Assessment of Quality of Life in Residential Estates in Lodz

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Abstract. Quality of life remains a principal concern of contemporary urban planning and design. This keyword repeats in documents of global organisations such as the UN and the policy documents of the European Union. To satisfy this requirement, we need proper evaluation framework which would enable planners and all involved stakeholders to make the appropriate decisions and transform the human living environment in the right directions. In the current paper, we have reviewed several assessment schemes used for urban benchmarking looking for methods which might indicate how to improve the quality of life of residents. The article uses the case studies of three housing estates in Lodz, Poland, which we assess looking for recommendations for future planning. The evaluation scheme addresses several features considered essential for citizens' well-being. We present the method of how to combine them to obtain a consolidated system of indicators. The current study is the first step towards a more developed framework of evaluation for the quality of life in urban planning.

Keywords: Quality of life · Assessment · Urban planning · Indicators

1 Introduction

Increasingly, we begin to pay attention to how, where, and in what conditions we live. First of all, both mental and physical health and care for it have become essential to us. The level of our awareness has increased significantly, and, as a result, we have started, as people, to pay more attention to the space that surrounds us, care for the natural environment or consider the quality of the air we breathe.

The notion of quality of life is also prevalent among researchers and scientists who have devoted many publications and scientific papers to this issue. It gained particular popularity in the area of public health, and in social science - it was from there that it migrated to the language of modern urban planning, but also into humanistic geography or economics. The form of rankings and ways the quality of life is measured reflect these disciplinary associations. The ambiguity of this concept has created many definitions that describe its meaning emphasising different aspects of reality, depending on the approach, but each of them comes down to asking the question of 'how people live?' (Petelewicz and Drabowicz 2016, p. 7).

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Despite the technological progress, formal aspects of development, such as the distribution of spatial structures, their proportions and dimensions, the nature and form of the relationship between them are critical and require optimisation. We refer here both to the forms of the public realm: squares, streets, parks, informal urban vegetation including the activities they accommodate, and to the built structures - their volume, shape, parcellation of lots and land uses. All these themes belong to the domain of urbanism.

The current study examines the quality of life in selected Lodz housing estates and tries to give recommendations on how to improve the living conditions of their inhabitants by using tools from the field of urban planning and design, depending on the scale of the concerned site and applied measures. After this introduction, we briefly present the research aims and scope and then review the current literature on the topic of quality of life in order to define to principal methods of assessment. Next, we present the available rankings and their methodology. Further, we proceed with the presentation of the three case studies of housing estates in Lodz, Poland. The discussion of the quality of life evaluation conducted for all of them follows along with the recommendations. Conclusions and paths for future research ventures wrap up the article.

2 Aims and Scope

In order to answer the question: how people live in selected Lodz housing estates and how to improve their living conditions by using urban planning and design tools, we have at first looked at the current way of assessment of the quality of life. The topicality of the presented issue and their multithreading requires comprehensive analyses of publications and scientific papers, evaluation standards and assessment schemes regarding the quality of life. The research outcomes served to prepare the evaluation matrix, which we have applied to the analysis of the case studies. A survey conducted among residents of the three selected housing estates completed the quantitative and qualitative assessment.

In scientific terms, the project aims to collect, organise and analyse data, which represent three parts of the city as a structure and as a system, including their evolution.

The more general practical goal of the study is to create a tool that supports improving urban design and rationalisation of functional solutions in Lodz housing estates based on norms and standards for assessing the quality of life. On this basis, the tool shall assist in transforming urban structures to improve living conditions.

The spatial scope of work includes fragments of three housing estates located in the City of Łódź:

- Dąbrowa located in the southern part of the city in the Górna district,
- Montwiłł-Mirecki housing estate in the western part of the city in the Polesie district,
- Radogoszcz - East in the northern part of the city in the Bałuty district.



Fig. 1. The research extents: A. the locations of the three housing estates examined in the current study; B. Dąbrowa housing estate; C. Montwiłł-Mirecki housing estate; D. Radogoszcz Wschód housing estate. Symbols: 1. City administrative borders, 2. Metropolitan zone, 3. Districts; 4, 5. Problem areas, 6. Buildings, 7. Roads and path, 8. Existing trees.

