Hungarian Geographical Bulletin 59 (1) (2010) pp. 35–50.

Spatial diffusion of mobile telephony in Hungary

Tiner, Tibor[1]

Abstract

This article deals with the role of mobile telephony within the information society in general, the conditions of its use and the spatial characteristics and spatial features of its diffusion in different types of Hungarian settlements. The introductory part of the paper gives a short survey about the most important features of wirelessness, as a technological basis of mobiltelephony. The following part of the study outlines some impacts of mobile telephony on the economy and the public sphere showing the main spatial trends observed nowadays in mobile communications development. The third part of the article makes a comparison between Hungarian settlements (small towns) of a developed region (the Budapest agglomeration zone) and of less-favoured rural regions of South West Hungary evaluating the reasons for considerable differences.

Keywords: mobile telephony, spatial diffusion, regional and local inequalities

Introduction

In the 20th century the telephone had to cope with the technical problem of transmitting communications between people over a distance. It operated on the principles of analogy, reciprocity and simultaneity. It enabled the long-distance transmission of the human voice while depriving the speakers of all other sensory modes of communications (Fekete, L. 2001).

The mobile telephone of the 21th century is providing for all the sensory modes of communications between people. But this wireless mobile phone with its digitalizing, dividing into parts and manipulating sensory signs will open a radically new period in the history of telecommunications because it will be free from spatial barriers.

With the appearance of the mobile telephone as a new medium of communication all conventional interpretations of the term 'telecommunications' need to be reconsidered. There is a fundamental new quality to this new instrument of communication in that is not confined to any given place

[1] Geographical Research Institute, Hungarian Academy of Sciences, H-1112 Budapest, Budaörsi út 45. E-mail: tinert@mtafki.hu – J. Selye University, ul. Hradná 21. 94501 Komárno 1. Slovakia. E-mail: tiner.tibor@selyeuni.sk

(Karácsony, A. 2001). It is no longer a certain place with its particular set of persons that is being addressed but rather a particular person wherever he (or she) might be.

The only way to create an information society is the organic integration of informatics and mobile telecommunications. This is because it is only the mobile telecommunication by the help of which information can be shared in society to a full extent. The essence of the mobile telephone service is a powerful symbiosis of telecommunications and information technologies (Sugár, A., *et al.* 2000). The centre of revolutionary breakthrough is people's communications demands and their satisfaction anywhere and at any time. This is the first service ever that is available in any country joining the network and in a broad sense it is the model of telecommunications infrastructure that the future information society may be built on.

Mobile telephony may be investigated on the basis of its wireless technology, its impacts on economy and society and last but not least on its spatial characteristics of penetration into settlements of different size and alternative level of development.

Global wireless technology as a fundamental technological innovation serving mobile telephony

Two wireless communications technologies have been widely adopted in recent years: the mobile (or cellular) telephones, and the wireless laptop communications through WiFi (Wireless Fidelity). A third phase has been started to appear in the late 2000s when the size and weight of portable computers (notebooks, laptops, palmtops) became much smaller and the new models of mobile phones equipped with top technologies have been transformed into a real 'hand-computers'.

The first limited mobile services were introduced in the United Kingdom 1940 and in the USA in 1947, followed by commercial introduction in 1979. Europe's first modern cellular system was introduced in Sweden, Finland and Norway still in 1981. Despite its early lead in the establishment of cellular telephone systems, mobile networks of the Continent suffered from compatibility problems, making it difficult for subscribers to use their mobile sets outside of country-based calling areas. As a consequence, compatibility and standard issues became critical and led to the development of a Pan-European GSM cellular system. This abbreviation came from the French Groupe Speciale Mobile today known as Global System for Mobile Communications.

By permitting compatibility among national networks GSM has become a crucial factor in Europe's lead in cellular phone penetration. Though mobile phone growth rates have slowed down considerably between 1995

and 2005, counting in compound of annual growth rates (CAGR) in Europe similarly to other continents of the world, the old Continent still has the second highest number of cell phone subscribers and the highest mobile penetration rate (Comer, J.C. and Wikle, T.A. 2008). (The value of latest parameter exceeds 100% when individuals owe more than one mobile phone using separate subscriptions for business and private purposes.)

Due to technical innovations mobile phones were rapidly introduced in the 1990s (Rogers, E.M. 1995; Lacohée, H., *et al.* 2003). In 2003 some 25% of the world population used mobile telephones and ca. 80% of them lived in areas covered of mobile telephone networks. Nowadays ca. 3.4 billion people (more than 50%) use mobile phones, most of them live in Europe, China, and in the USA. Still in 2002 the number of mobile telephone subscribers worldwide exceeded that of fixed ones (ITU 2004, 2009). As for Europe in 2008 there were 28 countries, where the penetration rate of mobile phones emerged above 100%. The same volume was only 19 in 2005. (ITU 2007, 2009).

