AN EVIDENCE-BASED INTEGRATIVE MAPPING TECHNIQUE FOR GUIDING SOCIALLY-RESPONSIVE URBAN DESIGN PROPOSALS

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Introduction

The role that design has to play in the generation of popular urban open spaces has been an important topic in theory, teaching and practice of urban design, as reflected in the large amount of literature on public urban open spaces. However, despite the accumulated body of knowledge in the field, the contemporary urban condition raises issues regarding the effectiveness of some design proposals in contributing towards the generation of well-loved and well-used public urban open spaces.

Even though human-environment inter-relationships are necessarily multifaceted, most of the theory, teaching and practice of urban design have focused on the visual aspects of open spaces, an emphasis which has led practitioners to over-emphasize the appearance of their creations. Recently this ocularcentrism has been highly criticized (Bentley et al., 1985; Carmona et al., 2010; Landry, 2006; Lynch, 1971; Malnar et al., 2004; Pallasma, 2005; Shaftoe, 2008; Taylor, 2009) as well as design solutions based exclusively on the practitioners' own preferences and intuitions (Bentley et al., 1985; Gehl, 2010; Rapoport, 2005; Ward Thompson, 2010).

In parallel, mapping techniques have been proposed as part of an attempt to make designers feel motivated to apply environment-behaviour knowledge in the design of urban open spaces. However, the majority of the mapping techniques developed so far have focused on specific aspects of urban experience, most notably the visual (Lynch, 1960; Thwaites et al., 2007; Ward Thompson, 2010) and behavioural (Gehl, 1987, 2010; Moore et al., 2010). Only a handful of techniques have attempted to collate in a single map, too often very difficult to read, different facets of human-environment inter-relationships (Sepe, 2009).

The lack of evidence-based approaches to design of urban open spaces which take into account the multidimensional and interconnected character of human-environment inter-relationships poses the following research question: "How can designers feel more confident that their design proposals will contribute towards the generation of socially-responsive urban open spaces?". To contribute towards the solution of this problem, an evidence-based

integrative mapping technique for guiding socially-responsive approaches to design of small scale urban open spaces was developed. The technique, to be termed MCEB, innovates in that it takes into account the multisensory, cognitive, evaluative and behavioural facets of human-environment inter-relationships as well as their interconnectedness.

The present paper is structured as follows: the key concepts which have guided the development of the MCEB mapping technique are outlined in the next section. Then, its operationalisation is described and its robustness is demonstrated by means of an experiment carried out in Liberdade Square, a central urban square located in a large Brazilian city, Belo Horizonte. The final section draws some preliminary conclusions.

Human-environment inter-relationships

Interactions between people and environments can be described as involving four interconnected dimensions interweaved with emotional reactions: perception, cognition, evaluation and action (Del Rio, 1999; Isaacs, 2000; Lang, 1987; Nasar, 1994; Rapoport, 1977, 1982). Perception is necessarily multisensory and multimodal. It involves all senses simultaneously. While seeing may easily occur without eliciting emotional reactions, smelling and touching, both activated at short distances, and hearing tend to involve intense emotional responses (Porteous, 1977, 1985; Rodaway, 1994; Tuan, 1977).

Emotional reactions, which can be positive, negative or ambivalent, arise automatically from interactions between people and environments (Kaplan, 1987; Nasar, 1988, 1994; Rapoport, 2005; Russel, 1988; Yang and Kang, 2005), and are assumed to alter people's moods (Porteous, 1996; Russel, 1988). Favourable emotional reactions elicited by environments are frequently referred to as aesthetic responses. Focusing on the sources of emotional reactions, they may be elicited by visual and non-visual sensory information (e.g. thermal delights), sensory patterns (e.g. geometrical shapes) as well as meanings (e.g. historic) (Lang, 1987, 1988, 2000).

Perception and cognition are so closely intermeshed that their conceptual distinction is more one of degree and focus than a clear dichotomy. This research accepts that perception occurs in the presence of a sensory source, while cognition concerns mental processes (Downs et al., 1973; Golledge et al., 1997). Thus, while perception involves all senses and is necessarily related to something occurring in the present, cognition is also connected with past experiences or with what is going to happen in the future (Downs et al., 1973; Golledge et al., 1997).

In order to perform our daily activities, we need not only to select multisensory information, but also to organize and synthesise it (Downs et al., 1977). For the purposes of

the present study, cognitive mapping refers to psychological processes by which our minds work on the multisensory input captured by our sensory systems, applying associations, meanings and prior knowledge (Downs et al., 1977; Kitchin, 1994) and cognitive map refers to an output of the cognitive mapping process (Kitchin, 1994).

Cognitive map, which metaphorically corresponds to a snapshot of how a person believes a given environment is at a specific moment in time, is defined as a mental construct which helps people to reduce, classify and order locational ("whereness"), attributive, evaluative ("whatness") and temporal ("wheness") information about environments (Downs et al., 1977; Golledge et al., 1997; Lee, 2003). Cognitive maps, therefore, provide people with information of where one is, what may happen next, whether it is pleasant or unpleasant and what action may be taken (Lang, 1994).

