Chapter 2
Evaluation of the Quality of an Urban Square

Abstract As shown in the previous chapter, the evaluation of a building layout is difficult. The same applies to an urban layout. However, the basic evaluation of the quality of a plaza (*P*), that is the basic element of urban composition, is relatively straightforward. This chapter presents a method for an Automated Geometrical Evaluation (AGE) of a *P*. Firstly, nineteen plazas from various countries have been evaluated by twenty respondents in so called Human Subjective Evaluation (HSE). Secondly, a preliminary investigation of HSE including the identification of categories which are redundant is demonstrated. Thirdly, three normalized properties derived directly from a plan of *P* are introduced: smallness (*S*), enclosure (*E*), and regularity (*R*). Finally, the evaluation method of *P* based on these properties is discussed. AGE based on *S*, *E*, and *R* (NP_{SER}) shows good agreement with HSE. The quality rating based on NP_{SER} of *P*, namely: fair, good, and excellent is presented. Some outlying cases are shortly discussed.

2.1 Introduction

Urban design is a multifaceted discipline involving many engineering and designing fields such as urban composition, planning, development, architecture, landscape architecture, transportation, economics, law and finance, among others. Public space (*PS*) has been defined in several ways based on: use, ownership, access, use, etc. Here, it is defined according to Ref. [5] as follows: "*publicly accessible places where people go for group or individual activities*". According to Ref. [11] a good *PS* has the following qualities: it is meaningful, democratic, and responsive. In the same Ref. so called *public space index* has been introduced. It assesses the quality of *PS* by observational assessment of the following qualities: pleasurability, comfort, safety, meaningfulness, and inclusiveness. Moreover, Ref. [15] has implemented geospatial analysis for automatic detecting of:

- Neighborhoods;
- Neighborhood centers;
- Edges among urban neighborhoods;

M. Zawidzki, *Discrete Optimization in Architecture*, SpringerBriefs
in Architectural Design and Technology, DOI 10.1007/978-981-10-1106-1_2

- So called "mixes", that is spatial distributions of various kinds of land uses in the given area;
- Proximity, which is defined as: the number and quality of places which can be reached and in general the ability to reach urban places.

This chapter concerns with urban composition—a field of design dealing with human perception of space. Although urban composition is not necessary for a city to function, as shown in Fig. 2.1(1), it is often considered valuable.

Modern cities probably serve the citizens overall better than the old ones, however, the quality of urban composition seems to worsen drastically with the advent of so called International Style in 1920s. Other totalitarian movements such as fascism and communism have also contributed to this deterioration. It seems like the public spaces became perhaps more impressive, mostly in terms of size, but lost connection with the human scale, which resulted in their lesser overall appreciation. Figure 2.1(2), (3) show an example of a Renaissance city and International Style-inspired district from 1970s. Although the sizes and overall form seems similar, there are also dramatic differences. The principal elements of classical urban composition are: dominants (monuments and high-profile buildings such as: churches, palaces, city halls, etc.), street frontages and plazas (P). These elements suffice to compose clearly defined diverse spaces, which most importantly relate well to the human scale: the street frontage (usually with commercial functions) contrasts with larger, but still enclosed Ps. The example shown in Fig. 2.1(3) neglects these rudimentary urban tools. As a result the hierarchy of spaces is lost, and the buildings indeed become merely a (...) *magnificent play of masses brought together in light* [7], as devised in 1923 by the protagonist of the International Style, Charles-Édouard Jeanneret alias Le Corbusier.

Although the definition of a dominant and a street frontage seems fairly straightforward (see Fig. 2.1(2)), the proper design of a P is substantially more difficult. Space syntax [8] is a well established set of theories and tools used for spatial morphological analysis with particular applications in urban science. The original research started in 1970s. An integration of space syntax into geographic information system (GIS) for modeling of urban spaces has been proposed in [10]. This chapter, however, concerns with a single P—an isolated node of the network and ignores the connectivity with other urban elements. According to [16], more important consideration in urban design than legibility is the aesthetics. The field study conducted in Dresden, Germany has investigated the relationship between urban form and the aesthetic experience [9], and argued that picturesque urban form may be more aesthetically appealing than other urban spatial arrangements. Here, however, the aesthetic value of Ps is ignored and the legibility of space is considered only.

Traditional evaluation, whether a certain urban square qualifies as a "good one" is difficult and most importantly—rather intuitive and arbitrary. This chapter instead of speculating on urban composition presents a straightforward phenomenological approach.