Wireless laptop communications were introduced in the developed world only in the late 1990s. It is currently limited to areas where proper aerials (mobile towers) are installed (hot spots), such as airports, restaurants, hotels, cafés and urban areas opened to public (downtown squares, city parks etc.). The simultaneous introduction of SMS (Short Message Service) and Internet services over mobile telephones and laptop WiFi communications has implied the availability of these two portable machines. These technologies grew out of the previously developed telephone and Internet technologies presenting a merger of mobility computerized information and communications (Kellerman, A. 2006).

In case of mobile telephony wirelessness is a possible equivalent term to the motorization and telephony relating to values, practices, norms and patterns within three spheres of individuals, society and space. It assumes the wide adoption of wireless communications devices by households. However, when compared to the telephone it obviously facilitates flexibility in both physical and virtual movements, whereas the telephone permits only virtual flexibility.

Wireless communications further simultaneously intrudes users' time and space as compared to possible time intrusion by the telephone. The use of mobile telephone thus ceases possible isolation. The use of either mobile phones or wireless Internet by the help of laptops means disappeared boundaries between the private and the public. Whereas telephones and computers were traditionally devices in communications to be used indoors and involving some privacy of communications, wirelessness implies less privacy and a change of social boundaries regarding the acceptance of communications activity in the public spheres. Finally, it can be stated that wireless communications in general can be considered as a third phase in social communication and networking (Wellman, B. 2001):

– The first phase was face-to-face communication, typifying social relations within traditional physical place-bounded communities.

– The wired telephony have led to the development of a second phase of social relations and networking. This place-to-place communication have replaced some of the local physical face-to-face relations in communities.

– The third phase is the person-to-person communication derived from the possibilities for wireless and placeless communication free from time limits, detached from household location and its communication infrastructure.

The impact of mobile information technologies on the economy and the public spheres

It is a well-known fact that the role of mobile telephony in all branches of economy is of great importance. It is because in the economic sphere technological and institutional changes are interconnected, the new technologies predicate new regulatory modes and new patterns of economic behavior. Being a part of the breakthrough in information technologies, mobile information technologies themselves have contributed to these changes.

It can be stated that mobile techniques as a part of information technologies replace mass production. The spatial spread transforms the micro and macro regular systems of production. As a consequence mobile telephony contributes to reduce transaction costs, enables increasing economic flexibility for firms, offers on-line businesses and influences greater mobility of production factors (Gedeon, P. 2001).

Observing and evaluating the complexity of the connection between the mobile telephony and public spheres intriguing contexts can be discovered. The wide use of new information and telecommunication technologies (ITC) has made clear that it is advantageous to treat the various types of communications within a single theoretical framework. The brand new mobile communication technologies have radically changed the space and time constraint of communications and have altered the habits and patterns of communication between the members of society (Heller, 2001). Consequently, the wide use of mobile phones embedded in modern telecommunication technologies induces a new public sphere. Instead of the former idea of a single public sphere, a complex structure of overlapping layers of various dimensions is coming about (Keane, J. 1966).

The rapid technological changes involve profound social transformation and raise numerous new technological problems. Some scientists are pessimistic seeing a growing cleavage within and between individual societies and the gap becoming irreversible (Castells, M. 1996–1998). But development has its positive aspects. Active creative communications may again

increase as opposed to passive consumption. At the same time the possibility to participate in local, national, regional and global public spheres gives a fresh impetus to the interactive communications of local, national and global citizens. Mobile communication devices make this possibility for development ever more secure and accessible.

Some regional and local characteristics of the diffusion of mobile communications

The development of mobile communications in the last decade was characterized by three marked trends (Erdősi, F. 1999):

1. Globalisation processes in mobile communication. The introduction of continent-wide or even world wide unified services, and intrusion of wireless networks into distant places in underdeveloped countries and regions (eg. Africa, Central-Asia etc.)

2. Integration of wired and wireless technologies and networks. This process first appeared in the USA, Japan and in developed countries of Europe and later it spread towards the Eastern European countries.

3. Fusion of mass media with telematics in developed countries. From the turn of the millennium hundreds of tv-programs (on cable networks or via satellites) and a wide range of telematic services have become accessible for mobile phone subscribers of Western Europe, the USA, Japan and other developed countries owing to technological innovations next generation (NG) mobile sets ('hand-computers') and the wide spread of hotspots, mainly in urban areas.

Here it should be emphasize that mobile devices may permit the development of geographically more flexible regional and local services, mainly for metropolitan areas. Mobile phones give the ability to provide location-based services to physically moving potential clients by identifying their exact location inside a given region via GPS (Global Positioning System) technologies (Kellerman, A. 2002). Furthermore, wireless devices encourage more travel, notably business travels mainly between cities, through the availability of virtual mobility, while physically on the road or in train.

Mobile telephone may permit faster more efficient and flexible use of time and space by individuals to fit the more flexible social nature of second modernity cities (Townsend, A. 2001; Zook, M. *et al.* 2004). This device leads to more efficient management of direct contacts in CBDs, as well as more efficient use of highways connecting large cities, where mobile phones are widely adopted as this communications device permitting immediate contacts when, for example, some rescheduling is required because of any unforeseen congestion. Moreover, mobile phones may further imply 'personal globaliza-

tion' as overseas destinations may be reached immediately from any location, frequently at high costs for calls, but at lower ones for SMS.

