Masters Program in Geospatial Technologies

Investigating the *spatial imprint* of *sense of place* dimensions among foreign residents of Lisbon

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Investigating the *spatial imprint* of *sense of place* dimensions among foreign residents of Lisbon

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Declaration of Originality

I declare that the work described in this document is my own and not from someone else. All the assistance I have received from other people is duly acknowledged and all the sources (published or not published) are referenced.

This work has not been previously evaluated or submitted to NOVA Information Management School or elsewhere.

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Vicente de Azevedo Tang

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Investigating the *spatial imprint* of *sense of place* dimensions among foreign residents of Lisbon

Abstract

Place is a part of the geographic space which people have imbued with symbols and connotations unfolded through psychological mechanisms. *Places* carry meanings for individuals, communities or even nations evidenced by bonds referred collectively as *sense of place*. Dissecting *sense of place* can aid planners in providing a social-psychological layer of the world characterized by the distinct relationships people possess towards the physical settings. In this research, different dimensions of *sense of place* experienced by foreign residents in the city of Lisbon were investigated through a map-based survey and following spatial analysis.

First, the map-based survey was structured on *sense of place* dimensions drawn from the environmental psychology and human geography research. The dimensions examined here were: (i) *place dependence* – functional attachment; (ii) *place awareness* – familiarity and exploration; (iii) *place identity* – special bonds and self-identity (iv) *place inherited* – rootedness and belongingness. The survey was shared online among international residents of the city and hand-drawn polygons were processed in order to represent the spatial lay-outs of *sense of place*. Subsequently, answers were split into two participant categories: *short-terms* and *long-terms.* Overlay analysis, spatial comparison metrics, cluster evaluation, statistics and the confection of map products were carried out in order to compare and visualize the distinct *sense of place* components.

Results, discussion and interpretation were brought forward through comparing dimensions between participant groups; between dimensions themselves, as well as identifying meaningful *places* within the urban landscape. The spatial *imprint* of *sense of place* in the specified context of study provided insights regarding the distinction between groups. Long-term and short-term dwellers' geographic dimensions of *sense of place* were found to have different patterns, properties and characteristics. Lastly, similar to other works within the same scope, this research asserts the potential of using GIS in providing new perspectives and methodologies from which humanities research can greatly benefit.

Keywords

Sense of place

Place attachment

Geographic Information Science

Participatory GIS

Spatial analysis

Urban intelligence

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Acronyms

SoP   Sense of Place

PA   Place Attachment

PI   Place Identity

PD   Place Dependence

PPP   Person-Process-Place

GIScience   Geographic Information Science

PPGIS   Public Participation Geographic Information System

GI   Geographic Information

GIS   Geographic Information System

VGI   Volunteered Geographic Information

SPAEF   Spatial Efficiency Metric

IST   Instituto Superior Técnico

1. Introduction

Within the geographic information science, the distinction between *space* and *place* has been gradually drawing attention to researchers in both its conceptualizations and applications [1]–[3]. *Place* can be defined as a portion of space in which interactions, activities and experiences occur, shaping meanings, perceptions and identities for an individual or a community [4],[5]. The relationship between people and the physical world traces back to ancient times and has been a prominent theme of discourse in philosophy as well as visual and literary arts [5],[6]. Sociology, psychology, human geography, economics, anthropology and their respective branches are a few examples of research fields in which studying *place* is either fundamental or plays an important role [7]. In geography, particularly in human geography, the concept is essential and it has been described as the "*science of places*" by the well-known French geographer Paul Vidal de La Blanche [8] *apud* [1].

Studies have been conducted to find spatial patterns of *sense of place* dimensions as well as to correlate them with social, psychological, geographic and cultural variables [9]–[14]. In addition, quantitative analysis has been made before in the scope of geographic information. Mapping *place* dimensions has not become commonplace due to constraints which arise from the inherent uncertainty of the conceptualizations and scarce operationalization frameworks [9],[14]. According to Acedo *et al*. [15], shortcomings can also come from two main sides: representing sociopsychological phenomena may not be suitable for providing insights to sociopsychological research itself; and reducing subjective and dynamic constructs into geographic primitives brings up different elements and degrees of uncertainty.

Although *sense of place* has been thoroughly analyzed through theoretical frameworks as well as through spatial methodologies on GI systems, spatial analysis of their dimensions for foreign residents in a new urban setting has rarely been carried out. Studies on *sense of place* regarding international residents have been mainly conducted through the use of qualitative approaches and mostly with forced immigrants in an attempt to understand the differences between *place* bonds with the new settings and with their country of origin [16]. Nonetheless, using geographic information principles and tools for investigating *sense of place* and other social constructs has been done in the city of Lisbon context [9],[15],[17],[18].