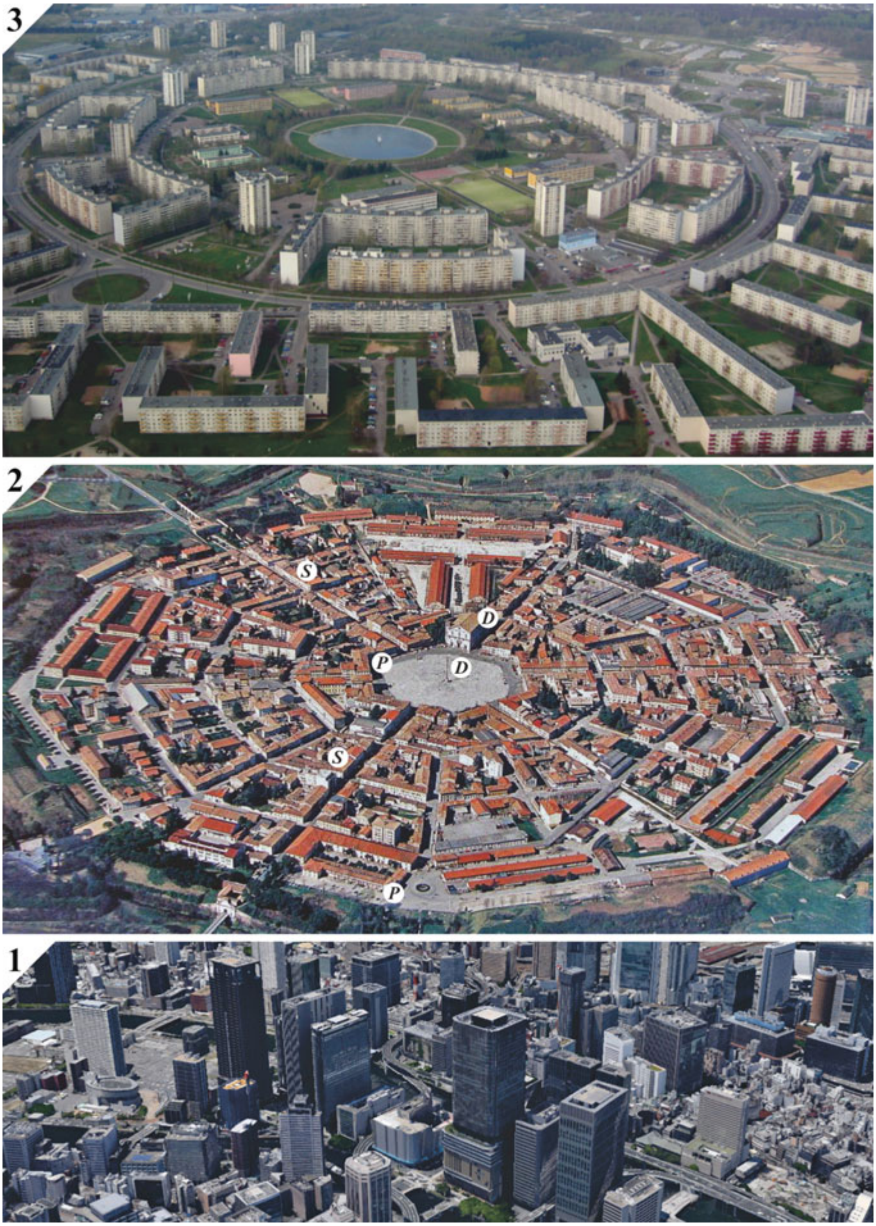

Fig. 2.1 **1** Osaka, Japan—no urban composition (present); **2** Palmanova, Italy (1593–1813), a city realized on utopian concept of Renaissance Ideal City. **3** Väike-Õismäe—a residential district in Tallinn, Estonia (1970). The sizes of Palmanova and Väike-Õismäe are comparable. *P*, *D*, and *S* stand: for plaza, urban dominant, and street frontage, respectively

2.2 Nineteen Plazas Subjected to Human Subjective Evaluation (HSE)

Figures 2.2 and 2.3 show: nine *P*s from Warsaw, Poland and ten worldwide *P*s, respectively. All *P*s have been evaluated by twenty respondents.

Each of the nineteen worldwide *P*s has been evaluated individually by twenty respondents. The evaluation has been done with a slightly modified questionnaire as used in [12]. Table 2.1 collects fifteen bipolar adjectival pairs and the semantic scale used in the questionnaire.

For aggregation of the values given by respondents, the responses have been transposed from −3–3 scale to 0–6. Further in text, only the "positive qualities", as indicated by boldface in Table 2.1 are used. They are called simply *qualities* from now on. Presented in this chapter approach differs from the methodology used in [12] in the following aspects:

- The main objective of this investigation is on the spatial perceptions of spaces. If possible, the aesthetic aspects were intentionally ignored.
- Instead of evaluation of photographs, respondents were exploring selected *P*s virtually by *Google Earth*.
- The group of respondents was smaller, namely twenty as oppose to three hundred persons.

The responses have been aggregated, averaged, and tabulated into the "matrix of plazas" (*MP*), that is nineteen (the number of *P*s) fifteen-dimensional (the number of HSE *qualities*) vectors. The transposition of *MP* forms the "matrix of qualities" (*MQ*). In order to find redundant *qualities*, the correlations among all *MQ* vectors have been investigated. Interestingly indeed, some responses have been practically equivalent. Namely, pairs: "Cozy"–"Comforting", and "Natural"–"Relaxed" showed 0.86 and 0.88 rate of correlation, respectively. Therefore "Comforting" and "Relaxed" have been omitted in further analysis. The values of responses for every *P* have been averaged, summed-up, and normalized to the range (0, 1). Therefore, this numerical value of measured assumed *quality* of *P* from now on is called "normalized accumulated quality", NAQ for short. The evaluations done by the respondents of all *P*s have been ranked by NAQ, as shown in Fig. 2.4.

2.3 Automated Geometrical Evaluation (AGE) of an Urban Square

The main concept presented in this chapter is to evaluate the spatial quality of *P*s solely by analyzing their plans. Such analysis is named here: the Automated Geometrical Evaluation of a *P*, AGE for short. Despite the opinion presented in Ref. [16] that: "*aesthetics is a more important consideration in urban design than legibility*", the focus of the investigations presented here is exactly on the "legibility" of a *P*.

