Interpretation Model of Urban Space Coherence

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Abstract. The paper presents our efforts to establish a model for urban space interpretation (IMUSC – Interpretation Model of Urban Spatial Coherence), intended as a pragmatic instrument for recognizing elements and phenomena that affect actual use of urban spaces. The initial premise proposes the mechanism for traceable linkage between the basic, mostly visible elements and features in the urban space, and three qualities concerning actual use: (a) access to the space, (b) movement within and through the space and (c) permitted/tolerated and stimulated sojourning of the users in the space. The model aims to assist with bridging the communicational gap between expert and lay public occurring in the formal or informal process of spatial co-deciding, by increasing comprehension of spatial complexities and hence developing common priorities concerning spatial values.

Keywords. Spatial qualities, interpretation model, public participation, urban design.

INTRODUCTION

Starting from a lack of suitable tools for exposing the complexity and coherence of urban space (as being understood from the theory of complex interacting systems) to nonprofessional public – we framed a model to demonstrate and interpret the distinctive spatial features that generate and form commonly preferred urban spaces. The model proposed is intended as an instrument to assist communication between the expert and lay public that has increasingly been involved in the process of urban decision making and search for a quality urban design.

A large body of literature and research in different spatial disciplines has evolved that attempts to explain the principles of good quality urban design, whilst reflecting the agenda set by Cullen, Lynch, Krier, and Jacobs amongst many others. The broad research scope has been examined either from the perspective of a user, different groups of users, public health, traffic, weather through the optics of the sustainable development, or merely in regard to a certain pillar (social, economical, environmental) of this development. The criteria for estimating of urban space advantages/shortcomings are being derived from either physical to societal or even solely perceptual spatial realities. Since the 1960s, researchers and others have developed a rich array of design evaluation approaches (Forsyth, 2010); however, the description and specification of these measures are rarely entirely clear, cohesive or unified. A systematic review of the literature and research engaged in estimating the quality of urban design (e.g: Rapoport, 1970; Frumkin, 2003; Franz et al., 2005, Ewing &
Handy, 2009; etc.) has proved the continuation of extensively recognized but abstractly defined merits, such as visual order, enclosure, openness, balance, continuity, identity, human scale, clarity, diversity etc. Bringing such abstract, at times vague and indistinct terminology and meaning into the dialog of urban decision-making raises relevant doubts concerning the reciprocal comprehension between the expert and non-expert public, as well as among the representatives of diverse spatial disciplines.

For this reason our attempt was to establish an interpretative model for identifying and tracing the vital spatial elements and arrangements that contribute substantially to the desired development of concrete urban space.

In addition, to objectify and clarify the abstract measures listed above we linked them to the observable visible aspects of space rather than the latent ones, and hence indirectly translate them to a more tangible form. While spatial quality becomes a meaningful concept only when related to an actual definition of space use (Rapoport, 1970), the main challenge was to create an insight into the space structure from the perspective of users' daily experiences – this is how a specific space accommodates the user's needs. We selected and highlighted three definitions of space use – additionally designated as operative qualities – that contribute significantly to the experiential/perceptual value of urban space: a) ease of access - different modes; b) ease of movement within and through the space and most importantly c) permitted/tolerated and stimulated sojourn of the users caused by the space functionality, amenities and appeal.

The model consists of two main parts: the first part is based on the generalization of spatial complexity and coherence into key spatial elements and simplified but systematic linkage to operational qualities (which serve at this point as an output). The second part of the model is a visual extension of those outputs, proposing experiential visual presentation of the essential pre-defined elements in the space/location that is observed.

The efforts were threefold: first, to form valid, applicable and convincing measures to assess valuable features of space design, and second, to indicate the developmental trait that considerably affect user's spatial experience which – taken as a consequence – derives from either prudent or poor design decisions; and third, to generically recreate urban spaces for research and communicative purposes.

The model aims to assist with bridging the communicational gap between expert and lay public (occurring in the formal or informal process of spatial co-deciding) by increasing comprehension of spatial complexities and hence developing common priorities concerning spatial values. It is an instrument for decoding professional language in terms of the approving urban design, and furthermore a method for identifying/tracing the contributors that generate the existing situation in a certain urban space.

