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SPATIAL METRO *TRACKING PEDESTRIANS IN HISTORIC CITY CENTRES*

This chapter describes the results of a series of pedestrian observation studies carried out in Norwich, Rouen and Koblenz as part of the Spatial Metro project. The goal of these studies was to observe pedestrian behaviour and to investigate pedestrian movement and experience in the city centres. The cities are engaged in improving the physical conditions and the experience of their city centres by investing in landscaping and engineering of public spaces, city beautification, wayfinding and in communication and information technology. (also see Spek, 2008)

The Spatial Metro project brings together a transnational group of partners, enabling them to co-operate with a view to improving city centres for pedestrians. The theme of Spatial Metro is 'Discovering the City on Foot'. The project aims to make city visits more enjoyable for pedestrians by making them easier to navigate, easier to walk around and easier to understand and appreciate (http://spatialmetro.org, accessed 11 July 2008).

The project has been allocated European Regional Development Funding through the INTERREG III/B Community Initiative. A group of ten organizations participate in Spatial Metro: The lead city of Norwich (UK) and the cities of Rouen (F), Koblenz (D), Bristol (UK), Biel/Bienne (CH), as well as academics from the University of East Anglia (UK), the Delft University of Technology (NL), the University of Koblenz (D) and the Swiss Pedestrian Association (http://spatialmetro.org, accessed 11 July 2008).

The main role of the chair of Urban Design was to develop instruments to evaluate visitor-experience and to observe the use of public space. The purpose of the observation studies was to evaluate the use of space in relation to investments, (rather than using the outcome as a design tool to pinpoint) opportunities and threads in the city; the outcome focuses on a comparison between the actual situation and real use.

For the observation of the public space, a specific method using Global Positioning System (GPS) devices capturing the movement of pedestrians was developed and put into practice. The recording of pedestrian behaviour was accompanied by a questionnaire adding background information on the participants. (Spek, 2006; Spek & Schaick, 2007)

This article will focus on the differences and similarities in pedestrian behaviour in three historic cities in three countries based on quantitative and qualitative research. Do people behave different in these three historic European cities? Can we distinguish different spatial patterns based on the origin and familiarity of the visitor and the purpose and duration of the visit?

After this introduction, the set-up and implementation of the fieldwork will be explained in 'Way of Working'. Here, the methods for processing the data and the criteria employed in connection with the analysis will be clarified. Following this, the results will be described and illustrations provided for each location. The chapter concludes with a synthesis comparing the findings of the different cities.

WAY OF WORKING

The method of collecting data on pedestrian behaviour is based on the Global Positioning System (GPS). GPS is primarily a system for navigation and orientation. The GPS system makes use of a network of satellites in orbit which send signals to earth (http://en.wikipedia.org/wiki/Global_positioning_system, accessed 21 Nov. 2007). A GPS device has the ability to receive these signals and compute its geographical position. At least three to four satellites are necessary in order to accurately determine a position (see chapter 3).

GPS devices are mainly known as navigation or orientation instruments such as car navigation systems or outdoor orientation equipment. The technique has been developed in the military in the United States. Since the year 2000, the technique has been more widely available to the public, although its accuracy is still limited (http://en.wikipedia.org/wiki/Global_positioning_system, accessed 21 Nov. 2007). Today, accuracy is around three to five metres in the open field. Europe is building its own global positioning system called Galileo. (see chapter 3; Spek, 2006; Spek & Schaick, 2007)

GPS tracking

The method of collecting data on pedestrian movement makes use of the ability that some GPS devices can store a sequence of positioning data at a determined time interval. This sequence results in a place-time log. The log file can be read out real-time or later and projected onto maps in a Geographical Information System (GIS). GIS has the ability to join different layers of information or different sources, but GIS also provides tools to process, model and visualize data. (http://en.wikipedia.org/wiki/Geographic_information_system, accessed 30 Nov. 2007; see chapter 4)

Why tracking pedestrians

With traditional methods it is possible to gain insight into pedestrian movement. However, this insight is limited to the scope of the method. Counting people at certain locations leads to insights into the density of the use of the public space only at these locations. Such methods do not collect information on journeys, patterns of use or route choices. Models could possibly estimate where people might walk. However, this would be based on a prediction, and not on an actual situation. Travel diaries might give insights in actual behaviour, but depend on the accuracy of people's minds. A case study in Delft (Spatial Metro workshop, Delft, February 2006: comparison between GPS output and mental maps) showed that the ability of people to reproduce a walked route in a map is inadequate. The actual walking pattern based on GPS tracks deviated repeatedly from the drawn map.

