S T U D I A R E G I O N A L I A
2015 41–42

László Jóna
Széchenyi István University Interdisciplinary Doctoral School of Engineering
HAS Centre for Economic and Regional Studies Institute for Regional Studies
West-Hungarian Research Department

THE FEATURES OF THE GOOD AND BAD FUNCTIONING CLOSED INNER COURTYARDS – THROUGH A HUNGARIAN EXAMPLE

Abstract: The UN in the World Urbanization Prospects The Revision 2014 titled report calls attention that the a growing part of the world's population lives in cities. And this trend is also true to those countries which population is decreasing. Because in spite of all this more and more people moving to the cities. Therefore the cities of the future will have to face significant demographic and sociological problems. Due to this the role of the public spaces will be more prominent than currently. Because the public spaces are those areas where in the cities living people independently from gender, age, religion, qualification, etc. could meet with each other. However the sizes of the public spaces resulting from their nature are bounded, therefore in the case of the cities the alternative routes providing possibilities for their expansion. Such an alternative route could be functioning the buildings with inner courtyard. Because the inner courtyards similar to the squares could have street furniture or playgrounds. But stores or restaurants also could operate inside there, as around the larger urban squares. However it raises the question that this is true in any cases to the inner courtyards? Or which criteria must be taken into account that an inner courtyard will be used by the pedestrians? Is it count at all, that where is located such a courtyard in the city? This study I'm looking for the answers to these questions through the example of two inner courtyards located in the downtown of Győr. During my research I have made traffic count in both courtyards and with the VISSIM program pedestrian simulations. From the results clearly turned out, that the traffic of the inner courtyards depends not only from their size, but their location in the city, from the traffic of the surrounding public spaces, and the there located stores, functions, and street furniture also.

Key words: inner courtyard, pedestrian simulation, traffic count, alternate routes, downtown, cities

JEL codes: R49, R59

1. Introduction

In a British study made in 1999 it was mentioned that in the future a significant part of the world's population will live in cities (for example in 1999 nearly 50% of the world's population live in one) (Thompson, 2002). Last year, this has been confirmed by the UN World Urbanization Prospects report titled, The Revision 2014, which according to in 2014 54% of the world's population lives in cities[1]. According to the forecasts made in the report in 2050, this rate will be 66%. So the cities of the future will have to face significant demographic and sociological problems because besides moving into the city various ethnic and religious groups according to the characteristic of the western countries the urban population shows an aging trend. And in addition the increasing number of the disabled people whose mobility even in a crowded city must be ensured. Therefore the public spaces will play an even more significant role in the cities life because this is the "space" in every city where regardless of gender, age, religion, qualification, etc. all social classes can be found. This is especially true for the public squares and parks where people can not only meet with each other from the different social groups but they can dialogue with each other as well; actively or passively relaxing, having fun, etc. All of this can significantly contribute so that these groups could get know each other (Thompson, 2002). However the public spaces of the cities including the squares and parks looking at their size are bounded. So for the expansion of the public spaces alternative routes could serve as opportunity. One of these are the inner courtyards, which are similar to the squares and could have restaurants, terraces, benches, etc. However it raises the question, could these be opened courtyards for the pedestrians in any situation? Could this affect the traffic of the courtyards where there are stores, restaurants, or street furniture, etc? Therefore I'm trying to show in my study that it depends that an inner courtyard "operates well" or are used. In addition the benefits and disadvantages of the inner courtyard houses design and in which cases is it worth to open for example an inner courtyard to pedestrian traffic. All this through the example of two inner courtyards in Győr, the Bécsi courtyard and under Kazinczy Street 18 and 20 can be found a building's inner courtyard. These two courtyards were selected because as it will be presented in the study they have a lot of similarities. Among others their sizes are nearly the same and the design also shows common features. Both courtyards can be approached through three passageways. However besides the similarities of these courtyards they also have significant differences.

The Bécsi courtyard in the downtown of Győr is located in an area with relatively high pedestrian traffic. From the eastern direction it is not only bounded by the busiest pedestrian street of Győr but it ensures a connection to another inner courtyard, where primarily among the younger generation a popular fast food restaurant and a smaller park with a playground can also be found. Inside the Bécsi courtyard not only stores but restaurants also operate which generates significant pedestrian traffic. However in the "Kazinczy courtyard" only a few smaller stores operate, a

[1] World Urbanization Prospects The 2014 Revision Highlights, United Nations, New York, 2014.

coffee shop or restaurant can't be found here and there is no street furniture. However another difference is that from southern direction the Kazinczy courtyard is bounded by a fairly low-traffic street and from its three exits two open to the medium traffic of Kazinczy Street. There is significant pedestrian traffic from the Kazinczy courtyard from the eastern direction bounded by Czuczor Gergely Street and Széchenyi Square. All these differences have a significant impact on the traffic of the courtyards. However it's questionable the degree of the differences between the pedestrian traffic of the courtyards and that the mentioned differences and what kind of impact it has on it? Or can it affect the traffic of the courtyard depending on the kind of services, stores, or street furniture that can be found there? Or the narrower area of the courtyard itself could be affected so that the people should go inside there? The study, among other points tries to answer these questions.

The first part of the study presents the short history of the two courtyards and there location in the downtown of Győr. Thereafter it will be presented the traffic counts and the results of the two courtyards. Finally with the VISSIM program pedestrian simulations will be presented in which the results show what size of maximum pedestrian traffic can pass through on the Bécsi and the Kazinczy courtyard without bottlenecks and in which passageways can bottlenecks be expected. Also the located obstacles in the courtyard will be highlighted and what kind of impact this has on the pedestrian traffic.

2. Methodological background

The research focuses on the two specific areas of urban planning and transportation science. Accordingly primarily literature on urban structure, urban history and pedestrian movement were processed. This was necessary because currently there is no literature, which would specifically address the alternative routes or inner courtyards studies. Previous research in the case of the inner courtyard buildings has studied its thermal comfort (Berkovic *et al.* 2012) and daylight factors (Du, Sharples, 2011). However, no related research has been conducted which would study, for example, what makes an inner courtyard "well functioning" or what kind of role these courtyards could play in the urban space.