The present paper unfolds the arguments in two steps. We begin by recalling background information on space and its quality and the section that reveals the initial suppositions and logic underlying the model setup. It discusses relevant theoretical grounds and describes key terms concerning urban space and spatial quality as the object to be communicated through the model (IMUSC). We then turn to the challenges associated with measuring characteristics of the built environment and determining its qualities through the optics of professional and non-professional public. The second part provides an insight into the model reasoning, its structure, essential elements, as well as its main advantages and constraints. We conclude with the discussion of the issues that must be addressed in extending this research to a broader context of spatial fragility/sensitiveness and yet deliberation on the modeling output visualization.

DIMENSIONS OF URBAN SPACE AND ITS QUALITY
Before we tackle the issue of identifying the spatial qualities for calling public attention to common priorities, we pause for a moment yet to explore the
crucial subject—the notion of the urban space. The first problem to be faced with namely is the difficulty of defining space, or rather deciding the kind of space which we are dealing with.

Space is, as quoted by (Tuan, 1975), “an abstract term for a complex set of ideas” that can be divided up or categorized into various ways concerning different disciplines and purposes. According to Rapoport (1970), spatial reality is not the relatively simple physical space which designers have traditionally been taught to manipulate. Bell (2006 cited by Hudson-Smith, 2008) for instance identifies three different kinds of geographic space: visual, informational and perceptual, whereas Hudson-Smith (2008) draws the distinction between the real and the digital space with addition of social component. Tuan (1975) exposes the importance of experiential space, derived from the compound of one’s sensation, perception and pre-created conception of the mere space, whereas the experience of space can be direct (presence in the physical space) or indirect (mediated depiction of space).

Despite the very different classifications of space, nearly all give us the undisputable surmise of the following rough outlines of space: 1) objective, real, physical, tangible, directly observable, also quantifiably measurable; 2) subjective, perceptual, experiential, also qualitatively measurable; 3) conceptual, informational, digital, cartographical, mediated.

In the field of architecture and urban design, spatial form is traditionally regarded as its most prominent concern; in fact it has been called the primary dimension of architecture (Franz et al., 2005). On the other hand, despite leaning towards the physical and visual appearance of space, mindful architects and urban designers are expected to include and deal with all the other dimensions that tightly interlace with the spatial form and its role. The subject of our research is thus primarily devoted to the physical, visually perceptible urban environments as are defined by the viewer’s prospect of its units as well as its observable cultural dimension and experiential charge. Yet the methodological focus of the study inclines towards revealing the potentials of the third - interpretative or informational category of urban space, which we claim can contribute to a higher public consciousness concerning the role of basic spatial features, their mutual interlacement and contribution to supposed urban quality. The characteristics of urban space, poetically quoted by the Frumkin (2003), affect us in many ways - we gain orientation from certain space cues, they can give us a sense of balance, capture our attention; urban space is a means of movement, it is a means of sojourning, it can evoke memories and arouse emotions, and can also connect people.

The crucial question at this point is how to determine the very different comprehensions of spatial qualities as well as the terminology used to describe them; what is the evidence of a good place, and how to unify numerous priorities in urban space that different individuals, public groups and professional public aspire to. Especially deep seems to be the discrepancy between the expert and general lay public. Thus, with the model proposed, we confront the two different vocabularies, attitudes and reasonings addressing spatial qualities, although both derive from the same fundamental and concrete spatial elements. With other words – plain spatial elements in this role have the potential to bring the distinguishing comprehensions of spatial quality to a common denominator.