The study here presented uses the conceptual scheme found in the context of human geography and environmental psychology, fields that study the relationship towards places through the concept of *sense of place* [7]. *Sense of place*'s intricacy does not stem only from its transdisciplinary character, but also from the construct itself, as the connections people establish with specific *places* are an elaborate combination of psychological processes, environmental features, individual characteristics, socioeconomic factors as well as cultural aspects [9].

Through the implementation of tools and techniques provided by the geographic information field, the distinct relationships foreign residents have towards the city of Lisbon were spatially assessed. Data was gathered on a map-based survey and spatial analysis was carried out aiming to

investigate the geographic dimension of *sense of place* experienced by foreign residents living in Lisbon. Discussion of the results was based on the interpretation of the different spatial patterns, localities and relationships of different dimensions of *sense of place*. In addition, mechanisms through which the participant groups develop distinct facets of *sense of place* in the urban context were also discussed.

1.1 Research aspects

Depicting the spatial dimensions of the relationships between people and the city is part of the human component of *urban intelligence* [9]. Albert *et al*. [9] interpret *urban intelligence* according to Roche's [19] definition as "*the urban stakeholders' ability to depict the connected complex urban places*" by considering the human aspect of smart cities (p. 1). In general, this investigation can help planners and decision-makers in various applications, such as: designing solutions for urban planning; supporting business in location-based services [11]; planning public health policies [11]; planning tourism and conservation of biomes, green areas and ecosystems [13]; planning social housing policies [20]; and creating frameworks for investigating the urban profile of civic engagement and social capital [21]. This is possible because different groups of people are attached to different *places*, enabling their characterization according to the objectives of specific applications. Therefore, methods and approaches used here are aimed to obtain the spatial *picture* of *sense of place* dimensions of foreign residents of Lisbon.

The term *imprint* adopted here carries the meaning of lay-out, surface or impression of the spatial dimension of *sense of place* and its dimensions. The research here conducted is aimed to obtain the geographic *imprint* of different *sense of place* dimensions experienced by foreign residents of the city of Lisbon through the implementation of tools and techniques provided by the geographic information field. The research questions hereby outlined are the following:

- Within the urban landscape, what are the meaningful *places* of foreign dwellers in Lisbon?

- If short-term foreign dwellers feel *sense of place* towards different areas of the city, how are they spatially characterized?

- What are the differences between the geographic distribution of *sense of place* dimensions *between* and *within* short-term and long-term foreign residents?

- What are the processes through which spatial distinctions of dimensions of *sense of place* emerge *between* and *within* participant groups?

By these means, the objectives in this study are shaped to answer the research questions through the following:

- Examining the spatial extent of *sense of place* dimensions of foreign residents in Lisbon

- Comparing and characterizing patterns and properties of the geographical dimensions of each *sense of place* dimension *between* and *within* each participant group

- Identifying *places* in the city that carry collective *sense of place* for the participants

- Discussing the possible mechanisms that cause the spatial differences of facets *of sense of place* for the study groups

The methodology here carried out was aimed to gather data regarding the different bonds, feelings and relationships foreign residents of Lisbon have towards *places* in the city through a map-based survey designed to collect spatial data. The lay-outs of the different dimensions were built based on the survey answers, which were processed to result in the spatial *picture* of the *place*-people connections. Then, methods of spatial comparison *metrics* and statistics, cluster analysis and map production were applied in order to examine patterns, understand correlations, identify hotspots, characterize clusters and compare extents.

2 Literature review

2.1 *Sense of place*

A notorious figure in *place* studies in human geography, Yu-Fu Tuan, defines *sense of place* (SoP) as a "*universal affective tie that fulfills fundamental human needs*" [4] apud [16], (p. 1). According to Stedman [22], people build SoP over time based on meanings attributed to the settings as SoP is not intrinsic to the physical world, but lies on symbolic representations people develop towards *places* through experience and interaction. Therefore, SoP stems from the interplay of visual, historical, psychological, environmental, social and even spiritual factors. Vanclay [7] states that is necessary to break down SoP into components as the term is too broad. The author cites the definition of SoP according to the Australian Government's State of the Environment Report: "*an intensely personal response to the environment, social and natural, which the individual experiences in daily life, at a broader level it can be the individual's perception of the whole region, state or nation*" [7], (p. 7). As for Williams and Stewart [23], they define SoP as *"the collection of meaning, beliefs, symbols, values, and feelings that individuals or groups associate with a particular locality"* (p. 19).

However, the broad character of the construct as well as its multidisciplinary nature has let different fields build conceptual schemes on which several methodological frameworks were developed [13]. Nonetheless, most frameworks consider SoP a multidimensional concept as it encompasses distinct aspects of how people connect to *places*. One of the first studies to elucidate the multidimensionality of SoP was carried out by Jorgensen and Stedman [24], who performed a statistical analysis of questionnaires using attitude theory as their theoretical foundation. From then on, researchers have been performing different kinds of analysis to either unravel or describe the different dimensions that the SoP construct can carry [11],[13],[15],[24].

