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A compact city and its social perception: A case study

This article examines the Polish city of Toruń in terms of the compact city concept. It analyses the theoretical elements of the compact city concept using Toruń as a case study and taking into account the psychological aspects (i.e., social perception) of a compact city. The case study collected primary data during fieldwork in 2013 and 2014. The methodology consists of a literature review, satellite photo grid analysis (250 × 250 m) and social perception of the compact city ($n = 128$) assessed through questionnaires with representative quantitative

data. The research was also supplemented with an analysis of the accessibility of the main sites in Toruń. The results are presented on a map of urban areas and graphs of social perception. The study concludes that Toruń is a compact city from the urban point of view, but it is not perceived as such from the psychological or social points of view.

Keywords: compact city, urban planning, sustainability, spatial concept, Toruń, Poland

1 Introduction

The discussion of sustainable urban growth of cities examines ideas of urban form and compact cities (Jenks & Burgess, 2000; Karwińska, 2011; Jim, 2013). The world has experienced unprecedented urban growth in recent decades. In 1900, around 14% of people lived in cities (Zubir & Brebbia, 2014). According to the United Nations (2014), today 54% of the world's population lives in urban areas, a proportion that is expected to increase to 66% by 2050. According to Eurostat (2014), in 2010 around 40% of the European Union (EU27) population lived in urban regions. In many European cities (especially in central Europe and the Baltics), an expanding or rapidly changing population and the growing influence of and dependence on motor vehicles has led to urban sprawl (Kubeš, 2015).

Cities are changing in shape and spreading out rather than retaining the compact nature that previously characterised many urban settlements in Europe (Nuissl et al., 2009; Szkaradkiewicz et al., 2015). An analysis of urban sprawl in Rome from 1949 to 2006 revealed interesting patterns of urban change. Rome grew from a compact city in the 1940s to one with urban sprawl by 2006 (Munafò et al., 2010). Urban sprawl is generally a negative phenomenon that creates a number of environmental, spatial, social and economic problems (Burton, 2000; Bramley & Power, 2009). The concept of the compact city emerged as a reaction to the great increase in sprawling suburbs after Second World War. This is one reason why the compact city is one of the most important topics on the international environmental agenda, which has launched numerous studies on how compactness affects sustainability in different manners and contexts (Jenks et al., 1996; Burton, 2002).

In the history of Polish towns, growth was mainly driven by industry, which attracted factories and workers to cities. Intensive housing and excessive building density degraded environmental conditions (Breheny, 2001; Tosics, 2005; Jim, 2013; Rogatka & Tomczykowska, 2015). The industrial downturn worsened in the 1980s and considerably slowed population growth in towns. The collapse of communism in 1989 launched a reform of the economic system, which led to the expansion of towns and affected their population (Szymańska et al., 2009a). After 1999, the Polish rural population started growing dynamically and steadily. Between 1999 and 2011, the rural population increased by 6.5% (Biegańska, 2013). Analyses from 1996, 2001 and 2006 indicated that the rural population in Poland is increasingly resembling urban behaviour patterns (Szymańska et al., 2009b). According to Eurostat, 28% of Poland's population now live in urban areas, with an increasing number of cities. The broad goals are to limit the spread of cities and improve efficient land use. In Poland, the

official urban population figures refer to localities that have the status of towns. Cities are the most important parts in settlement systems, and appropriately shaping urban space is as important as the social, economic, urban and environmental points of view.

2 Theoretical background and hypotheses

There is a large volume of varied literature on the physical and functional development of cities (including compact cities). In a compact city, spaces have important mixed land use (e.g., residential, social services and recreation), so that each resident has optimum access to the basic services that the city offers (Balchin et al., 1992; Pallares-Barbera et al., 2011; Malul et al., 2012). Maximum use of land already urbanised and re-use of brownfield sites (or recycling space) is recommended, instead of investment outside the city that appropriates largely agricultural areas (Jencks et al., 1996; Neuman, 2009; Rogatka, 2011a, 2011b).

Figure 1 shows that the aspects of compact city practices relate to a range of urban planning concepts, including sustainable urban development (see, e.g., Welbank, 1996; Gordon et al., 2009; Kerbler, 2012; Verovšek et al., 2013; Cerar, 2014; Hoxha et al., 2014; Pompe & Temeljotov Salaj, 2014; Rankel, 2014). The most important basic elements of city compactness include the following:

- *Mixed land use and high density*: a mix of features gives all residents easy access to services, roads and housing;
- *Comprehensive service facilities*: these include employment, legal and social services, gyms, playgrounds, libraries, public toilets, grocery stores, restaurants and healthcare facilities;
- *Short distances*: these encourage walking and cycling (in a mosaic-like structure, distances are short and residents do not often need cars in everyday life);
- *Reduced pollution*: renewable energy sources reduce pollution;
- *Car dependency*: cities where automobiles are the predominant transport not only limit residents' freedom of choice for mobility, but also create a culture of addiction to automobile use;
- *Encouraging cycling*: bicycle lanes and bicycle racks promote cycling and cycling safety;
- *Social interactions*: these refer to well-organised urban infrastructure; for example, green areas, where people from various socioeconomic strata can meet and socialise;
- *High population density*: a compact city reduces costs and diminishes the impact on the environment;
- *Encouraging walking*: this refers to urban planning aspects that promote walking in urban areas;