Fig. 2.2 The nine *P*s from Warsaw, Poland: **1** Old Town Market, **2** Mariensztat, **3** Savior Sq., **4** Dabrowski Sq., **5** Politechnika Sq., **6** Union of Lublin Sq., **7** Constitution Sq., **8** Bank Sq., **9** Crossroads Sq

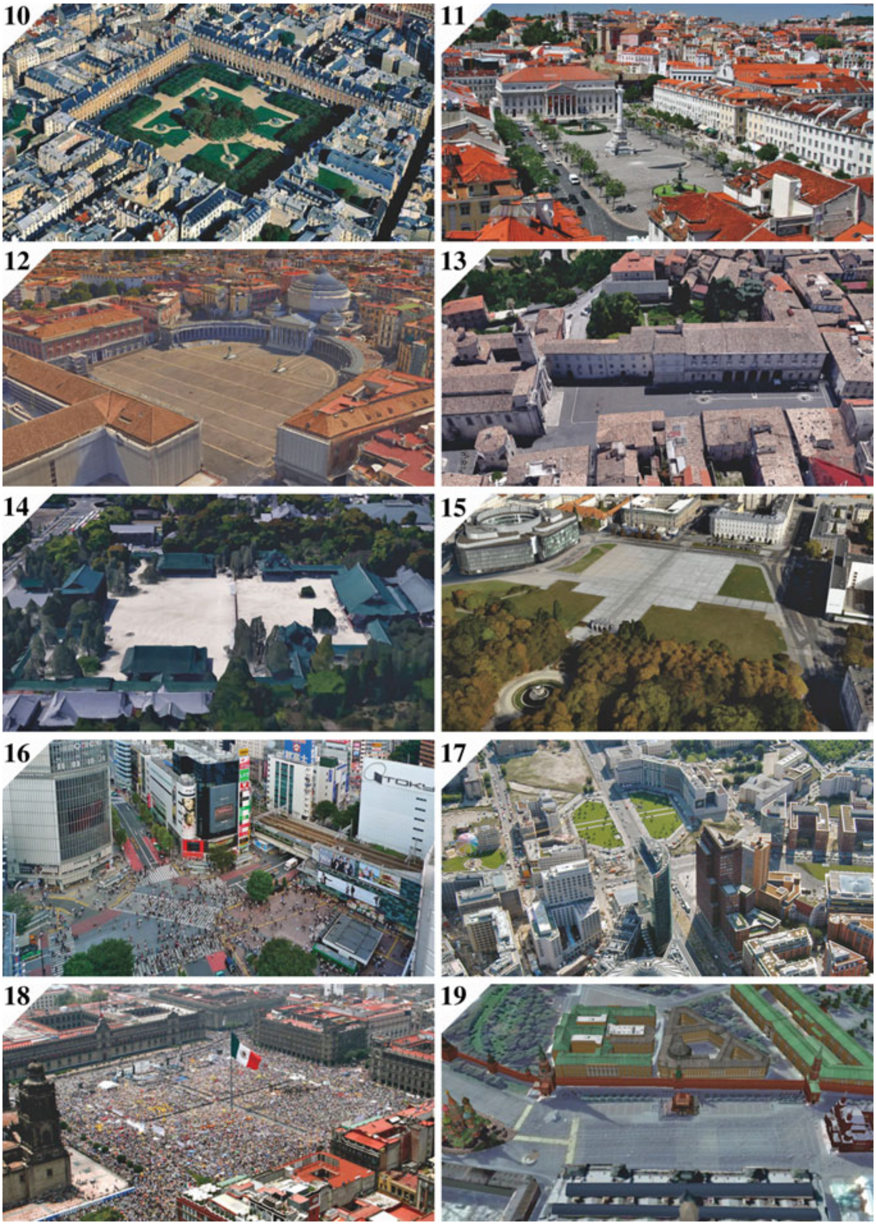

Fig. 2.3 **10** Place des Vosges, Paris, France; **11** Praça Dom Pedro IV, Lisbon, Portugal; **12** Piazza del Plebiscito, Naples, Italy; **13** Piazza Arringo, Ascoli Piceno, Italy; **14** Heian Jingu, Kyoto, Japan; **15** Pilsudski Sq., Warsaw Poland; **16** Shibuya, Tokyo, Japan; **17** Potsdamer Platz, Berlin, Germany; **18** Zocalo, Mexico City, Mexico; **19** Red Square, Moscow, Russia

Table 2.1 The questionnaire for human subjective evaluation (HSE) of plazas

1	Dull	−3	−2	−1	0	1	2	3	**Dynamic**
2	Repelling	−3	−2	−1	0	1	2	3	**Attractive**
3	Chaotic	−3	−2	−1	0	1	2	3	**Arranged**
4	Artificial	−3	−2	−1	0	1	2	3	**Natural**
5	Boring	−3	−2	−1	0	1	2	3	**Interesting**
6	Disturbing	−3	−2	−1	0	1	2	3	**Comforting**
7	Cacophonous	−3	−2	−1	0	1	2	3	**Harmonious**
8	Dysfunctional	−3	−2	−1	0	1	2	3	**Functional**
9	Tense	−3	−2	−1	0	1	2	3	**Relaxed**
10	Unsocial	−3	−2	−1	0	1	2	3	**Social**
11	Harsh	−3	−2	−1	0	1	2	3	**Cozy**
12	Uninspiring	−3	−2	−1	0	1	2	3	**Inspiring**
13	Plain	−3	−2	−1	0	1	2	3	**Diverse**
14	Flimsy	−3	−2	−1	0	1	2	3	**Sound**
15	Inaccessible	−3	−2	−1	0	1	2	3	**Accessible**

Conversely, the aesthetic, in other words, architectural aspects of *P*s are being disregarded, in accordance with Camilo Sitte: (...) "*just as there are furnished and empty rooms, so one might also speak of furnished and unfurnished plazas*"*(...)* [14]. Three geometrical properties (called simply *properties* from now on, which match HSE have been identified: *smallness*, *enclosure* and *regularity*.