Using GPS technology it is possible to acquire accurate and detailed insights into actual behaviour. The technology will provide insights into the exact departure and return time, time spent at specific locations, destinations, the walked route or geographical route of the journey, the speed and the mode of transport (see chapter 3).

An important aspect of GPS tracking is to collect information on the whole journey from departure to return. In the event of activity-based research, people will probably have a GPS device for a certain period of time at their homes. In the event of studying pedestrian behaviour, this would make no sense, as it is not clear when and how often people will visit the city centre. Collecting data about pedestrian movement in cities requires other ways of distributing and collecting devices and gathering data. Other systems could involve tracking people living or working in a specific building, street or area or tracking people from a specific point at which they enter the city centre.

For the Spatial Metro project, the main target group is visitors of the city centre. The main points of interest are shopping (retail) or leisure (culture, heritage, drinking, dining). The most feasible

way of collecting as much data as possible within a short period of time is to distribute and collect the tracking devices at an access point to the city. Access points are e.g. train terminals, bus stations and parking facilities. Parking facilities assure that people will return to their cars and thus return the device. Free parking was offered to people who decided to participate. This way of working meant that no GPS devices were lost. The drawback was that only visitors arriving by car were recorded.

To collect generically useable data without different weekdays affecting the data, data needs to be covered throughout the week. The time frame depends on both the target group and the opening hours of the activities in the city centre – the so called destinations or anchor points. In general, the distribution of the devices started around 10am and continued until around 5pm. People returning late were able to return the devices to the car park information desk (24/7). This practical time constraint excludes people who expect to arrive late.

Field work

From June 20th until June 26th 2007, a team from Delft University of Technology (DUT) in cooperation with Norwich City Council (NCC) carried out fieldwork in Norwich. After that, the field work in Rouen was carried out from October 1st until October 6th 2007 in cooperation with Rouen City Council (Marie de Rouen). Finally, from October 8th until October 14th, fieldwork was carried out in Koblenz in cooperation with Koblenz City Council (Stadtverwaltung Koblenz)

In each city, fieldwork was carried out from two different parking facilities at the same time. This made it possible to collect sufficient and comparable data within one week. The data will be generically useable and comparable as all data from the different locations is collected under the same conditions.

In principle, the chosen facilities were on either side of the city centre. In Norwich the first location was St. Andrews Car Park (1000 cars, opened June 2005), an important parking facility on the northern side of the centre core near The Lanes. The second location was Chapelfield Shopping Mall (1000 cars, opened in 2005 as well), located on the southern side of the centre core and developed at the location of an old chocolate factory. In Rouen the first location was Vieux Marché (400 cars), on the Westside of the city centre. The second location was Haute Vieille Tour (430 cars) on the Southwest side of the city centre. Finally, in Koblenz the location on the Westside was Löhr-Centre, a car park on top of the shopping mall (1400 cars). The second one on the Eastside was Görresplatz, an underground car park (350 cars). (also see Spek, 2008)

Procedure

The information and co-ordination point for the distribution and collection of GPS devices was located near the pedestrian entrance/exit of the parking garage. People leaving the parking garage were handed out flyers explaining the background and setup of the study and asked to contribute to the research. If they matched the 'shopping' or 'leisure' target group, a GPS was presented in return for their parking ticket. To understand the behaviour better, a questionnaire had to be filled in on return. Participation was extremely high. No personal information on any of the participants was kept. (Spek, 2008)

illustration 7.1
GPS-devices used in the Spatial Metro project

Processing data

Data was collected from two different sources: track logs resulting in temporo-spatial quantitative information and questionnaires resulting in social-geographical qualitative information. For data management reasons and to keep all data anonymous, a unique code was allocated to every entry.