The adoption of mobile telephones has been expanding fast in less developed countries of East Central Europe, such as Hungary, where at the same time mobile telephones have began to supersede the fixed wired telephones operated by MATÁV (Hungarian Telecommunication Company) and now they are decisive factor of telecommunications. The spread of mobile telecommunication services in Hungary has taken place according to the model experienced world-wide, in the framework of a process spreading from the centre towards the periphery. Namely, the coverage penetration has run from the capital city (Budapest) towards other regional centers along the main radial expressways.

A brief review of two decades of mobile and wired telephony in Hungary

In Hungary there are three mobile communication companies: T-Mobile Hungary (before May 2004 named Westel Hungary), Pannon GSM and Vodafone. They have started their activity in 1993, except for Vodafone which entered the market only in 2000. These three companies after having divided the Hungarian mobile market have became very prosperous and profitable firms. Nowadays T-Mobile is the largest GSM network provider in the country.

Deregulation of the economy in the 1990s has led to an explosive and permanent growth of the mobile communications market in Hungary. This process has resulted more than 12 million mobile phone subscribers in the country (121 mobile subscribers per 100 inhabitants) at the end of 2008. T-Mobile the biggest mobile operator in the country already providing services to over 5,5 million mobile users (44.7%). Pannon GSM has 4 million subscribers (33.4%) and Vodafone has nearly 2.6 million ones (21.9%).

Since the second half of the 1990s mobile operators started to compete with the MATÁV's wired telephone services. This challenge ended successfully. From 2000 the number of fixed phones in dwellings started to fall, in 2002 the number of mobile phones and domestic calls initiated by mobile phones have already exceeded that of fixed phones in Hungary *(Figure 1).* After the turn of the millennium a second phase of this competition started focusing the broadband telecommunication network development (Tiner, T. 2009).

A spectacular increase has taken place in the number of hotspots based on WiFi technology promoting mobile internet use. In 2008 more than 1300 registered hot spots were available for potential users all over the country, 41% of them located in Budapest. The rate of chargeable ones is 56% in the country towns *(Figure 2).* Main part of hotspots in Budapest is concentrated in downtown and can be found in public buildings (hotels, restaurants, pubs,

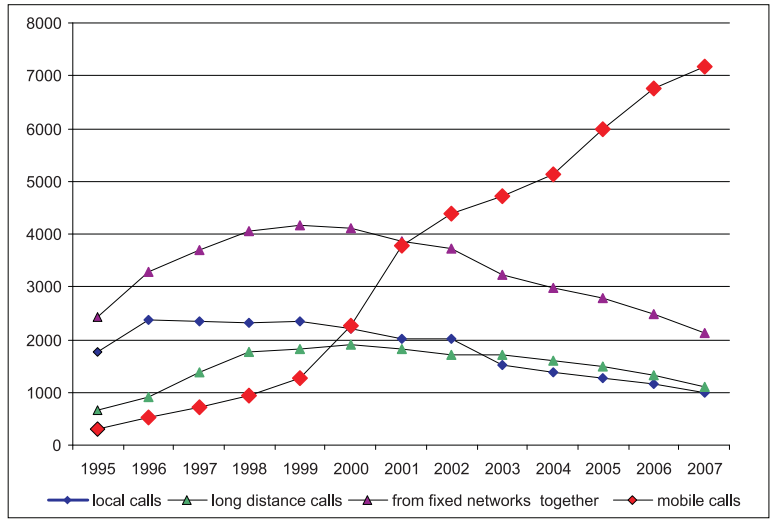

Fig. 1. Telephone calls initiated in fixed and mobile networks in Hungary. *Source:* Statistical Yearbook of Hungary 2009. KSH, Budapest

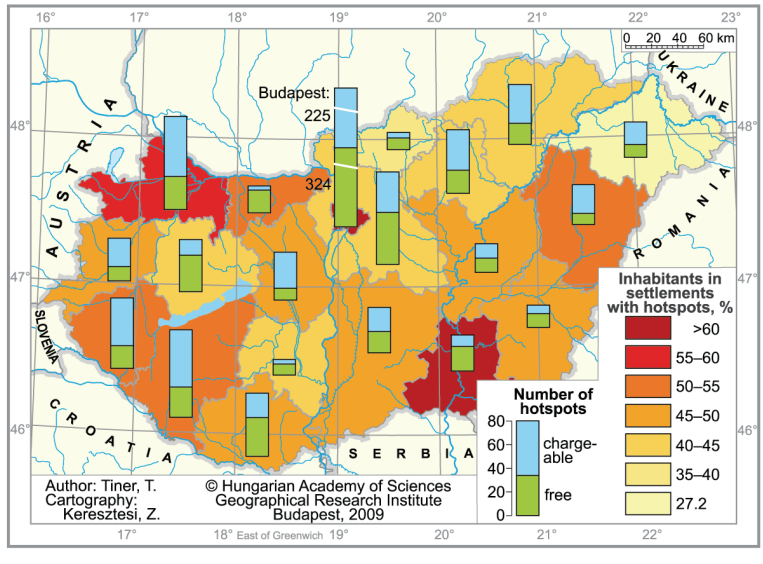

Fig. 2. Spatial structure of hotspot availability in Hungary, 2008. Source: Kocsis, K. and Schweitzer, F. eds, 2009

cafés, telecottages etc.) or in the vicinity of mobile phone towers with aerials *(Figure 3)*. 51% of all hotspots can be used free, the rest is chargeable.