Another important facet of cognitive maps is that, although they are stable, they are not fixed (Kitchin, 1994): the longer the exposure to sources of stimulation, the greater the quantity, and possibly accuracy, of information stored (Bell et al., 1990; Kaplan et al., 1982). Although cognitive maps tend to vary from person to person, commonalities amongst individual cognitive maps can also be detected because of the physiological similarities among individuals, the socio-cultural basis of environmental cognition and the objective aspects of environments. In this regard, Porteous (1977, 107) points out: "It is likely that individuals belonging to a fairly uniform group in a specific area will not have mental maps which are entirely unrelated". A composite of individual cognitive maps is to be termed collective cognitive map.

The MCEB mapping technique attempts to better understand the inter-relationship between collective cognitive maps and pedestrian activity patterns as part of an attempt to define evidence-based guidelines to inform approaches to design of urban open spaces more responsive to people needs and preferences.

If it is accepted that behaviour is mediated by cognitive maps (Downs et al., 1973, 1977; Golledge et al., 1997; Kitchin, 1994; Lang, 1994; Lee, 2003; Porteous, 1977), it follows that instead of urban designers relying exclusively on their own preferences and intuitions, they should aim to understand user preferences by empirically studying the inter-relationships between collective cognitive maps and behavioural patterns.

Since cognitive maps are mental constructs, the problem becomes one of externalizing the cognitive map from the mind of the perceiver. In this regards, it is important to be aware that an individual can externalise information assembled from his/her cognitive

map in either words or images and external representation assembled from cognitive maps are framed by demand.

According to the transactional model described above, first, at the perceptive level, multisensory information is absorbed; second, the mind works on the multisensory input applying associations; third, evaluations are made; and fourth, action is taken. Through action, people affect environments. Although presented as a linear model, perception, cognition, evaluation and behaviour actually define a continuum full of overlaps interweaved with emotional reactions.

The MCEB mapping technique, to be described in the following section, takes into consideration the multisensory, cognitive, evaluative and behavioural facets of human-environment inter-relationships and their interconnectedness.

The MCEB mapping technique

The MCEB mapping technique comprises four major stages: preparatory, fieldwork, graphical and interpretative. The multifaceted character of human-environment inter-relationships will demand the production of four research instruments to gather different types of data by means of a multimethod approach. Sketch map and structured interviews are to be used to externalize multisensory, cognitive (or meaningful) and evaluative information assembled from the users cognitive maps. Unstructured observation, place-centered mapping and individual-centered mapping techniques are preferred to collect behavioural data.

The preparatory phase aims to construct a platform for the fieldwork stage and it will result in production of the research instruments. The preparatory phase is important because some features of the research instruments as well as the procedures to be followed during the fieldwork activities may vary depending on (i) research aims, and (ii) site characteristics. The instrument 01 is to be designed to gather multisensory, cognitive (or meaningful) and evaluative data, while the instruments 02 and 03 are to be constructed to record behavioural data.

The instrument 01 opens with a five scale scoring about overall evaluation of the site. Information on the major visual aspects of the case study site is to be collected by asking people to draw a sketch map. Attributive, evaluative and locational information on the sounds and smells which define the character of the case study site at specific days and times are to be gathered by asking specific questions.

Individual-centred mapping technique is to be applied retrospectively to gather information on pedestrian traffic. On the instrument 02, the movement of the participant

through the site is to be drawn in a simplified map by asking the participant: "Could you please draw in this map the route that you have followed?"

The place-centred mapping is to be used to gather information on what types of optional stationary activities take place where and how. The instrument 03 will be constructed to record behavioural data on a sufficiently detailed plan of the case study site. The data collection will take place during the second phase of the MCEB mapping technique: the fieldwork phase.

In the graphical stage, the data gathered during the fieldwork activities are to be processed, summarized, combined, and represented in word clouds and maps through the use of the SPSS, tagcrowd web tool and GIS. The tag crowd web tool is to be used for easy visualization of some key perceptual and associational aspects that define the collective identities of the case study site and the GIS environment for spatializing its multisensory collective cognitive structure.

The generation of the non-visual sensory maps will involve the subdivision of the pedestrian spatial continuum of the case study site into discrete sub-units to upload the non-visual sensory information associated with each of them. The thematic maps are to be overlapped in composite maps to represent the multisensory, cognitive, evaluative and behavioural character of human-environment inter-relationships.

In the last stage, an interpretative pursuit based on an inductive reasoning will guide the analysis of the word clouds and maps produced in the graphical stage. The analysis here is more a case of theoretically informed interpretation than measurement of factual data, as done by other researchers (see, for example, Thwaites et al., 2007).

