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Measure and proportion as keyword for qualitative town squares

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Abstract

The authors of this paper refer specifically to public space as that of the town square.
According to Italian tradition town squares have been clearly recognised since the Renaissance period.
There are several studies about meaning, perception, and the shape of public spaces such as squares but there is no research about their actual measures, proportions, and about the presence of some recurrent numbers.
This study develop a thematic synthesis about meaning, definitions and proportions before seeking similarity about spatial dimension using simple statistical instruments.
The study comes from a pedagogical exercise, undertaken in the last three years in the Course of Urban Design at University of Pavia, where students developed 80 data sheets based on free web information measures of Italian and European squares.

Keywords: public space; landscape; contemporary city; urban project; urban regeneration.

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Introduction

The town square is a central place in citizens' minds; it is a place full of cultural and social meanings. It has settled historical signs and founded the values of civilization, of meeting, spirituality of the religious space, political and administrative power, stage of identity and sense of belonging to a community, which allows everyday demonstration of the power of "civitas".

> *Public squares are one of the significant public spaces in an urban environment. Urban squares are open public spaces, which reflect the cities' identity and the communities' cultural background* (*Murat*, 2013).

The specific function of the square does not automatically define a spatial form. Each different function can be expressed in many different forms. Except new designed ones, squares changed their function along the centuries. Each development testifies that the archetypes are structural; they are spatially and not functionally determined.

> *Squares are living organisms in continuous change with the variation of socioeconomic conditions and technological tendencies.*

Main definitions and approach to the study of squares

Since the classical period there have been several studies by famous scholars that have identified categories and construction characteristics of the squares. From the semantic point of view we can recognise different definitions such as on the formal, symbolic and perceptive, social and aesthetic level.

From the social and the aesthetic one Palladio stated that the square is a place where people can gather to carry out business; it is an essential and useful place to their different purposes and needs.

Another scholar who worked on the topic, on social and aesthetic level, is Marco Romano. He defined squares as the realisation of a civic desire to emphasise the symbolic importance of socially recognised and relevant behaviour and feeling, connected to a consolidated collective theme with a recognizable architectural appearance. (Romano, 2004)

Collective themes, concerning thematic roads and squares, each of which has its own name and its own way of being recognised, are the demonstration that "civitas" try to achieve its property as a symbol of art. These urban elements, with their symbolic meaning, are able to connect different parts of the city from the most significant to the disqualified suburbs.

Marco Romano (2004) defined as thematic squares: the; main square, market square, convent square, greenfield of the fair, church's square, monumental square and the national square. All of these squares were conceived to respond to specific needs through their functions.

The symbolic meaning of collective themes persists even if their original social meaning has declined, so the main square can maintain or assume the role of political heart although the town hall buildings moved to another place.

From the symbolic and perceptive point of view Camillo Sitte (1889/1981) defined the Square as the result of many individual actions, a slow collective construction, a complex stratification of different languages and a choral monument. Moreover, he added that the

square should be studied as a work of art, using the same parameters and regulations that come from the study and the result of some creative actions.
From the formal point of view we can underline Krier, Sitte and Zucker.
Sitte (1889/1981) defined two types of squares: the deep type and the wide type. The character of either is determined by the characteristics of the dominant buildings.
Paul Zucker (1959) also outlined different types of urban squares; he indicated different types of squares in visual and perceptive dimension:

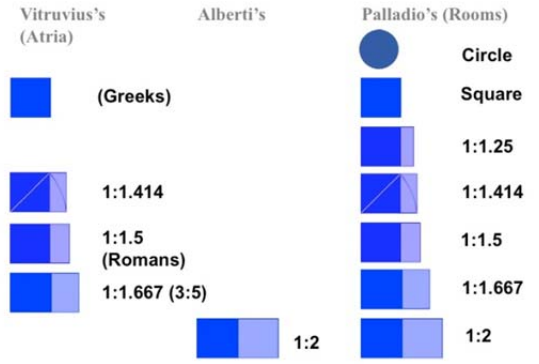
1. The closed square is characterised by self-contained space and by a complete enclosure;
2. The dominated square is characterised by one individual structure or a group of buildings toward which the open space is directed and to which all other surrounding structures are related;
3. The nuclear square is characterised by space formed around the centre;
4. The grouped square is characterised by the combination of spatial units. A sequence of squares, different in size and form, could develop in only one direction, thus establishing a straight axis.
5. The amorphous square is different from the ones above mentioned.