Selected fragments analysed in this study are comparable in terms of surface and functional systems. Similar characteristics enable us to compile the results of the study and conduct a comparative analysis. Moreover, we assume that based on the results of the analysis, it shall be possible to determine joint recommendations for housing estates in Lodz. Referring to the temporal scope of work, it covers the period from March 2019 to February 2020 (Grela 2020).

3 Research Background

The topic of quality of life has been extensively researched for the past decades in several fields, of which the most representative are public health (Guyatt GH 1993, Carr 2001, Devlin 2018) and social science (Testa and Simonson 1996, Kruk et al. 2018). As the first step, we conducted an exploratory bibliometric analysis of the SCOPUS database that confirms this observation (Fig. 2A) and shows quantities of yearly publications as high as 38 769 and rising trend lines. The analysis referred to the presence of the string 'quality of life' in article's title or keywords. Contrary to the popularity of the subject in the disciplines mentioned above, the urban planning and design research observe much less abundant development; however, trends are growing too (Fig. 2B). In this case, the measures included asking a question related to the previous condition in conjunction with the presence of expressions' urban design' or 'urban planning' anywhere within the body of the article. The trends prove the increasing interests in the topic among theoreticians and practitioners of city planning.

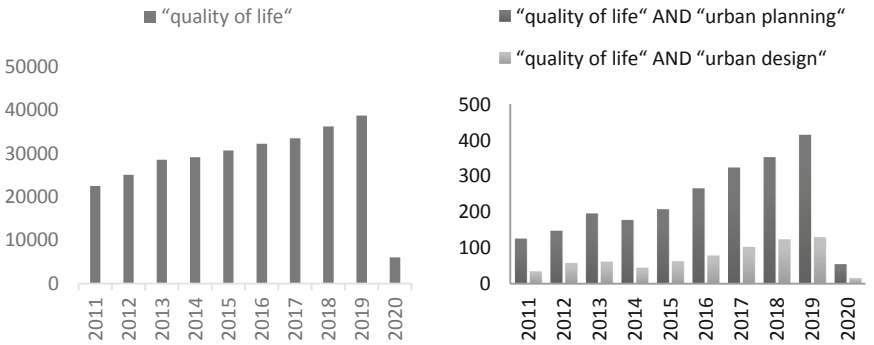

Fig. 2. The results of an exploratory bibliometric analysis of Scopus with regard to A. quantities of publications on quality of life (string 'quality of life' in the title or keywords), B. the conjunction of two research interests: quality of life and urban planning or design.

3.1 Quality of Life – Research Review

The state of knowledge in the subject might be systematised as follows: the first group covers extensive research on the subject, and the second – audits and rankings by various national and international bodies and institutions. Moreover, a robust body of literature includes government, European and global documents, legislation and manuals by UN (2017), UN-Habitat, EU, WHO and other institutions. The European Union's and United Nations' priority is to improve the quality of life. SDG-3 directly focuses on ensuring healthy lives and promoting "well-being for all at all ages" (UN 2016); other goals also indirectly address this topic. Quality of life remains one of the critical issues of the New Urban Agenda 2030 (UN 2017). These goals are to be achieved thanks to, among others, the focus on optimised urban form (UN 2016a).

Moreover, the requirement to achieve the collaboration and support of all concerned stakeholders calls for the explicit assessment framework (UN-Habitat 2014). European Union actively implements the program 'A Europe that protects its citizens and enhances their quality of life' (EU 2019), which directly refers to the environmental conditions.

As researchers emphasise, the socio-economic and environmental conditions of quality of life should be measured, but our understanding should not be limited to just that. In order to fully grasp the complexity of the urban environment, we need to picture specific assessment against the backdrop of other related phenomena, such as, among others, sustainability and climate resilience (Schmitt 2015, Naboni 2019). Quality of life and well-being are the elements which should play a role in a broader integrated system of the parametric data used for regenerative design, next to the vulnerability and physical environment assessment (Naboni 2019).

3.2 Indicators and Measurements

Planners and decision-makers use indicators to evaluate specific phenomena and to assess the ongoing transformations and implementation of defined goals. They need such explicit information to support decisions and scenarios in the political process. Specific measures require established standards in order to become accepted and hence useful. The shared framework enables the common understanding of a concept and hence, communication between all parties.