When studying urban history and urban structure literature the focus was the city structure of Győr and history of its inner courtyards. After processing the available studies Bécsi and Kazinczy courtyards were chosen for future studies, which entail pedestrian traffic count, bicycle traffic count, the count of the dog walkers, and, in the case of the Kazinczy courtyard, the traffic count of the local stores.

The selection of the traffic counting method was made after the review of the relatively rich amount of literature dealing with pedestrian movements. Previous research mostly deals with the escape route of pedestrian crowds in emergency situations, and with the microscopic and macroscopic modeling of pedestrian route choice. The main variables of microscopic modelling are the trajectories and time headways while the main macroscopic variables are flow, density, and speed (Daamen, 2004). Therefore, for the study of pedestrian movement, or behaviour

primarily microscopic simulation programs have been used. Among professional circles one of the most popular of these programs is the VISSIM developed by PTV. The special feature of this software is that the movement of the pedestrians is based on the Dirk Helbing and Péter Molnár kind "Social Force Model". The essence of the "Social Force Model" is that it assumes all pedestrians wants to reach their destination by the shortest route. However, the direction of pedestrian movement is influenced by various external factors, such as other pedestrians, different obstacles (house walls, pavements, streets, trees, etc.) as well as, for example, shop windows, street musicians, artists, market vendors etc., or even objects (eg. fountains, statues, etc.). All these psychological and physical factors are part of the VISSIM pedestrian movement study model (Dávid *et al.* 2010, Helbing, Molnár, 1995).

In the older version of the software pedestrians could only move in lanes similar to passenger cars, but recent developments have made it possible for them to move around on the available whole surface, and if necessary avoid each other. So it's not accidental that the VISSIM, besides the preparation of transport, and evacuation plans, can also provide significant support to planners in preparation of the land use plans.

3. The Bécsi and the Kazinczy courtyard

Under Kazinczy Street number 18 and 20 can be found a building (Fig. 1) that is located in the heart of the historical city on the southwest corner of Széchenyi Square, which is the most widely known square and for a long time the only main square of Győr. Those two buildings are bounded from the north by Kazinczy Street, from the east by Czuczor Gergely Street and Szécnenyi Square, and from the south by an alley named Csillag Street. Kazinczy Street probably began being built up in the 16th century parallel with today's Király Street after the construction of the Bécsi Gate. The east-west traffic of the medieval castle has always gone though the Raba River but the guarding of the western entrance only came later during the reconstruction of the castle when the Bécsi Gate was built. The building up of houses on Kazinczy Street could have played an additional significant role for Széchenyi Square, which functioned in the 16th century as a big market place of the city, and therefore at the time was called Market Square. Opening into the Market Square were houses with the shops and workshops of traders and craftsmen. The market expanded into the neighbouring streets further increasing not only the north-south but as well as the east-west traffic of the square. So presumably under Kazinczy Street number 18 and 20 it can be found a building from the 16th century in which stores had been operating. However on the map of the downtown of Győr made by Imre Hrusovszky in 1793 it's clear that both houses already had inner courtyards at the time. And on a map made in the last quarter of the 19th century the inner courtyard of both buildings had already shown significant similarity to the current one (Borbíró and Valló, 1956).

Under Kazinczy Street number 18 and 20 can be found the buildings' courtyards, which were connected by a passageway, which was due to the creation of the Kazinczy courtyard. Under the number 20 can be found a house with an inner court-

Fig. 1. The Kazinczy courtyard in Győr
Source: own editing.

yard, which is bounded by from the east by Széchenyi Square, and Czuczor Gergely Street is a narrower north-south expanse of the courtyard. However the areas of both of the inner courtyards (the Kazinczy courtyard 300 m^2 and the Bécsi courtyard 379 m^2) are nearly identical. The inner courtyards can be approached form three directions, which open from two entrances to Kazinczy Street and one to Csillag Street (Fig. 2). From Széchenyi Square a closer inner courtyard has only one entrance, which can be approached from Kazinczy Street. In the western courtyard part of the

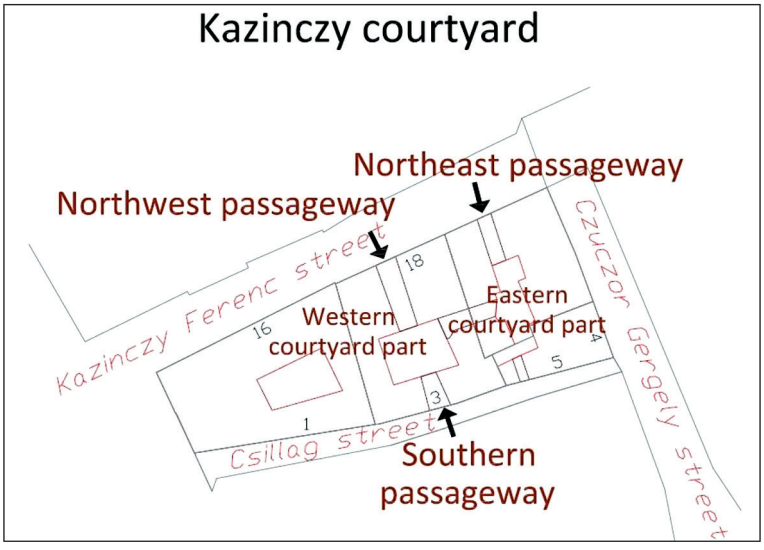

Fig. 2. The passages of the Kazinczy courtyard
Source: own editing.

two buildings connected and in the passageway that connects the two courtyards there are two smaller shops, and in the eastern part there is a hairdressing salon. And similar to the Bécsi courtyard this courtyard is also closed for the night.