The experiment

To demonstrate the usefulness of the MCEB mapping technique to identify the urban design elements and qualities most likely to characterise well-used and well-loved small-scale urban open spaces, this section provides a summary of the experiment carried out in Liberdade Square (Figure 1).

Figure 1. Liberdade Square, an urban square located in the central area of Belo Horizonte, Brazil.

This space was selected as a case study site because it is one of the most popular urban squares within the central area of Belo Horizonte, a city stablished in 1897 to be the new capital of the state of Minas Gerais (Figure 2). Liberdade Square, conceived to be a civic and administrative centre, functions today as a cultural complex. It is located in a mixed-use economically active area, which also concentrates services, commercial, institutional and residential uses. Listed buildings and monuments built at different periods and designed in distinct styles, scales and heights currently characterise the area.

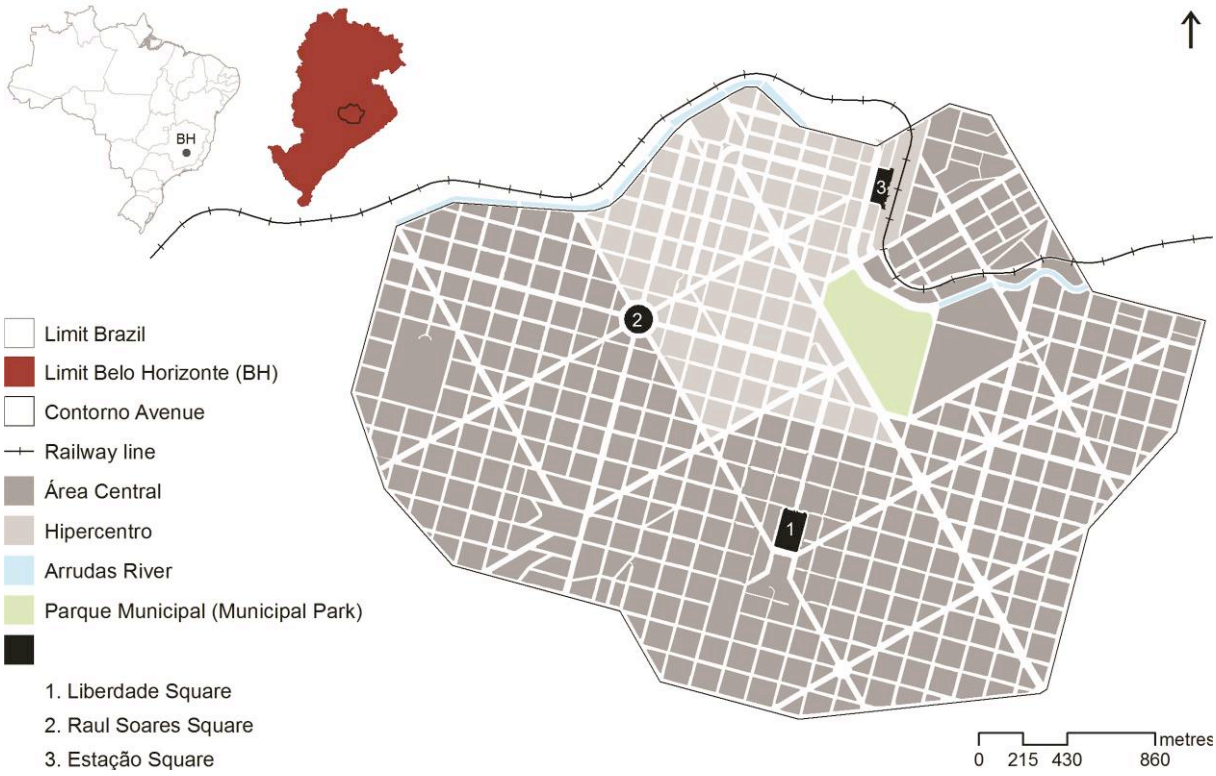

Figure 2. Location plan of Liberdade Square in Belo Horizonte.

The introductory phase

Since the aim of the experiment was to identify the urban design elements and qualities most likely to attract and retain people in central urban squares within large cities, it was decided that the fieldwork activities would take place on weekdays during the lunch-time break, from 12 until 14 o'clock. This time boundary was chosen because it is a period when a large range of everyday optional activities is likely to occur. Optional activities (e.g. people-watching) are defined by Gehl (1987) as those pursued only when time and external conditions are highly favourable.

This category includes those activities that the participants choose to perform when they have time available and when the physical environment invites them to do so. Necessary activities (e.g. waiting for the bus), in turn, are those which are more or less compulsory and their incidence is influenced only slightly by the environment. Necessary and optional activities are defined as sub-classes of social activities.

During the introductory phase, unstructured observation sessions took place to yield enough information for deciding what to ask and observe during the fieldwork activities. To increase the representativeness of the sample, the fieldwork activities were scheduled on different weekdays. Users younger than 16 years old were excluded from the study because of ethical reasons. The size of Liberdade Square impelled the use of trained interviewers and

trained observers as well as its subdivision into small spatial units to proceed with the place-centered mapping technique.