Indicators stem directly from parameters which serve as input data. Coefficients, by turn, are derived from indicators; they are mathematically combined sets of values. These parameters portray and provide the measures of the phenomena which we study. An established set of indicators offers a normative framework for the assessment of the planning process and the comparison of the outcomes. UNECE (2019) proposes a classification of indicators into the following groups: leading indicators (LI) which use objective values, and sentiment indicators (SI) – based on surveys and evaluation by the concerned citizens.

Based on the environmental conditions, indicators should offer clear information on the current trends which might be understood by all stakeholders (World Bank 1997). This requirement assumes the need for the clarity of synthesis and might involve some simplifications. Verbruggen and Kuik (1991) emphasise the possible need for generalisation in order to increase conciseness. The complexity of urban issues makes the approximation inherent part of indicators system.

In the current elaboration, we analyse the liveability based on the criteria used by quality of life assessment schemes. The most recognised are the following ones:

- Global liveability rankings:
  - Human Development Index (HDI), United Nations Development Programme (UNDP) – since 1990,
  - Global Liveability Index (GLI) by the Economist Intelligence Unit (EIU),
  - Quality of Living Survey (QoLS) by Mercer,
  - Gallup & Healthways Well Being Index (G&H WBI), since 2012,
  - Worldwide Cost of Living Survey (WCoLS) by EIU,
  - Quality of Life Survey by Monocle (the lifestyle Magazine), since 2006,
  - World Development Indicators (WDI) by World Bank,
  - Global Liveable and Smart Cities Index (GLSCI) by the Asia Competitiveness Institute,
  - TomTom Traffic Index;
- European liveability rankings:
  - Urban Audit (UA), since 1997 by the European Statistical System (ESS) and Directorate-General for Regional and Urban Policy of European Commission,
  - Quality of Life in European Cities (QoLiEC) by the European Commission (EC) Eurobarometer,
  - the European Quality of Life Survey (EQLS) by the European Foundation for the Improvement of Living and Working Conditions (Eurofound),
  - EU-SILC – The European Union Statistics on Income and Living Conditions (Eurostat),
  - European green city index (EGCI) by EIU and Siemens,
  - European Cities Monitor (ECM) by Cushman & Wakefield (C&W);
- Polish rankings:
  - Quality of life in Poland. 2017 edition,
  - Public opinion research on quality of life assessment in Lodz and residents' expectations regarding the budget of the City, 2007 (Lodz QoLA),
  - Eurostat's Urban Audit in Kielce in 2009.

The criteria which define liveability according to specific rankings have been listed in Table 1. The official rankings use the coefficients that consist of several criteria and many indicators to define the quality of life in cities (Schmitt et al. 2015). Even though they measure the same phenomena, the approaches differ, which makes explicit the various understanding of the concept.

Table 1. Fields covered in specific rankings; the table taken and adapted from (Grela 2020)

	Public health	Knowledge and science	Standard of living	Culture	Environment	Infrastructure &transport	Politics	Safety	Social interaction	Demography	Labour market
Global liveability rankings											
HDI by UNDP	X	X	X								
GLI by EIU	X	X		X	X	X		X			
QoLS by Mercer	X	X	X	X	X	X	X		X		
G&H WBI	X		X						X		
WCoLS by EIU			X								
QoLS by Monocle	X				X	X	X	X			X
WDI by World Bank	X	X			X	X	X	X		X	X
GLSCI by ACI	X	X	X		X	X	X	X	X	X	X
TomTom TI						X					
European liveability rankings											
UA by ESS	X	X	X	X	X			X	X	X	X
QoLiEC by EC			X		X	X					X
EQLS by Eurofound	X	X	X					X	X		X
EU-SILC by Eurostat	X		X							X	X
EGCI by EIU					X						
ECM by C&W						X					X
Polish liveability rankings											
QoL in Poland 2007	X	X	X		X			X	X		X
Lodz QoLA 2007			X								X
UA Kielce 2009					X						

ISO norms developed methodologies to measure city services, sustainability and quality of life along with additional criteria and indicators for smart and resilient cities:

- ISO 37101:2017 'Sustainable development in communities – management system for sustainable development for use',
- ISO 37120:2018 'Sustainable cities and communities — Indicators for city services and quality of life',
- ISO 37122:2019 'Sustainable cities and communities – Indicators for smart cities',
- ISO 37123:2019 'Sustainable cities and communities – Indicators for resilient cities'.