The Bécsi courtyard (Fig. 3) in Győr is located at the edge of the former castle wall surrounded by the downtown next to the Fehérvári Gate, which was the southern entrance of the city. Arany János Street, which once ran right next to the castle wall began being built up from the 18th century. Then two-storey houses were built in which the courtyard wings had relied on the castle walls. The demolition of the castle walls began in the second half of the 19th century when the city started to grow south. Not long after this at the end of the 19th century and early 20th century the ground floor of the houses became home to stores, banks, restaurants, etc. However during the Second World War a lot of buildings were destroyed in the downtown and after 1970 the one-story houses were also demolished. Only three historical buildings have remained from the old installation of houses of Arany János Street 18, 20 and 22. These three buildings were independent residential houses until the end of the 80s. Then they had been renovated and the courtyard of the three buildings were connected with passageways and thus was born the present Bécsi courtyard (Winkler, 1988).

The Bécsi courtyard similar to the Kazinczy courtyard can be divided into two major parts where between the number 18 and 20 houses and not only stores but also a coffee shop, ice cream shop, and a restaurant can also be found. However it's an essential difference that the inner courtyards of the Kazinczy Street buildings give home to only three smaller stores and a hairdressing salon. Both courtyards can be approached from three directions. On the east side and entrance can be found from which the Bécsi courtyard opens to Baross Street, on the north side an entrance can be found which opens onto Arany János Street, and the southern entrance opens up behind the Bécsi courtyard into a parking place (Fig. 4). The north entrance of the Kazinczy courtyard overlooks a key pedestrian traffic street while Kazinczy Street on

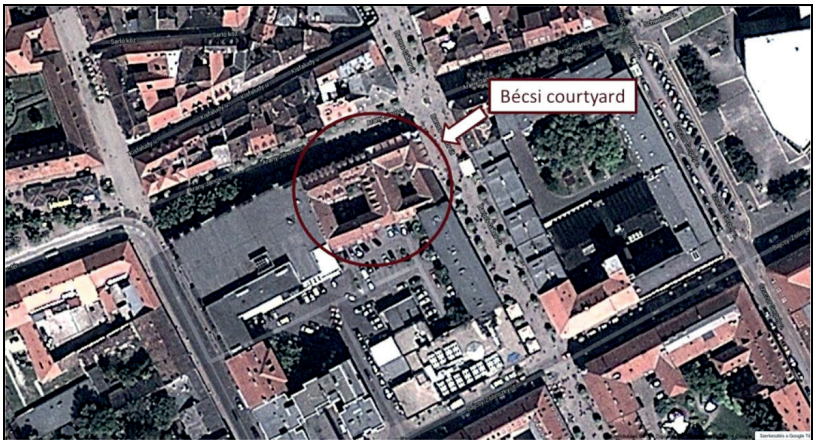

Fig. 3. The Bécsi courtyard in Győr
Source: own editing.

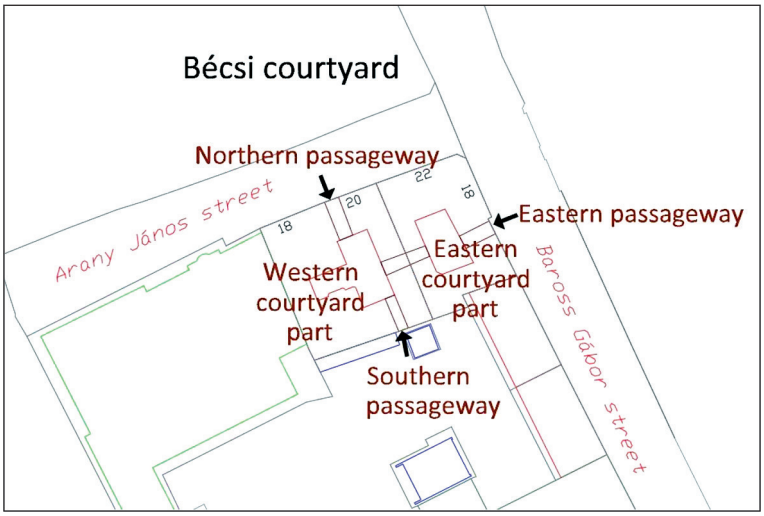

Fig. 4. The passages of the Bécsi courtyard
Source: own editing.

the south has a low amount of traffic. In the case of both courtyards the entrances are closed for the night and only in the morning are they reopened.

The pedestrian traffic of the Bécsi courtyard is not only influenced by the courtyard and what can be found there; like several stores, an ice cream shop, a coffee shop, and a restaurant, but also the location of the courtyard in the city. Towards the east of the Bécsi courtyard another inner courtyard can also be found where there is a fast food restaurant and a small park with a playground. In addition the pedestrian traffic between the two courtyards occurs through the busiest pedestrian street of Győr. However it's not a negligible aspect that the northern passageway of the Bécsi courtyard opens onto Arany János Street, which has a significant amount of pedestrian traffic too. This is due to the fact that at the western end of Arany János Street there is a department store and a smaller square where a market also operates, along with a bus stop. However the traffic of the Kazinczy courtyard is primarily due to Széchenyi Square and city structures of the north-south oriented Jedlik Ányos and Czuczor Gergely streets. These streets play a significant role in the connection of the downtown along with the Révfalu district from the north. Therefore significant pedestrian traffic around the Kazinczy courtyard comes from only the eastern and northern direction because the southern side is bounded by Csillag Street. This small street, which is actually an alley, has significantly lower traffic than the surrounding pedestrian streets. This is all due to the fact that there are no stores or significant restaurants, only a bar. Csillag Street provides a passage between Baross and Czuczor Gergely streets but with it northern direction parallel to Kazinczy Street and in a southern direction parallel to Kisfaludy Street it also fulfils this function in which pedestrian traffic is much higher. All of this impact can be felt on the traffic of the Kazinczy courtyard. Therefore to determine the amount of pedestrian traffic in the Kazinczy courtyard a study was made in the summer of 2012.