The fieldwork stage

During the fieldwork stage in Liberdade Square 149 users carrying out optional activities were interviewed, 144 sketches were produced, 130 pedestrian routes were recorded and 464 optional stationary activities were reported to occur during the place-centered mapping procedure.

The graphical stage

The third stage of the MCEB mapping technique included the classification and coding of the data gathered during the fieldwork stage, the uploading of the summarized data on to tagcrowd web tool to produce word clouds or GIS environment to generate a variety of maps. The outputs of the graphical stage are analysed below.

The interpretative stage

A minority of users (2.7%) approached by the interviewers evaluated the quality of the space where they were spending time within Liberdade Square as "unpleasant" or "very unpleasant". It follows that Liberdade Square is likely to provide a high degree of choices and opportunities to carry out pleasurable stationary social activities within it.

"Relaxing connotations" (56 references), "natural aspects" (29 references) and "climatic conditions" (16 references), accounted for 39.2%, 20.3% and 11.2% respectively of the aspects most valued by the stationary users interviewed in Liberdade Square. The results in Figure 3 suggest that this central urban square tends to be perceived and cognized as a naturally appealing oasis within a busy urban context.

Figure 3. Aspects of Liberdade Square perceived by its users as supportive of stationary activities.

The central alameda (56 references) as the element sketched by the largest number of stationary users approached by the trained interviewers. The other visual elements sketched include different types of urban furniture, natural elements and buildings (Figure 4).

Figure 4. The collective visual cognitive structure of Liberdade Square.

The "sounds from transportation machines" (134 mentions) were the sound elements mentioned most often in addition to "fauna sounds" (85 mentions), "human sounds" (52 mentions), "water sounds from fountains" (25 mentions) and "sounds as indicators" (19 mentions). The word cloud from the answers given by the participants tends to validate the idea that "sounds from transportation machines" have become the dominant sound element in central urban spaces within large cities (Porteous, 1996) (Figure 5).

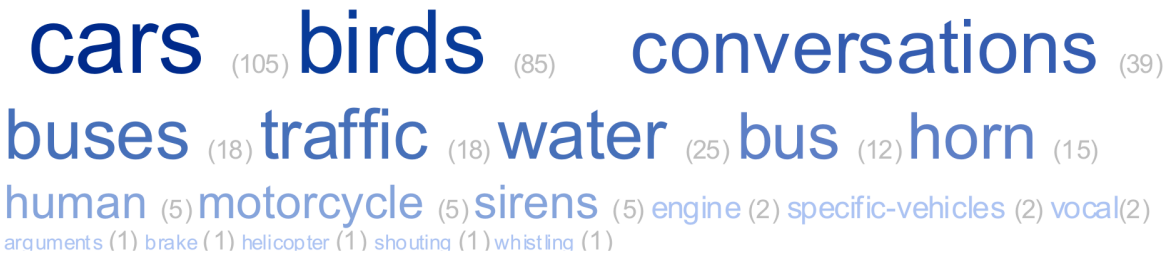

Figure 5. Word cloud of the sound elements most often associated with Liberdade Square.

Liberdade Square was most frequently associated with "natural smells", including "smell of greenery" (43 mentions), "smell of flowers" (41 mentions) and "smell of fresh air" (19 mentions). The word cloud from the answers given by the participants shows that smells of flowers and plants define the olfactory collective identity of Liberdade Square (Figure 6).

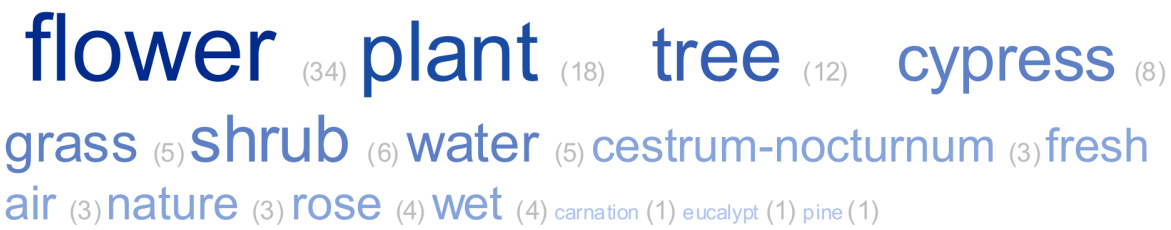

Figure 6. Word cloud of the smell elements most often associated with Liberdade Square.

Reinforcing previous findings (Kang, 2007; Yang et al., 2005), a Mann-Whitney U test revealed that "natural sounds" ("water sound from fountain" and "fauna sounds") tend to provide higher levels of preference than "urban sounds" ("sounds from transportation machines" and "sounds as indicators") (Table 1). Therefore, it appears that users of urban open spaces within large cities are calling for more naturally appealing sensoryscapes.

Table 1. Difference between "natural sounds" and "urban sounds" in terms of levels of preference.