Before we leap forward to explain the model, the following principles that form the core of the model should be highlighted:

A) Expert optics – reasoning and language
The language for communicating the spatial qualities has been developed within different domains, mostly architectural design, urban planning, and, more recently, by scholars of cultural studies, and social geography. Also theories from environmental psychology (e.g. Polic et al. 2005; Winkela et al. 2009), urban sociology (e.g. Molotch 2011), and
studies related to physical activity and health (e.g.; Frumkin 2003; Ewing and Handy 2009; Pucher et al. 2010, etc.) use the existent, rather abstract and conceptual terminology and notions to describe the characteristics of build environments. The latter prove to become a hindrance when introducing empirical approach into the research on spatial quality that demands exact and traceable measuring. Frumkin (2003) claims that many recommendations for “good places” are available, but few are based on empirical evidence of measurable criteria, and thus are often incompatible with current research practice. Nevertheless, the preliminary problem for the modeling also seems to become the multiplication of notions, their often indistinct meaning, vague interpretations and, especially, the inconsistency regarding the use and dissimilar taxonomies. Here, the abstract definitions of spatial quality seem to fail in providing the expert public with a solid tool to assess the urban space or in offering an applicable instrument for communicating it to general public.

According to the review of literature addressing the quality of urban design (investigating user responses to different spatial features or presenting guidelines for urban designers), an extensive list of the terms used was documented. Additionally systematic clustering was made in regard to similarity of meanings and further comments of the authors. The most overlapping or weakly definable expressions were eliminated and further regrouping was made to extract the most frequent and applicable terms that have emerged in professional language to express spatial qualities. As a result the list of more recurrent and recognized merits was proposed for further pursuance: 1) balance, 2) visual legibility, 3) unity, 4) identity, 5) adaptability/flexibility, 6) maintenance, 7) diversity, 8) functionality/ease of use. Although the listed qualities are yet far from exact definitions that could enable direct measuring, they represent the starting point for communicating/discussing the issue of spatial quality within single and among different spatial disciplines. The next step was to break down the complex and structured spatial qualities into more tangible definitions and afterwards link them to visible elements and phenomena in urban space. In other words, we force the conceptual merits of professional vocabulary to capture though simplified but tangible form through relating it with concrete spatial fragments.

B) User optics – reasoning and attitude
By contrast, an average user of the urban space rarely or never wonders about the notions, such as enclosure, linkage, visual order, or unity that characterize a definite urban location. Rather, one is concerned with the potential of this place suiting his needs and expectations on the level of his experiences with it. It is therefore also the spontaneous reaction of the user (in regard to the stimuli of given spatial features) to co-create the place with his behavior as he uses it. Gehl (1981) states that experiencing other people, interacting with them or merely observing them or being among them provides a particularly colorful and attractive opportunity for stimulation, gain of valuable information and pleasing sojourning in the urban space. The latter can considerably enrich the experience of a build environment and objects within it; however the supporting conditions are to be given first (through prudent design) that “life between buildings” occurs. This brings us back to the basic elements and features of this very space, designed with strong or weak potential to facilitate user’s needs.

As stressed above, users’ needs and responses to the given urban space are the users’ scale for its appraisal. Observing through the prism of vital operative qualities – with the emphasized value for the user – we assume that well designed urban space should enable and stimulate: 1) optimal and balanced physical access using different travel modes; 2) comfortable movement through the space; and 3) pleasing sojourning throughout the spatial functionality, its program, amenities and appeal.
The presence of operative qualities in urban space that signify its vital worth for users, we claim, is of great importance for place prosperity. From the aspect of our study the more important fact is that such defined qualities are closer to general public comprehension and reflect tight linkage to the observable, by far measurable, spatial elements and features. On the other hand, yet a cursory glance at the operative qualities reveals their indisputable bond to the principles of professional measures (formerly described) at the same time. The question nevertheless is: to what extend can one (a user) associate own experiences to professionally defined spatial qualities?

Combining these two aspects is the main idea and objective of the model (figure 1).

THE ART OF SQUEEZING URBAN SPACE INTO A MODEL
There is a variety of things that are commonly referred to as models: in architecture a model most often refers to geometric computer aided models that represent scaled-down urban space; in geography, likewise, a model is often pertained to a representation of topographic space in a reduced scale. In social geography and social disciplines even more often the same term corresponds to representation/explanation of complex empirical objects, phenomena, relations and physical processes in a logical and objective way, not necessarily directly related to physical space. There are numerous categories and sub-categories of such models introduced in the literature that range in regard to abstractness...