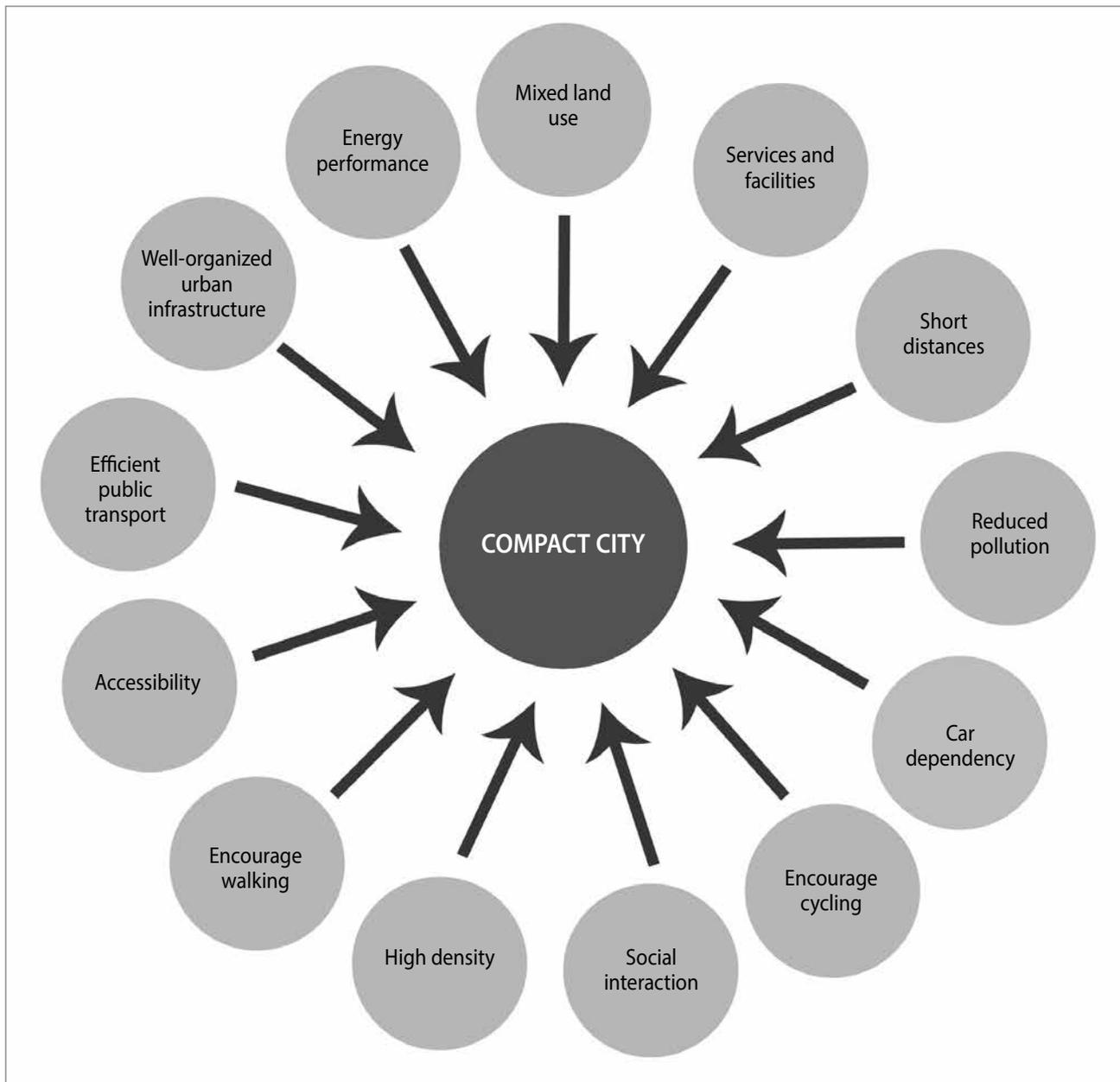


Figure 1: Main elements of a compact city.

- *Accessibility*: 100% barrier-free access and connected public spaces;
- *Efficient public transport*: punctuality and comfort make the public transport system more attractive;
- *Well-organised urban infrastructure*: a well-planned city layout with a good public transportation system encourages walking and public transport use;
- *Energy performance*: district heating and local energy generation using renewable resources.