4. The study of the courtyards pedestrian traffic

To study the pedestrian traffic of the Kazinczy courtyard one day was available at the end of July 2012 because the residents of Kazinczy Street number 18 and 20 didn't support carrying out further studies. Similar to the former studies as it happened in the case of the Bécsi courtyard the pedestrian traffic was counted at three different times. The three time periods were in the morning from 9:00 to 10:00, in the afternoon from 13:00 to 14:00 and in the late afternoon from 16:00 to 17:00. In the selection of the time periods it was an important aspect that in the case of the morning period to avoid the morning rush because this would have overlapped with the late-afternoon time period when the after work time pedestrian traffic was more relevant. Each one-hour time period was broken down into 15 minutes.

In the Kazinczy courtyard similar to the Bécsi courtyard not only the pedestrian traffic was counted but also the bicycle traffic, the store traffic, and the number of the dog walkers. However in the Kazinczy courtyard there are no benches or chairs therefore no survey data was taken regarding the number of the street furniture. Also data was not collected with the absence of restaurant or ice cream shop, in particular how many people used their terrace or how many people were waiting in a line. However it must be mentioned that at the time of the study of the Kazinczy courtyard's pedestrian traffic only two businesses were in operation because the hairdressing salon was under reconstruction and the third business was opened later. And all of these, even if not significantly, could have impacted the traffic of the courtyard.

Comparing the pedestrian traffic of the Kazinczy courtyard with the average of the three days (17th, 22nd, 26th August 2011) of pedestrian traffic of the Bécsi courtyard it's clear that it is much lower. In the Bécsi courtyard based on the averages of three days 38 people was the lowest value (Fig. 6) in the case of the Kazinczy courtyard the highest value didn't even reach 20 people (Fig. 5). It's also a significant difference that the number of the children is well below the Bécsi courtyard in fact in the afternoon studied time period not one child walked through the Kazinczy courtyard.

What is common in the case of both courtyards is that the highest pedestrian traffic was observed between 13:00 and 13:15. According to the field study this was probably due to the lunch break because most of the workers in the downtown at this time went to lunch or back to their work place. The significantly lower pedestrian traffic of the Kazinczy courtyard had several reasons for this. While counting the traffic of the two courtyards it was observed that the coffee shop, the ice cream shop and the restaurant of the Bécsi courtyard had a significant number of people attracted to the courtyard (this was due to it being a summer study and the obvious attraction to the ice cream shop and coffee shop.) However it was also an important aspect that in the Bécsi courtyard there are chairs that can provide rest and the passageways are connected to streets with significant pedestrian traffic. In contrast in the Kazinczy courtyard are no restaurants or ice cream shops neither chairs nor benches. And as it was mentioned in the previous chapter the Kazinczy courtyard provides a walk through possibility from southern direction due to the low-traffic.

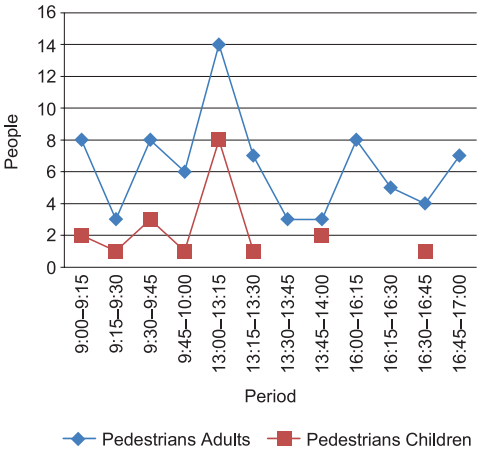

Fig. 5. Pedestrian traffic in the Kazinczy courtyard (30 July 2012)
Source: own editing.

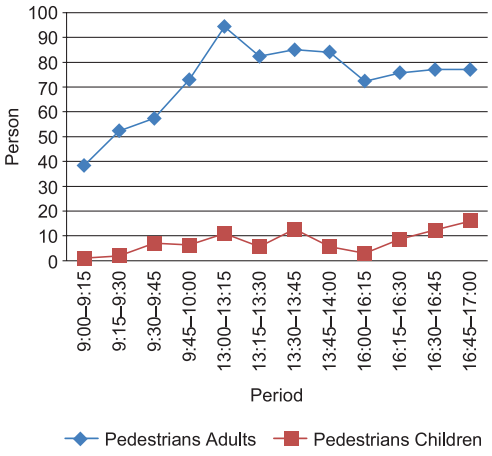

Fig. 6. Pedestrian traffic in the Bécsi courtyard based on the average of the three day study (17–26 August 2011)
Source: own editing.

Most of the courtyard-visiting pedestrians after their visit to one of the businesses leave mostly in the direction through which they had approached it.

As it was previously mentioned during the time of the traffic count in 2012 a total of two businesses had been operating in the Kazinczy courtyard. So besides the pedestrians it was also counted those who have entered these two stores. From the results it turned out that these stores had quite low traffic. However what this study also clearly demonstrated was that the highest traffic was between 13:00 and 13:15 when 14 people entered the stores (Fig. 7). Before that between 9:45 and 10:00 there was also more "significant" traffic (6 people) than in the afternoon between 16:00 and 16:15 and in the morning between 9:30 and 9:45 when equally 4 people visited the stores.

Besides the pedestrian traffic the cyclists also have been counted. However as it can be seen in the graph a total of three adult cyclists entered the Kazinczy courtyard (Fig. 8). In contrast to this in each of the studied time periods at the Bécsi courtyard there was a continuous flow of cyclists (Fig. 9). However it's also true, that none of courtyards had more than two cyclists enter at any given time on average. (In the Bécsi courtyard looking at the three days separately there was only one period of time between 9:00 and 9:15 when there were four adult cyclists.) The difference between the two courtyards is that in the case of the Bécsi courtyard in a studied time children also cycled through it.

We can say none of the bicycle traffic in the courtyards is significant but it must be emphasized that in the Bécsi courtyard due to its location in the downtown more people could turn around with a bicycle. What must be noted in the case of both courtyards is that due to their size, except for some of the children, the adults can only push a bicycle next to them while they walk and the reason for this is that each courtyard leads to pedestrian streets where the cycling is forbidden.