2.2 Dimensions of *sense of place*

There are a multitude of terms in the literature which not only caused confusion but also blocked advances in the research field for a while [25]. As pointed out by Hidalgo and Hernández [25] terms such *as community attachment, sense of community, place attachment, place identity, place dependence* and *sense of place* had been used in ways that it became difficult to discern the conceptual structure underlying these constructs. On the other hand, researchers started to

employ questionnaires and factor analysis to distinguish dimensions of SoP. As pointed out previously, the pioneer study of Jorgensen and Stedman [24] carried out with lakeshore property owners suggested the existence of three dimensions: *attachment, dependence* and *identity*. The authors define *place attachment* as the *"individual's affective or emotional connection to a spatial setting"*; *place identity* as the *"individual's cognitions, beliefs, perceptions or thoughts that the self is invested in a particular spatial setting"*; and *place dependence* as the *"perceived behavioral advantage of a spatial setting relative to other settings"* [24], (p. 238).

A certain degree of confusion also arises between the terms *sense of place* and *place attachment*, as the former is mostly used by human geographers and the latter by environmental psychologists [7],[25]. Shumaker and Taylor's [26] definition of *place bonding* is the *"person-place bond that evolves from specifiable conditions of place and characteristics of people"* [26] *apud* [27], (p. 221). Environmental psychologists Scannell and Gifford [16] introduced their study defining *attachment* as the *"bonding between individual and their meaningful environments"*, (p. 1). Both Shumaker and Taylor's and Scannell and Gifford's conceptualizations are therefore similar to the holistic approach of *sense of place* geographers tend to adopt.

In fact, environmental psychology is the main field which has been delving thoroughly into the different SoP dimensions using surveys based on psychometric scales [21],[23],[24],[28]–[30] For instance, Williams and Vaske [31] described and quantified meanings people created towards different land use settings. Their analysis of questionnaire data allowed the authors to distinguish two dimensions of *place attachment*: *place dependence* – the physical quality of a *place* in terms of features and conditions that can support desired activities, also called *functional attachment*; and *place identity* – the symbolic quality of a *place* in which affective relationships develop as a component of self-identity, also called *emotional attachment*. Therefore, the authors assessed *place attachment* as one unit comprised of two dimensions: *dependence* and *identity*.

As for Pretty *et al*. [10], their conceptual and empirical framework contained three separate dimensions for the SoP construct: *place attachment, place identity* and *place dependence*. Hence, their research approach is similar to the work of Jorgensen and Stedman [24]. The authors considered *place identity* (PI) as a "*symbolic extensions of the self*" (p. 275) built through experiences within the *place*; *place attachment* (PA) as the emotional bonding people have with a *place*; and *place dependence* (PD) as a "*goal-oriented behavioral component*" (p. 275), meaning the conditions of a *place* to satisfy specific activities of the individual [10]. Although early works have treated *attachment, identity* and *dependence* as separate constructs based on attitude theory, other studies have demonstrated that the PI and PD can be treated as dimensions of PA. Brown and Raymond [32] investigated the validity of a two-dimensional model for PA combining landscape values through exploratory factor analysis, deriving high-reliability results. Nevertheless, the authors mention that "*we also recognize other researchers consider place attachment as a separate place dimension, to be examined alongside place identity and place dependence*" (p. 92).

In addition to the definitions described previously, some authors also mention and define other components of SoP, such as: *place satisfaction* – an overall judgement of the "*perceived quality of a setting*" [22] (p. 672); *place familiarity* or *place awareness* – the level of knowledge people have regarding a certain *place* [7]; *place commitment* – the measure of how much people are willing to contribute to their local *place* [7]; *nature bonding* – the connection to the natural environment [33]. Researches have also drawn parallels between *place* and *social* concepts. For instance, Manzo and Perkins [34] built a framework on which *social capital* and *sense of place* dimensions were connected based on their cognitive, affective and behavioral subdimensions. Using a similar theoretical framework (Figure 2.1) and existing literature, Acedo *et al*. [21] carefully schematized the associations between *social capital* and *sense of place* components. The correlation between the constructs was evident due to the common variables used to build these dimensions.