Compact cities also minimise people's ecological footprint. The United Nations Environment Programme estimates that 75% of CO₂ pollution comes from cities (Gordon, 1990;

Johnston 1990; Bratina Jurkovič, 2014). Climate change is destabilising the environment and strongly impacts urban life, and so it is important to reduce carbon pollution. A compact city also contributes to sustainable urban spaces (e.g., in transport, energy and land use) and can play a key role in green growth strategy in cities (Matsumoto, 2011). Compact cities are also called "green cities" (Zhang, 2000; Burton, 2002; Xuan Thinh et al., 2002). In a compact city, everyone lives and works within walking or cycling distance of everywhere else, or a network of compact urban districts connected by rapid public transport minimises the need for cars and impacts on the environment. In contrast, dispersed urban space fosters progressive decentralisation of activity and industrial

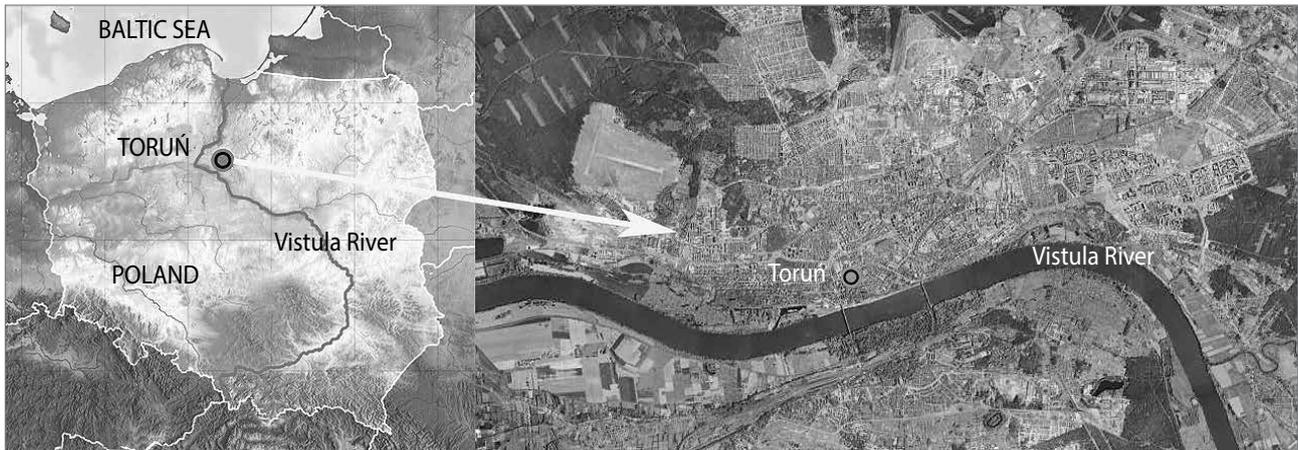


Figure 2: Location of Toruń in Poland (source: authors' modification of a Google Earth image).

and residential suburbanisation, with a clear predominance of suburban-style low-density housing, fragmentation of territory and specialisation of individual areas (Cadman & Payne, 1989; Ashworth & Graham, 2005; Jole, 2008).

The literature on the psychological aspects of compact cities can be analysed from many perspectives. Urban space has a social character because it is produced in a collective process; the social perception is a result of a subjective point of view (Hall, 1990; Lay, 1996; Sassen, 2001). Properly organised space in cities (and corresponding urban systems) must foster social inclusion, prevent social exclusion, and promote identification and interaction between people. The living area and all the elements needed for survival (e.g., buildings, infrastructure and landscape) must be treated as a group of experimental behavioural phenomena manifested in the personal relationship between people and place (i.e., the sense of place). This unique relationship has been named *topophilia* by Yi-Fu Tuan (1974). People perceive space and decide whether it meets their requirements regarding compactness (Johnston 1990; Jole, 2008).

The word *urban* comes from Latin *urbanus* 'belonging to a town'. Urban areas are built by people and contrast with surrounding areas. According to various definitions, a compact city is a spatial urban structure characterised by compact urban areas with urban agglomeration. The paper's hypothesis is that the physical (urban or functional) structure of a compact city interacts with psychological aspects; namely, the social perception of a compact city. A city can be compact from the urban point of view, but its social perception may be totally different. This article investigates selected elements of the compact city concept in Toruń by analysing spatial structure and how residents perceive these elements. The research examines the spatial structure of Toruń (i.e., where urbanised and non-urbanised spaces are concentrated) and respondents' perception of selected aspects of this spatial structure. The authors

also examine how residents accept the compactness of the city. They investigate whether the city is compact from the urban point of view, and whether the same perception is shared by its residents.

3 Study area

The case studied is the city of Toruń in northern Poland, covering an area of 116 km² (Polish Central Statistical Office, 2014). Figure 2 shows a map of the study area in Poland. In 2013, the total population was 203,447 with a density of 1,765 inhabitants per km² (Polish Central Statistics Office, 2014). The criteria for choosing Toruń were that it is a medium-sized city, with a medieval history and architecture, and a spatial layout with an easily delimited old town centre, and because it is on the UNESCO World Heritage List. The city is also on a river that forms a geographical barrier. The city is divided into two parts and is interesting with regard to compactness.

One of the most important social problems in Poland is the outflow of inhabitants from cities to suburban areas, which has resulted in a decrease in the population of Toruń in recent years. The population decreased from 211,955 in 1999 to 203,447 in 2009 (Polish Central Statistics Office, 2014). A significant number of inhabitants with homes in the country have not formally deregistered their residence in the city, and so this number is actually lower. The development of urban structures should be conducted such that people are willing to stay in a city that is both friendly and well organised.