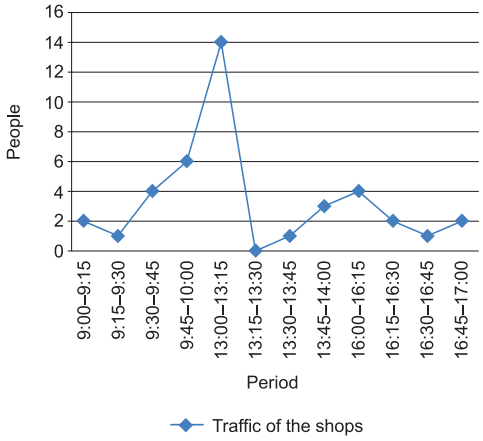

Fig. 7. The traffic of the stores in the Kazinczy courtyard (30.07.2012)
Source: own editing.

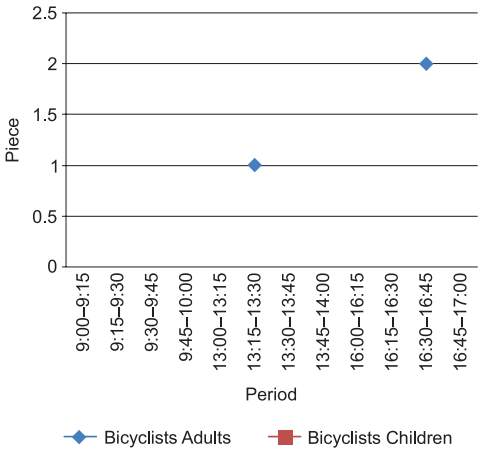

Fig. 8. Bicycle traffic in the Kazinczy courtyard (30 July 2012)
Source: own editing.

Finally besides the pedestrians and the cyclists the number of the dog walkers was also counted. Looking at the rate of the dog walkers it can be said about both of the courtyards as in the case of the cyclists' number that it is similar. In the Kazinczy courtyard a total of one person entered, at three different times, who was walking a dog (Fig. 10). However in the Bécsi courtyard based on the three-day average in the morning between 9:15 and 9:45 and in the afternoon between 13:00 and 16:15 there were those who were walking a dog (Fig. 11). Looking at the rates

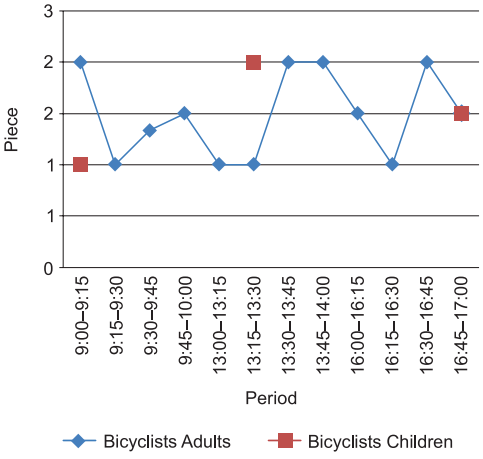

Fig. 9. The bicycle traffic in the Bécsi courtyard based on the average of the three day study (17–26 August 2011)
Source: own editing.

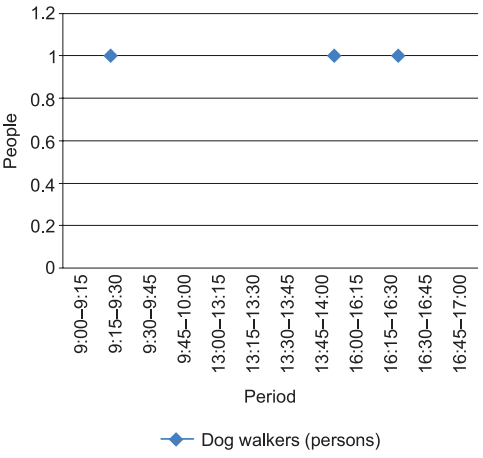

Fig. 10. The number of the dog walkers in the Kazinczy courtyard (30 July 2012)
Source: own editing.

of the dog walkers in the Bécsi courtyard from 9:15 to 9:30 the value (3 people) was the highest. However after that, except for two time periods in the Bécsi courtyard, in both courtyards one dog walker entered. The biggest difference between the two courtyards was that in the Bécsi courtyard there was a more continuous presence of the dog walkers than in the Kazinczy courtyard. However at the same time none of them were significant.

One explanation for the highest number of the dog walkers in the Bécsi courtyard on the basis of the field study is that some of the people living there own a dog and some of people living around the courtyard could also be dog owners.

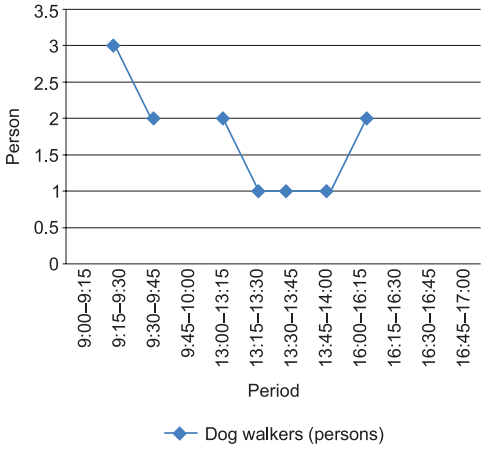

Fig. 11. The number of the dog walkers in the Bécsi courtyard based on the average of the three day study (17–26 August 2011)

Source: own editing.

Therefore the significant difference of the two courtyards pedestrian traffic can be summarized as follows: the traffic of the inner courtyards depends on that there is street furniture (*e.g.*, chairs, benches), services of the courtyard (*e.g.*, restaurants, coffee shops, ice cream shop, etc.), from the traffic of the surrounding streets and finally from its location in the urban fabric. On this basis the following can be concluded form the Bécsi and Kazinczy courtyard:

- The Bécsi courtyard has a much higher (adult, and children) pedestrian traffic than the Kazinczy courtyard
- In the Kazinczy courtyard the stores have low traffic
- The bicycle traffic in both courtyards is low
- The number of the dog walkers in the Bécsi courtyard is higher

In order to determine how much traffic can be deduced in the two courtyards and at which passageways could bottlenecks occur a pedestrian simulation was used to provide help.