Attitude theory	Sense of Place	Social Capital
Affective	Place Attachment	Sense of community
Cognitive	Place Identity	Collective Efficacy/Empowerment
Behavioral	Place Dependence	Neighboring and Citizen Participation
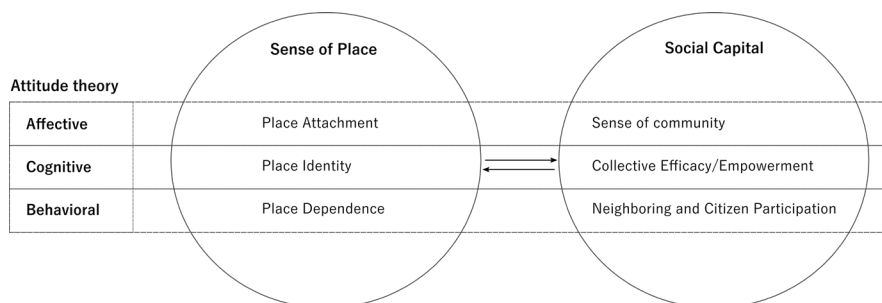
Figure 2.1. Theoretical framework used by Acedo *et al*. for establishing relationships between *social capital* and *sense of place* dimensions (modified scheme from Acedo *et al*. [21]).

The existing frameworks for analyzing and defining SoP dimensions in *place* research were summarized by Rollero and Piccoli [29] based on the literature review carried out by Hernández *et al.* [28]: (i) PA and PI as the same concept; (ii) PA as a dimension of PI; (iii) PI as a dimension of PA; (iv) PA and PI as dimensions within a supra-ordered concept. The concise literature review on the dimensions of SoP here presented do not make justice to the multitude of conceptual frameworks and definitions within the scope, as expressed by Scannel and Gifford [16]: "*these definitions remain scattered in the literature, and thus the theoretical development of the concept has not yet been acknowledged, nor has a more general definition of place attachment been agreed upon*" (p. 2).

2.3 Operationalizing *sense of place*

Sense of place is not accessible through direct observation, yet it can be inferred based on people's responses and actions [24]. In order to analyze its dimensions and quantify them, researchers have combined questionnaires, psychometric scales and various statistical methods. The predictors and variables used to structure psychometric scaled questionnaires vary in the literature depending on the conceptual or methodological framework. For example, Lewicka [35] assessed PA based on different attributes: *demographic factors* – such as age, education and gender; *physical factors* – type of housing and building size; *social factors* – neighborhood ties and sense of security.

Structural equation modelling is often used in environmental psychology to assess and define the relationships between different SoP dimensions and their predictors. Rollero and Piccoli [29] used both quantitative and qualitative data to build a structural equation model in which cause indicators such as cultural level, age, gender, social relationships and length of residence were surveyed to assess their contribution in forming *place attachment* (Figure 2.2).
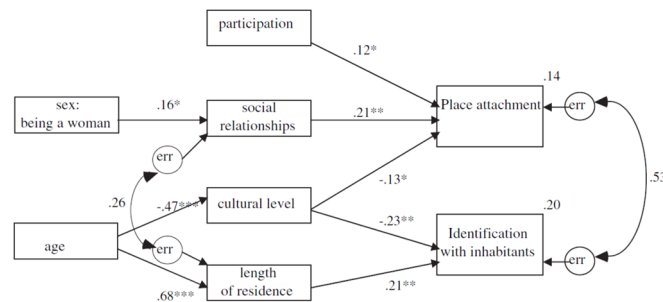
Figure 2.2. Place *attachment* prediction model with regression weights, variances and correlations obtained after statistical analysis of self-reported questionnaires (from Rollero and Piccoli [29])

Different latent variables and indicators have been hypothesized and tested. For instance, Deutsch *et al*. [36] built their structural equation model of *sense of place* using six different dimensions – *attachment, dependence, identity, satisfaction, atmosphere* and *community* – which in turn had several different survey questions as indicators, and explanatory variables such as sociodemographic attributes and "*description of the day*". Scannel and Gifford [16] explored all commonalities of *sense of place* in different fields through an exhaustive literature review and built a tripartite organizing framework – PPP. The person-process-place framework (Figure 2.3) splits *place attachment* into three main components: *person – who* is attached; *process – how* they are attached and *place – to where* in space an individual or community is attached. According to the authors, the PPP framework can aid the operationalization of the constructs both in quantitative and qualitative analysis of *sense of place*.
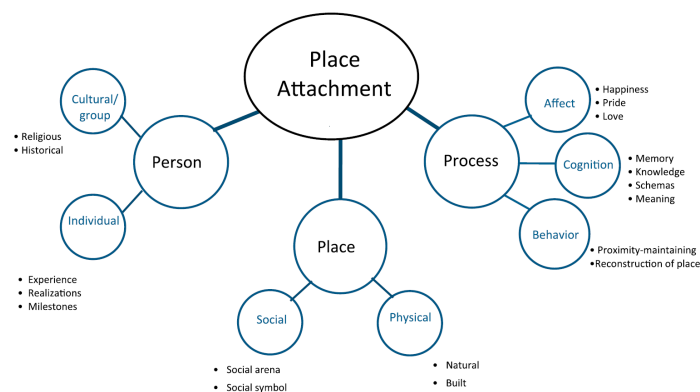
Figure 2.3. The PPP tripartite framework of *place attachment* (from Scannel and Gifford [16]).