4 Research methods

The research is based on satellite photo data (image Landsat from 2009), grid analysis and a questionnaire on the social perception of the compact city. The research also included accessibility analysis. The case study collected primary data during

fieldwork in Toruń. The study used a mixed-method approach, combining qualitative research tools with a questionnaire, a satellite photo, a grid diagram, accessibility analysis and social perception of compact city analysis. The reason for combining these methods was to verify the study's hypothesis. The combination of quantitative and qualitative methods also offers a holistic view of the compactness of the city. A satellite photo, a grid diagram and an accessibility analysis were used to analyse the city's compactness. A questionnaire was used to explore the city regarding its social (or psychological) compactness.

4.1 Satellite photo and grid analysis

A satellite photo of Toruń was used for preliminary analysis of the city's functional structure. The grid analysis was carried out using a geographical information system (Microstation V8) and a Landsat satellite photo from 2009. The grid cells measured 250 × 250 m and were examined for consideration as urban or non-urban. The scale of the grid was chosen to minimise measurement mistakes (Turskis et al., 2006) and because of the 200 m spatial resolution of the satellite photo. The indicator used was based on an image view analysis, assuming that when one cell has 50% or more urban elements it is urban. After this analysis, the urban cells were marked dark grey. If a cell had 50% or more non-urban elements (especially green areas), it was considered non-urban. After this analysis, non-urban cells were marked light grey.

4.2 Questionnaire

The questionnaire had twenty-three questions. A questionnaire with 128 respondents was considered valid for the analysis (a total of 224 questionnaires were administered). A template questionnaire was designed by the second author. Only questionnaires whose respondents were residents of Toruń were included in the study; the rest were discarded. The data were collected in Polish in Toruń over a three-week period in October and November 2013 using a printed questionnaire and a virtual database available at a website. Respondents answered multiple-choice questions. Probability sampling was applied to determine the sample size for the entire population. A previous pilot phase was carried out to estimate population variance and heterogeneity level based on the variable of local residence. At this stage, sixteen questionnaires were administered. The time required to answer, questions, clarity of issues and possible improvements were considered. Based on probability sampling for a finite population with a margin of error of 10% and a confidence level of 95% for a 50% heterogeneity level of the population, the recommended sample should include ninety-six questionnaires for the population. For some questions, the respondents were asked to choose on a scale from one to ten for

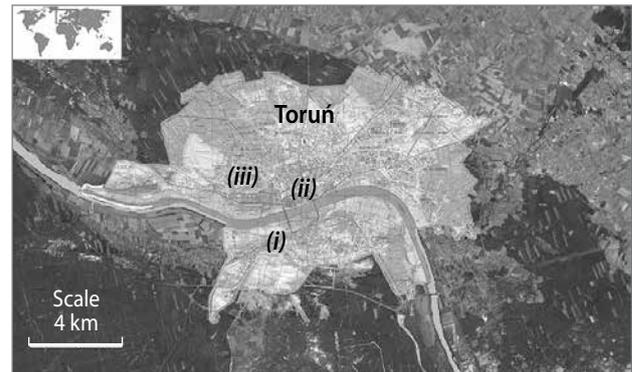


Figure 3: Borders of Toruń (source: authors' modification of a Google Earth image).

perceptions related to each question (1–4 = negative, 5–6 = neutral, 7–10 = positive).

5 Analysis and results

This section reports the findings of an integrated evaluation of city compactness, which used a geographical information system (GIS) to calculate the rate of urban areas and questionnaires to determine the social perception. The aim was to better understand the interactions of urban structure and social perception. The authors divided the analysis into three parts: accessibility of three locations, the compact city grid and social perception of the compact city.

5.1 Analysis of accessibility of three locations

The authors analysed accessibility in the city between three main points: the main train station, the old town and the Nicolaus Copernicus University campus. The criterion for choosing these three points is their importance for visitors and residents. Based on analyses of Figure 3 and fieldwork by the authors in 2014, the walking distance between the train station (point *i*) and the old centre (*ii*) is 3.5 km and requires forty-five minutes on foot or fifteen by bicycle, with quite good accessibility conditions. The distance between the old centre (*ii*) and the university campus (*iii*) is 3 km and requires thirty minutes on foot or fifteen minutes by bicycle. Easy access to selected parts of the city is associated with a well-developed transportation infrastructure. Figure 4 shows some compact city elements that encourage cycling and public transport use.

