Thus we queried data from the internet, which is also accepted by academic literature (BURGHOUWT, G. ET AL. 2007, ZOOK, M. - BRUNN, S. 2006). We used a global distribution system's (GDS) interface (www.orbitz.com) for collect the air fares from the internet. The data survey was performed a predetermined period of time. The collection dates were: from 1.st to 4.th of February 2010. and examination contains the fares and time of flights between 2010 from 1.st till 8.th of March.

The data concern on round trip tickets and the date of one month in advance of data collection the following Monday-Monday interval. The data survey concern traffic data between each of the 25 special cities and the selected 100 city, which contained the lowest fares and flight time, the departure-, transfer- and arrival airports, as well as the fares of shortest flights. The constraints of the website and the data gathering instruments every day a monitoring data-survey had been made to check-up the fares at definite connections. We compared the monitored fares with the collected fares which showed no significant difference.

After organizing the data, thematic maps and schematics were made and analyzed by using GIS program (ArcView). The figure showing the area of influence (see Fig. 3.) based on the nearest neighbour interpolation procedure. The map is presenting an idealized world

without oceans showing field of influence, for better understanding the outline of continents and countries were also included. The points of the grid are the cities of the cheapest flight's and values are representing the transfer values of the cities. The field of interest was calculated of the 12 nearest neighbour interpolation process. Values of field of interest are showing an expected value of transfer value afielding from the city.

3. SPATIAL NETWORK ANALYSIS CONSIDERING THE CHEAPEST FLIGHTS

At the beginning of the research we had the pre-assumption that the cheapest flights, comprise more cities, with more transfers, and involve less direct ways. The assumption was verified as 3530 transfers were counted during the shortest flights; meanwhile the cheapest flights produced a total of 4781 transfers. Several large transfer nodes can be observed in context of cheapest flights on (Fig. 2.).

In North America four strongly separated transit node-network appears in the area of New York – Washington, Chicago, San Francisco – Los Angeles and Houston – Dallas. In Europe, the lack of space and transport geographical features London, Amsterdam, Frankfurt, Madrid square (which also includes Paris) is conducting the vast majority of European air transport.

The prominent role of Moscow drawn on the map, which has origin in the intensive relations with Beijing, New York and Bangkok. But it can be treated as Europe's eastern gate. The third big transit node is the East Asian one, which includes a traditional centre city, Tokyo, and newly rising cities like Beijing, Shanghai, Bangkok and Hong Kong.

The Middle East region is emerging as a fourth centre region. Dubai and Doha's leading role became univocal during the research. Data on the cheapest flights shows Doha is fourth with 257, and Dubai is sixth with 214 transfers in the ranking, outranking cities such as London, Frankfurt, Tokyo, Paris or Chicago.

It is also noteworthy that the number one airport of the Australian continent, Sydney has low transfer values. But Figure 4 and Figure 5 shows it has notable role in relationships, especially when we examine the shortest flights. This can be explained therewith Sydney is usually the starting and endpoint and not functioning as a "turningpoint-city" like, New York, Tokyo which cities have high-value of transfer and also have a high intensity of contact.