2.4 *Sense of place* and geographic information

Although *sense of place* and its related constructs are social-psychological concepts, they are fundamentally attached to a geographical dimension [9]. The space-*place* dichotomy has been

extensively discussed by human geographers, yet it has not been substantially approached within the GIScience. Merschdorf and Blaschke [37] argued that the terms have been used almost interchangeably in the literature. The authors carried out an in-depth revision of the role of *place* in GIScience regarding the formalization and operationalization of *place* constructs. They identified that the branches of VGI/crowdsourcing, semantics and ontologies are areas concerned in operationalizing *place*.

Before research was conducted through combining *place* studies and geographic information, spatial dimensions were only considered as a scale of *attachment* strength such as towards the house, apartment, neighborhood, city and country. Lewicka [35] demonstrated that perishes and districts are poorly consolidated through cognitive mechanisms due to the arbitrary character of administrative areas, causing people to report lower values of *place attachment* towards these scales. According to the author, administrative boundaries generally lack symbolism for building cognitive spatial representations as people tend to abstract spatial information in the form of places.

In the scope of natural resource management, Brown and his colleagues have applied map-based methodologies for measuring SoP together with landscape values [13],[14],[32]. As brought up by Brown [13] at the time, the concepts lacked suitable operational definitions, limiting their applications and requiring the need to *"connect special place locations (geography of place) with their underlying perceptual rationale (psychology of place)"* (p. 19). In their pioneer research, Brown *et al.* [14] mapped PA using internet-based PPGIS combining variables of landscape values, PA and *home range*. Figure 2.4 shows the map-based survey results of *place attachment* and *home range* considering their area overlap.
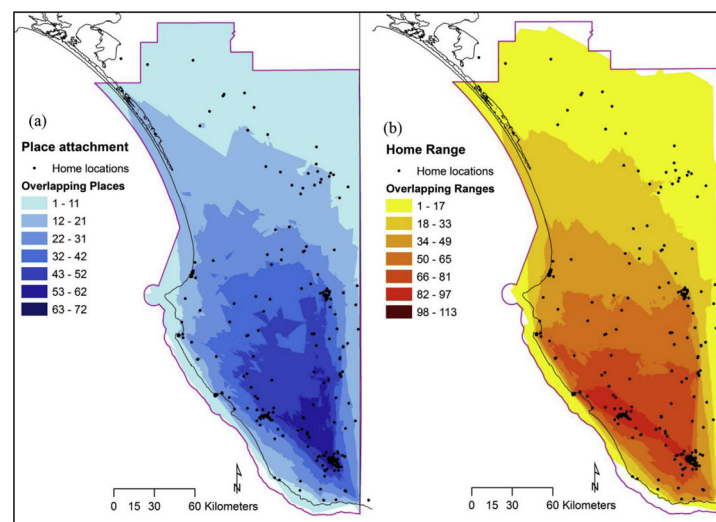
Figure 2.4. Spatial distribution of overlapping values for *place attachment* and *home range* based on hand drawn polygons from the PPGIS survey (from Brown *et al.* [14]).

Jenkins *et al.* [11] gathered crowdsourced data from Twitter and Wikipedia to analyze collective SoP in different cities. Their study combined social media, GIS and SoP for *"gaining an understanding of the building blocks of these urban environments"* (p. 17) by means of a process

the authors refer to as *"moving from a geometrical view of the world around us to a platial view"* (p. 17). In their research on spatializing SoP, *social capital* and *civic engangement*, Acedo *et al*. [18] developed a GIS platform to "*render space as a subjective place that covers the people's feeling towards places and human relationships*" (p. 2). Users of the platform are able to draw polygons according to questions designed to assess each social-psychological construct, enabling visualization and analysis (Figure 2.5). Their motivation was to investigate predictors, create a social-spatial layer of the city (Lisbon) and demonstrate the relevance of GIScience in citizen social information [18].

Figure 2.5. Application built by Acedo *et al*. to gather users' data on *sense of place, civic engagement* and *social capital* (from Acedo *et al*. [18]).

Also in the city of Lisbon, Acedo *et al*. [17] examined the spatial relationship between areas where people feel SoP and areas that people take part in activities. The data for SoP was acquired using the application developed by Acedo *et al*. [18], while activity was represented by geolocation of *Twitter* posts. Their spatial analysis concluded that social media data can serve as a proxy for bounding SoP spatial dimensions. Along similar lines, Acedo *et al.* [9] investigated the spatial relationship between SoP and *social capital* also using the same application developed by Acedo *et al*. [18]. Their motivation was to show the possibilities of VGI/PPGIS in understanding social synergies to promote urban intelligence, treating the city as a network of places. Acedo *et al.* [15] took a step further by implementing the topological relationships between SoP, *social capital* and *civic engagement* into a structural equation model. In fact, imbuing the topological relationships into the model resulted in better statistical fits in almost all cases [15].