5.2 Analysis of the compact city grid

In the first stage of the research, the urban form was converted into a 250 × 250 m cell grid. The values of urban areas were calculated in terms of land use. Each grid cell was examined

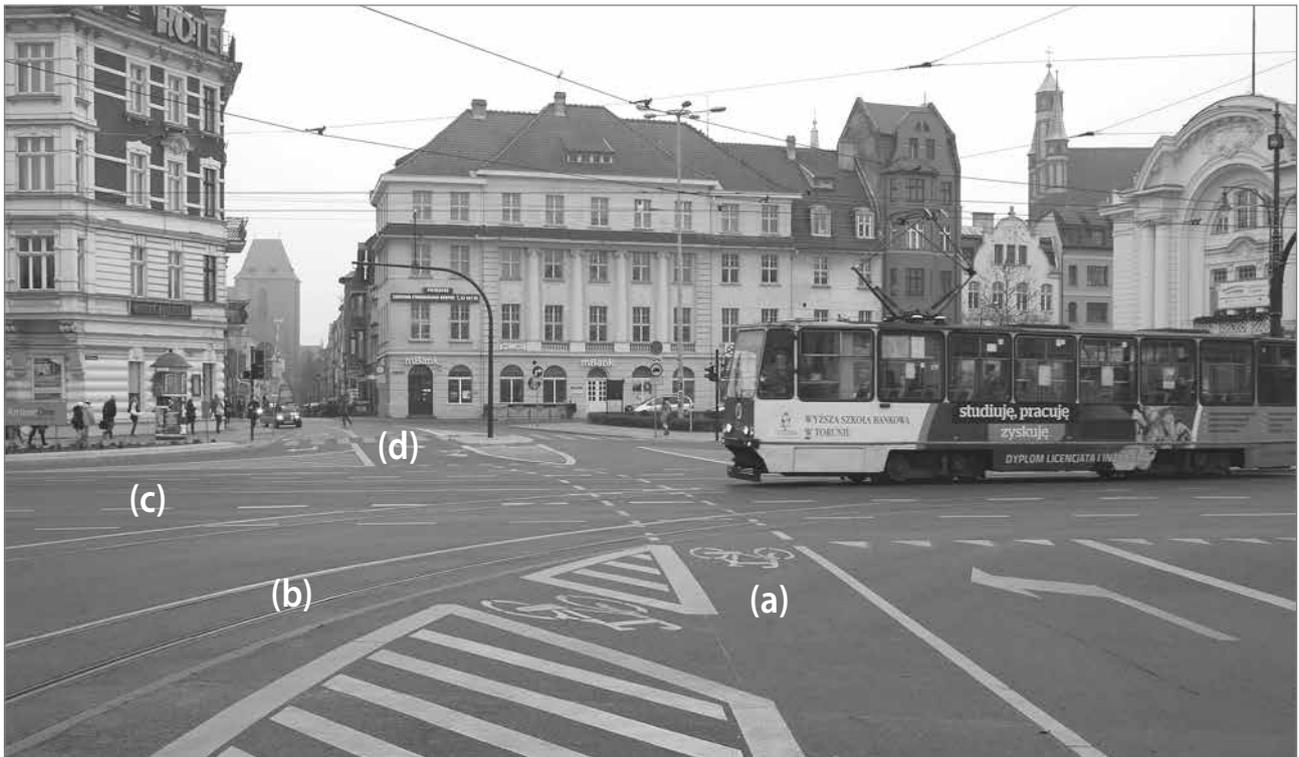


Figure 4: A public space in central Toruń with bicycle lanes (a), tram (b), bus/car (c) and pedestrian (d) areas (photo: Rodrigo Rudge Ramos Ribeiro).