Back to telephone supply, it is worth mentioning that 60% of the Hungarian population had both wired and mobile telephone in 2008. 25%

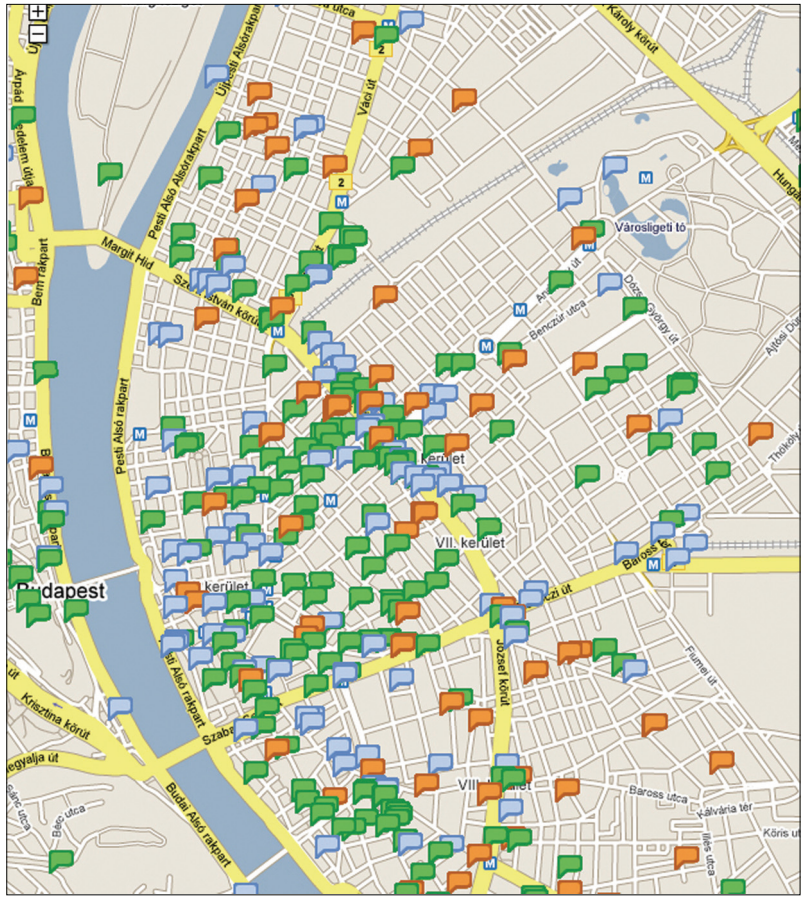

Fig. 3. Hotspots in the heart of Budapest. Green flags mark free access. Source: www.hotspotter.hu

was the owner of only mobile telephone and an additional 13% had a fixed line exclusively. (3% of the population had none.)

Since the early 2000s the expansion of mobile telephony has been accompanied with a sharp and perpetual competition between the three mobile operators and the two fixed-line network operators in Hungary. The main fixed-line telephone operators Magyar Telekom (former state-owned MATÁV Hungarian Telecommunications Company Ltd.) and Invitel Telecommunication Co. the main fixed-line telephone operators investing huge sums of money into technical development of their networks do their best to preserve or maintain their share in telecommunications market of Hungary by investing huge sums of money into technical development of their networks. Concomitantly they are also competing with each other in the field of wired telephony.

The historical background of this process is the following.

In 2000 Deutsche Telekom obtained majority (nearly 60%) ownership in MATÁV. Next year the Hungarian company could become an international telecommunications group when the consortium led by MATÁV acquired majority ownership in Macedonia's national telecommunications company Makedonski Telekomunikacii (MakTel), so MakTel became a consolidated subsidiary of the Group.

2001 was the official date of full liberalization of the Hungarian telecommunications market. The area of fixed-line telephony was the last segment of telecommunications where the market was opened. At that time MATÁV Group achieved leading position in mobile telephony, internet and business data communication markets and obtained over 80% share on the fixed-line telephone market.

In December 2003 MATÁV announced connection of the 100,000th ADSL line. During that year the number of Hungarian towns where this service was available tripled to reach 128. Since January 1, 2004 – when the Electronic Communications Act entered into force that contained EU-compatible market regulatory provisions – fixed-line number portability became a reality in Hungary.

One year later MATÁV acquired a 73% majority ownership of the Telekom Montenegro and has become a strategic investor in the South East European region. In May 2005 the MATÁV Group was renamed Magyar Telekom Group with members T-Com, T-Online, T-Mobile, T-Systems and T-Cable branches jointly offering the full range of telecommunications for residential and business customers.