2.3.1 Smallness

One of the fundamental properties of a *P* is its size. According to the classic book on urban design [14] by Camilo Sitte, "*A plaza that is too small usually does not give due effect to monumental buildings; on the other hand, one that is too large is, obviously, still more awkward (...). Such giant squares of vast dimensions occur in modern cities almost solely as drill grounds*". This quote indicates that size is a natural property of *P*, and that it has always been considered by urban planners. Most importantly, however, in principle, the relations between the sizes and NAQs of *P*s are not obvious. Surface area is a straightforward measurement of the size of a *P*. According to the responses in the questionnaires on the investigated nineteen worldwide *P*s, with sizes ranging from very large to medium, the "vastness" is not perceived positively. The surface area of each *P* has been re-scaled in relation to the extreme-sized *P* within the set. The smallest and largest *P*s are: Mariensztat (P_2, shown in Fig. 2.2(2)), and Zocalo (P_{18}, shown in Fig. 2.3(18)), respectively. The surface areas of P_2 and P_{18} are: approx. 4,500 m^2, and approx. 57,600 m^2. The former is within suggested in Ref. [2] range for "ideal plazas"; the latter has been selected as a reference, because despite its

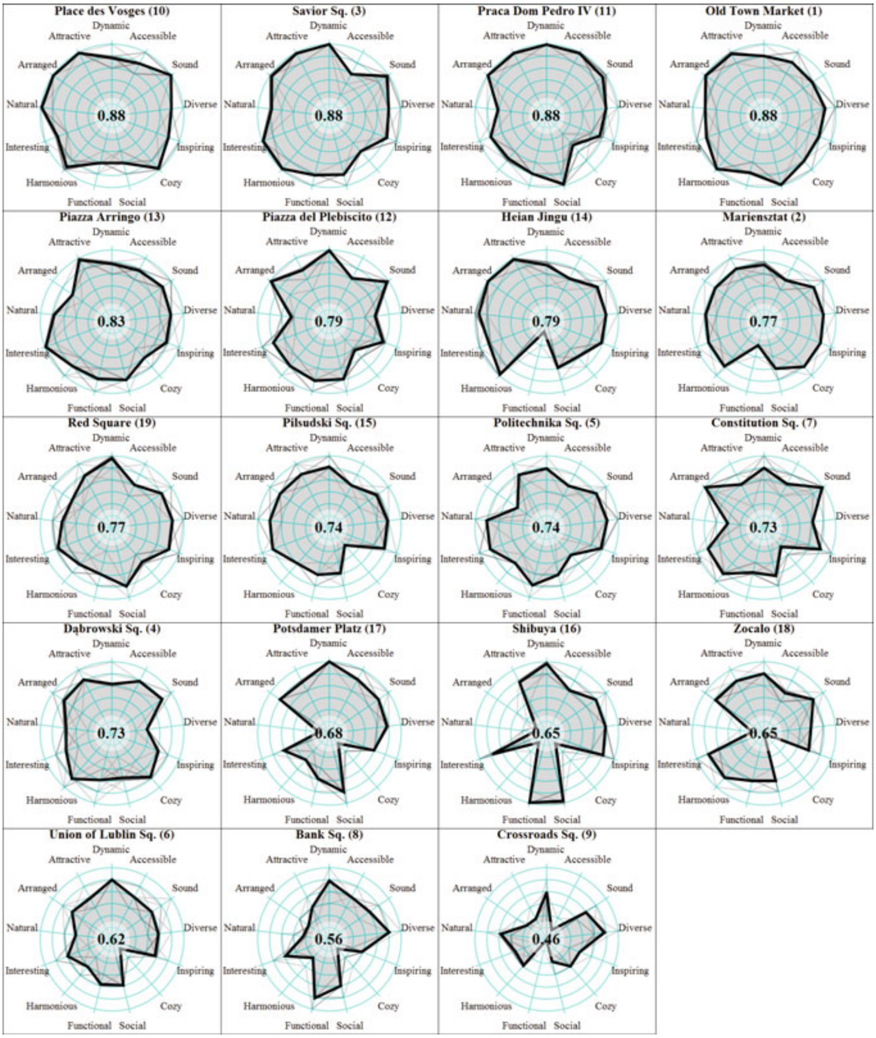

Fig. 2.4 Human subjective Evaluation. *P*s ranked according to the values of NAQ, shown in the center of every graph. All twenty individual evaluations of *P*s and their means are shown as gray lines and gray filling, respectively

enormous size, it has legible, well-defined form. There are even larger *P*s worldwide, however, they do not provide the sensation of enclosed space anymore. They can be designed by strict geometric relationships visible in their plan. However, they do not create perceptible barriers due lacking vertical elements in the perimeters of such *P*s proportional to their horizontal dimensions. In other words, such enormous *P* can be considered as an “open space” rather than an “urban space”. Such gigantic *P*s are listed here: [17]. Thus the notion of *smallness* (S), as a positive property has been defined, as follows:

$$S(P) = 1 - \frac{A_P - A_{P_2}}{A_{P_{18}} - A_{P_2}} \tag{2.1}$$

where A_P is the surface area of a given plaza P;

A_{P_2} and $A_{P_{18}}$ are the surface areas of: Mariensztat (P_2: 4,500 m^2) and Zocalo (P_{18}: 57,600 m^2), respectively.

2.3.2 Enclosure

In the same book [14], Sitte writes explicitly: "*the main requirement for a plaza is the enclosed character of its space*". So called, enclosure (E) is a property derived directly from P's plan. The calculation of its numerical value is explained in Fig. 2.5.

The enclosure is naturally normalized and the range of possible values is from 0 to 1, for completely open, and completely enclosed spaces, respectively.