Krier (1979) had also a physical approach of urban space and defined three major shapes (squares, circles and triangles) that might be modified through angling, segmentation, addition, merging, overlapping and distortion.
Lastly, Kevin Lynch (1960) identified the cities and the urban space through five elements: paths, edges, districts, nodes and landmarks; both of them relating on the physical shape and the symbolic aspects.

Proportion and relationship

Along the history of architecture, proportion has always been the key to define an "ideal harmonic space" and scholars have been studying it in horizontal and vertical ratio.
Vitruvius (15 B.C./1960) wrote in his treaties that the width is obtained by assigning to it 2:3 of its length.
Palladio (1570/1997) fixed seven different ratios that should be followed: circular one, 1:1, 1:1.25, 1:1.414, 1:5, 1:1.667, 1:2.
According to Palladio, also Alberti (1755) defined the ratio of 1:2. (Fig. 1). (Moughtin, 2003). Sitte (1889/1981) argued that the width should not be greater than three times the length.
Sitte (1889/1981) wrote that the height of its principal building is the minimum dimension for the square, and the absolute maximum is the double of its height.
For Zucker (1959) the spatial impression is a product of the individual sizes of adjacent houses, of higher and lower eaves, of the relationship of length and breadth, of the location of the monuments and fountains and of variations in the architectural treatment.
Zucker (1959) argued the maximum building height should be that on which its architectural features might still be visible from the floor of the square, giving a height/length ratio of between 1:4 and 1:6.
Kevin Lynch (1981) suggested dimensions should start from 12 meters to 24 meters along each side, and go up to 100 meters for large squares (Carmona et. al., 2003).

Alexander (1987) suggests a maximum of 22 meters for small squares, while Gehl (2011) suggested a dimension of 30-35 meters for the optimum size of a square in order to enable people being able to recognise the other people in the space from one side to other.



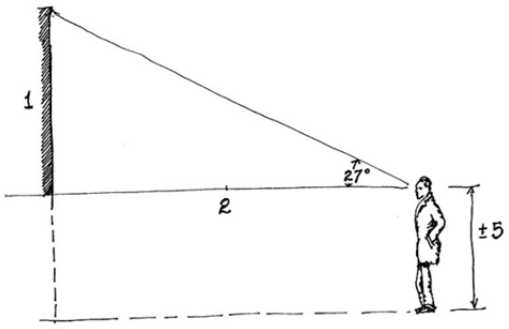


Fig. 1 (on the left). Horizontal relationship. Source: http://londonsquares.net/design-issues/
Fig. 2 (on the right). Vertical relationship. Source: http://londonsquares.net/design-issues/

So when determining the size of an urban square, visual perception should also be taken into account (Murat, 2013). According to the most theorists the maximum angle, at which a building can be seen clearly is 27°, or at a distance which equals about twice its height. (Fig. 2).

Methodology and sources

During the course of Urban Design (4th year of the Master Degree in Building Engineering and Architecture, Faculty of Engineering, University of Pavia – Prof. Roberto De Lotto) in academic years 2010/2011 and 2011/2012 the study of open spaces were oriented to look into the dimension and the proportion of several open spaces in Italy and Europe.
Students were advised to look up open source information to define measures of selected spaces. Measures concerned plan measures and the height of the surrounding buildings.
The schedule that students have used to complete each data sheet is shown in Table 1.
To get the measure of the plan, the most employed instrument was Google Earth (with its instrument "ruler").
To get the measure of the heights of the surrounding buildings students used bird view (of Live Maps) and street view images; in some cases some buildings were already modeled in Google Earth 3D and students could download the file.
This kind of measuring could not provide precise size but the error was accepted considering the main aim of the work, which is the definition of proportions of real spaces. Indicatively the average error is about the 5-10%.
All information were collected in 80 datasheets and available at the website http://urbanisticaunipv.wix.com/delotto
Following is a example datasheet.

Name and number of students group	**Google earth image** Localization (Fig. 3)
Address and name of the square	
Square plan - Size (lenght, width, perimeter, area) (Fig. 4)	
Cross section and Transversal section (Fig. 5-6) - Height of building; - Presence of portico; - Roof (such as pitched roof or flat roof).	
Other informations - Measure on plan and section (Figg. 7-8) - Views indications (Fig. 9) - Google earth panoramic photo (Fig. 10) - References	

Table 1. data sheet

All the selected public spaces are historical squares that during the centuries have had several changes, adjustments, and modifications both in the shape and in the surrounding buildings. Present situation is not the result of a specific project but the result of a historical stratification, which Alexander (1987) calls "organic growth". For this reason, for instance, it is very difficult to have uniform sides of building built with the same height. Therefore, the height chosen for the ratio is the "average" of elevated buildings.