Processing the data consisted of 5 steps: (1) validation, (2) cleaning, filtering and repairing, (3) individual analysis, (4) collective analysis based on the questionnaire and (5) findings and conclusions. The results of processing are layered analysis drawings in GIS, Photoshop and Illustrator. A selection of these drawing will be used to illustrate the results. (Spek, 2008)

Step 1 Validation

The assessment of temporo-spatial data was based on track data, matches between track data and questionnaire, the start point of the track, the end point of the track, and the readability and consistency of the track. If all questions received a positive response, the file was marked as valid. Otherwise, the file was rejected or had to be cleaned. In further steps of the analysis only valid tracks were taken into account. (Spek, 2008)

Step 2 Cleaning, filtering and repairing

The quality of the raw track log files varies depending on several factors. Cleaning, filtering and evaluating the tracks are necessary to determine validity. Within this study, tracks were only filtered and assessed, with no information which was lacking being added. (Spek, 2008)

Step 3 Analysis of individual data

After validation of the tracks the next step was the specific analysis of the route from the access point to the activities. For all distribution points a map with the alternative routes was generated. All tracks were checked with regard to the route used to walk into the city and the route used to return to the car park. Further, the type of journey was determined. A distinction was made between three types: (A) AREA, the destination is within the direct surroundings of the car park; (B) RETURN TRIP, same route to/from destination, probably a single destination and (C) ROUND TRIP, circular journey, different route, probably multiple destinations.

The following step in this type of analysis is the investigation of destinations and the time spent on these activities. Starting with a list of individual destinations, the result will conclude with a growing list of collective destinations ranking in time or frequency. This is very detailed research and as such has not yet been proposed within this study.

An important aspect for the analysis of tracks starting from Chapelfield and Löhr-Center is that people might start or end their journeys in the shopping mall. Time spent out on the streets can thereby be compared to time spent in a shopping mall and differences in behaviour can also be compared based on the type of starting point. (Spek, 2008)

Step 4 Analysis of collective data

The tracks themselves give an impression of use of the city when projected onto a map. Each individual track represents a person or group. Computations are required to create the collective image covering a selection of respondents. This can be established in GIS software where the temporo-spatial data was analysed using density calculations. With density calculations the number of lines or the number of points within a range of a certain locations are computed and visualised using a specific colour. The colour differs based on lower and higher values. This

technique simplifies line or point drawings. Using a legend it is possible to limit the visible data and emphasize structures.

All data was collected with a frequency of 5 seconds. Each dot on the map can therefore be interpreted as representing 5 seconds. Point density represents the time spent at a location. Using the outcome of the questionnaire, density drawings were made for four space-related themes: (1) origin, (2) purpose, (3) familiarity and (4) duration. The demographic themes such as age, group and gender have not been used to prepare specific spatial maps.

Within the theme "Origin", four subgroups can be distinguished: local, regional, national and international visitors. The theme "Purpose" can be divided into shopping (retail), leisure (i.e. drinking, dining, culture, heritage) and other purposes, including living, education, business or other formal appointments. Within "Familiarity" the subgroups are firstly visitors, occasional visitors and regular visitors. Lastly, the "duration" of the trip is based on the period of time between the distribution and the return of the GPS device. A representative subdivision is based on a two-hour time period, leading to the categories 'less than two hours', 'two to four hours' and 'more than four hours'. Per theme two representative subgroups were chosen for the visualisation of the results and conclusions. (Spek, 2008)

Step 5 Findings and conclusions

The background data provided in the questionnaire was analyzed using statistical software, namely SPSS. Frequency tables show how many times an alternative was mentioned. Cross tabulations provide insight into the relationships between subjects or categories.
The analysis also includes the fabrication of conclusion maps. These maps summarize and elaborate the outcomes of the analysis drawings. The maps contain three elements (Spek, 2008):

(1) edge	hard borders in the city which are hardly crossed
(2) no-go area	neglected parts of the city within the range of the access point
(3) attractors	main destinations, buildings and spaces/places

RESULTS

In the following paragraphs the results will be amplified per location. In 'Synthesis' a comparison will be made between the cities and the locations. In the last paragraph 'Reflection', the method will be discussed in respect to the Spatial Metro project and the investments.