4 Methodology – Case Study

In the current research, we applied two methods: the first one based on the established standards and indicators and the second, which uses a questionnaire to capture a subjective assessment by the inhabitants. The former we might classify as a leading indicator (LI), the latter – as sentiment indicator (SI) (UNECE 2019). Having reviewed and summarised the methods to evaluate the quality of life carried both by private and public institutions, we have selected a comprehensive set of indicators for the investigation of parts of the three housing estates. In the first group, principal sources of data include housing associations, internet sites of local government and statistical agencies, mobile applications, and direct measurement of physical structures. At this stage, due to the data availability, assessment based on social research has partially replaced formal data sources.

4.1 Analysis of Indicators

Based on the analysis of indicators above, we have selected the recurring themes, such as security, social and technical infrastructure, mobility, sport and recreation, environment and climate change, and, referring to the research profile, urban planning. Each of these areas gets a set of indicators (Fig. 3). Most of them follow the cited standards; some we have transformed and adapted to the conditions of the analysed housing estates. While referring to security, we propose two indicators: (A1) a sense of security at home and (A2) direct contact with crime expressed by the number of crime events.

The topic of social infrastructure also receives two indicators: (B1) the availability of services and their diversity represented by the Walkscore calculation algorithm and (B2) the percentage of public buildings accessible to people with disabilities. The measures which describe technical infrastructure include (C1) the share of the city's population served by sewage and (C2) number of connections to the gas network per 1 000 people (residential).

Mobility receives six indicators that refer to (D1) number of users using shared transport per 1000 inhabitants, (D2) length (km) of bicycle paths per 1000 inhabitants, (D3) number of bicycles available from bicycle-sharing services within the estate per 1000 inhabitants, (D4) length (km) f public transport system per 1,000 inhabitants, (D5) annual number of public transport journeys per inhabitant and (D6) number of parking spaces.

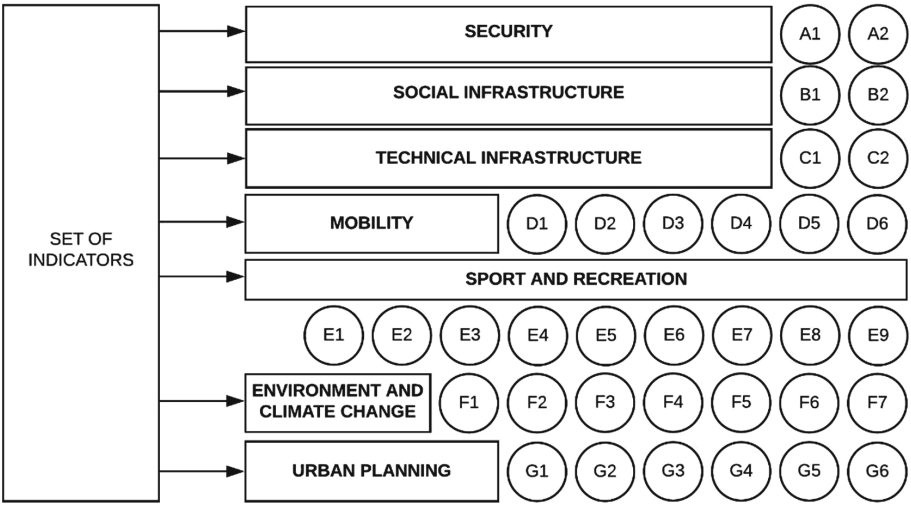

Fig. 3. Categories and indicators describing quality of life assumed in the current study.

We use nine indicators to depict sport and recreation. In this number six address urban vegetation: (E1) green areas (hectares) per 1000 inhabitants, (E2) satisfaction with recreational and green spaces, (E3) the share of people who live closer than 300 m from the park, (E4) the size of urban parks per inhabitant, (E5) the ratio of park area to the built-up area, (E6) housing estate vegetation per each housing estate owner. Remaining three indices feature (E7) housing share in the total estate area, and sites for recreation: (E8) the number of square meters of public indoor recreational space per inhabitant, (E9) the number of square meter of outdoor recreational space per inhabitant.

The next theme environment and climate change features six indicators: (F1) exposure to excessive noise (% of households), (F2) share of biologically active space, (F3) percentage of buildings constructed or renovated in the last five years following the principles of ecological construction, (F4) number of air quality monitoring stations in real-time per square kilometre (km2), (F5) share of energy from renewable sources, (F6) particulate matter 2,5 μm (PM 2.5) and (F7) particulate matter 10-μm concentration (PM10).