2.3.3 Regularity

Qualitative evaluation of regularity is very easy for human perception. However, the quantitative evaluation of the degree of regularity is much more difficult. Moreover, a strict mathematical evaluation of the regularity of given shapes is also problematic. There are algorithms capable of detecting regular polygons implemented for recognizing of traffic signs. Refs. [4, 13] present the application of these algorithms

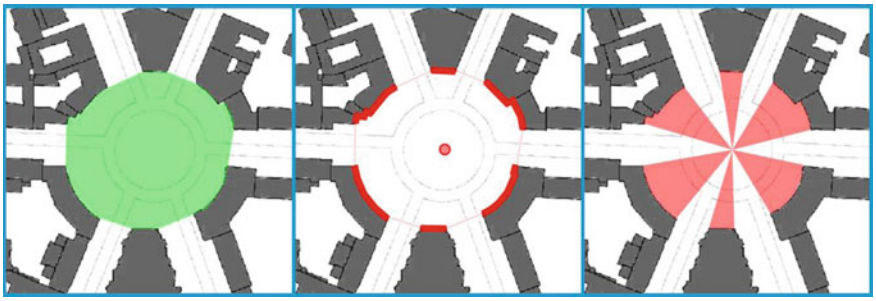

Fig. 2.5 Three steps of enclosure calculation: **1** Identification of the entire surface area occupied by a P (shown in *green*). **2** Identification of the vertical elements (usually building facades) which surround the P and the centroid of the P (shown as thick *red lines* and a *red dot*, respectively). **3** The surface area of the sectors projected from the centroid on the surrounding vertical barriers is calculated. Finally, the latter area is divided by the total area of the P

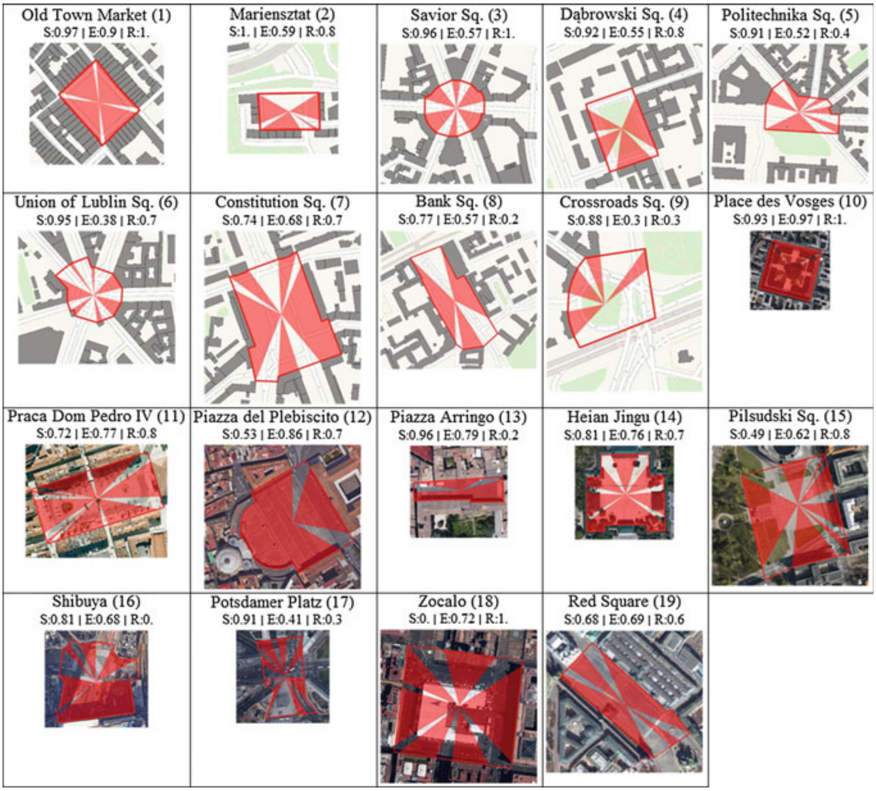

Fig. 2.6 All *P*s with calculated: smallness (*S*), enclosure (*E*), and regularity (*R*)

for analyses of photographic images. Traffic signs, however, are convex, therefore the research on regularity focuses on this class of geometrical shapes [3, 6]. In this chapter the assessment of regularity has been done arbitrarily based on intuition of each respondent. The assigned values range from 5 to 0, for perfectly regular (for example P_{10} shown in Fig. 2.3(10)) to extremely irregular (for example P_{16} shown in Fig. 2.3(16)), respectively. Figure 2.6 shows the plans of all nineteen *P*s with numerical values calculated for the three *properties*.

2.4 Correlation Between Automated and Human Evaluation of Plazas

Figure 2.7 shows correlation between the "normalized accumulated quality" (NAQ) pf *P*s assessed in the "human subjective evaluation" (HSE) to the three geometrical *properties* defined above. As Fig. 2.7 indicates, the three *qualities*, namely: "diverse",