Norwich St. Andrews

The fieldwork in Norwich was carried out from Wednesday June 20th until Tuesday June 26th 2007. The first distribution location was located at St. Andrews car park on the northern side of the historic city centre. This relatively new car park has approximately one thousand parking spaces. Most of them are used by commuters, but specific spaces are reserved for shoppers. The car park is open 24 hours, 7 days a week. The full daily rate is 5.00 pounds. The fieldwork facilities were located near the southern exit on the route to the city centre. This car park is an ideal starting point for destinations around St. Andrews Plain and the Norwich Lanes shopping district. In total, 370 people responded resulting in 173 directly useable tracks. The graphical result of the collective use of space is illustrated in **illustration 7.2**. The origin of the respondents at this location was generally local (84%), although regional visitors were also represented (11%). As expected, the main purpose was shopping (80%), followed by leisure (12%). Most respondents were regular visitors (80%), followed by occasional visitors (18%). People generally stayed in the city centre 2-4 hours (48%), with 40% staying for a shorter period. The main route people took to walk to the centre was Exchange Street, directly in front of the exit and leading to the market and the main shopping street. Alternative routes were along St. Andrews Street and Charing Cross. The return route was generally the same. (Spek, 2008)

Illustration 7.2
Norwich St. Andrews – all valid tracks of seven days

Legend:
circles 400m/800m; dots with a 5-second interval

Norwich Chapelfield

The second distribution location in Norwich was located at Chapelfield mall, a car park and shopping mall on the southern side of the historic city centre. This is also a relatively new car park with approximately one thousand parking spaces. The main focus of the car park is shopping and leisure. The full daily rate is 20.00 pounds, but special flat rates are also available. Access to Chapelfield Car Park is limited from 8am to 10pm. This car park is an ideal starting point for destinations on the southern side of the city centre. The distribution facilities were located near the main exit to the car park in the central hall. In total, 270 people responded resulting in around 80 directly useable tracks. The graphical result of the collective use of space is illustrated in **illustration 7.3**. The origin of the respondents at this location was generally local (80%), although regional visitors were also represented (17%). There were scarcely any national or international visitors at the location. As expected, the main purpose was shopping (90%), followed by leisure (8%). Most respondents were regular visitors (72.5%), followed by occasional visitors (27.5%). People generally stayed in the city centre for 2-4 hours (45%), with 40% staying for somewhat shorter periods. The main routes taken leaving the car park and returning to it were the same, namely Malthouse Road in the direction of Gentleman's Walk. The main destinations were the shopping streets leading to Norwich Lanes and Tombland. In comparison to St. Andrews, the response was far lower, and there were more regional visitors, more shopping as the main purpose, more occasional visitors and people generally stayed for a slightly shorter period. (Spek, 2008)

Illustration 7.3 Norwich Chapelfield – all valid tracks of seven days

Legend: circles 400m/800m; dots with a 5-second interval

Rouen Vieux Marché

The fieldwork in Rouen was carried out from Monday October 1st until Saturday October 6th 2007. The first distribution location was located at Vieux Marché car park on the western side of the historic city centre. The fieldwork facilities were located near the pedestrian exit of the garage. The car park is located in the main pedestrian area, which makes it an ideal starting point for the main cultural and commercial destinations. In total, 240 people responded resulting in 150 directly useable tracks. The graphical result of the collective use of space is illustrated in **illustration 7.4**. The origin of the respondents at this location was generally regional (46%), although local visitors were highly represented (37%). As expected, the main purpose was shopping (69%), followed by leisure (18%). Most respondents were regular visitors (64%), followed by occasional visitors (25%). People generally stayed in the city centre less than 2 hours (57%), with 35% staying for longer periods. The main route people took when walking to the centre was Rue du Gros-Horloge, directly leading to the Gros-Horloge ending at the Cathedral. Alternative routes were two parallel streets, namely Rue Saint-Lô and Rue Rollon. The route back was generally the same. The main destination was the shopping area between Vieux Marché and the Cathedral. (Spek, 2008)