In 2007 several small local telephone operators (eg. Hungarotel, Pantel, V-holding, Euroweb etc.) merged into Invitel Telecommunication Company, the second largest service provider in the fixed-line telecommunications. From that year Magyar Telekom has been in sharp competition with Invitel. Its concession service area comprises 14 primary districts of the country covering nearly 17 % of Hungary's population.

For 2008 Magyar Telekom has become the principal provider of telecommunication services in Hungary, which operates local telephone services and long distance dialing in 38 primary districts. Its latest technical innovations achieved makes possible to install a 2,700 km long optical NG-WDM (Next Generation Wavelength Division Multiplexing) backbone network in 2009. With the help of it Magyar Telekom offers its customers super-fast wireline broadband access, which is much faster than ever before. The relative commercial values of supplying fixed-line telephony to households and the volume of initiated calls are steadily diminishing since 2000 owing to the rapid spread of mobiles all over the country. Meanwhile considerable regional differences exist in this field of telephony.

Since 2009 both fixed-line operators offer broad band wired internet packages at a decreasing price including a large choice of cable-tv programs and telephone services for their subscribers.

By the end 2013, Magyar Telekom plans to cover approximately 780,000 households with a fiber-to-the-home (FTTH) network and to further upgrade 380,000 households to whom a hybrid-fiber-coaxial network is currently available.

In spite of their efforts these companies will not be able to get back their subscribers living in towns or villages mainly because of the dynamic penetration of mobile internet services and HDSPA offered by the three mobile telephone operators at a low fares.

Spatial diffusion of mobile phones in two different regions of Hungary

This part of the study is aimed to demonstrate the main differences of mobile telephone diffusion process in two poles of regions inside Hungary as sample areas. The first is the agglomeration zone of Budapest (most developed region of the country), and the second is a less-favored rural microregion (Ormánság) in South Transdanubia (Tiner, T. 2004, 2008).

Surveys were made in 2005 (for two small towns chosen from the agglomeration zone) and in early 2006 (for villages of the Ormánság region). Investigation was based on a primary type research, namely questionnaires collected from a sample of 2x150 secondary school students (aged 15–18 years) living in two small prosperous towns of the agglomeration zone of Budapest (Budaörs and Szentendre, both with ca. 25,000 inhabitants), and from another sample of 150 students (with same age structure) living in 29 different small-sized villages (between 54 and 360 inhabitants) of Ormánság microregion *(Figure 4.).*

Questions referred to rate of mobile telephone users among secondary grammar school students (their distribution by place of residence, types of mobile sets, year of getting their first mobile phone, the monthly cost of use, monthly income of the family, educational level of parents etc.).

Comparing the two groups of students living in very different circumstances, investigation has led to interesting conclusions. Instead of detailed verbal explanation of answers the results are demonstrated on *figures 5–8*.

The figures presented above have made it clear the followings:

– Students of towns belonging to the agglomeration zone of Budapest had mobile phone much earlier than students living in villages of the Ormánság region. (Time gap was some 2 to 3 years). The rate of mobile telephone users is much higher among young citizens (94.0% of students in case of Budaörs, and 92.6% in Szentendre) opposite to students of Ormánság region (with a rate of 53.3%).