	Liberdade Square
	natural (Md=3, n=108) and urban (Md=1, n=155), U =134, z =-14.87, p = .001

The graphical representation of the collective sonic cognitive structure of Liberdade Square represented in the Figure 7 shows that (i) "sounds from transportation machines" and "sound as indicator" were most often associated with its boundary, (ii) "water sound from fountain" was frequently associated with the adjacent areas of the water fountains, (iii) "human sounds" were expected to be heard in the central alameda as well as nearby the bandstand, and (iv) "fauna sounds" were often associated with the central alameda.

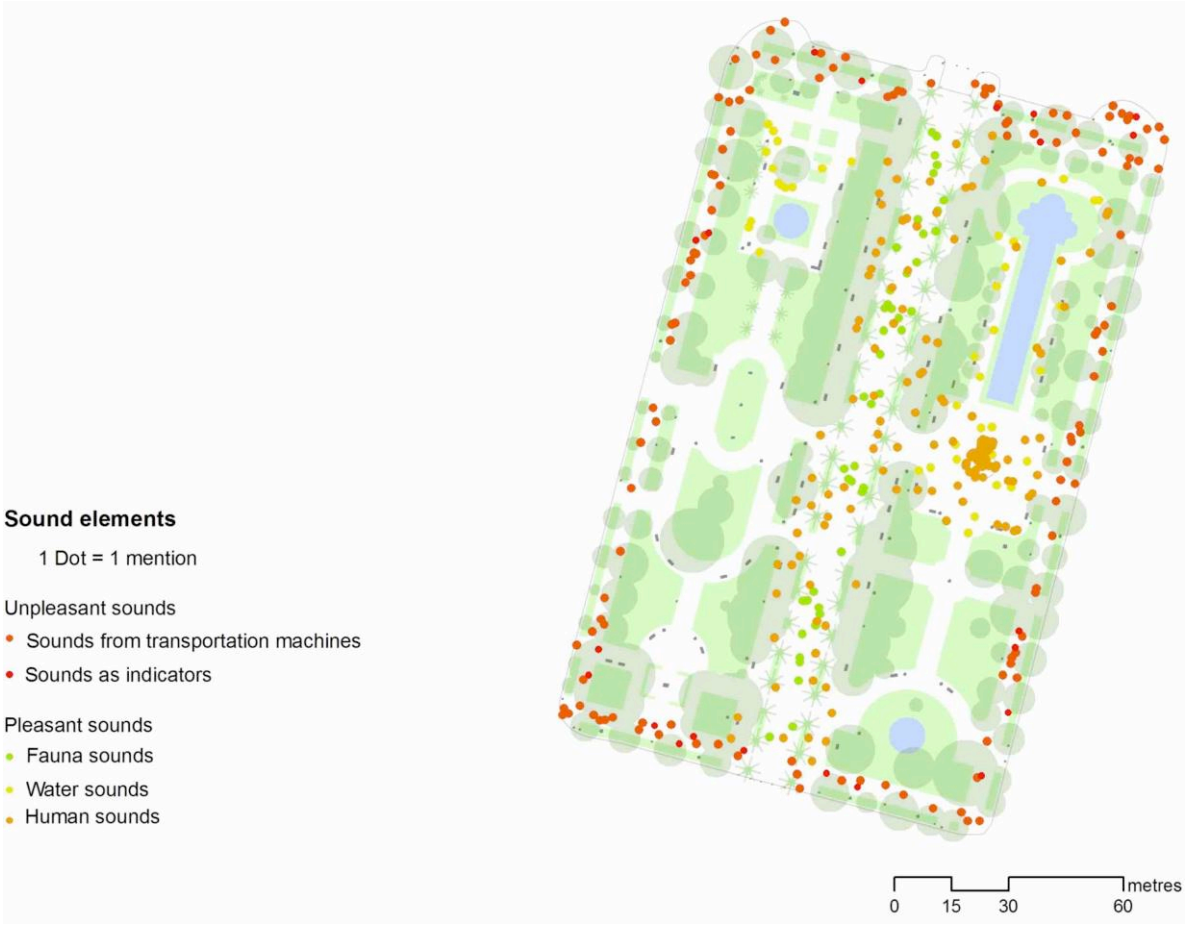

Figure 7. The collective sonic structure of Liberdade Square.

The graphical representation of the collective olfactory cognitive structure of Liberdade Square shows that (i) "smell of greenery" and "smell of fresh air" were more frequently associated with the surroundings of the linear water fountain perpendicular to Gonçalves Dias Street, while (ii) "smell of flowers" was most often associated with the proximities of the flower bed framed with roses localized in its western portion (Figure 8).

One conclusion from the above must be that although non-visual sensory experiences do not impose on their perceivers a particular concrete spatial form, they do impinge on them the cognition of *atmospheres* associated with positive, negative or ambiguous codes. It follows that the quality of the non-visual sensory experiences afforded by urban open spaces does matter to those inclined to spend time within them, possibly influencing their behaviour as well as their overall sense of well-being, and should be, therefore, objects of design.