2.5 *Sense of place* and mobility

As discussed by Gustafson [20], mobility includes international or internal migration, residential mobility inside the same region, daily commuting as well as leisure or occupational traveling. One of the consequences of a mobile world is the development of *sense of place* towards more than one place, establishing bonds to multiple places through different processes of meaning formation [20],[38]. As pointed out by some researchers, literature shows that *sense of place* and mobility are classically seen as opposite or exclusive phenomena, but these studies might overlook some qualitative distinctions in SoP when comparing the concept between more and less mobile

individuals [20],[39]. This is due to the fact that people who are more mobile may develop relationships towards places by creating meanings through different processes when compared to native people [20].

A study with middle class immigrants in Manchester demonstrated that although a strong *place attachment* was developed, its characteristics were a reflection of a selective preference of aesthetic and physical attributes of the *place* [40] *apud* [20]. However, while immigrants are adjusting to the new settings, commonality and diversity can play different roles in forming *attachment*; people seek familiar physical features and local immigrant communities or look for exposure to new ways of life, or even a combination of both [41]. Length of residence has often been a direct measure of *place attachment* in psychometric scales, but other researchers argue that duration should be treated as a predictor [20]. The reason behind this is that spatial knowledge increases over time, enabling people not only to acknowledge their surroundings but also to acquire more information and consequently develop new feelings towards new *places* [41]. Immigrants away from home may develop SoP towards the neighborhood, the city and also the country, through an active effort to help facilitating the transition [41].

Based on semi-structured interviews, Chow and Healey [42] assessed the transitional process of first-year undergraduate students who had moved away from home to study. The authors qualitatively explored the mediating variables that impact on *place attachment* and *place identity*, which are dynamic and prone to disruption since these relationships evolve both through space and time. The authors conclude that during the transitional context, *sense of place* naturally manifested during the adjustment to a new socio-spatial environment.

One of the reasons high correlation between *sense of place* constructs is often present lies on the fact that most of the research focus on native or long-time residents [28]. According to Hernández *et al*. [28], concepts overlap because natives or long-term residents usually report high scores for all dimensions. Their study showed that different *place* dimensions yielded more variability on their intensities for non-native residents. The authors concluded their study pointing out the need for conducting more analysis with people of different nationalities in order to examine the role of cultural differences and the different processes through which these individuals construct distinct *place identities* [28].

2.6 Theoretical framework

A four-dimensional model of *sense of place* was adopted in the study (Figure 2.6). The framework was conceived based on a combination of Trąbka's [43] defined structure and the existing literature on the topic. Trąbka [43] studied how different dimensions of *sense of* place emerged among voluntary polish immigrants in Oslo and London. The author conducted semi-structured in-depth interviews and revealed that their *sense of place* was dynamic and could be dissected into a dynamic ladder: *place dependence* – affordances and new opportunities*; place discovered* – sense of mastery and pleasure from exploring *place*; *place identity* – arena of self-expression; and *place inherited* – family ties and life-shaping experiences in a *place*.

Dimensions used and respective descriptions

Place Dependence *Jorgensen and Stedman (2001); Scannell and Gifford (2010); Trąbka (2019)*	Functional attachment based on the affordances, opportunities, amenities and resources a specific place can provide for goal-oriented behavior. Activities can include shopping, entertainment, leisure, daily tasks, physical activitiy, working, studying and living
Place Awareness *Vanclay (2008); Lewicka (2013); Trąbka (2019)*	Dimension regarding knowledge and familiarity. The bond stems from a combination of behavioral aspects such as navigation skills in certain areas; and emotional aspects such as enjoyment and sense of mastery that comes from actively exploring places
Place Identity *Jorgensen and Stedman (2001); Williams and Vaske (2003); Chow and Healey (2008); Scannell and Gifford (2014); Trąbka (2019)*	Emotional attachment developed when places acquire a symbolic meaning and could become part of self-identity. Frequent or habitual interactions in and with places can foster place identity. Places might even be incorporated into one's self-definition.
Place Inherited *Hernández et al. (2007); Scannell and Gifford (2010); Trąbka (2019)*	Deeper attachment related to feelings of rootedness and belonging. Significant social interactions, life-shaping events and family ties are components which can shape places into forming this dimension. This bond is developed in the long-term

Figure 2.6. *Sense of place* dimensions used in this study with their respective descriptions.