5. The traffic simulation of the Bécsi and Kazinczy courtyard

The simulations have been made with the help of the VISSIM 5.40 program in which a pedestrian application is based on the so-called "Social Force Model". This model's findings are related to the pedestrian movements as follows (Helbing, Molnár, 1995, Helbing *et al.* 2001):

1. Pedestrians normally always choose the most comfortable, namely the fastest, route to achieve their destination, therefore it has the shape of a polygon.
2. The motion of the pedestrians is influenced by other pedestrians too because the pedestrian keeps a certain distance from other pedestrians, which is influenced

by pedestrian density and the desired speed. However it plays an important role the private sector and the so-called territorial effect, which means that the pedestrian normally feels increasingly uncomfortable if a strange person gets closer to him, and may react in an aggressive manner.

3. The pedestrians not only keep a certain distance from each other but also keep a certain distance from the borders of buildings, walls, streets, trees, obstacles, etc., namely the so-called artificial and natural borders. Owing to the fact that the pedestrians feel more uncomfortable the closer to such a border they must walk by and they have to pay more attention, for example, not touching the walls of the houses. This is the so-called "repulsive effect".
4. The movement of the pedestrians is sometimes effected by other pedestrians such as friends, street musicians, artists, etc., or even objects (*e.g.*, fountain, statue, etc.), which is the "attractive effect". This effect is also responsible for the formation of pedestrian groups when acquaintances or friends stop to talk to each other.

Therefore the simulations made with VISSIM program have given a real picture of what kind of traffic or problems may occur over or under a certain number of pedestrians. Both courtyards' simulations have been made on the basis of the field study in 15 minutes (900 seconds) time intervals and only the number of the pedestrians was modified during the studies.

According to the simulations the following can be said for the Bécsi courtyard (Fig. 12):

– In the Bécsi courtyard with over 2500 people, such a size has congested the pedestrians in front of the southern passageway around the terrace of the coffee shop, as to make it unwalkable.

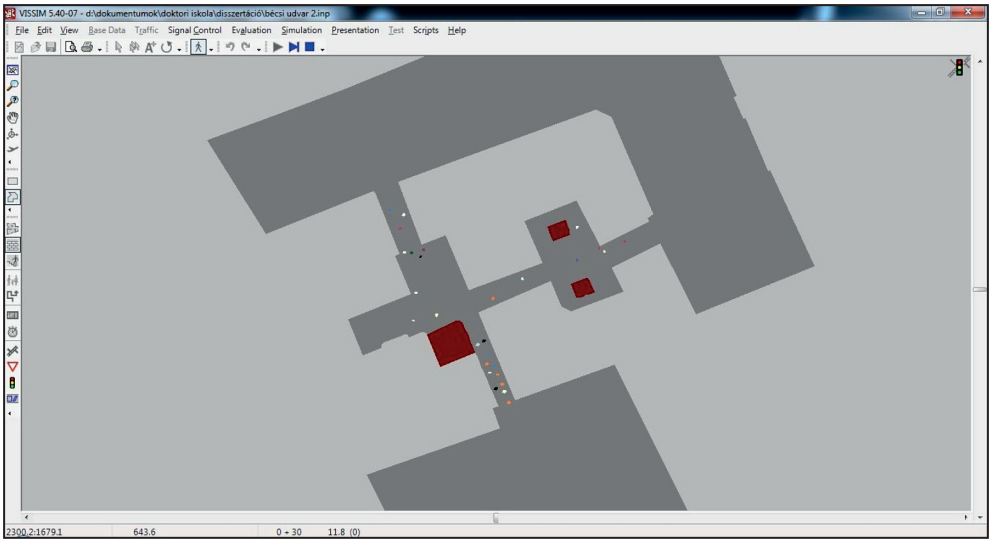

Fig. 12. The simulation of the Bécsi courtyard with the VISSIM program
Source: own editing.

- In the case of 2000 people no obstacles have been formed at the eastern and northern passageways but at the southern one smaller bottlenecks have occurred. The bottlenecks at the southern passageway are explained by that from the three passageways it's the narrowest and located there in the courtyard is the terrace of the coffee shop. (And in the southern passageway there is an ice cream shop, which could generate periodically significant traffic.)
- In the case of a closure of the Arany János Street northern passageway the two parts of the courtyard connecting passageway of the Bécsi courtyard becomes unwalkable with 2000 people. In this case the significant pedestrian traffic on Baross Street leading to the eastern and southern passageways are not enough to deliver the traffic.
- With the closure of the Baross Street eastern passageway, bottlenecks are formed first in the front of the southern passageway around the terrace and then in the northern passageway.
- During the simulation into the smaller courtyard of the Bécsi courtyard where there are two obstacles located that are approximately 5 m^2 and 1 meter high no bottlenecks occurred in the pedestrian traffic.

The simulation of the Bécsi courtyard has shown that during 15 minutes 1500 people without bottlenecks can pass through the courtyard. The first smaller bottlenecks were formed by 2000 people in the southern passageway. Due to the fact that the southern passageway is not only the narrowest from the three passageways of the courtyard but also there is located in the courtyard a terrace of a coffee shop. Inside the passageway not far from the terrace an ice cream shop is located which also generates periodically significant traffic. In the VISSIM program it can't be set to take into account the traffic of the various restaurants or stores but it still can be seen that this passageway could cause serious problems in the case of higher traffic or even escape.

According to the field studies the busiest passageways of the courtyard were to the Baross Street opening top the east and to the Arany János Street opening to the north. Therefore it was interesting to see what kind of changes happened over 2000 people in the movement of the pedestrians if one of the passageways were closed. However it should be noted it's not sure that the closure of the northern passageway in reality would lead to what the simulation experienced as significant bottlenecks. Insamuch as the southern passageway opens to one of the most popular parking place of the downtown in Győr where the pedestrians also in a large number could fit next to each other. In addition the eastern passageway of the Bécsi courtyard as it already has been mentioned leads to the busiest pedestrian street of Győr. Both public spaces offer further alternative routes to the direction of Arany János Street. All of this is true during the closure of the eastern passageway that bottlenecks are experienced because even in the direction of Arany János Street or the parking place both can be access Baross Street.