Fig.2. The number of passenger transfers by cities
/ Numărul transferurilor de pasageri pe oraşe
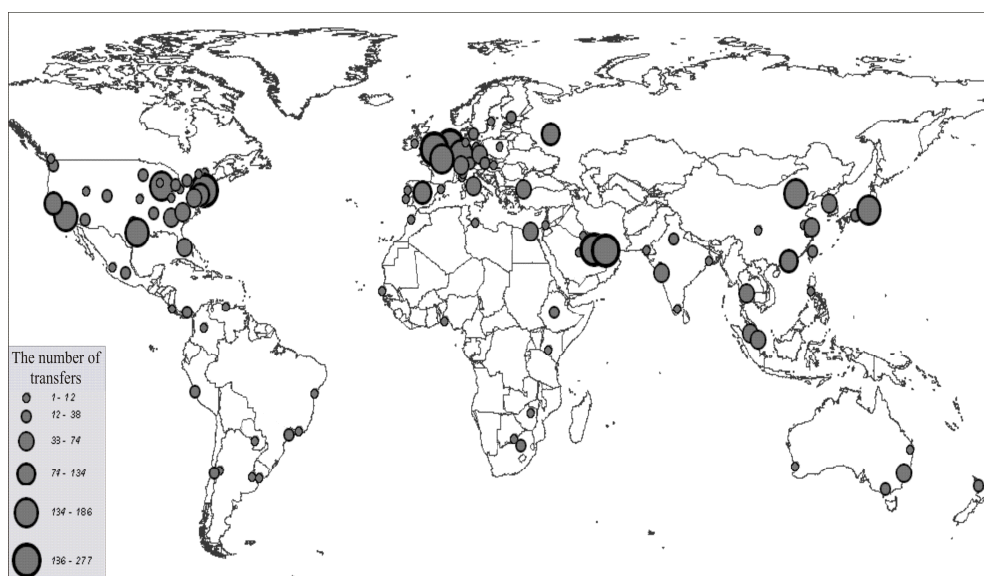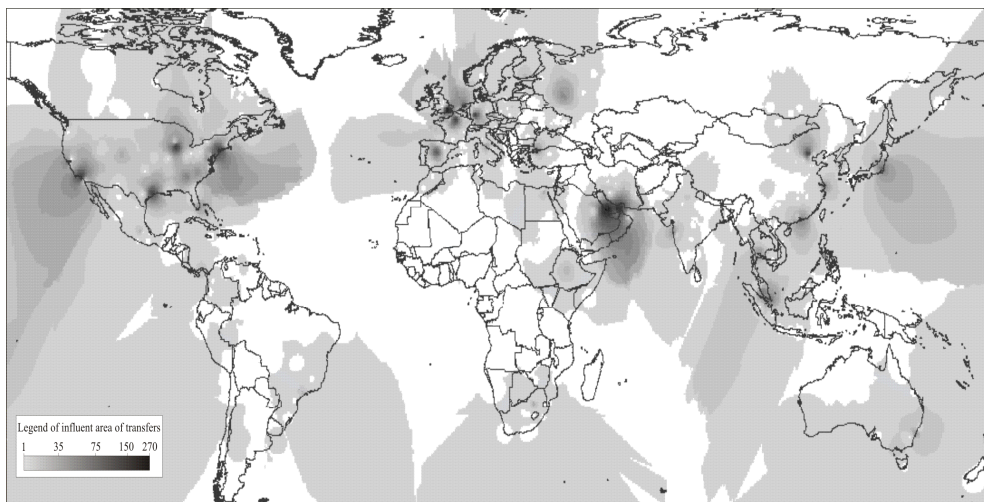

Source: edited by authors

Figure 3 represents the influenced area of the cities according to the transfer-values. Large ocean territories are within the influenced area, such as Sao Paolo and surroundings in South America and the South Atlantic Ocean, or Johannesburg and it's region in South Africa where, despite the low number of transit comparing to the world, they are so significant in their region, that their influenced area would have impact on an area size of Australia. It is a typical feature for the peripherals.

The primate city is the only point for the country to connect to the world economy, whose impact is so big that it is difficult to compete with for other cities in the country or for neighbouring countries. So the figure should consider with theoretical point of view, which is intended to illustrate the magnitude of the most important transfer cities.

In Europe and North America, the major cities' influenced area often connected due the high density of the main transfer cities. That is the reason why in the London-Paris-Amsterdam triangle the transit availability cannot sink lower level so in the map it is continuously dark coloured.

Other results can be got when the same procedure is performed but with normalization by population. In that case smaller transit value in sparely populated area would result big influenced area, meanwhile mass transfer valued, densely populated area would count as smaller and less important node, which would be inadequate.

Fig.3. The magnitude of transfer cities
*/ Mărimea oraşelor de transfer*

Source: edited by authors

Examining the cheapest flight's connections (Fig. 4.) three global cities rise, which were previously mentioned New York and Tokyo, and London. These three cities had been earlier determined by Sassen (1991) as the leading centres of the global economy, and it seems that the leading role impacts the air traffic flows, and also the coordination in context of the cheapest flights. Analyzing the orientations of the most intensive relations, New York connects Europe, Asia and the U.S. market, while Tokyo ensure availability between market in East Asia and the east and the west coast of North America. London has decisive role in Europe which maintain a closer relationship with American cities.

Other interesting fact to observe is the Mexico-Texas enclave, which is a specific transport connection between Houston, Dallas and Mexico City. Wherein Houston and Dallas managing domestic traffic, which is the reason for close relation. Despite Mexico City is multilaterally subordinated, mainly Houston's role emerges from the subordinating cities. The large-scale Mexican migration into the southern states of the USA can strengthen links between the two cities. Also demonstrating data that for Los Angeles Mexico City is the third most important relations and connection is also important between Mexico City and Atlanta in the context of the cheapest flights.