The last category covers spatial planning and management issues defined by a set of five indicators, including (G1) land use, (G2) coverage with local spatial development plans (%), (G3) yearly number of citizens involved in the planning process per 1000 inhabitants, (G4) cleanliness and aesthetics of the city, (G5) number of decisions on building conditions and decisions on public goal investment location per 1000 inhabitants, and (G6) number of building permits per 1000 inhabitants.

4.2 Social Research

The spatial scope of the questionnaire examining the citizens' opinions on the quality of life in the three housing estates covered the entire Radogoszcz-Wschód estate and

two fragments of the two other estates: Montwiłł-Mirecki and Dąbrowa; the extents are shown in Fig. 1. The online survey was running between the first and the 20th of January 2020. The results are exploratory; thirty respondents of a variegated profile in each location answered the questions (Table 2). We used both open and closed questioned; additionally, there was a form for respondents to add their insights.

Moreover, to measure the value of features describing the quality of life, we have asked questions referring to the impact of these features. Respondents answered a question about the most relevant characteristic. We used the number and frequency of indications by respondents to assign weights to the specific indicators and categories. Each indicator, as defined in the previous section, received its weight to show a more objective picture of the housing estate, reflecting the current values and norms which refer to the quality of life of residents.

5 Results and Discussion

5.1 Assessment of the Quality of Life in the Three Housing Estates

The Table 2 includes the primary data on three selected fragments of housing estates. Table 3 presents the results of assessments of the three sites based on the quality of life standards. The research uses the data from the Geostatistics Portal (https://geo.stat.gov.pl/imap/), from the National Census of Population and Housing 2011.

Table 2. Basic information about the problem areas

Housing estate	Dąbrowa	Montwiłł-Mirecki	Radogoszcz Wschód
Size of the area	17,16 ha	14,25 ha	24,15 ha
Population living in a given area	5253	1948	5754
Built up areas	3,38 ha	2,68 ha	2,86 ha
Total green areas	8,03 ha	5,91 ha	13,92 ha
Vegetation within institutions	1,96 ha	1,39 ha	1,38 ha
Vegetation in the housing estate	4,26 ha	4,52 ha	9,59 ha
Parks area	1,81 ha	–	2,94 ha

Security has been evaluated based on the two indicators: the personal sense of security using the questionnaire responses (A1) and direct contact with crime (A2), based on the National Hazard Safety Map data (mapa.geoportal.gov.pl/iMapLite/KMZBPublic.html). The dataset contains no incident threatening the safety of residents for these housing estates.

Table 3. The results of assessments of the three sites based on the quality of life standards

Theme	No.	Source	Dąbrowa	Montwiłł-Mirecki	Radogoszcz Wschód
Security	A1	GUS, 2017	3,15	3,58	4,2
	A2	Rokicka, 2013	0	0	0
Social infrastructure	B1	PN-ISO 37120	77	72	57
	B2	PN-ISO 37122	0,7	0,67	1
Technical infrastructure	C1	PN-ISO 37120	100%	100%	100%
	C2	PN-ISO 37120	100%	100%	100%
Mobility	D1	PN-ISO 37122	103	238	307
	D2	PN-ISO 37120	0 km	0 km	0 km
	D3	PN-ISO 37122	2,86	0	0
	D4	PN-ISO 37120	0,22 km	0,63 km	0,24 km
	D5	PN-ISO 37120	3,00	5,55	2,24
	D6	QoLS, Lodz 2012	5%	25%	25%
Sport and recreation	E1	PN-ISO 37120	1,53 ha	3,03 ha	2,42 ha
	E2	GUS, 2017	2,55	3,6	4,28
	E3	UA Kielce 2009	10%	0%	20%
	E4	UA Kielce 2009	3,45 m^2	0 m^2*	5,11 m^2
	E5	UA Kielce 2009	0,54	0 m^2*	1,03
	E6	UA Kielce 2009	8,11 m^2	23,18 m^2	16,67 m^2
	E7	UA Kielce 2009	24,82%	31,68%	39,73%
	E8	PN-ISO 37120	0 m^2	0 m^2	0 m^2
	E9	PN-ISO 37120	0,65 m^2	1,79 m^2	0,54 m^2

(*continued*)

Table 3. (*continued*)