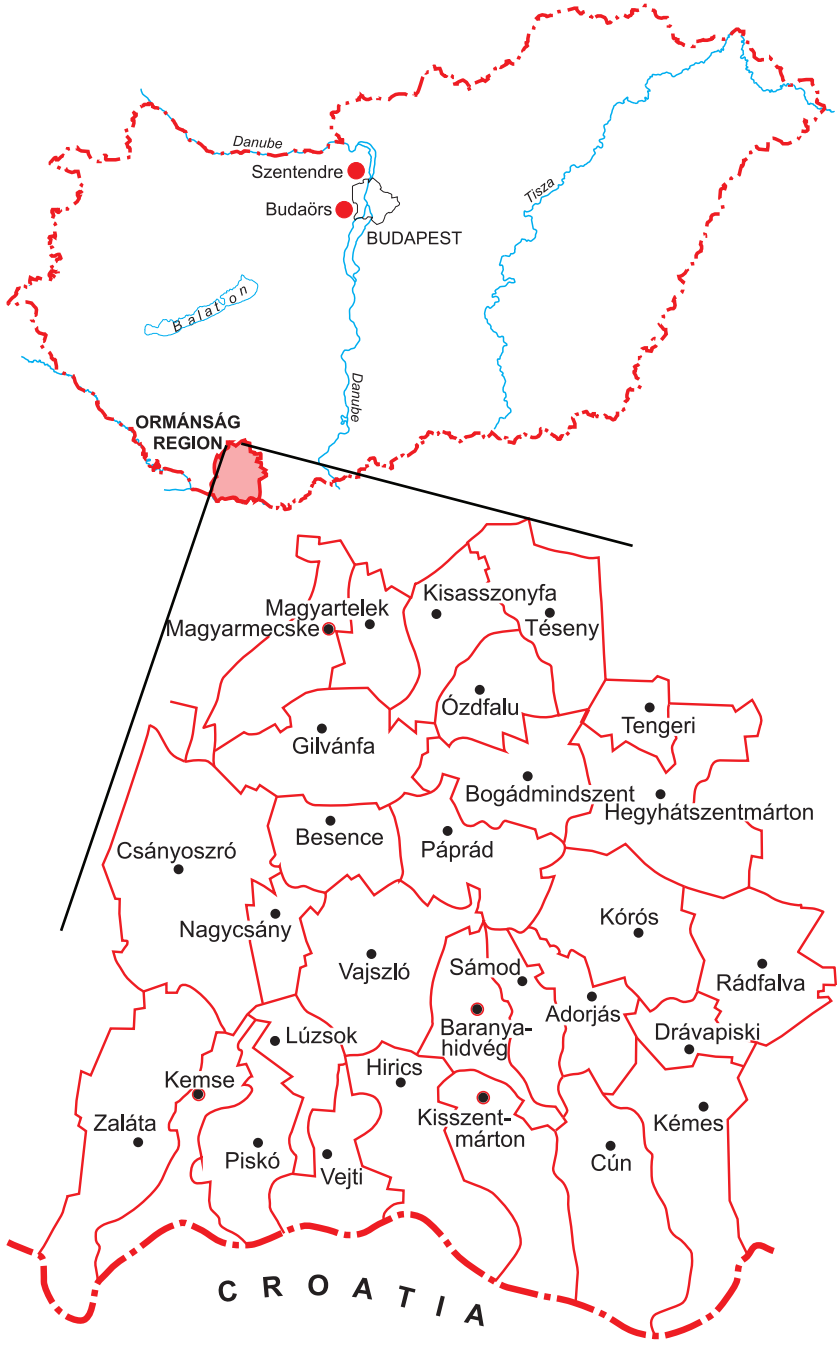

Fig. 4. Map of sample areas

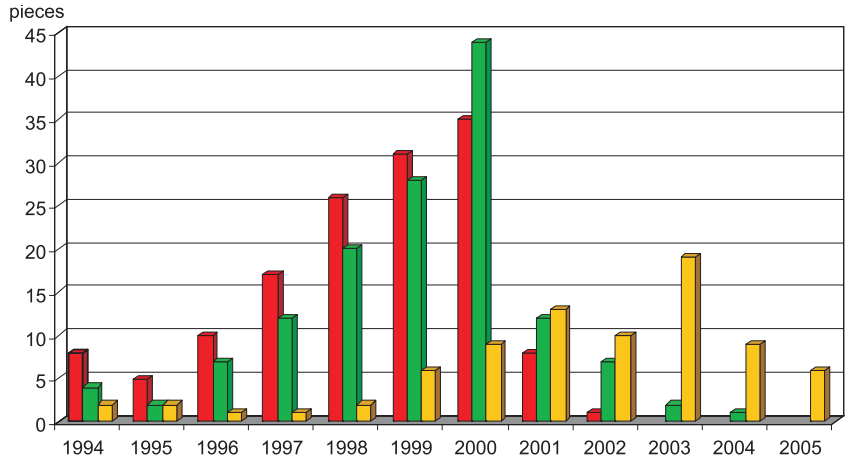

Fig. 5. Annual increase of mobile phone stock in the sample areas

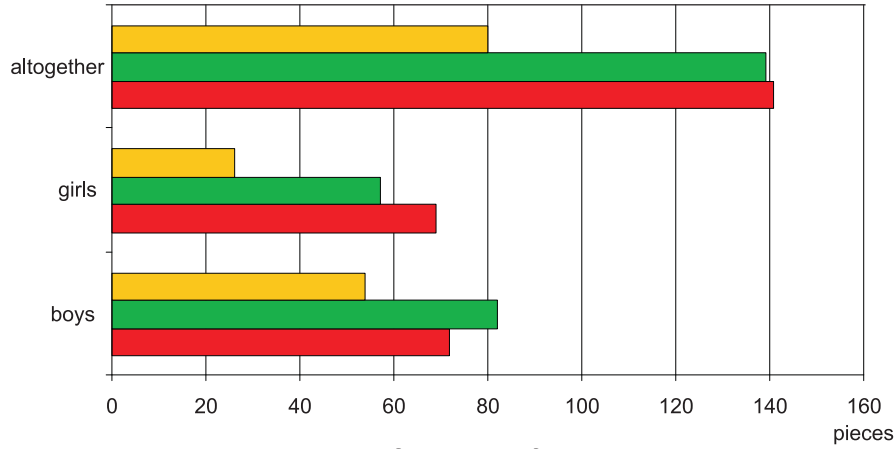

Fig. 6. Distribution of mobile telephone owner students by gender

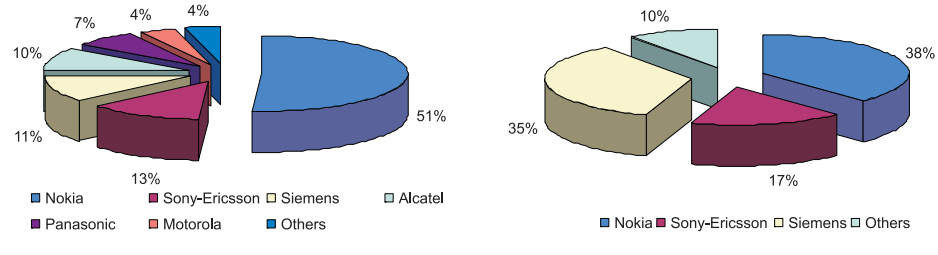

Fig. 7. Share of different type of mobile phones among students in two towns of Budapest agglomeration (A) and in Ormánság region (B), 2005