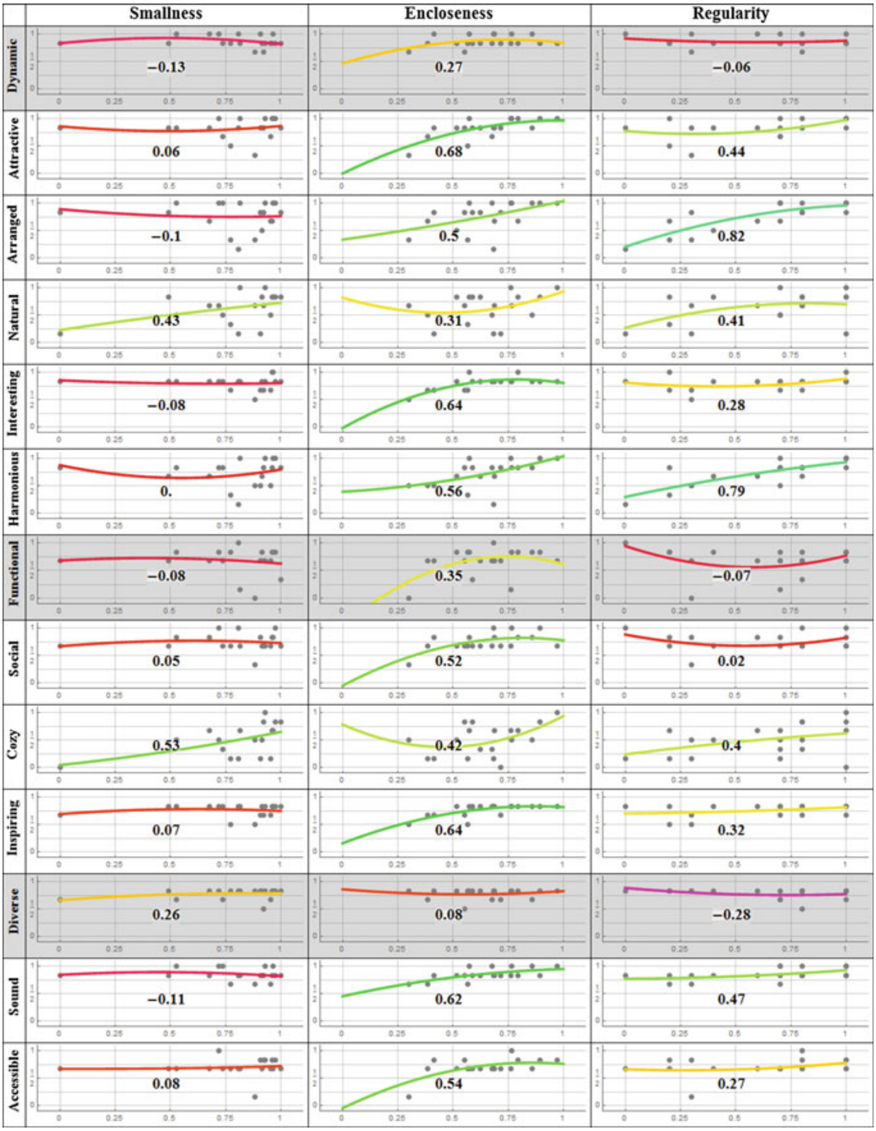

Fig. 2.7 Correlations among NAQ values of the subjective *qualities* (shown as rows) and geometrical *properties* derived directly from *P*s plans (shown in columns). Color of the *fitting line* corresponds to the correlation level. *Cyan* and *red* represent the strongest and weakest correlations, respectively. *Gray background* indicates the cases where there is no correlation between the *qualities* and *properties*

"functional", and "dynamic" show practically no correlation to the *properties*, thus these *qualities* have been removed from the mathematical model.

The NAQs of *P*s have been compared to the normalized totals of the respective *properties*, as shown in Fig. 2.8.

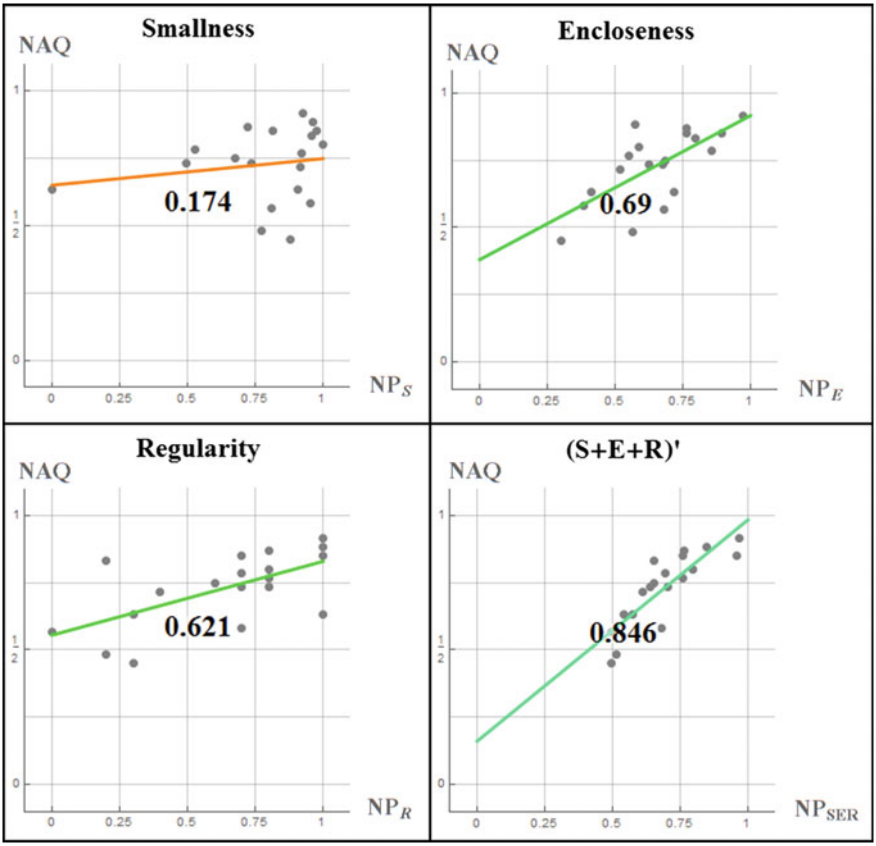

Fig. 2.8 Correlations Between NAQ and individual and combined and normalized geometrical *properties* of *P*s. The color convention of the *fitting lines* as in Fig. 2.7

As Fig. 2.8 indicates, the correlation of normalized geometrical *properties* of *P*s based solely on: smallness, enclosure and regularity show poor, good and good correlation to NAQ, respectively. Combining these three *properties* to a single normalized sum (NP_{SER}) improves the correlation with NAQ.