The eastern passageway, which is the smaller courtyard, of the Bécsi courtyard from a community aspect can be said that it is underused because in contrast to the larger courtyard part there are no benches or chairs located there. Only one business premises can be found in that area with a smaller tree and a specially de-

signed column, which once functioned as a show-window but currently it's empty. Therefore this courtyard offers a good opportunity for a larger green area or new street furniture placement. Therefore during the simulation an approximately 5 m² obstacle has been placed in this area to find out if it can cause bottlenecks in the pedestrian traffic. From the results it turned out that any obstacles present won't have an effect on the pedestrian traffic or on the traffic of the passageways if the eastern courtyard would be reconstructed.

According to the simulations the following can be said form the Kazinczy courtyard (Fig. 13):

- In the Kazinczy courtyard in the case of a 1500 person simulation the pedestrians have left the courtyard without bottlenecks through the southern and the north-western passageways.
- In the case of a 2000 person simulation the Kazinczy Street opening north-western passageway smaller bottlenecks would occur.
- According to the simulations the traffic of the northwestern passageway was the highest and the northeastern passageway the lowest. This is primarily due to that from the three passageways of the courtyard the northeastern is the narrowest.
- In the middle of the courtyard an obstacle was place that was approximately 4 m² and 1 meter high and it caused no bottlenecks in the pedestrian traffic.

As it already has been shown in the previous chapter the pedestrian traffic of the Kazinczy courtyard is much lower than in the Bécsi courtyard. The simulations have confirmed that over 2000 people bottlenecks occur in the north-western passageway. So in contrast to the Bécsi courtyard it was less than 500 people that number of the pedestrians won't form bottlenecks at any of the passageways.

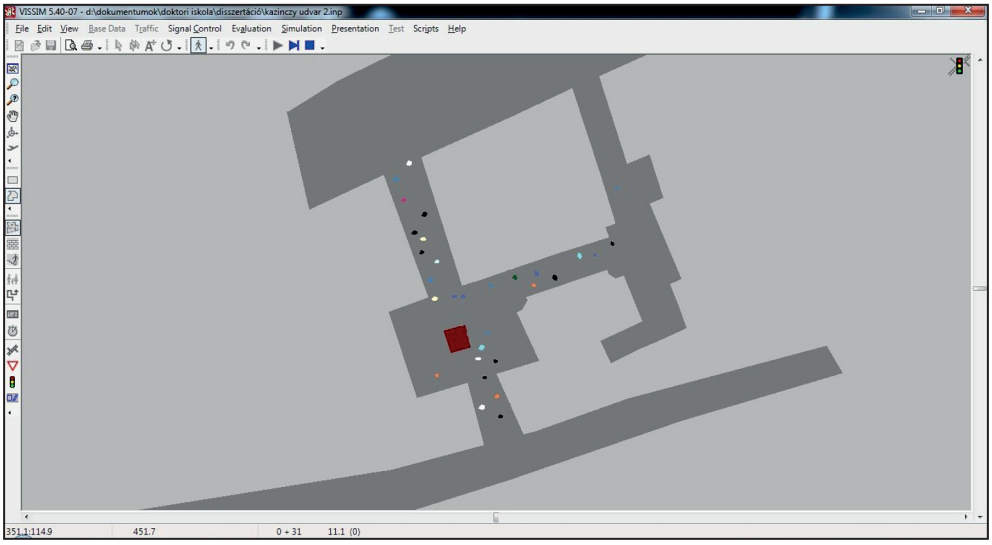

Fig. 13. The simulation of the Kazinczy courtyard with the VISSIM program
Source: own editing.

The busiest passageway of the Kazinczy courtyard is the north-western passageway despite the fact that approximately 15 meters from it can be found its north-eastern passageway as well. This is according to the on-site monitoring, the traffic counts, and simulations due to the following: the north-western passageway is much wider than the north-eastern one from which it has a lower "repulsive effect". The north-eastern passageway is not permanently open as is the north-western one, and approached from Kazinczy Street or Széchenyi Square it cannot be seen clearly that it opens into a courtyard. In front of the north-western passageway a table for the pedestrians is displayed, which shows the courtyard and what stores can be found in it. The southern passageway leads to an alley in which the pedestrian traffic is quite low and it there can't be found any significant traffic generating things like stores, restaurants, or functions (*e.g.*, fountain, playground). In the Kazinczy courtyard the stores are primarily located in the western part of the courtyard and in the eastern part of the courtyard connecting passageway. All of this is due to the fact that most of the people visiting the courtyard use the north-western passageway and leave also through it.

In the Kazinczy courtyard in contrast to the Bécsi courtyard there is not only any street furniture for relaxation but it also lacks a green area. Therefore, it was especially important during the simulation to consider the possibility of how that would effect the pedestrian traffic if in the middle of the courtyard if for example there would be an approximately 4 m^2 area established for this purpose. According to the studies the separation of an area of this size from the larger part of the courtyard wouldn't have any effect on the pedestrian traffic of the courtyard.

The simulations have proved that in the case of both courtyards it is approximately 2000 people who, besides smaller bottlenecks, can still pass through the courtyard. It also turned out that if there are more than 2000 people in the western part of the Bécsi courtyard around the terrace of the coffee shop and in the Kazinczy courtyard inside the north-western passageway this can cause serious bottlenecks, which make both places unwalkable. However it also has been proved that in both courtyards there is the potential to develop smaller green areas, which wouldn't cause bottlenecks in the pedestrian traffic and in the pedestrian traffic of the passageways depending on its width. However, the simulations have shown that the Kazinczy courtyard could receive less pedestrian traffic and from its three passageways only the north-western can expect serious traffic. Therefore it can be said that from the two courtyards the design of the Bécsi courtyard is much better from the aspect of pedestrian traffic.