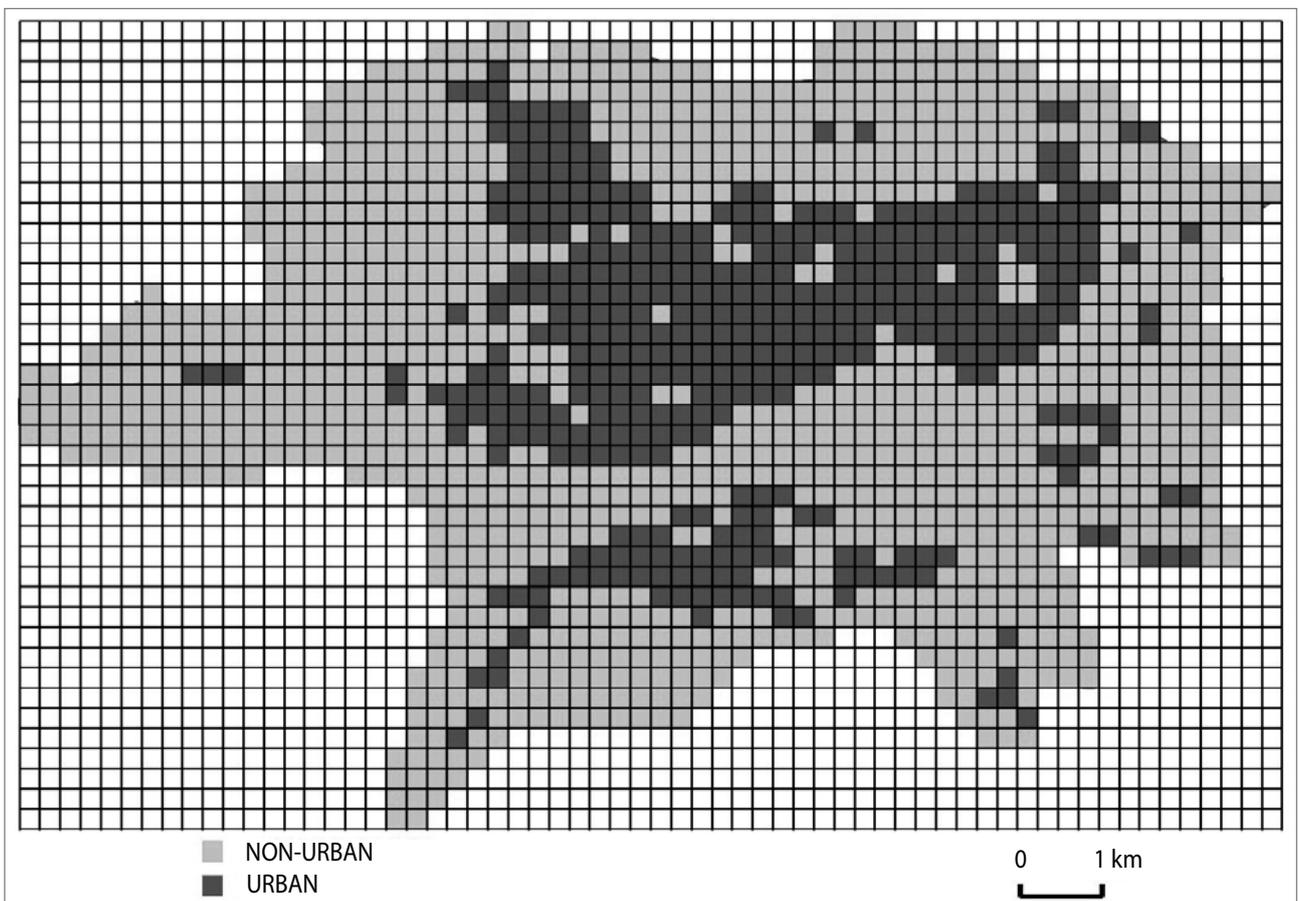


Figure 5: Grid map of Toruń.



Figure 6: Main city bridge (photo: Rodrigo Rudge Ramos Ribeiro).

for consideration as urban or non-urban (Figure 5). Urban cells marked dark grey have 50% or more urban elements. Non-urban cells were marked light grey. Figure 5 shows two main urban concentrations, referred to here as the northern and southern urban islands. Together they include 22% of the urban cells. Despite the spatial barrier of the Vistula River, the city is growing steadily in the north and south. These parts are connected by three bridges: two road bridges and one rail bridge. The Vistula River is one of Europe's largest rivers and crosses Toruń as one of the largest geographical obstacles in the city's spatial structure. Figure 6 shows one of the bridges in the city connecting these two areas of the city.

From the point of view of the grid network analysis, Toruń is quite compact. Urban areas are located in the core zone, and less urbanised or non-urbanised surround the urban areas, creating a green belt that seamlessly connects the suburban natural areas, ensuring the preservation of natural habitats. In addition, in the midst of urban areas there are "green islands" (parks, squares and lawns; Table 1). Seventy-eight percent of all the squares were non-urban, with a high content of green areas. The remaining 22% are urban areas: mainly housing, communication, services, factories and warehouses. Thus, the spatial structure of the city is compact, further characterised by a considerable share of green areas.

Table 1: Grid map analysis.

Non-urban area	Urban area
78%	22%

5.3 Analysis of social perception of the compact city

This section reports the findings of the questionnaires. The aim is to better understand the interactions of social (or psychological) perception and the compact city. The social perception of Toruń as a compact city (Figure 7) is neutral, with 29% of responses between 5 and 6. There is a considerable balance between negative and positive. Thirty-four percent of respondents considered Toruń not compact; whereas 39% claimed that Toruń is very compact, especially given the short distances and short times spent on transportation. In general, Toruń is not perceived as very compact. Respondents also evaluated energy conditions and issues related to renewable energy. The social perception of how much emphasis Toruń places on energy production (Figure 8) is negative, with 81% between 1 and 4. Thus, according to the respondents, Toruń is not compact with regard to energy production, including the use of renewable energy resources.

One element of a compact city is well-organised public spaces (parks, squares, etc.). The study highlights how they are

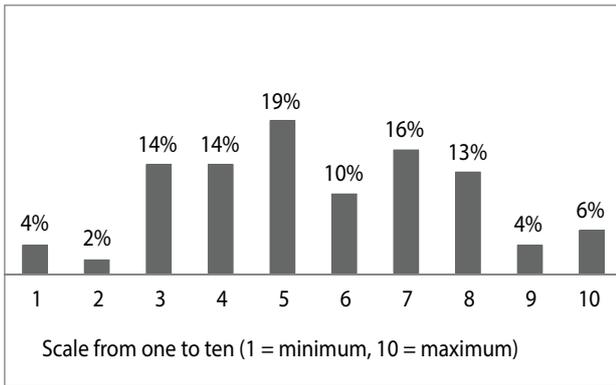


Figure 7: Responses to: "How compact do you consider your city?"