Figure 1
Initial premise underlying the model (IMUSC).
of representation, scopes of the subject matter that they are taken to represent, means and techniques used to create them (computational, statistical, mental, mathematical, data, etc.), also concerning the level of conceptualization of the subject and purpose of the model use (e.g. education, professional collaboration, data synthesis etc.). However, the categories of models as (Frigg and Hartman 2009) states are not always mutually exclusive, even more - one frequently employs a combination of them to explain the subject matter in an optimal way.

**IMUSC DISPOSITION**

The previous statement is close to what IMUSC stands for: a model for interpretation of spatial structure, (which being of significance to operative qualities of urban space) implying a set of modeling techniques that support:
- input of spatial data: preparation and generalization,
- extraction of relevant urban elements (variables),
- search for their mutual relation in influencing operative qualities (entity-relationship modeling),
- assigning weight to those relationships (to approximate a real situation in selected geographic entities – in our case public spaces in Ljubljana),
- mapping of interaction among elements and the operative qualities (agent-based modeling),
- parametric modeling as a means for extracting the collection of probability distributions
- output of data: primarily visual presentation techniques.

**METHODS**

For IMUSC conception different methods were applied and divided into three foremost work phases that lead to the final result (software application).

**Phase one**

Initially two fundamental segments were prepared:

a. We defined the crucial leverage forces by which a single operative quality is modified/achieved. Accessibility for instance is conventionally defined by overcoming the spatial resistance (distance) in time and space. In most fundamental terms this implies certain intake of time and energy
– perceived either as physical or financial stake – as well as the continuation of prearranged infrastructure. While such demarcation might be applicable in large-scale spaces with lump-flat estimations of travel accessibility, it has limited importance in observed mid- and small-scale spaces. Tackling urban spaces through experiential perspective additional factors gain relevance in regard to accessibility assessment. Thus, four accompanying decisive factors (along with the time and energy consumption) that significantly affect the level of accessibility were appended: a) infrastructure support b) traffic regime – by modes; c) level of comfort within the single travel mode and d) level of traffic safety – by modes. The latter two are reflected in the users’ sense of safety and comfort that consequently influence/regulate the users’ choice of route and travel mode (figure 2).

Similarly as demonstrated by accessibility, decisive factors for other operation qualities were searched for. The preselected merit of “passing through” follows roughly the same forces as accessibility; however, it pertains exclusively to the characteristics within the selected location while in the case of accessibility spatial context is also taken into account.

The factors that influence the intensity of users’ sojourning in a particular space seem to be more structured. We define it throughout the activities facilitation, functionality (apart from movement which is being dealt with separately), appeal, level of interest etc. While in some cases, the relevant forces that drive the intensity of sojourning and human behavior are highly evident and can be quantifiably measured, in many other situations it is far from suchlike detection and revelation and we had to lean merely upon the scarce existent theories deriving from behavioral studies to determine them.

b. Once we defined the optics (accessibility, passing, sojourning) through which the urban spaces would be looked at, the next phase consisted of an attempt to capture the highly nuanced characteristics of the build environment through direct and indirect (use of data sources) observations of the open and publicly accessible spaces in the city of Ljubljana. We attained that by analyzing the visible spatial reality into the basic shapes and elements that hide beyond a wider notions of: natural elements (tree, river bank, green plot, flower decoration etc.), urban furniture (bench, trash, bike rack etc.), program (daily services, shops, snack&drink facilities, urban art performance, street vendors, market stall), traffic infrastructure (cycling path, roadway, street crossing, traffic lights, sidewalk, etc.), elements of cultural, historical and symbolical enrichment (monuments, art installations, architectural heritage etc.), basic geometry of the space, transition between indoors and outdoors (restaurant terrace, shop-window, balcony) etc. Moreover, relevant agents of the spatial context (not tangibly manifested in the selected locations) were added according to their presumed/suppositional influence on the operative qualities within the location.

Each element/feature was then set up as an entity, capturing a finite number (an interval) of possible states either in terms of quantitatively or qualitatively appointed attributes.