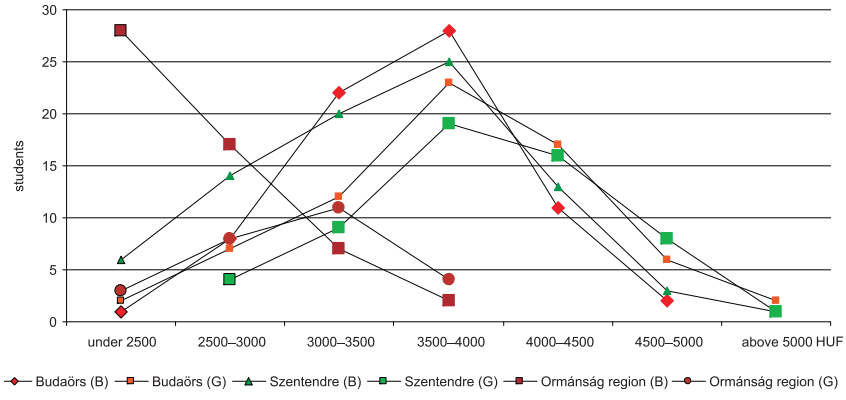

Fig. 8. Average sum of monthly telephone costs among students asked in the sample areas. – B = boys; G = girls

– Rate of girls among mobile users much lower in the less-favoured rural region investigated than among students living in prosperous satellite towns of Budapest agglomeration.

– The leading type of mobile phones used by students is the Nokia, but further two ones (Sony-Ericsson and Siemens) are also popular with users of sample areas. In case of village students of Ormánság region only three types are in dominancy among young mobile phone users. This phenomenon reflects a poorer choice of sets offered by phone stores in this rural region (and in rural regions in general).

– Average sum of monthly mobile telephone costs among the students of villages only one third to one fourth of that students in Budaörs and Szentendre. Furthermore, girls spend more money in general than boys, so their time for call is longer when using their mobile telephone.

Two additional records during the research have to be mentioned:

a) It was generally observed, that the rate of mobile phone users depends on the annual income and the educational level within the family. In case of the students of Budaörs and Szentendre these rates exceed the national average and they are far higher than the average for the villages of the Ormánság region.

b) An interesting phenomenon is, that in case of both type of student groups it is the father in the family who bought the first mobile phone. But in case of the two towns, 64% of children of 14–16 years old become the next mobile owners, and not their mothers. In case of village students the mothers are the second having got mobile phones in the family, and not the children.

Conclusions

Research has made perfectly clear that the spread of mobile phones in regions representing very different levels of economic development followed the hierarchic expansion as found elsewhere.

The process began much earlier in the Budapest area, than in Ormánság where there is still a relatively low level of mobile supply (25%) among the students living in the villages investigated.

Inhabitants with higher education were among the first in these poor communities to purchase their first mobile in the late 1990s and they are still the only group of local communities who use wide range of services offered by mobile operators and other private firms belonging to different branches of commerce and personal services.

Naturally, the increasing spatial diffusion of mobile telephony in a less-developed region is a very positive process. The stable advantage of prosperous regions and cities with dynamically increasing economy present a permanent obstacle for poor regions and settlements located on the peripheries to make improvements in their marginal position.

Additional problems of less-favoured regions:

– Steady out-migration of skilled workers owing to the lack of local workplaces and/or low wages offered by small or middle-sized companies in the rural areas.

– A high rate of retired people in the countryside who cannot afford to spend on telecommunication services.

– Increasing rate of unskilled and unemployed Roma population living in hundreds of villages in north-eastern and south-western regions of Hungary (their number is estimated round 700,000 for 2009). Considerable part of these Roma families (often with 5–9 children) try to make their living basically on social aid coming from state or municipality budget from month to month. Nowadays they do not have any perspectives to get stable workplaces and regular income.

The factors above hinder the diffusion of telecommunications innovations and the effective use of their modern equipments across the backward regions of Hungary.

Consequently, the capital and the towns of its agglomeration zone where the different innovations of new telecommunications technologies (such as mobile phones) appear immediately and soon start to diffuse are able to preserve their advantage in effective and multifunctional use of mobile sets over regions having connected into this process only in later phase. This process hinders the emergence of peripheries and conserves their backward position in the process of long-term regional development.

References

Castells, M. 1996–1998. *The Information Age I–III.* Oxford, Basil Blackwell Publishers, 556 p., 462 p., 418 p.