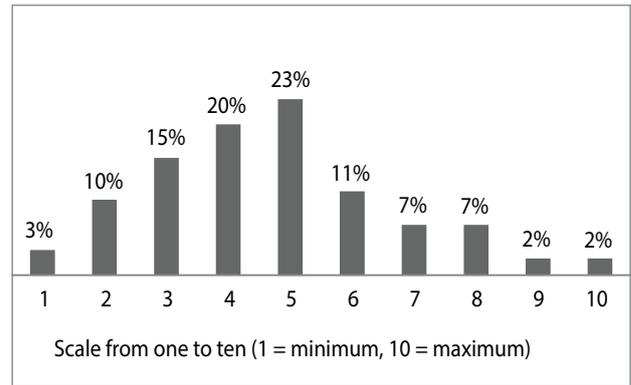


Figure 10: Responses to: "Mark your perception of activities related to a sustainable lifestyle in your city of residence on a scale of 1 to 10."

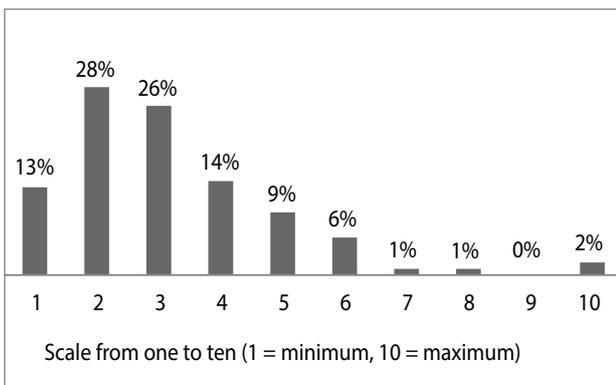


Figure 8: Responses to: "How much emphasis does your city place on energy production (e.g., the use of renewable energy resources)?"

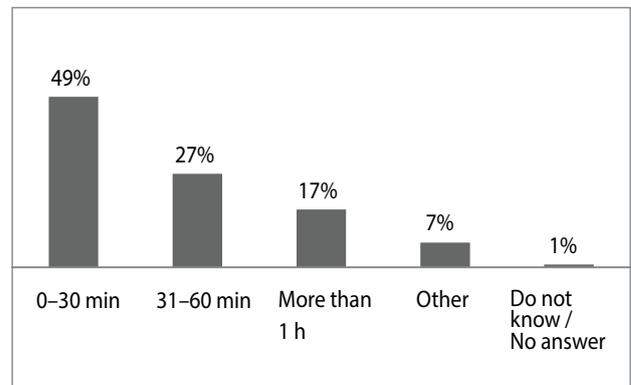


Figure 11: Responses to: "How much time do you spend in transit?"

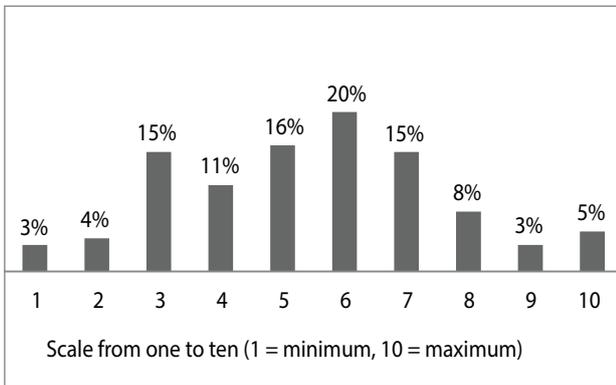


Figure 9: Responses to: "Mark your perception of public spaces (e.g., parks) in your city of residence on a scale of 1 to 10."

perceived by residents. The social perception of public spaces in Toruń (Figure 9) is neutral, with 36% of the answers between 5 and 6. Sixty-seven percent of respondents perceived public spaces in Toruń as well or very well organised. The city has one of the oldest parks in Poland, City Park (Pol. *Park Miejski*). Good availability and high-quality public spaces in Toruń have great influence on the good reception of these spaces in respondents' opinion. The social perception of sustainability-related activities in Toruń (provided by the local government, non-governmental organisations, etc.; Figure 10) is negative,

with 48% of answers between 1 and 4. Toruń is therefore a non-compact city regarding perception of sustainable activities. However, most respondents spend less than one hour in transport in the city, which is well laid out and can be called "a city of short distances" (Figure 11). These aspects encourage walking (29%) and cycling (14%), and also bus use (27%) or even mixed transport modes (Figure 12).

6 Discussion

The results of the grid network and accessibility analyses suggest that Toruń is compact because the city has urban areas with two main urban islands. There are "green islands" of parks, squares and lawns between the urban areas that complement the urban features. Thus, the city has a compact spatial structure characterised by a considerable share of green areas (Jacobs, 1961; Campbell, 1996; Wang, 2002). Toruń is also compact based on grid analysis because its northern and southern parts are connected by three bridges: two road bridges and one rail bridge. The natural obstacle of the river is therefore not a problem in the development of this compact city. Toruń has clear boundaries and is easily definable in the landscape, which is an added value of urban centres that de-