Figure 3. Localisation
Google Earth image
Source: http://urbanisticaunipv.wix.com/delotto

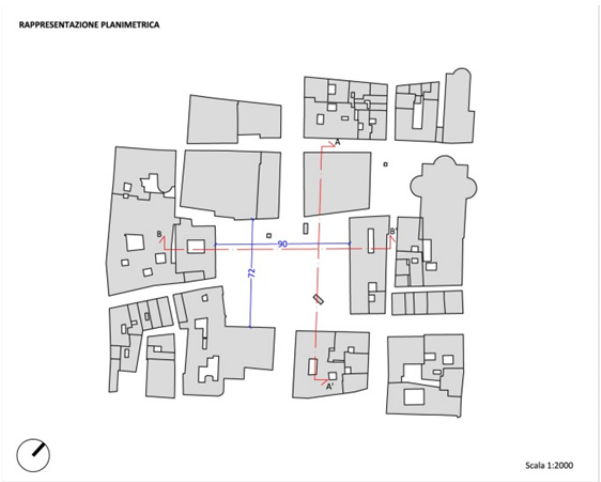


Figure 4. Square layout
Source: http://urbanisticaunipv.wix.com/delotto

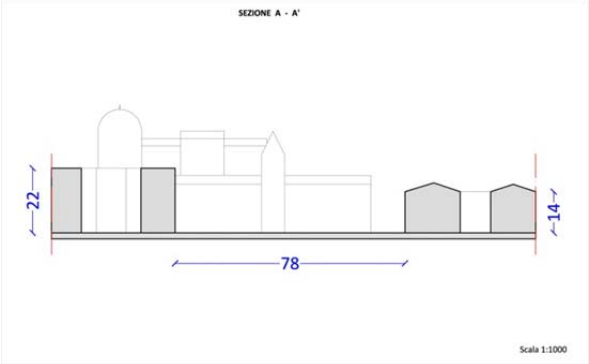


Figure 5. Cross section
Source: http://urbanisticaunipv.wix.com/delotto

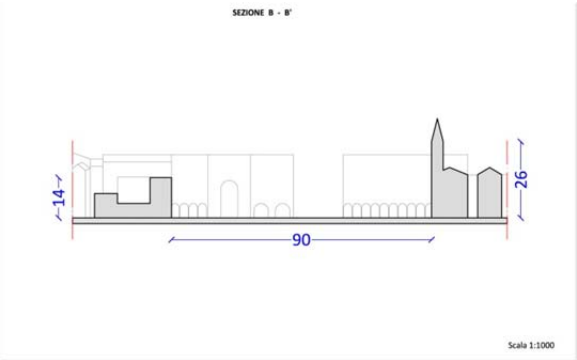


Figure 6. Trasversal section
Source: http://urbanisticaunipv.wix.com/delotto

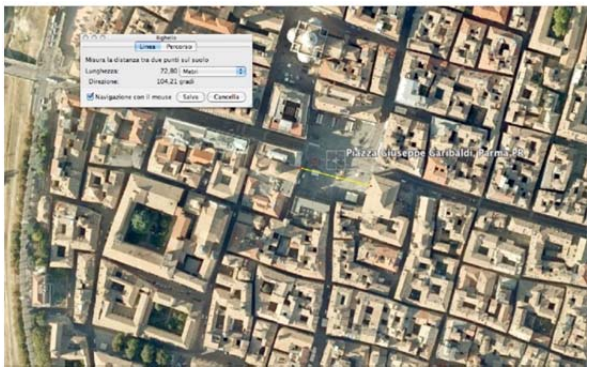


Figure 7. Measure with rules
Source: http://urbanisticaunipv.wix.com/delotto

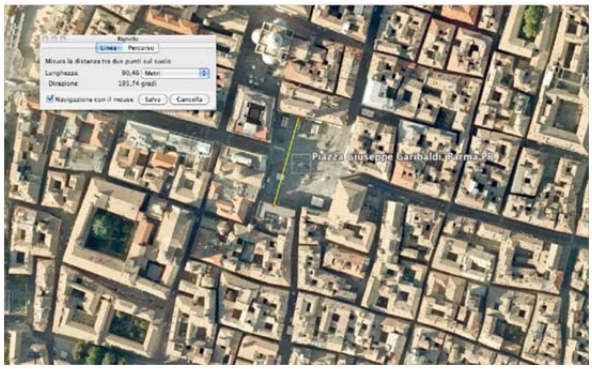


Figure 8. Measure with rules
Source: http://urbanisticaunipv.wix.com/delotto

Figure 9. Views indication
Source: http://urbanisticaunipv.wix.com/delotto

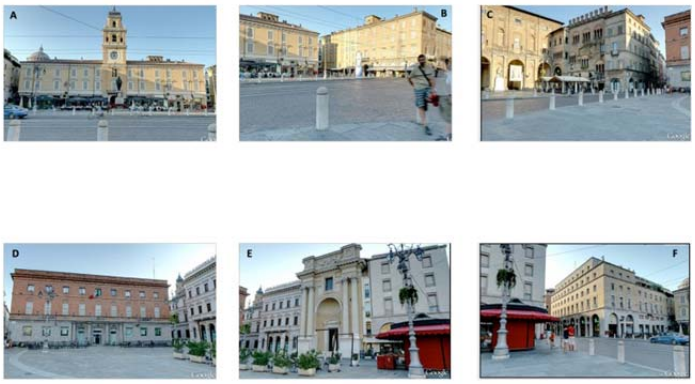


Figure 10. Views of the square
Source: http://urbanisticaunipv.wix.com/delotto

Data treatment and results

Starting from this data set, all information was treated and analysed with the aim to verify whether the classical proportions were recognisable in present squares.
After the effected modification along the centuries, recurrent proportion might be the same at present. Following Sitte and Zucker definitions, only closed squares were considered. At present authors could work on 27 squares chosen from 80 open spaces that have been analysed and measured.
In the following Table 2 there is list of considered squares with dimensions and some basic proportions.

City	*Square's name*	*Lenght [mt]*	*Width [mt]*	*Area [sqmt]*	*L/W*	*Hl [mt]*	*Hw [mt]*	*L/H*	*W/H*
Bruxelles	Grand Place	110	57	6.270	1,93	24	22	4,58	2,59