*Fig. 4. The schematic of the most important connection between cities
considering cheapest flights
/ Schema celor mai importante legături dintre oraşe după cele mai ieftine zboruri*
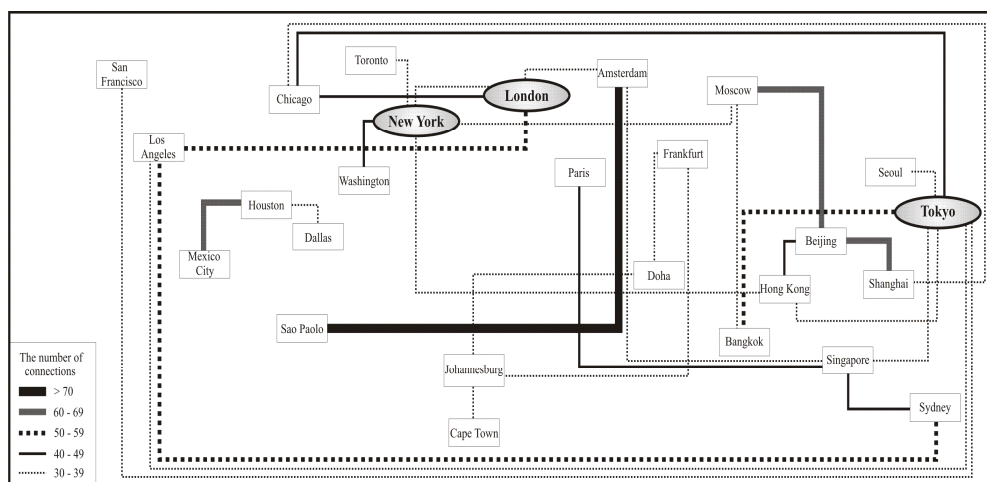
Source: edited by authors

Cape Town is a peripheral city, which is only connected with 3 different settlements, in the frame of cheapest flights. Of total 50 journeys, 39 are with Johannesburg which intensifies the relationship and the other two relations are dwarfed by Johannesburg – Cape Town link. The peripheral transport situation is clear, which is coupled with a subordinated role.

4. NEW SPATIAL PATTERN AS A RESULT OF SHORTEST FLIGHTS

At the connections in context of shortest flights our pre-assumption was that less transfer and more direct link between the cities will be notable. The assumption has been proven, but more interesting facts came to light. Decrease in the number of transits was resulted the reduction of connections. While the cheapest flights had 9094, until the shortest flights had only 7707 connections within the cities. This is due to the fact that in the case of the cheapest flights more transfer city is involved in the distribution of services, so the number of connections will also grow. Thus the cheaper flights provide better accessibility to the different parts of the world. However, the links are more diverse, and have more destination possibilities numerous transfer erodes the availability by increasing the time distance, thus also reducing the competitiveness of the city. A really competitive centre city is available without transfer, and the voyage is cheap and fast at the same time. Many of these cities have multifarious connections an excellent example of this is Paris.

At the case of the shortest flights (Fig. 5.) the schematic gives much more complex picture of the contact points, comparing to the cheapest for flights. The figure 5 shows only

one global centre, Paris instead of a multiple structure. The main airports of the French capital have 549 journeys and possessed a total 72 different direct relation to other cities. Meanwhile number of nodes, such as New York, Dubai, Tokyo, are significant, however, the contact intensity is far behind Paris. Even London has more direct links than Paris with 74 direct relations, the number of journeys is much lower, and only 459, which mean more cities are linked, but the more cities get less service. The situation is similar in case of New York, where the number of direct relationship is 71, but only 476 journeys are related to these cities. While Paris is the absolute joint city out of the examined cities, New York is easier accessible than London, because fewer direct connections get more journeys.

Fig.5. The schematic of the most important connection between cities considering shortest flights /
Schema celor mai importante legături dintre oraşe în funcţie de cele mai scurte zboruri
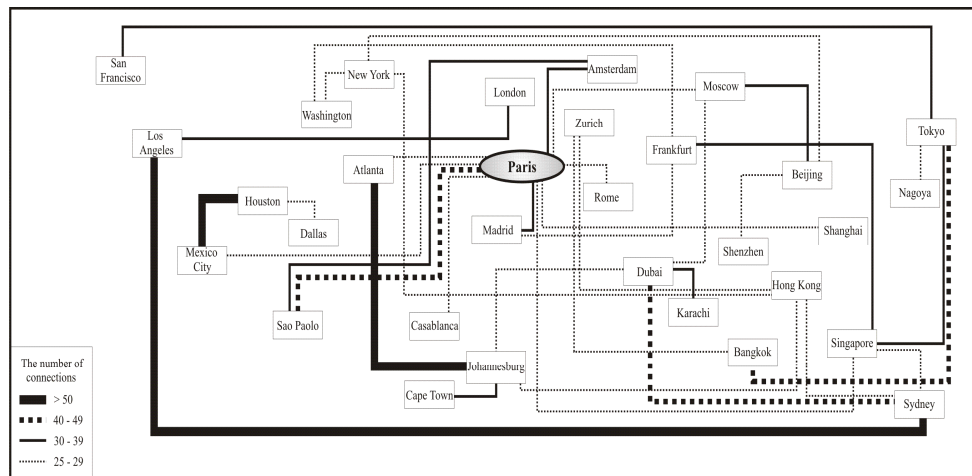
Source: edited by authors

In context of shortest flights clear peripheral city is outlining. Karachi, the largest city and financial capital of Pakistan is related only to six different settlements, with a total 49 journeys, of which 30 is managed with Dubai and nine with Bangkok. Subordinated peripheral position of Karachi is crystal-clear, which is to say a dominant one-sided dependency. The Middle East's transfer center role is also appearing among the shortest flights. Dubai is the third out of the cities with 214 transfers, however Doha is only on the seventh place it together still gives significant position in the world. The growing economic and political power of the Arabic oil-countries and the emerging tourism resulting high number of transfers and relations in the region, which gives the area fourth force in air traffic network.