Theme	No.	Source	Dąbrowa	Montwiłł-Mirecki	Radogoszcz Wschód
Environment and climate change	F1	PN-ISO 37120	5%	10%	0%
	F2	UA Kielce 2009	47%	41%	57,61%
	F3	ISO 37122	No info	1 building	No info
	F4	ISO 37122	No info	No info	No info
	F5	PN-ISO 37120	No info	No info	No info
	F6	PN-ISO 37120	17 µg/m^3	64 µg/m^3	9 µg/m^3
	F7	PN-ISO 37120	24 µg/m^3	70 µg/m^3	14 µg/m^3
Spatial planning and management	G1	UA Kielce 2009	0,19	0,19	0,12
	G2	UA Kielce 2009	0%	0%	0%
	G3	ISO 37122	No info	No info	No info
	G4	QoLS, Lodz 2012	2,68	2,73	3,73
	G5	UA Kielce 2009	4,19	3,08	2,26
	G6	UA Kielce 2009	4,38	11,29	1,56

Table 4. Walk Score punctation, Source: https://www.walkscore.com/, access: 7.02.2020

Walk score	Description	
90–100	Excellent accessibility	Everyday matters do not require a car
70–89	Good accessibility	Most things might be fixed on foot
50–69	Average accessibility	Some things might be fixed on foot
25–49	Car dependent	Most things require a car
0–24	Total car dependency	Nearly all things require a car to be fixed

Social infrastructure assessment involves two indicators: the availability of services (B1) and accessibility of public buildings for disabled people (B2). We have used the online Walk score tool to calculate the availability of services within walking distance. Table 4 reveals the threshold values of the method. The outcomes of the walk score evaluation are biased for the Radogoszcz Wschód estate due to the assumed research extent, which excludes the primary service hub. The results for the two other estates are similar, with slightly higher values for the Dąbrowa estate. The facilities for disabled

are available in all public institutions in Radogoszcz Wschód; both other estates lack sufficient equipment. Both technical infrastructure conditions: sewage (C1) and gas access (C2) are satisfied for all three case study areas.

Six features define mobility. Shared modes of transportations (D1) include shared bikes systems which occur the most popular in Radogoszcz Wschód and the least used in Dąbrowa. The results might stem from the level of awareness of inhabitants, their age profile and the stations' availability. The length of bicycle paths (D2) in all three sites equals zero that offers the possibility for improvements. Numbers of bicycles available for sharing per 1000 inhabitants (D3) might be assessed only for Dąbrowa estate; the two other sites do not accommodate such facilities. Montwiłł-Mirecki housing estate features the highest length of the public transport network per 1000 inhabitants (D4), whereas the Dąbrowa estate is the least equipped. We acquired the two remaining mobility-related indicators from the survey. The annual number of travels by public transport per capita (D5) shows that in Montwiłł-Mirecki citizens use this mode of transportation the most. At the same time, the lowest levels affect housing estate Radogoszcz - East. The results might be affected by the age of respondents as well as the inhabitants' income levels. The question about the parking lots (D6) demonstrates that all three estates lack sufficient parking spaces according to the local citizens. The situation in Dąbrowa has been assessed as the worst. The reasons might be related to the rising numbers of individual vehicles and the inability to meet rapidly growing demands.

Nine indicators fall into sport and recreation category; of this number six address green areas and remaining three housing and recreation availability. The highest share of green space per 1000 residents (E1) occurs in Montwiłł-Mirecki estate, which stems from the direct vicinity of the Zdrowie Park. This parameter is reflected by the presence of the buffer zone shown in Fig. 7, which illustrates the catalogue of features being measured. The residents of Radogoszcz Wschód estate feel the most satisfied with recreation and green areas (E2), while these living in Dąbrowa are the least happy. The next indicator, which refers to the share of people living closer than 300 m from the public park (E3) confirms the above results. Montwiłł-Mirecki estate leads for the same reason as above, followed by Radogoszcz Wschód where 20% of residents live close to the park and Dąbrowa estate with 10% of inhabitants living within the buffer of 300 m from urban greenery. We calculated the share of urban greenery per capita (E4) and the ratio of park areas to built-up areas (E5) for two sites: Dąbrowa and Radogoszcz Wschód, the results repeat these described above, with a higher amount of public greenery in Radogoszcz Wschód estate. Instead, the Montwiłł-Mirecki estate features a vast urban park in the direct vicinity. Moreover, the same estate features the highest share of housing estate green per inhabitant (E6), followed again by Radogoszcz Wschód. The highest proportion of green areas within the estate to its total area (E7) we find in Radogoszcz Wschód and the lowest in the Dąbrowa estate. There is no indoor public recreational space in any of the three housing estates which means that the next indicator (E8) equals zero. The size of outdoor facilities per capita (E9) is the highest in Montwiłł-Mirecki estate and the lowest in Radogoszcz Wschód.