2.4.1 AGE and HSE Correlation

Finally the correlation between the automated geometrical evaluation (AGE) based on NP_{SER} with the human subjective evaluation (HSE) based on NAQ has been investigated. Figure 2.9 compares the two types of evaluations: NP_{SER} and NAQ for all nineteen *P*s. *Ps*. The sequence of *P*s in this Figure follows the sorting based on NAQ. As Fig. 2.9 indicates, there is a good agreement between NAQ values and the

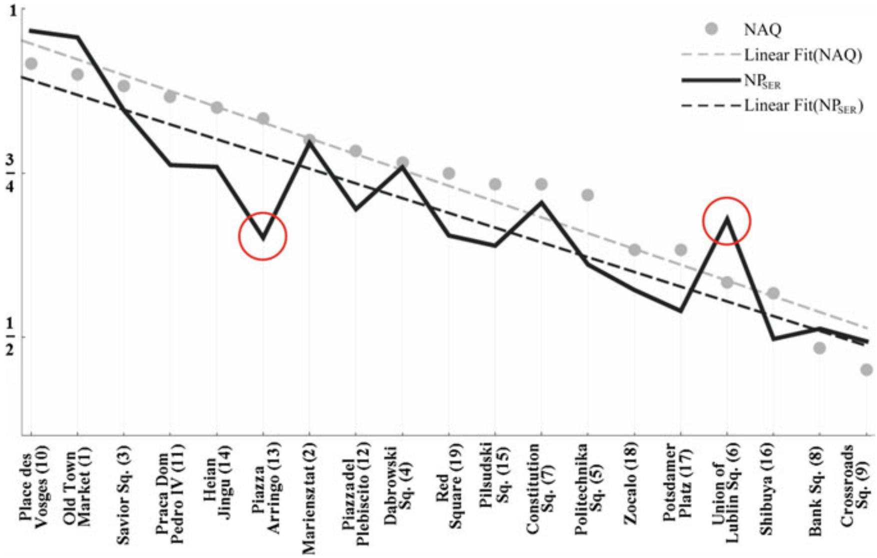

Fig. 2.9 Nineteen worldwide plazas sorted according to NAQ and subjected to the automated geometrical evaluation (AGE) by NP_{SER}. *Red circles* indicate two exceptional cases: one under-rated and one over-rated

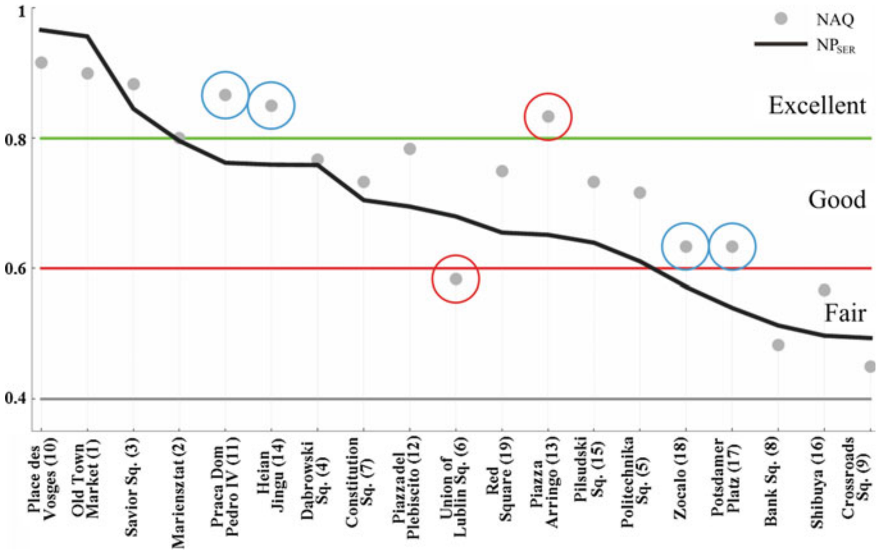

Fig. 2.10 Rating of plaza quality according to AGE divided into three arbitrary classes: excellent, good and fair. *Red circles* indicate the same exceptional cases as in Fig. 2.9. *Cyan circles* indicate four cases which have been "under-rated" by AGE

Table 2.2 The exceptional cases

P index	**NAQ**	**NP_{SER}**	**Comments**
6	0.58	0.68	Union of Lublin. This P is quite well defined. Two tollhouses indicate that it used to be the administrative border of the city. This results in P_6 being a major communication node with heavy vehicular traffic. Despite the urban attractiveness, these circumstances make it less pleasant for the visitors.
13	0.83	0.65	Piazza Arringo. Due to the proportions in plan, this P can viewed as a widened street. It does not form a well defined coherent space. However, due to the beauty and harmony of the surrounding architecture, as well as the usage of urban compositional elements (e.g. two fountains), P_{13} is an exquisite public space.
11	0.87	0.76	Praça Dom Pedro IV. This place has been one of the main squares in Lisbon since the Middle Ages. It is very large, which resulted in lower NP_{SER} rating. However, the size fits well the population demand which is not included in AGE. Moreover, P_{11} is a masterpiece of classical monumental urban space.
14	0.85	0.76	Heian Jingu. The plan of P_{14} is somewhat complicated. However the urban composition, placement of plants and presence of wooden architecture makes this place very attractive.
18	0.63	0.57	Zocalo. P_{18} is extremely large. In this study it is the maximum size reference for rescaling the property of smallness. Nevertheless it is the main square in central Mexico City, one of the most populated cities in the World. Thus, its size seems quite relevant.
17	0.63	0.54	Potsdamer Platz. P_{17} in the present form has been completed in the late 1990s. Despite its under-defined form it is an attractive social place in Berlin.