6. Conclusions

From the studied Kazinczy and Bécsi courtyards it has become clear in the paper that the traffic of the former is much lower than the traffic of the latter. This significant difference according to the results can be summarized as follows:

– The traffic of the inner courtyards depends on the traffic of the courtyards surrounding public spaces (streets, squares),

– The traffic of the inner courtyards, besides the stores, is also influenced by the services (*e.g.*, restaurants, coffee shops, ice cream shops), the street furniture (*e.g.*, chairs, benches) and the functions (*e.g.*, fountains, playgrounds),
– The traffic of the inner courtyards depends on the width of the passageways and the level of the surrounding public spaces pedestrian traffic,
– The traffic of the inner courtyards depends on how much it is indicated clearly that the entrances lead to an inner courtyard.

Taking into account the listed criteria it can be conclude that the low pedestrian traffic of the Kazinczy courtyard comes also from the deficiencies of these points. As it could be seen in the Bécsi courtyard not only bounded by the busiest pedestrian street of Győr but all of its three exits leads to a public space with significant pedestrian traffic. Inside the courtyard not only stores but a coffee shop, restaurant and an ice cream shop also can be found. In addition for relaxation there are not just chairs providing opportunities but the terrace of the coffee shop also.

Of the three entrances of the courtyard in the front of two of them a table advertises that there is a coffee shop, restaurant, and ice cream shop. Therefore it is no accident that its busiest passageway is the one to Baross Street, which is the busiest pedestrian street and also the largest table there advertises that in the courtyard there can be found a coffee shop. In contrast to the Kazinczy courtyard where only three smaller shops and a hairdressing salon operates there are no street furniture or restaurants. From the courtyard the surrounding public spaces to the eastern direction located at Czuczor Gergely Street and Széchenyi Square there is significant pedestrian traffic. From the three exits two lead to the northerly direction located on Kazinczy Street, which has medium pedestrian traffic and one to Csillag Street with low pedestrian traffic. And in the courtyard the stores are located only in the front of the north-western entrance and there is a table showing this for the pedestrians.

The pedestrian simulations also have proved the findings relating to the traffic of the inner courtyards because in both cases the least busy were the narrowest passageways. However the simulations have proved that a certain number of the pedestrians in each are possible for such a transformation or expansion, which currently is missing from the given courtyard. Such an expansion could be the green area or the street furniture placement, for example in the Kazinczy courtyard. However what must be important to note is that these inner courtyards are not parts of the main transport networks but only functioning as an alternate route because as it could be seen in each courtyard the traffic capacity was finite. However they provide an opportunity for the pedestrians to reach their goal in a shorter and a more interesting route. However, for these courtyards to function well and be attractive it's important where they will be constructed in the city and how. So wherever an inner courtyard might be built up or opened in the future the above listed criteria must be taken into account in every case if we want to see it as an area full of life.

However it would be important to make further research in this field regarding how it would be effect a city's climate with the increase of green areas and water surfaces (*e.g.*, fountains, drinking fountains) in the inner courtyards. The Climate-Friendly Cities – A Handbook on the Tasks and Possibilities of European

Cities in Relation to Climate Change titled book states that around the world it is increasingly gaining ground the garden placement and the greening (Ministry of Interior – Váti Nonprofit Kft 2011), which could have a positive effect on the microclimate of its narrower environment for example in the summer heat. And in our country in recent years we have experienced extreme weather changes, which also give reasons to continue such studies.

References

Borbíró V., Valló I., 1956, *Győr városépítéstörténete*. Budapest: Akadémiai kiadó.
Berkovic S., Yezioro A., Bitan A., 2012, *Study of thermal comfort in courtyards in a hot arid climate*. "Solar Energy" Vol. 86, No. 5, pp. 1173–1186.
Daamen W., 2004, *Modelling Passenger Flows in Public Transport Facilities*. DUP Science, The Netherlands.
Dávid G., Zubor L., Nitsch G., 2010, *Korszerű számítástechnikai eszközök a gyalogos létesítmények forgalmi tervezésében*. "Városi Közlekedés", 1, pp. 13–24.
Du J., Sharples S., 2011, *Assessing and predicting average daylight factors of adjoining spaces in atrium buildings under overcast sky*. "Building and Environment", Vol. 46, No. 11, pp. 2142–2152
Ministry of Interior – Váti Nonprofit Kft., 2011, *Climate-Friendly Cities – A Handbook on the Tasks and Possibilities of European Cities in Relation to Climate Change*, Ministry of Interior – VÁTI, Budapest.
Helbing D., Molnár P., 1995, *Social force model of pedestrian dynamics*. "Physical Review E" 51, p. 4282–4286.
Helbing D., Molnár P., Farkas I.J., Bolay K., 2001, *Self-organizing pedestrian movement*. "Environment and Planning B: Planning and Design" Vol. 28, No. 3, pp. 361–383.
Jóna L., 2013, *Pedestrian traffic and the closed inner courtyards in the 21st century*. "Acta Technica Jaurinensis" Vol. 6, No. 4, pp. 52–70.
Thompson C. W., 2002, *Urban open space in the 21st century*. "Landscape and Urban Planning", 60. pp. 59–72.
Winkler G., 1988, *Győr, Arany János utca 18–22*. Tömbmegújítás, Magyar Építőipar, Vol. XXXVII, No. 1–2, pp. 18–19.
World Urbanization Prospects The 2014 Revision Highlights, 2014, – United Nations, New York.

Affiliations:
László Jóna
Széchenyi István University
Interdisciplinary Doctoral School of Engineering
Egyetem tér 1, 9026 Győr (Hungary)
HAS Centre for Economic and Regional Studies
Institute for Regional Studies
West-Hungarian Research Department
Liszt Ferenc 10, 9022 Győr (Hungary)
e-mail: jonal@rkk.hu

For citation:
Jóna L., 2015, *The features of the good and bad functioning closed inner courtyards – through a Hungarian example*. "Studia Regionalia" Vol. 41–42, pp. 51–67.