The four-dimensional model was drawn from Trąbka's [43] as her work considered and deducted important aspects pertinent to the study here carried out, such as: dimensions are considered dynamic both in space and time; dimensions tend to develop sequentially; participants' activities concerns aspects of the urban context; individuals can either skip the development of specific dimensions or not develop certain bonds at all; and finally, participants are foreigners currently living in a new urban setting. Therefore, the main dimensional structure here defined is an attempt to fit a sequential model of *sense of place* based on residence time. The spectrum on which *sense of place* is dismembered considers the evolution from immediate perceptions [44] and functional attachment to emotional attachment and deep relationships with *places*.

Nevertheless, Trąbka's [43] *sense of place* dimensions are derived from a deductive approach within a rather specific research context. As a consequence, the theoretical framework currently adopted also defines *sense of place* dimensions based on the literature review on the topic, mainly withdrawn from studies in environmental psychology. Furthermore, Trąbka's *place discovered* was replaced here by *place awareness*, which not only considers the discovery and exploration relationship towards *places*, but also carries cognitive aspects of familiarity, representing a transition from functional to emotional attachment. Final dimensions assessed here were: *place*

dependence – functional attachment; *place awareness* – exploration and familiarity (transition from functional to emotional attachment); *place identity* – emotional attachment and self-identity; and *place inherited* – deep emotional attachment strongly correlated to aspects of *social capital.*

In addition, literature confirms that *sense of place* dimensions are distinct but often highly correlated with each other, although felt with different intensities by different people in different contexts [10]. Therefore, this research acknowledges the dynamic and interrelated nature of *sense of place* dimensions while investigating their spatial relationships.

3   Methodology

3.1 Overview and study design

Methodology consisted of two main segments: map-based survey for data collection and analysis of gathered data. Study design with described steps is found in Figure 3.1 and the study area was the municipality of Lisbon, Portugal. Next sections will elucidate all the steps, tasks and tools used throughout the research.

3.2 Survey

3.2.1   Survey123 and survey structure

The platforms used to design and carry out the survey were the Survey123 online and desktop environments. Survey123 for ArcGIS is a tool developed by ESRI for creating and sharing customized surveys both on web and mobile formats [45]. Survey123 online had several limitations regarding the type of questions, structure format and online map compatibility; therefore, Survey123 desktop platform was used to build the survey and Survey123 online mainly for final editing, sharing, data downloading and dashboard observation.

Both platforms were connected through ArcGIS Online and used concurrently for adjusting, designing, managing and publishing the final survey. However, Survey123 desktop was used for building the survey based on XLSForm tool, which is the framework for designing questionnaires in the desktop environment. XLSForm is a standard for authoring and sharing forms in Excel through a specific syntax for creating XLS based questionnaires [46].
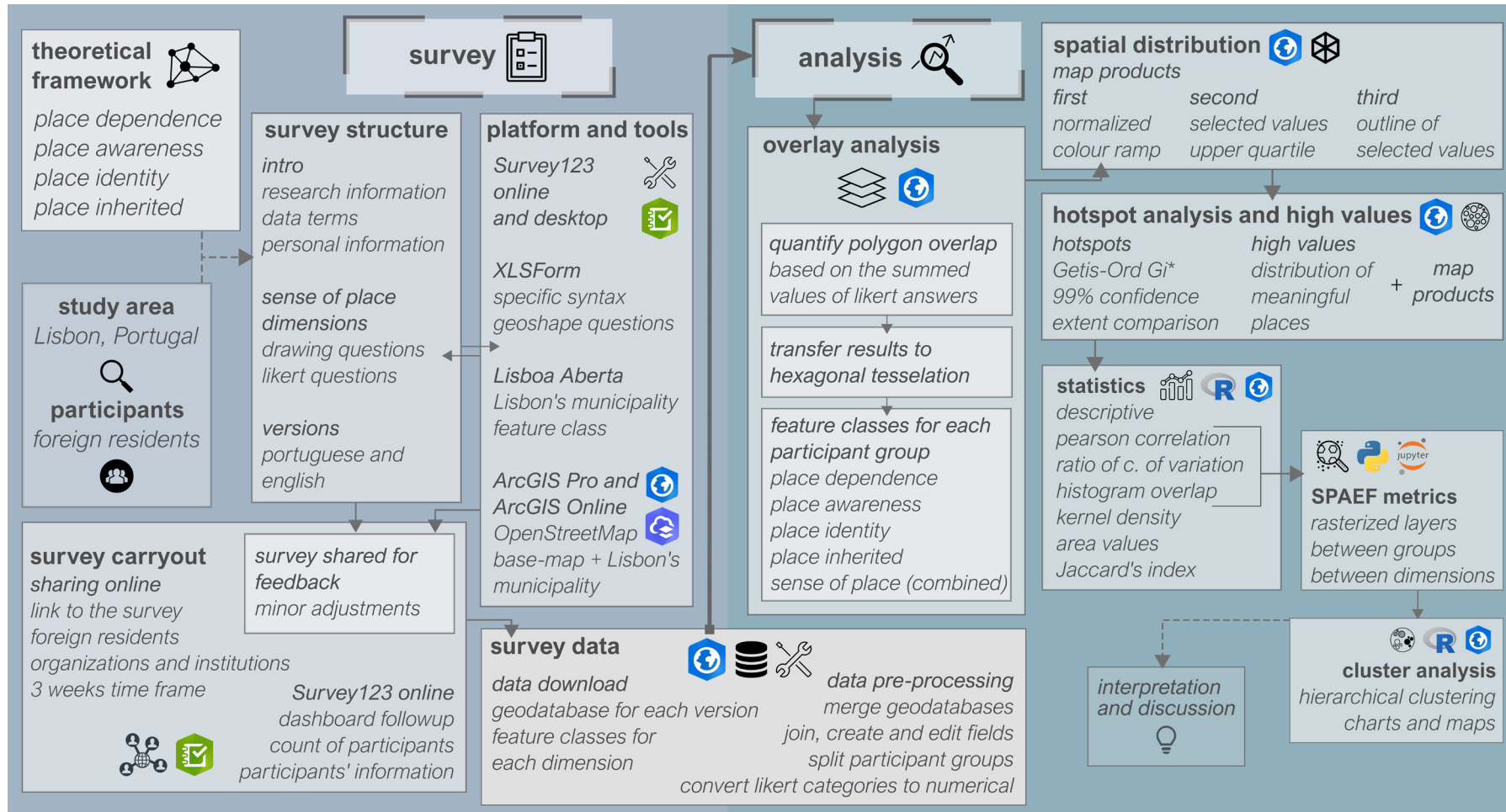
.