Illustration 7.4
Rouen Vieux Marché – all valid tracks of seven days

Legend:
circles 400m/800m; dots with a 5-second interval

Rouen Haut Vieille Tour

The second distribution location was located at Haut Vieille Tour car park on the south-eastern side of the historic city centre, directly south of the Cathedral. The fieldwork facilities were located near the main pedestrian exit of the garage. The car park is not located in the pedestrian area, but is relatively close to the main cultural and commercial destinations. In total, 180 people responded resulting in over 130 directly useable tracks. The graphical result of the collective use of space is illustrated in **illustration 7.5**. The origin of the respondents at this location was both regional (42%) and local (39%). The car park is also used by international visitors (11%). As expected, the main purpose was shopping (66%), followed by leisure (21%). Most respondents were regular visitors (58%), followed by both occasional visitors (22%) and people on a first-time visit (20%). People generally stayed in the city centre for less than 2 hours (50%), with 38% staying for longer periods of 2-4 hours. The main route people took to walk to the centre was Rue de L'Epicerie, directly leading to the Cathedral. Most other alternatives were also used. Remarkably, the route back varied significantly to the route taken in. The main destinations were the Cathedral and from there Vieux Marché via the Rue du Gros-Horloge. In comparison to Vieux Marché, the response was lower, but the origin of people was more or less identical; the same applies to the respondents' purposes. In Haute Vieille Tour, more respondents were new visitors and people tended to stay for longer periods. (Spek, 2008)

Illustration 7.5
Rouen Haut Vieille Tour – all valid tracks of seven days

Legend:
circles 400m/800m;
dots with a 5-second interval

Koblenz Löhr-Center

The fieldwork in Koblenz was carried out from Monday October 8th until Saturday October 13th 2007. The first distribution location was located at the Löhr-Center – a car park on the roof of the main shopping mall on the western side of the city centre. A new railway station for the city centre is planned at the rear of this mall, with its main entrance situated at the Löhr-Rondell. The fieldwork facilities were located near the main pedestrian exit of the garage. The mall is located on the edge of the pedestrian area and is relatively close to the historic city centre, but the main tourist destinations such as the riverfronts are beyond reach. The mall has three exits: one on the Southside to Löhr-Rondell, one in the middle on the western side and one on the northern side of the building which connects to a pedestrian tunnel. In total, 180 people responded resulting around 100 directly useable tracks. The graphical result of the collective use of space is illustrated in **illustration 7.6**. The origin of the respondents at this location was mainly regional (60%). National and international visitors also use this car park (20%). As expected, the main purpose was shopping (75%), followed by leisure (22%). Most respondents were occasional visitors (50%) but the location is also used by new visitors (20%). People generally stayed between 2-4 hours (58%) or less than 2 hours (26%). A large group only uses the car park to access the city (40%), but the car park is also used for the mall itself – 33% of all visitors stay in the mall for over one hour. The exit people mainly took when walking to the centre was the Western exit directly leading to the Löhrstrasse. However, the route back varied significantly to the outbound route. The main destinations were within a range of 400 metres, and were mainly on the Löhrstrasse – the shopping street. (Spek, 2008)