Comer, J.C. and Wikle, T.A. 2008. Worldwide diffusion of cellular telephone, 1995–2005. *The Professional Geographer* 60. (2): 252–269.

Erdősi, F. 1999. Regional characteristics of the development of transportation and telecommunication during the systemic change. In *Regional processes and spatial structure in Hungary in the 1990s.* Ed. Hajdú, Z. Pécs, Centre for Regional Studies, 123–155.

Fekete, L. 2001. Ember, gép és kommunikáció: néhány évvel a kommunikációs eszközök konvergenciája előtt. (Man, machine and communication: a few years before the convergence of communication instruments.) In *Mobil információs társadalom. A 21. század kommunikációja. Tanulmányok. (Mobile information society. Communications in the 21st century. Studies.)* Ed. Nyíri, K. Budapest, MTA Filozófiai Kutatóintézet (Institute for Philosophical Research HAS), 111–120.

Gedeon, P. 2001. A mobil információs technológia hatása a gazdaságra. (The impact of mobile information technologies on the economy.) In *Mobil információs társadalom. A 21. század kommunikációja. Tanulmányok. (Mobile information society. Communications in the 21st century. Studies.)* Ed. Nyíri, K. Budapest, MTA Filozófiai Kutatóintézet (Institute for Philosophical Research HAS), 13–22.

Heller, M. 2001. Új kommunikációs helyzetek és szükségletek: A hierarchikus nyilvánosságok kialakulása. (New communication situations and needs: The development of hierarchic public spheres.) In *Mobil információs társadalom. A 21. század kommunikációja. Tanulmányok. (Mobile information society. Communications in the 21st century. Studies.)* Ed. Nyíri, K. Budapest, MTA Filozófiai Kutatóintézet (Institute for Philosophical Research HAS), 31–44.

ITU 2004, 2007, 2009 (International Telecommunication Union). www.itu.int.d/ict statistics

Karácsony, A. 2001. A politikai kommunikáció transzformációja. (The transformation of political communication.) In *Mobil információs társadalom. A 21. század kommunikációja. Tanulmányok. (Mobile information society. Communications in the 21st century. Studies.)* Ed. Nyíri, K. Budapest, MTA Filozófiai Kutatóintézet (Institute for Philosophical Research HAS), 23–30.

Keane, J. 1966. Structural transformation of the public spheres. *The Communication Review* 1: 1–26.

Kellerman, A. 2002. *The Internet on Earth: A geography of information*. London, Wiley, 226 p.

Kellerman, A. 2006. *Personal mobilities*. London and New York, Routledge, 210 p.

Kocsis, K. and Schweitzer, F. eds. 2009. *Hungary in Maps.* Budapest, Geographical Research Institute of HAS, 175 p.

Lacohée, H., Wakeford, N. and Pearson, I. 2003. A social history of the mobile telephone with a view of its future. *BT Technological Journal* 21: 203–211.

Rogers, E.M. 1995. *Diffusion of innovations*. New York, Free Press, 160 p.

Sugár, A., Szűcs, J., Vannai, N., Iváncsics P. and Imre, S. 2000. Információs társadalom a jövő évezred küszöbén egy mobilszolgáltató szemével. (Information society on the eve of the millennium – as seen by a mobile phone service provider.) In *Az információs társadalom. Magyarország az ezredfordulón. Stratégiai kutatások a Magyar Tudományos Akadémián. Közlekedés, hírközlés, informatika. (Information society. Hungary at the turn of*

the millennium. Strategic research in the Hungarian Academy of Sciences. Transport, telecommunications, informatics.) Ed. Glatz, F. Budapest, Magyar Tudományos Akadémia (Hungarian Academy of Sciences), 181–192.

Tiner, T. 2004. A hazai mobiltelefónia területi elterjedésének néhány sajátossága. (Some features of regional diffusion of mobile telephony in Hungary.) *Földrajzi Értesítő* 53. (3–4): 237–246.

Tiner, T. 2008. A mobiltelefonok elterjedési sajátosságai az Ormánság néhány törpefalvában. (Spatial diffusion of mobile phones in some draft villages of the Ormánság microregion, south-west Hungary.) *Földrajzi Értesítő* 57. (1–2): 213–227.

Tiner, T. 2009. Telecommunications. In *Hungary in Maps*. Eds. Kocsis, K. and Schweitzer, F. Budapest, Geographical Research Institute of HAS, 172–177.

Townsend, A. 2001. Mobile communications in the twenty-first century city. In *Wireless world: social and interactional aspects of the mobile age.* Eds. Brown, B., Green, N. and Harper, R. London, Springer, 62–77.

Wellman, B. 2001. Physical place and cyberplace: the rise of personalized networking. *International Journal of Urban and Regional Research* 25: 227–252.

Zook, M., Dodge, M., Aoyama, Y. and Townsend, A. 2004. New digital geographies: information communication and place. In *Geography and Technology.* Eds. Brunn, S.D., Cutter, S.L. and Harrington, Jr. J.W. Dodrecht, Kluiwer, 155–176.