It is striking that the number of journeys between Sydney and Los Angeles exceeds all the links. One reason is that Sydney is a travel starting- and endpoint, as it has been mentioned earlier, the city has only a limited number of connections, and can be reached

through certain cities such as Los Angeles (51 connections), Dubai (40), Singapore (27), Melbourne (21), Brisbane (20), Auckland (19). The half of the mentioned connections are in the Australia and Oceania region, so these relations are not connecting Australia into the world economy. The situation is similar in case of the Atlanta-Johannesburg relation, where the capital of the Republic of South Africa predominantly only can be achieved through Atlanta. Atlanta is the gate of Johannesburg.

As it can be seen on the schematics the case of the shortest flights gives apparently more diverse picture of the air connections but a fact should be taken into account, the scale of the two schematic maps are different, which simplifies the first one, but shrinking the scale was the only way to represent the connections without spatial distortion.

CONCLUSIONS

During the research air traffic data was analyzed, whether the fares and flight time is a network make over force, seeking to find connections between the global city-hierarchy and air transport.

We came to the conclusion that in case of the cheapest flights (economic distance) demonstrates spatial pattern of a multi-polar world ordered by the three center region, headquartered in New York, London, Tokyo. In air traffic their rank is similar such as their role in the global economy.

In the globalizing world of the 21st century the time is an important factor in space. It has its own force to change spatial patterns. The shortest flights (time distance) data analysis also showed that shorter travel time and less transfer considerably increases travel costs. So the change of time-price ratio results new network-pattern and new regional spatial structure compared to the cheapest flights. As a result Paris became a centre also by the cheapest and the shortest flights. Also several other prominent centers - some new as well-emerges e.g. Dubai, Singapore, London, New York however, their role is less significant compared to Paris considering that the French capital is leading centre in both concern.

Overall, in between three centre-regions' (North America, Europe, East Asia) global cities (e.g. New York, Los Angeles, London, Paris, Tokyo, Singapore) a worldwide network of air traffic was established, in which the "fourth force" was successfully integrated into, can be described as the Middle East (Doha, Dubai).

The resulted global network has strong interdependency, where the center subordinates the peripheral cities bilaterally or multilaterally. Even relationship mainly occurs within same ranked and powered cities.

The possible directions for further research include the examination of the effect of seasonality on air travel, and on the spatial relationship. Also searching the answer if the enlargement of air transport relations would results more intensive connections, and peripheral and semi-peripheral areas could step on higher level in the global world hierarchy.

REFERENCES

ACI - Airports Council International (2006): World Airport Traffic Report 2006. ACI World Headquarters Geneva, Switzerland

Burghouwt, G. – Van der Vlier, a. – De Wit, j. (2007): Solving the lack of price data availability in (European) aviation economics*?* ATRS World Conference, Berkeley, USA

GAWC - Globalization and World Cities Study Group and Network (2008): The world according to GAWC 2008. Loughborough University

Grubesic, T.H. – Matisziw, T.C. – Zook, M.A. (2008): Global airline networks and nodal regions. Geojournal 71. 53-66. p.

Matsumoto, H. (2004): *International urban systems and air passenger and cargo flows: some calculations*. Journal of Air Transport Management 10. 241-249. p.

Matsumoto, H. (2007): International air network structures and air traffic density of world cities. Transportation Research Part E, 43. 269-282. p.

Sassen, S. (1991): *The Global City: New York, London, Tokyo.* Princeton University Press, Princeton.

Smith, D. A. – Timberlake, M. F. (2001): *World City Networks and Hierarchies*, 1977-1997. An Empirical Analysis of Global Air Travel Links. American Behavioral Scientist 44. 1656-1678. p.

Tóth, J. (2001): *Általános társadalomföldrajz* II. Budapest-Pécs. Dialóg Campus Kiadó

Wallerstein, I. (1974): *The modern world system. Capitalist agriculture and the European world economy in the sixteenth century.* Academic P XIV, New York – San Francisco - London

Zook, M. – Brunn, S. (2006): *From podes to antipodes: New dimensions in mapping global airline geographies*. Annals of the Association of American Geographers 96 (3), 474-490. p.