The category of environment and climate change includes seven indicators. We have estimated the exposure to excessive noise expressed by the share of affected households (F1) based on the acoustic maps and have found the highest levels in

Montwiłł-Mirecki estate – due to the proximity of railway, shooting range and a speedway stadium. The Radogoszcz Wschód estate remains the quietest one. The percentage of biologically active land (F2) amounts to over 40% in all sites, with the highest values in Radogoszcz Wschód and the lowest one in Montwiłł-Mirecki estate. The three next indicators (F3 to F5) have not been evaluated due to the limited availability of data. Air pollution results measured as concentrations of PM2,5 (F6) and PM10 (F7) were based on remote real-time air monitoring stations data and on the information made available by social activists – initiative MM and refer to 4th February 2020. The air in Radogoszcz Wschód estate was the least polluted, while in the Monwiłł Mirecki estate the air quality was the worst.

The built-up land ratio (G1) remains at similar levels for all the three sites, with the lowest parameter's values in Radogoszcz Wschód estate. The two next indicators (G2 and G3) are not available as the estates are not covered with local plans of spatial development. For the Monwiłł Mirecki estate, the procedure has recently started, and the citizens' participation in it is not yet possible to assess either. Citizens assess Radogoszcz Wschód estate' s cleanness and aesthetics (G4) the highest, the second rank belongs to Montwiłł-Mirecki estate. The most decisions on construction conditions per 1000 residents (G5) have been issued in Dąbrowa estate, while the least in Radogoszcz Wschód. The highest numbers of building permits (G6) were issued in Montwiłł-Mirecki estate, the lowest to Radogoszcz Wschód.

5.2 A Consolidated Assessment – Method

Each indicator was assigned its weight to learn which of the selected fragments of housing estates features the highest quality of life, both based on criteria derived from standards and social research. The weight of the indicator enables us to show a more objective picture of the housing estate, reflecting the current values and norms which refer to the quality of life of residents (Fig. 4). The weights were assigned based on social research.

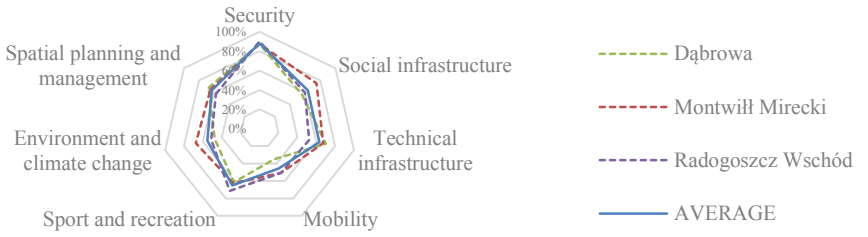

Fig. 4. The chart shows the weights collected through the social survey which reflect citizens' attitudes towards the indicators used in the study.

Respondents pointed out the most relevant indicators based on their preferences. We used the number and frequency of indications by respondents to assign weights to the specific indicators and categories. We summed up the quantities of choices per

indicators within each class to obtain more consistent results. Next, we have brought all the values to a common denominator. Therefore, we normalised the results using the total of respondents multiplied by the number of indicators.

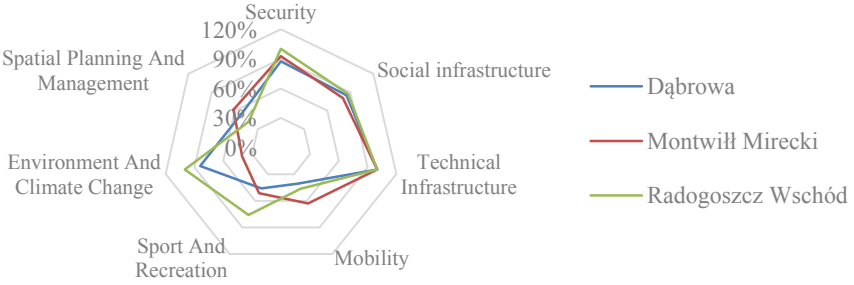

Fig. 5. The assessment results: The chart presents objective values based on the measurements and collected data