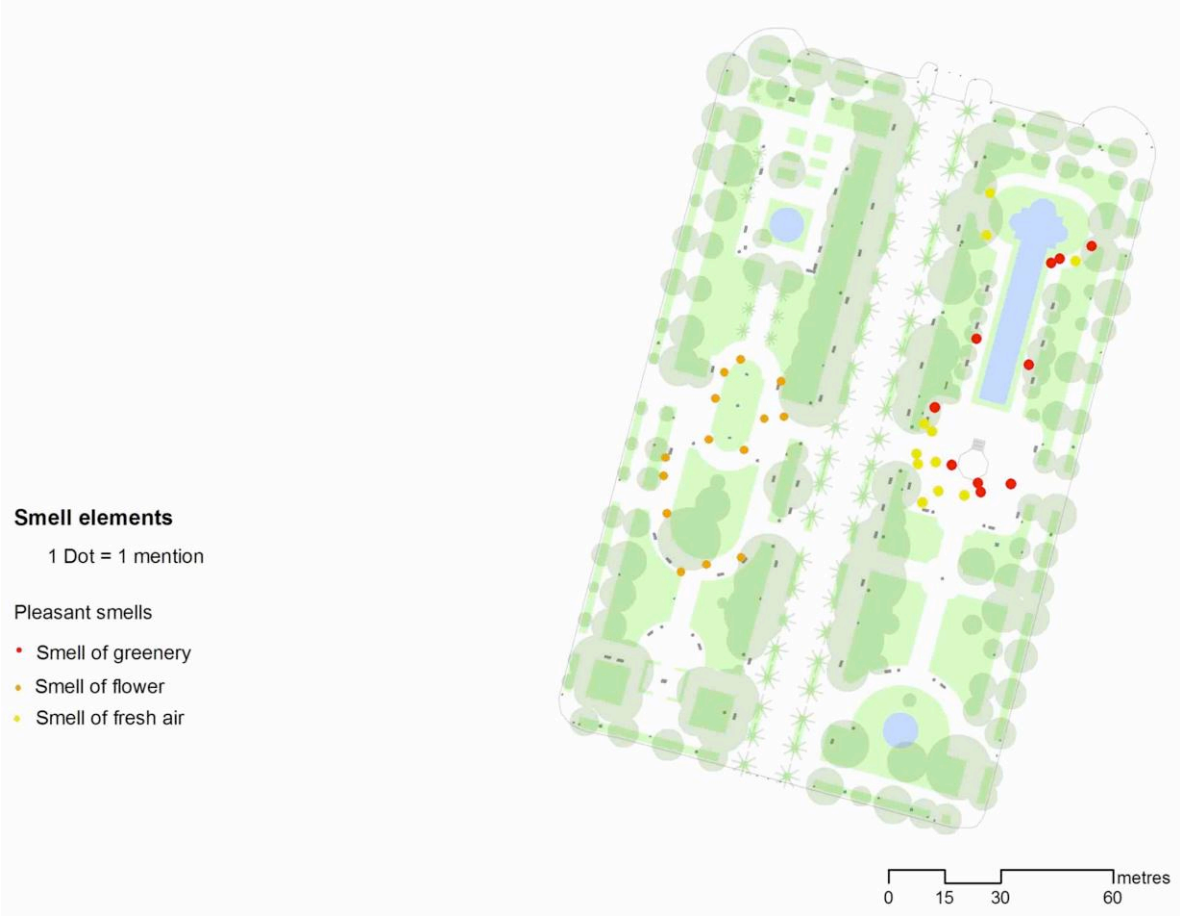

Figure 8. The collective olfactory structure of Liberdade Square.

The quantitative analysis of the data obtained from the place-centred mapping shows that "talking" and "watching" accounted for 46.6% and 24.4% respectively of the optional stationary activities reported to occur in Liberdade Square, while more infrequent sorts of activities, including dating, playing games and so on, corresponded to 29.1%. This evidence suggests that Liberdade Square attracts and retains people for a variety of reasons.

The majority of optional stationary activities reported to occur in Liberdade Square (81.5%) were sitting activities and more of half of the sitters (69.6%) were observed spending time sitting on benches. During the observation sessions, it was verified that the large majority of the benches used by people during the fieldwork activities were under shade.

The behavioural map shows that the most used benches in Liberdade Square were along well-used routes and in zones likely to offer opportunities to enjoy favourable climatic conditions (Figure 9). This observational data reinforces the findings of previous studies which found that spaces which offer opportunities to sit, observe people and experience favourable weather conditions do tend to attract and retain people (Marcus et al., 1990; Metha, 2009; Whyte, 1980).