Illustration 7.6
Koblenz Löhr-Center – all valid tracks of seven days

Legend:
circles 400m/800m; dots with a 5-second interval

Koblenz Görresplatz

The second distribution location was located at the Görresplatz car park on the eastern side of the city centre between the shopping district and the waterfront. The fieldwork facilities were located near the main pedestrian exit of the garage. The car park is located in the pedestrian area and is relatively close to the main cultural and commercial destinations. In total, 120 people responded resulting in around 100 directly useable tracks. The graphical result of the collective use of space is illustrated in **illustration 7.7**. The origin of the respondents at this location was mainly regional (54%). A fair number of national and international visitors also use this car park (38%). The main purpose was shopping (48%), directly followed by leisure (43%). Most respondents were new visitors (40%), followed by both occasional visitors (32%). People generally stayed in the city centre between 2-4 hours (51%), with 36% staying for shorter periods of less than 2 hours. The main route taken on leaving the location led to the shopping streets via the Firmunstrasse. However, remarkably enough, the route back varied significantly to the route in. People tended to browse their way back to the car park leaving a sprawled pattern of use. In comparison to the Löhr-Center the response was lower but more profitable. The origin of people in both locations was mainly regional, although Görresplatz had a greater number of national and international visitors. This factor affects the purpose statistics; in comparison to Löhr-Center, virtually twice the number of visitors to Görresplatz had leisure as their purpose, a number almost equal to that for shopping. In Görresplatz, far more respondents were new visitors, but people tended to stay for shorter periods. (Spek, 2008)

Illustration 7.7
Koblenz Görresplatz – all valid tracks of seven days

Legend:
circles 400m/800m; dots with a 5-second interval

CONCLUSIONS

This paragraph will give an overview of the results and conclusions of the different cities and locations. The result of the themes will be compared with a view to understanding the differences and similarities in visitors' behaviour in different cities. The comparison will be based on the four main themes: purpose, origin, familiarity and duration. Two graphical themes have been added, namely distance and spatial pattern.

Origin

Origin is divided into three separate categories: local, regional, (inter)national (see **illustration 7.8**). In all cases, national and international were the smallest groups. Especially in Koblenz, national and global visitors were represented (Görresplatz 38% and Löhr-Center 21%). In Koblenz, the majority of visitors were regional (59 and 54% respectively). Rouen is more orientated toward regional (42-46%) and local visitors (37- 39%). Norwich therefore seems to

Illustration 7.8
Visitors to the three cities (6 locations) according to three scales of origin: local, regional and (inter)national

be operating on the lowest scale with mainly local visitors and a tendency toward attracting regional visitors (81-84% and 11-17% respectively).

Purpose

The primary purposes of the visitors were shopping and leisure (see **illustration 7.9**). Not surprisingly, the shopping purpose was much higher at the two mall locations (Norwich 89% and Koblenz 75%). The main purpose in Norwich was shopping (79-89%), followed by Koblenz (48-75%). Rouen was somewhere in the middle (66-69%). The leisure purpose was mainly represented in Koblenz Görresplatz (43%). In the other cities, leisure was only indicated for 8-22%. Within shopping, a distinction is made between daily, fashion and luxury and non-daily shopping. Koblenz represents the highest ranks for daily purposes (15-18%), followed by Rouen (1015%) and Norwich (5-10%). In Norwich on the other hand, Fashion & Luxury were more frequently indicated as shopping purposes (50-63%) compared to the other cities (26-43%).