Catania	Piazza Duomo	73	65	4.745	1,12	20	28	3,65	2,32
Dublin	San Patrick Square	145	76	11.020	1,91	26	12	5,58	6,33
Firenze	Piazza della Repubblica	90	80	7.200	1,13	28	26	3,21	3,08
Firenze	Piazza Santa Croce	103	48	4.944	2,15	14	19	7,36	2,53
Glasgow	George Square	163	101	16.463	1,61	23	37	7,09	2,73
Lion	Place Bellecour	270	177	47.790	1,53	20	23	13,50	7,70
Lion	Place des Terreaux	116	63	7.308	1,84	30	26	3,87	2,42
Lisbon	Plaza Dom Pedro	196	92	18.032	2,13	28	18	7,00	5,11
Lodi	Piazza della Vittoria	76	76	5.776	1,00	14	22	5,43	3,45
Madrid	Plaza Mayor	130	95	12.350	1,37	22	20	5,91	4,75
Madrid	Plaza de Espana	236	112	26.432	2,11	117	27	2,02	4,15
Manchester	Alber Square	110	55	6.050	2,00	29	22	3,79	2,50
Mantova	Piazza del Sordello	150	57	8.550	2,63	26	17	5,77	3,35
Milano	Piazza Duomo	160	130	20.800	1,23	60	53	2,67	2,45
Modena	Piazza Grande	75	47	3.525	1,60	12	18	6,25	2,61
Napoli	Piazza del Plebiscito	170	170	28.900	1,00	45	26	3,78	6,54
Palermo	Piazza Pretoria	80	42	3.360	1,90	13	15	6,15	2,80
Paris	Place Pompidou	170	52	8.840	3,27	28	42	6,07	1,24
Parma	Piazza Duomo	55	55	3.025	1,00	20	20	2,75	2,75
Parma	Piazza Garibaldi	90	72	6.480	1,25	26	22	3,46	3,27
Pienza	Piazza Pio II	23	23	529	1	11	11	2,09	2,09
Stockholm	Stortorget Square	60	35	2.100	1,71	18	18	3,33	1,94
Torino	Piazza San Carlo	170	76	12.920	2,24	22	22	7,73	3,45
Trieste	Piazza Unità d'Italia	157	81	12.717	1,94	19	16	8,26	5,06
Warsaw	Rynek Starego Miasta	103	75	7.725	1,37	26	23	3,96	3,26
Venezia	Piazza san Marco	179	71	12.709	2,52	24	26	7,46	2,73
Vigevano	Piazza Ducale	155	47	7.285	3,30	10	10	15,50	4,70