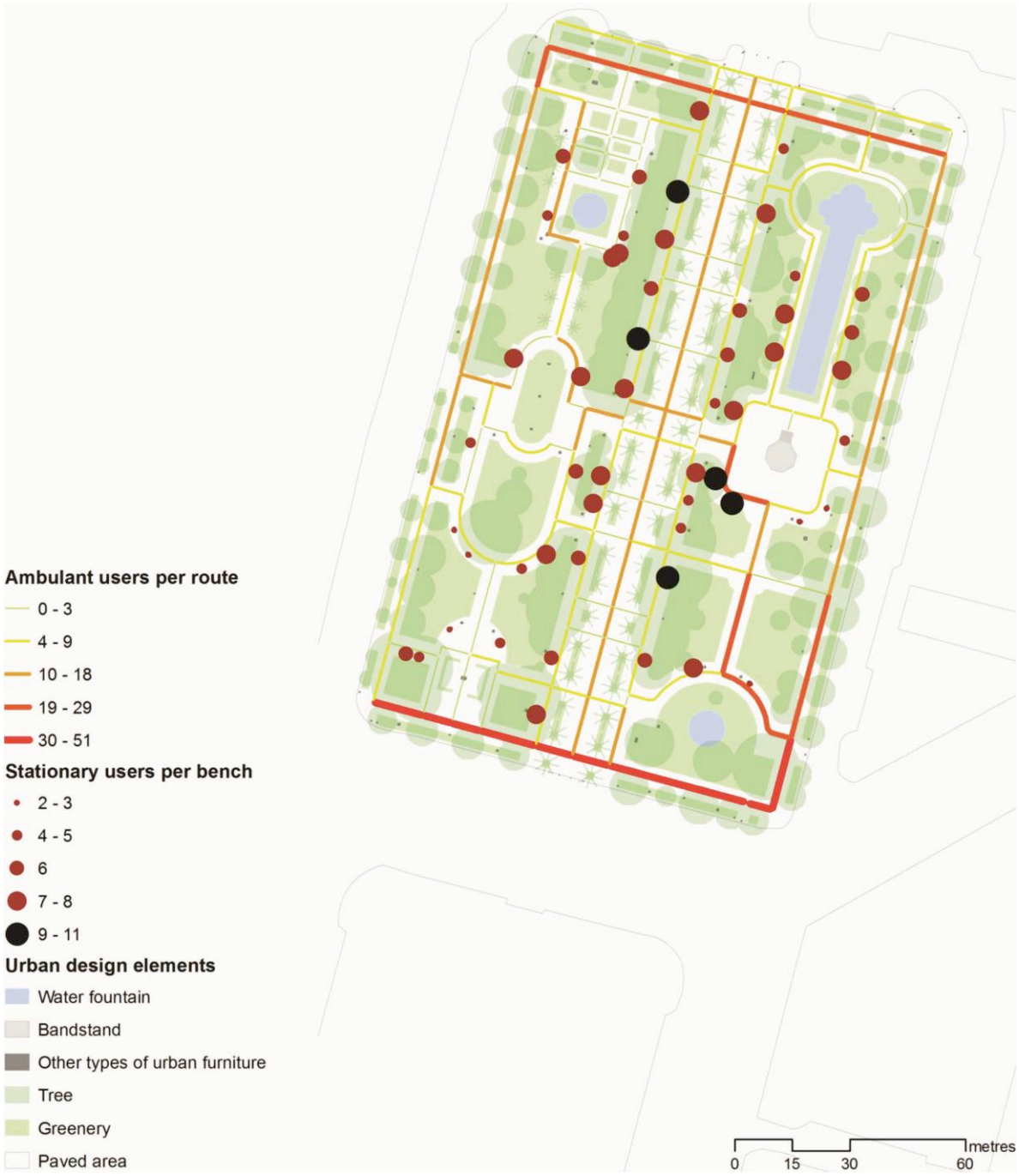

Figure 9. Behavioural map.

The MCEB map shows that the preferred benches in Liberdade Square were along well-used routes, under shade, within spaces likely to be associated with positive naturally appealing non-visual multisensory effects and from where people could see landmarks (Figure 10). Nowadays, it is widely accepted that people tend to prefer spaces spaces that facilitate the fulfilment of their needs (Carr et al., 1992; Francis, 2003; Kaplan, 1987; Lang, 2000). Discovery, comfort, relaxation, passive and active forms of engagement have been identified by previous research as common user needs that urban open spaces can help satisfy (Carr et al., 1992; Francis, 2003).

Figure 10. The MCEB map of Liberdade Square.

Discovery, according to Carr et al. (1992, p. 134), 'represents the desire for stimulation and the delight we all have in new, pleasurable experiences'. The MCEB map suggests that the most-used benches are likely to address the user need for discovery because they are afford people-watch and are associated with a wealth of pleasant non-visual sensory experiences.