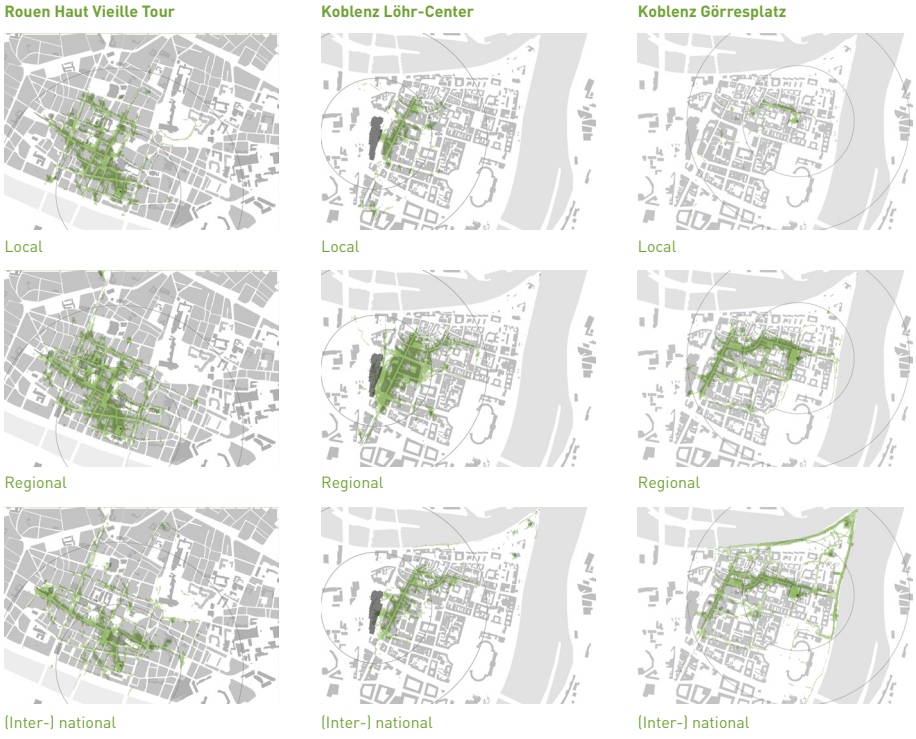

Illustration 7.9
Visitors to the three cities (6 locations) according to the purpose of their visit: shopping or leisure

Purpose

Norwich St. Andrews

Shopping

Leisure

Norwich Chapelfield

Shopping

Leisure

Rouen Vieux Marché

Shopping

Leisure

Illustration 7.10
Visitors to the three cities (6 locations) according to their familiarity with the city: first-time visitor, occasional visitor or regular visitor

Familiarity

Norwich St. Andrews

First Visit

Occasional

Regular

Norwich Chapelfield

First Visit

Occasional

Regular

Rouen Vieux Marché

First Visit

Occasional

Regular

Rouen Haut Vieille Tour

Shopping

Leisure

Koblenz Löhr-Center

Shopping

Leisure

Koblenz Görresplatz

Shopping

Leisure

Rouen Haut Vieille Tour

First Visit

Occasional

Regular

Koblenz Löhr-Center

First Visit

Occasional

Regular

Koblenz Görresplatz

First Visit

Occasional

Regular

Illustration 7.11
Visitors to the three cities (6 locations) according to the length of their visit: less than two hours, between two and four hours or more.

Familiarity

The assessment of familiarity with the city was based on the frequency of visits: first-time visitor, occasional visitor or regular visitor (see **illustration 7.10**). The respondents in Norwich clearly marked themselves as regular visitors (73-79%). The group hardly included any new visitors (0-3%). Rouen was visited by a mix of regular (58-64%) and occasional (22-25%) visitors. In Koblenz, the visitors were a mix of occasional (32-50%) and new visitors (18-40%). These figures correspond with the origin of the participants, assuming that locals visit the city centre more often and national and international visitors only incidentally.

Duration

For the duration, the time between distribution and collection of the GPS devices was calculated. Three workable divisions were made: less than two hours (< 2hrs), between two and four hours

(2-4hrs) and more than four hours (> 4hrs). The first conclusion is that the presence of a mall does not influence the total time spent. Both malls function as attractors and access points to the city. In this sense, a short time is spent in the mall and a longer period in the city. However, people also stay in the malls for longer periods and leave the malls for more limited periods. This influences the registered image of use outside the mall. A clear distinction can be made between the time spent in these three cities (see **illustration 7.11**). Participants stayed in Rouen for the shortest period of time: most of them under 2 hrs (50-57%) and some 2-4 hrs (35-38%). In Norwich, the respondents mainly stayed 2-4 hrs (45-48%), and some shorter (40%). Koblenz was the city where people generally stayed the longest: 2-4 hours (51-58%) and some shorter (26-36%).