Table 2. Data related to 27 European closed squares. Source: http://urbanisticaunipv.wix.com/delotto

Where:
- L is Length;
- W is Width;

- L/W is Length/Width (shape ratio);
- Hl is the height of the highest building in the short side;
- Hw is the average height of the buildings along the long side;
- L/H and W/H are proportions;

In the following list, the only Pienza square was designed to be the quintessential of squares. The measures of all sides and heights of the buildings are proportionate with ratio 1:2.
Looking at the physical dimensions, a wide variety of measures and proportions are evident.
All data was analysed with simple statistical instruments.
First of all, the average values were calculated (Table 3):

	Lenght [mt]	*Width [mt]*	*Area [sqmt]*	*L/W*	*Hl [mt]*	*Hw [mt]*	*L/H*	*W/H*
Av	129,11	76,07	11.208,75	1,78	26,96	22,89	5,25	3,49

Table 3. Average values

The medium extension of the selected spaces is a little more than a hectare; the shape ratio is about a rectangular shape, not far from 1:1,732 (1,732 is square-root of 3).
The proportion on the longitudinal section is close to 1:5, the proportion on the transversal section is almost 1:3,5.
Looking at the average value there are not so many relations with the classical numbers that theorists defined in their treatises but in Zucker's ones.
Looking at the Standard Deviation (the variation or dispersion from the average value) and the Coefficient of Variation (also known as Relative Standard Deviation; calculated as ratio between Average value and Standard Deviation and it is the measure of frequency distribution, a sort of dispersion of the average value) it is clear that the dissimilarities are very widely distributed (Table 4).

	Lenght [mt]	*Width [mt]*	*Area [sqmt]*	*L/W*	*Hl [mt]*	*Hw [mt]*	*L/H*	*W/H*
Av	129,11	76,07	11.208,75	1,78	26,96	22,89	5,25	3,50
SD	56,32	36,08	9.996,13	0,63	20,38	9,09	3,09	1,52
CV	0,44	0,47	0,89	0,36	0,76	0,40	0,55	0,44

Table 4. Standard Deviation (SD) and Coefficient of Variation (CV)

For example, the average longitudinal proportion is close to 1:5 but with a Standard Variation that is the 55% of this value. So it can't be statistically considered as a recurrent value.
On the transversal proportion there is a lower error, but it remains about the 44%.
So author applied the analysis to more narrow application sphere.
First of all the squares with a length equal or superior to 150 meters have been excluded together with Pienza (a very small square). Table 5 shows results.

	Lenght [mt]	*Width [mt]*	*Area [sqmt]*	*L/W*	*Hl [mt]*	*Hw [mt]*	*L/H*	*W/H*
Av	94,40	62,73	6.125,20	1,55	21,47	22,89	4,62	3,11
SD	25,47	16,36	2.823,58	0,40	6,15	4,21	1,38	1,11
CV	0,27	0,26	0,46	0,25	0,29	0,20	0,30	0,36

Table 5. SD and CV in smaller squares

In this case, the Coefficient of Variation is sensibly minor than in the previous example. Except for Area (46%) this value is between 20% and 36%, mainly between 20% and 30%.
It means that average proportion values for such squares are more credible. Longitudinal proportion is close to 1:4,5 (may close to 1:4,47, we argue that 4,47 is the double of square root of 5 – but this kind of conjectures have infinite possibilities) and transversal ratio is around 1:3.
These values are different, and lower, than the plain average ones. In the widest squares, considering that the height of buildings does not vary so much, the lengths have strong influence. It means that the square are lengthen rectangle.
Ordering the main list by the value L/H, two squares have very high values (Table 6):

City	*Square's name*	*L/H*
Lione	Place Bellecour	13,50
Vigevano	Piazza Ducale	15,50

Table 6. L/H highest values

Removing from the list these two squares and calculating Average, SD and CV the values do not change significantly (Table 7).