The chart (Fig. 5) which presents the assessment results uses percentage units. We normalised every parameter using the maximum for a given indicator. In case when a given category comprises more than one indicator, the diagram shows the arithmetic mean. For the negative values – noise and the concentrations of PM2,5 and PM10, we included the adverse numbers. In the first case, we used the maximum noise level based on the Directive relating to assessment and management of environmental noise (European Commission 2002), in the two other the respective levels of pollutants according to the Directive on ambient air quality and cleaner air for Europe (European Commission 2008). The results, which indicated exceeding the norms, received 0%, and those within the acceptable range – an evaluation proportional to the highest measured value. The chart (Fig. 6) presents the results multiplied by the weights counted in the previous step. Therefore, the last graph shows an assessment that takes into account the normative system established based on the local citizens' preferences.

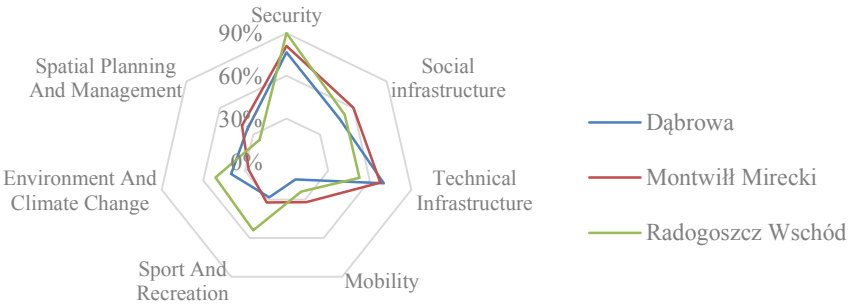

Fig. 6. The chart takes into account the values of weights based on the citizens opinions and values expressed in the survey.

As the last step, we have performed the summative assessment based on the average values of all the categories. The results show that residents of Radogoszcz Wschód estate perceive their quality of life the highest, whereas those who live in Dąbrowa the lowest.

The current research shows that the existing evaluation schemes which are used for benchmarking and rankings of cities from various perspectives address the quality of the physical environment, which is subject of interest in physical planning. We derived the data for the current study either from the social survey among citizens or the measurement of physical features of the environment. In both cases, the questions pertain to the actual qualities of the physical form. Figure 7 shows the elements of the physical environment for which the calculations have been performed.



Fig. 7. The plan drawing which presents all the features being evaluated in the current study, using the example of Montwiłł-Mirecki housing estate. Symbols: 1. Study area, 2. Buildings, 3. Multifamily housing, 4. Residential and service development, 5. Services, 6. Technical infrastructure, 7. Garages, 8. Sport and recreation areas, 9. Transportation areas – impervious surfaces, 10. Organised green areas – parks, 11. housing estate vegetation, 12. Public institutions vegetation, 13. Deciduous and coniferous trees, 14. Rows of trees. 15. The 500 m buffer to the nearby park.

6 Conclusions and Future Research Avenues

The contemporary urban planning requires informed decisions which take into account the well-being and quality of life of urban citizens. The parametric tools might support such decisions and help in their optimisation (Naboni 2019). They offer the potential to integrate the directions for the environment transformations with citizens' bottom-up insights. In the current paper, we have reviewed the existing evaluation and benchmarking schemes in order to design a framework for the assessment of the quality of life as currently understood in these various approaches. The assessment included both the quantitative and qualitative elements, based either on the formal features of physical structures and on the residents' opinions.

The method has been tested for the evaluation of three housing estates in Lodz, Poland. We have compiled the assessment and obtained summative results which enabled the overall evaluation both of the objective physical and demographic characteristics of quality of life and the subjective perception by the residents. The latter has been done thanks to the usage of weights based on the survey results.

Furthermore, in the next phase, we envisage the following steps:

- more direct linking of the parameters to the GIS system to measure, analyse and compare the physical, social and economic data on city functioning,
- PPGIS-based surveys which would enable citizens to express their opinions within the GIS systems directly.

Using GIS in spatial planning can provide technical input to measuring the spatial quality of life and improve accuracy in decision-making. The results may contribute to public discussion and help involve residents in the spatial planning process.

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