Comfort has been identified as a basic need (Carr et al., 1992; Francis, 2003; Shaftoe, 2008). The MCEB map shows that the most-used benches are likely to enhance one's sense of physical comfort because they are located in zones away from unpleasant non-visual sensory sources (e.g. cars). Intrusive sensory information is likely to induce mental fatigue. Since a sense of anxiety accompanies disorientation (Lynch, 1960), it may be argued that the landmarks (e.g. Palácio da Liberdade) that characterise the views from the most-used benches, as shown in the MCEB map, may enhance one's sense of psychological comfort by helping people to feel micro-located.

Passive interactions, another common user need, do not involve either talking or doing anything special and can lead to relaxation. Since the most-used benches are along well-used routes, as shown in the MCEB map, they provide opportunity to people-watch, or

rather, these spaces may fulfil the user need for passive form of engagement. In addition, some elements that characterize these well-used spaces, people, interesting features, fauna, plants, trees, flowers and water, are stimulants of relaxing experiences (Carr et al., 1992; Francis, 2003; Thwaites et al., 2007).

By feeling at easy, people may feel motivated to carry out social contacts with other people and/or explorative, risk and playful activities. The preferred benches, therefore, may facilitate discoveries and active forms of engagement. Active interaction represents direct and dynamic involvement with elements of urban design, people and other non-fixed elements that characterize urban settings (Carr et al., 1992; Francis, 2003). From the preceding, it may be argued that people tend to prefer those spaces likely to address a variety of basic needs.

The key urban design elements that emerged from the experiment as supportive of stationary social activities in public urban open spaces are: landmarks, props and atmospheres. Landmarks (e.g. Palácio da Liberdade) are highly visible and distinctive elements that stand out from the background. They help users to feel micro-located, fulfilling their need of psychological comfort.

Props (e.g. benches) are those three-dimensional objects that provide support to carry out stationary activities. This element of urban design may address the user need for physical comfort, passive engagement and relaxation. Atmospheres are remarkable non-visual sensory effects able to reinforce the character of urban settings and to trigger intense (positive or negative) emotional reactions (e.g. traffic noise). Opportunities to experience pleasant atmospheres tend to attract and retain people in public open spaces, as shown in the MCEB map, possibly because they help users to fulfil their need for relaxation, discovery and active forms of engagement.

The findings of the experiment suggest that while some elements of urban design are likely to attract and retain users, others act as supports and yet others even repel people, reinforcing the results of previous research (see, for example, Mehta, 2009). The evidence also suggests that designing for legibility and pleasantness may contribute towards the generation of spaces supportive of social activities. Aesthetics and legibility, then, emerge as highly important qualities of urban design to attract and retain people in urban open spaces within central areas of large cities.

At this point it is important to stress that, although they are relevant, these findings should be interpreted with caution since generalizations are made on the basis of how

one central urban square located in Belo Horizonte, a large Brazilian city, is perceived and used during weekdays from 12.00 until 14.00 by people at least 16 years old.

Conclusion

This section evaluates the MCEB mapping technique, a model to identify the most common user needs and preferences in any given small-scale urban open space, and discusses further research. The use of multiple sources of evidence through a multimethod approach proved to be an essential strategy to obtain a holistic view of the multifacetated character of human-environment inter-relationships.

The application of sketch map technique and structured interviews in situ was a helpful way of externalizing multisensory, cognitive and evaluative data assembled from user cognitive maps, while allowing the researcher to have first-hand experiences. The place-centered mapping technique proved to be a useful way to gather data on stationary behaviour in urban open spaces and the retrospective individual-centred mapping technique was confirmed to be a quick and simple method to acquire information on pedestrian traffic. It is possible that some routes may have been misrepresented due to the spatial complexity which characterises Liberdade Square.

The GIS environment, by allowing the graphical display of perceptual-cognitive-evaluative- behavioural data in a clear manner, revealed hidden trends and allowed data to be statistically summarized as well as collated and analyzed in a multitude of different ways. On the other hand, data input and checking for data-entry errors required many hours of labour.

The MCEB mapping technique also demonstrated its merits in investigating the inter-relationships between the urban design characteristics small-scale of urban open spaces and perceptions and social behaviour. Further, the urban design elements (props, landmarks and atmospheres) and qualities (aesthetics and legibility) that emerged from the experiment as supportive of social activities in urban open spaces are applicable to the design of most gathering urban open spaces.

On reflection, the MCEB mapping technique can be enhanced in some aspects. Firstly, it may be extended to incorporate the perceptions of some minority groups. Hence, it is considered highly useful to pursue changes in the methodology proposed, whenever necessary, in order to incorporate and investigate different users perspectives. These limitations in themselves, therefore, present opportunities for further research.

From the above, it is argued that the MCEB mapping technique does support an evidence-based socially responsive approach to design of different types of small-scale urban open spaces in all sorts of cultural contexts by revealing user needs and preferences. Since the

outputs of the MCEB mapping technique, word clouds and maps, are connected to the visual thinking styles of designers, it is hoped that practitioners, as well as students, may feel motivated to apply environment-behaviour knowledge throughout the process of multisensory urban design in different contexts.

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