	Lenght [mt]	*Width [mt]*	*Area [sqmt]*	*L/W*	*Hl [mt]*	*Hw [mt]*	*L/H*	*W/H*
Av	122,69	73,31	9.952,69	1,73	27,88	23,38	4,97	3,29
SD	50,62	30,94	7.220,27	0,58	20,84	9,07	1,87	1,30
CV	0,41	0,42	0,73	0,34	0,75	0,39	0,38	0,40

Table 7. SD and CV in squares with more homogeneous L/H

CV in proportions records remains high, while the average values are not so different from the plain statistics.
Considering a more narrow set, and excluding all the squares in which L/H is equal or higher than 6, the results are (Table 7):

	Lenght [mt]	*Width [mt]*	*Area [sqmt]*	*L/W*	*Hl [mt]*	*Hw [mt]*	*L/H*	*W/H*
Av	110,44	75,06	9.556,88	1,51	32,50	23,44	3,75	3,28
SD	52,47	36,01	8.375,55	0,51	25,38	9,32	1,14	1,36
CV	0,48	0,48	0,88	0,33	0,78	0,40	0,30	0,41

Table 8. SD and CV in squares with more homogeneous and smaller L/H

The longitudinal ratio is lower (as easily predictable) but CV does not vary significantly.
From all these attempts, it is obvious that the dispersion of the values does not depend on specific dimensions; so the average record is not as significant.
Also considering only Italian squares without Pienza (Table 9), there is not a significant homogeneity in the distribution of values.

	Lenght [mt]	*Width [mt]*	*Area [sqmt]*	*L/W*	*Hl [mt]*	*Hw [mt]*	*L/H*	*W/H*
Av	118,87	74,47	9.529,07	1,73	23,53	22,67	5,96	3,41
SD	44,43	34,17	7.216,85	0,72	13,31	9,71	3,26	1,17
CV	0,37	0,46	0,76	0,41	0,57	0,43	0,55	0,34

Table 9. SD and CV in Italian squares

Discussion and conclusions

In the introduction and in the first chapter of the paper, the issue regarding the meaning and value of city squares in respect of the whole city life has been presented throughout the review of many relevant scholars, who faced the argument along centuries of history of architecture and urban projects.
From the social, symbolic, aesthetic and perceptive points of view, scholars underlined that there is a tight connection among the space (that forge the square), the buildings (that define the square's shape and its civic meanings) and the value that citizens confer to it during the evolution of the city.
Moreover, the formal and spatial aspect was approached as a key point to address the physical issues toward a successful transmission of urban qualities. This research aimed to find out an "objective" mix of measures and proportions from common individual senses. Essentially this issue is same as the relation between shape and function (or meaning), and it passes through all architecture history.
Another aspect emerges from the review of scholarly writings: the historical stratification and the uniqueness of collective spaces. A square is the result of a cooperative action diluted along the centuries and very often it is does not come from a detailed project, considered as precise act of will. In the same time, following Romano's approach, the common intention of "civitas" and its continuous acting was guided by a kind of aesthetic rule, even if it was applied to small parts of the whole space and it may regard only buildings and their very close spatial jurisdiction.
Analysed squares were selected with a morphological criterion and they were founded in very different historical periods in European context. In selected cities the most recent

structural interventions vary from XVI to XX century, crossing very different cultural developments.
For these last two reasons, it was foreseeable that in considered squares measures and proportions might vary a lot.
Collected data and their elaborations demonstrate that, along history, formal criterion lost their dominance to define the public space in spite of the meaning and collective value that the "civitas" attributes them.
Statistical analyses results demonstrate that classical proportions are untraceable in actual squares. On the contrary, many squares studied present with Zucker's proportions (1:4 and 1:6).
So, from the collected data, perceptive theory seems the only formal rule present, which has guided the realisation and transformation of the squares.
Considering the small number of examples analysed, presented elaborations may not have a statistical relevance. There is an interesting indication in Table 3 about the average value of L/W (squares' shape in plan) that is close to 1:1,732 (square root of 3), but it is true that Standard Deviation and Coefficient of Variation indicate that this value is highly variable.
In other words, this analysis does not exclude the possibility to find recurrent proportions in closed squares. So the first further next step of presented research is to measure more examples.
Another next step is a more detailed definition of the specific characteristics of the squares basing on their main theme. In presented list there are mainly church's squares and monumental squares, but they are mixed together. Maybe, persistent proportions (or measures) may occur for specific themes.
A further next step of the research is to analyse and measure new designed squares in existing contexts, trying to find out the recurrence of specific proportions.
This study may help designers and scholars to define a new set of measure and proportion that, with the appendix of real spaces, can help decisions in spatial aspects.

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