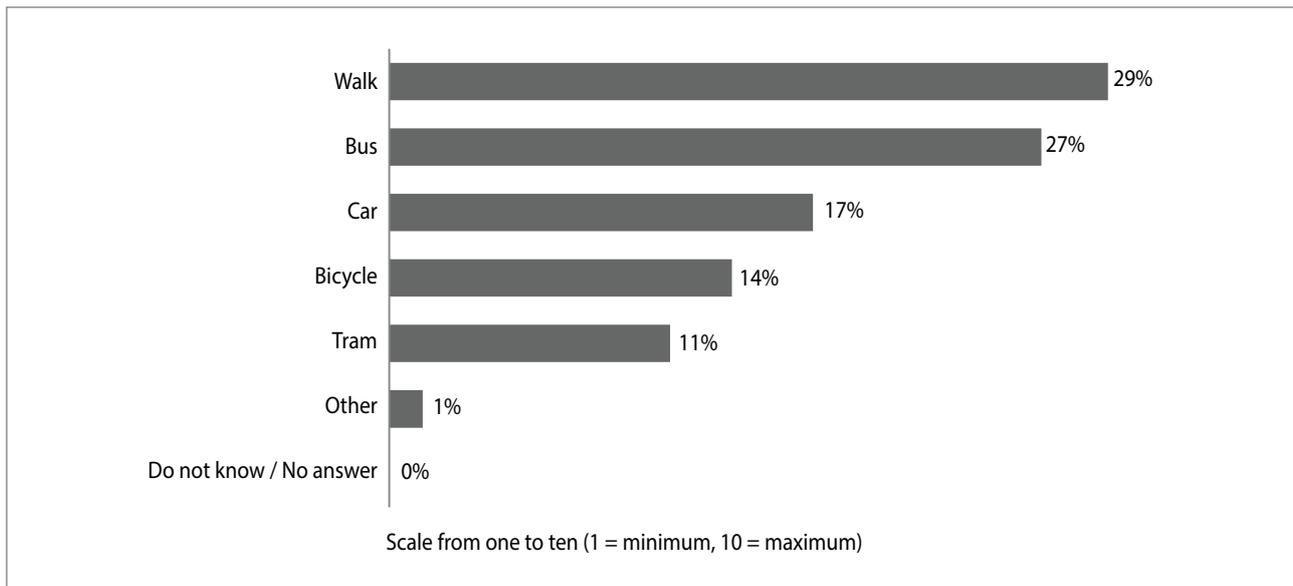


Figure 12: Responses to: "What type of transport do you usually use in the city?"

velop following the principle of a compact city. The compact city has both physical and functional dimensions (Xuan Tinh et al., 2002). Physical compactness refers to the spatial configuration of land-use within the city. The functional aspect is associated with compactness, density and the particular capacity of various functions connected with daily activity (Bizjak, 2012).

The compact city also has a third dimension: a psychological (or social) one. Toruń is not generally socially perceived as a very compact. Toruń is a non-compact city in terms of its limited number of sustainable activities. Thus, the elements that should be improved are energy management and the use of renewable energy resources, and attention should be drawn to making the urban policy more sustainable because it currently focuses largely on infrastructure. These factors especially affect respondents' perception of the city as non-compact (Deimer, 1998; Capello & Camagni, 2000). On the other hand, some factors characterise Toruń as compact according to the respondents. Toruń's public spaces are well organised, which is good. High-quality public spaces in Toruń and their accessibility have a significant influence on the good reception of these spaces in respondents' opinion. Toruń is also compact due to its short distances. The city is well-organised in terms of the transport network because it is easy to navigate by bicycle, on foot, or even by car or bus.

Finally, from an urban point of view, Toruń is compact, but from residents' point of view there are still some aspects that require improvement. The city is meant for its residents, and so their needs and requirements should be satisfied (Breheny, 1992; Scoffham & Vale, 1996; Sassen, 2001; Ho et al., 2012).

7 Conclusion

Cities are a mark of human civilisation, and so appropriately shaping urban space as a compact city is a priority. A compact city does not mean a small city, but a city with well-designed and well-utilised space for people. A compact city works well when it is not only good for the urban area, but also for the countryside. Intensification of land use allows the use of existing facilities, and encourages walking and public transport use. Overall, a sustainability oriented city allows proper development of compactness. One principle of a compact city is that everything should be easily accessible to all residents because the forms of compact cities impact the urban milieu and social quality. Urban form can also affect the ability of cities to provide residents with a good way of life while minimising impacts on nature and depletion of natural resources. In addition, the concept of a compact city improves urban sustainability. Sprawl has negative effects such as consumption of land, fragmentation of ecosystems, higher cost of public services, social segregation and increased fuel consumption. It is essential that the compactness of the city not be a state, but a process – creating compactness should be an ongoing goal. Public participation in shaping the city is important because people need to influence urban policy in order to feel good in their city.

A compact city has not only a physical (functional or urban) dimension, but also a very important psychological (or social) one, created by its users' perception of space. In terms of social perception, Toruń is not generally perceived as highly compact. Even if a city like Toruń is compact from the urban point of view, efforts should be made to create a maximum compactness level in the relationship between people and the city. A city

is compact when it gives residents a sense of compactness and improves the quality of their lives. Attention should be drawn to conducting a more sustainable urban policy. The idea of the compact city should be part of metropolitan master plans and governance plans because specific aspects of the compact city can be used to respond to various socioeconomic issues while paying attention to the quality of life.

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