Walking distance and form of covered area

For the spatial pattern, three types can be distinguished: line (or axis), area and main area with satellite destinations. Most locations fall within the area type. Exceptions are Koblenz Löhr-

Center with a strong axis as spatial character for all movement, and Norwich St. Andrews, undoubtedly an area with satellite destinations. To measure the maximum distance, circles of 400 and 800 metres were projected into the result drawings (5 and 10 minutes walking time respectively, depending on the spatial structure and local conditions). Evidently, Koblenz Löhr-Center has the smallest reach of approximately 400 metres. The other exception, also a mall location, was Norwich Chapelfield. Here the maximum walking radius was approximately 600 metres. All other examples had a maximum walking radius of approximately 800 metres.

REFLECTION

The tracking and questionnaire data give good insights into the behaviour and background of a large group of various types of visitors to the city centre. The technology makes it possible to collect and visualize data of movement. The background data provides the opportunity to select data and focus on specific themes and aspects. Using this method, it becomes clear that people behave in different ways in these historic European city centres. Different programmes (functions) are available, as well as different ways to access the city and different structures to use the city as a pedestrian. Up to the present, the method has only been used to monitor and visualise the dynamics in the participating historic cities. The method has not yet been used as a tool to evaluate or address urban design issues. However, this application of the tool can be foreseen.

Application of the results

In Norwich, various design issues can be mentioned. St. Andrews seems to be well-integrated its surroundings and contributing to the city. Especially Exchange Street has become a key access street into The Lanes. Chapelfield on the other hand seems to rely on connections to the north alone. The route between Chapelfield Mall and Gentleman's Walk is not consistent. The Chapelfield Gardens and the area around the bus station are scarcely used and scarcely directly accessible. More integration could be useful to activate these opportunities. Remarkably, King Street and Prince of Wales Street were both scarcely used by the respondents. It might be that the participating population is not attached to these areas, and that tracing visitors arriving at the railway station would show a different response. Still, in combination with Tombland as a turning point, the position in the network of the historically rich King Street could be improved. New access or arrival points on the eastern and western side would create new access streets. Finally, the investments in St. Andrews Plain should be part of a strategy to attract people to the area and connect smoothly to other areas such as Tombland and The Lanes. (Spek, 2008)

In Rouen a frame has been developed based on strategic routes (the lines), nodes (the stations) and access or arrival points (the gateways). The frame is strengthened by a light master plan,

the illumination of key buildings and guiding people safely at night. The GPS tracking study indicates several issues. One of these is the neglect of the waterfront. A new route along the water has been suggested, but connections to the current urban tissue are required to improve the waterfront's attractiveness and accessibility. The Rue du General Leclerc offers High Quality Public Transport (TEOR), but is scarcely used by pedestrians. It is a border area between the pedestrian zone and waterfront. The Rue de la Republique is a barrier and due to the intensity of the traffic, not a pleasant route for pedestrians. Finally, the area around the Musee des Beaux-Arts is not well-integrated into the routes followed by the participants on their visits to the city centre. The area has an interesting public square. (Spek, 2008)

Finally, in Koblenz the Spatial Metro investments are part of a strategy for the Bundes Gartenschau in 2011. Up to the present, the research results have shown a limited use of the network and public spaces in the city centre; pedestrian activity is located in the main pedestrian streets. The Spatial Metro investments include essential upgrades of the current shopping streets for pedestrians. Other investments are crucial with a view to completing this work and providing a consistent system of public spaces and programmes. Essential projects are the Schlossstrasse and Zentralplatz. Further redevelopment is necessary to upgrade the waterfront and connect it better to the city centre and historic city. A first essential step has been set by redesigning the Löhrrondell, the key location connecting Schlosstrasse, Löhrstrasse, Löhr-Center and the new railway station. (Spek, 2008)

CONCLUDING REMARKS

The findings in this study are based on the explanation of the statistical information, the assessment of the drawings (density image of a theme), a comparison within the series of the theme and a comparison between locations. All outcomes should be considered as results derived from the behaviour of the participating population. The study does not provide insight into the background and behaviour of all visitors, but only the cooperating population.

The GPS method influences the potential population participating in the research and in this case, limits it to visitors arriving by car. Nevertheless, the results of the observation give a striking and useable image of the city.

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