Red and green backgrounds indicate the case where a P has been: “over-rated” and “under-rated” by AGE, respectively linear model of NP_{SER}. Figure 2.10 shows the values of the automated geometric evaluation (AGE) of all *P*s, and divides them in three classes: excellent, good and fair. The sequence of *P*s in this Figure follows the sorting based on NP_{SER}.

As Fig. 2.10 indicates, six *P*s have been misclassified by AGE. These errors are qualitatively rather small.

Five *P*s have been rated lower by AGE than HSE, once AGE has "over-rated" a *P* in comparison to HSE.

The cases of "under-rating" by AGE, in other words *P*s "over-rated" by HSE can be explained by the fact that either these *P*s are situated in exceptionally attractive locations and (or) these *P*s are exceptionally aesthetic. Although in this survey the aesthetic values have been purposely ignored, it may indicate that it is not fully achievable by human respondents, and most likely they have been subconsciously biased towards aesthetically appealing *P*s. On the other hand, one case where AGE has given higher value than HSE can be explained by heavy vehicular traffic at this location which most likely is repelling to the respondents, causing them to view it lower. All the exceptional cases are commented in detail in Table 2.2.

2.5 Conclusions

- Many of the plazas considered in this chapter are among the best in the world, thus the quality rating proposed here may be viewed as rather "harsh". Even the plazas here rated "fair" can most likely be considered as "elite".
- The number of users assumed for a given plaza is a principal parameter in urban design. However, since presented here model of AGE focuses solely on the geometrical properties derivable from the plans, this parameter has not been included in the model. Nevertheless, it could be easily implemented if the relevant data was available.
- The definition of *smallness* presented here seems over-simplified. It simply gives linearly better values for smaller plazas. This proportionality is based on two plazas selected arbitrarily. It is rational to relate the smallness of the plaza to the number of its potential users.
- AGE presented here deliberately excludes the aesthetics. Despite this major limitation, it gives meaningful results. Most importantly, it is not intended as an "absolute evaluation" tool. However, it provides a reliable and straightforward evaluation methodology for identification of areas for potential improvements of a given plaza. Nevertheless, as Table 2.2 indicates, aesthetics of surrounding buildings may strongly affect the perception of a plaza.
- It is desirable that the evaluation of plaza's regularity was also done not in an arbitrary, but in an automatic way. This issue, however, seems particularly difficult. Alternatively, if a fully automated method would not be possible, more systematic and rigorous should be considered.
- the Human Subjective Evaluation (HSE) model is very simple as it adds a number of responses and normalizes the value to the range (0, 1). It would be interesting to

further investigate the inter-dependencies among the *qualities*. AGE model could be fine-tuned to more systematical HSE model.

- The model od AGE presented here requires some amount of "manual" labor, which to a certain degree could be automated. However, the idea of a fully automated AGE based on aerial photography, although very attractive, seems very difficult. It is mostly due to the fact that even advanced aerial photography recognition methods [1] are not fully reliable. It is usually caused by the radiometric similarity between the image background and roofs of the buildings.

References

1. Ahmadi S, Zoej MV, Ebadi H, Moghaddam HA, Mohammadzadeh A (2010) Automatic urban building boundary extraction from high resolution aerial images using an innovative model of active contours. Int J Appl Earth Obs Geoinf 12(3):150–157
2. Alexander C, Ishikawa S, Silverstein M (1977) A pattern language: towns, buildings, construction, vol 2. Oxford University Press
3. Aloupis G, Cardinal J, Collette S, Iacono J, Langerman S (2009) Detecting all regular polygons in a point set. arXiv:09082442
4. Barnes N, Loy G, Shaw D, Robles-Kelly A (2005) Regular polygon detection. In: Tenth IEEE international conference on computer vision, 2005. ICCV 2005, vol 1, pp 778–785. IEEE
5. Carr S (1992) Public space. Cambridge University Press
6. Chalmeta R, Hurtado F, Sacristán V, Saumell M (2013) Measuring regularity of convex polygons. Comput Aided Des 45(2):93–104
7. Corbusier L (1931) Towards a new architecture. Courier Corporation
8. Hillier B, Hanson J (1984) The social logic of space. Cambridge University Press
9. Isaacs R (2000) The urban picturesque: an aesthetic experience of urban pedestrian places. J Urban Des 5(2):145–180
10. Jiang B, Claramunt C (2002) Integration of space syntax into gis: new perspectives for urban morphology. Trans GIS 6(3):295–309
11. Mehta V (2014) Evaluating public space. J Urban Des 19(1):53–88
12. Perovic S, Folic NK (2012) Visual perception of public open spaces in Niksic. Proc Soc Behav Sci 68:921–933
13. Piccioli G, De Micheli E, Parodi P, Campani M (1996) Robust method for road sign detection and recognition. Image Vis Comput 14(3):209–223
14. Sitte C (1986) City planning according to artistic principles. Rizzoli
15. Talen E (2011) The geospatial dimension in urban design. J Urban Des 16(1):127–149
16. Taylor N (2009) Legibility and aesthetics in urban design. J Urban Des 14(2):189–202
17. Wikipedia: list of city squares by size. http://en.wikipedia.org/wiki/List_of_city_squares_by_size

http://www.springer.com/978-981-10-1105-4

Discrete Optimization in Architecture
Architectural & Urban Layout
Zawidzki, M.
2016, XIV, 105 p. 96 illus., 82 illus. in color., Softcover
ISBN: 978-981-10-1105-4