**Phase two**

The central part of the model systematically links the elements and the tree operative qualities. Two of which are being observed from the perspective of (four) different travel modes. For this reason a conceptual data scheme was generated and embedded in the model. It first defines the input variables and describes the semantics, taxonomy and relationships of the entities proposed. To each relevant correlation additionally weight was assigned (MS Excel and Grasshopper used), where generalizations and pondering are based on the data/knowledge deriving from a statistic database [1] and interdisciplinary studies dealing with Slovenian cities (e.g. Dalla-Valle et al. 2003; Plevnik 2008; Bole 2010; etc.). However, fundamental/theoretical input from relevant fields is applied by means of a wider literature, not necessarily related to the Slovenian environments.
As a result, a numerical estimation of operative qualities (of selected/processed urban space) is defined according to the elements’ presence/absence in the space (assigned states: 1, 0) and their characteristics (discrete intervals), as well as in regard to the contextual spatial circumstances. Thus, each element traceably indicates the impact on each operative quality of the space given. To model and illustrate this series of assertions apparently, principles of parametric modeling were employed (Grasshopper).

**Phase three**
The subsequent and final part of the model is a visual extension of the outputs, proposing a visual presentation of the interpreted patterns within the space/location that is at issue. In this phase of our work the visualization interface is attached to the outputs indirectly – not employing a computationally programmed approach. However, a methodical approach is adopted to depict the above mentioned outlines in a comparable, systematic and generic way, where decisive factors, such as graphic mode, perspective manner, scale, level of abstractness, complexity, level of detail, intuitiveness, are taken into account. The visualization extension will additionally be linked automatically, generating a 3D model of the location and its elements (according to the pre-defined fuzzy rule set), which further presented as a series of experiential vistas that contain generically depicted output parameters.

**CONCLUSION**
Although the models seem to become an increasing means for representing, learning, explaining and simplifying urban space phenomena, there is, as Frigg and Hartmann, (2009) claim, “no such thing as a perfectly faithful model”. Faithfulness, they further advocate, is always restricted to some respects and so it is the case with IMUSC.

First, in geospatial terms IMUSC is valid within the frames of Slovenian urban context, more accurately – it is intended for interpretation of public spaces comparable to Ljubljana (cultural, geographical, socio-economic dimensions). Second, the proposed relations between operative qualities and spatial features derive from a diverse set of data, information and knowledge, of which some are to a lesser or greater extent quantifiably explicit, computationally compatible, convenient for model processing or adjusted to mid-scale spaces. Although it seems the research methods in contemporary spatial disciplines incline towards highly quantifiable measuring, there is a relevant hesitation due to the numerous limitations of such positivistic principles. Nevertheless, we can claim without hesitation that holistic representation of space cannot be captured simply by composing the above mentioned knowledge (acquired by either quantitative and qualitative methods) into one structure or a model, while the methodologies, techniques, output formats, optics and initial goals of separate investigations are extremely diverse, often poorly comparable. Joining this heterogeneity of knowledge in one system was a great challenge and obliged us to form a flexible model structure, compliant enough to enable convergence of explicit and implicit assumptions concerning urban spaces.

Moving back to the applicative aspect of the model, our central concern tended to incline towards the visualization of the outputs – as a means to meet the general public comprehension of spatial qualities. Addressing the issue of visualization as the answer to effective communication between expert and general public (King et al. 1989) as well as a key to converge their priorities concerning urban decision-making is our ongoing interest of research. Contemporary tools allow us to accurately capture the 3D reality with textures, colours and other elements [2]; besides, the public have been primed to expect immersive applications, also interactive and dynamic depictions. For the model proposed, it is important not only how close to the actual reality the visualisation is drawn, but also how to effectively convey the messages that lie hidden beyond the tangible elements depicted.

By visualisation we strive towards merging two principles: first, rousing one’s experiential percepience that would then rule his decisions and attitude...
concerning fragile urban spaces; and second to pledge a certain level of genericity in visual design that has a potential for prompt and repeated application in different spatial circumstances. Although at times nearly diametrically opposite principles, they could, combined successfully, soften the sharp edges between particularly subjective, intuitive, unique representation of urban spaces on one hand, and extremely objective, automated and computerised on the other hand.

REFERENCES