Figure 3.1. Methodology structure of the research.

The XLSForm syntax allowed all required functionalities of Survey123 platform such as different types of questions, including *geoshape* questions for hand-drawing polygons on map; different logic and validation rules for constraints and conditions; question grouping; as well as the enablement of inserting media such as images. Figure 3.2 shows a segment of the survey in XLSForm format on Survey123 desktop.

type	name	label	hint	constraint
begin group	note1			
note	note2			
note	note3	Hello!	 The following survey is part of my thesis research. Its aim is to investigate	
select_multiple [terms]	data_terms	terms		
end group				
begin group	residencetime	time of residence		
select_one list_time_of_residence_for_how_long_	residencetimequestion	how long have you been living in Lisbon?		
end group				
begin group	residencelocation	residence location		
text	residencelocationquestion	what is the zip code of your current residenc	 <i>if you do not wish to share this infoi	regex(., '^\d{7}$')
end group				
begin group	background	background		
select_one countries	backgroundquestion	what is your home country?	<p> </p><p><i>please select your answ	
end group				
begin group	dimensions	sense of place dimensions		

Figure 3.2. Initial sections of the survey on XLSForm format. Type column shows examples of specific syntax and constraint column displays one example of a *regex* expression for postal code filling restriction.

The complete survey can be found in Annexes in both English and Portuguese versions. First, participant would find information regarding the aim of the survey, approximate time of completion, recommendations and contact details. Then, in order to proceed and fill the survey, participant had to agree with the stated data terms.

Secondly, time of residence, home country and postal code of residence location (optional) questions were asked. Each of the four sections corresponded to a dimension, split into two subsections: the first subsection incited the participant to think about specific *places* according to the dimension (Figure 3.3); in the next page the subsection contained the questions asked to guide the map drawing, the map itself for drawing the areas as well as instructions; the second subsection consisted of a *likert* scale question to obtain additional information regarding the intensity of the specific relationships towards the drawn areas (Figure 3.4). The order of the *sense of place* dimensions' sections in the survey was defined according to the theoretical framework. In addition, answering the *place dependence* section was compulsory since it represents the dimension of daily tasks, activities and routine based *place* interactions.

Map-based functionality for hand-drawn polygons is only enabled on Survey123 desktop through the implementation of the *geoshape* question type of XLSForm. For each main section, one *geoshape* question was added to allow participants to draw areas within the city of Lisbon. Participants could interact with the online map by zooming, browsing, searching for specific regions and enlarging to full screen mode. Polygons could be built through either defined geometric shapes or freehand drawing, and participants could delete and edit the shapes after delimitating them. These steps are shown in Figure 3.5.

Figure 3.3. First subsection of the *place dependence* section of the survey.

Figure 3.4. Second subsection of the *place dependence* section of the survey.

Participants were encouraged to draw more than one area for each dimension, and in order to do so, instructions were added so they would be able to add other maps for polygon drawing since Survey123 platform does not allow to draw more than one polygon per map. Therefore, after participants were finished with each polygon, they either went to the next subsection or clicked on a button that would add another map for drawing. This could be repeated as many times as desired by the participant.
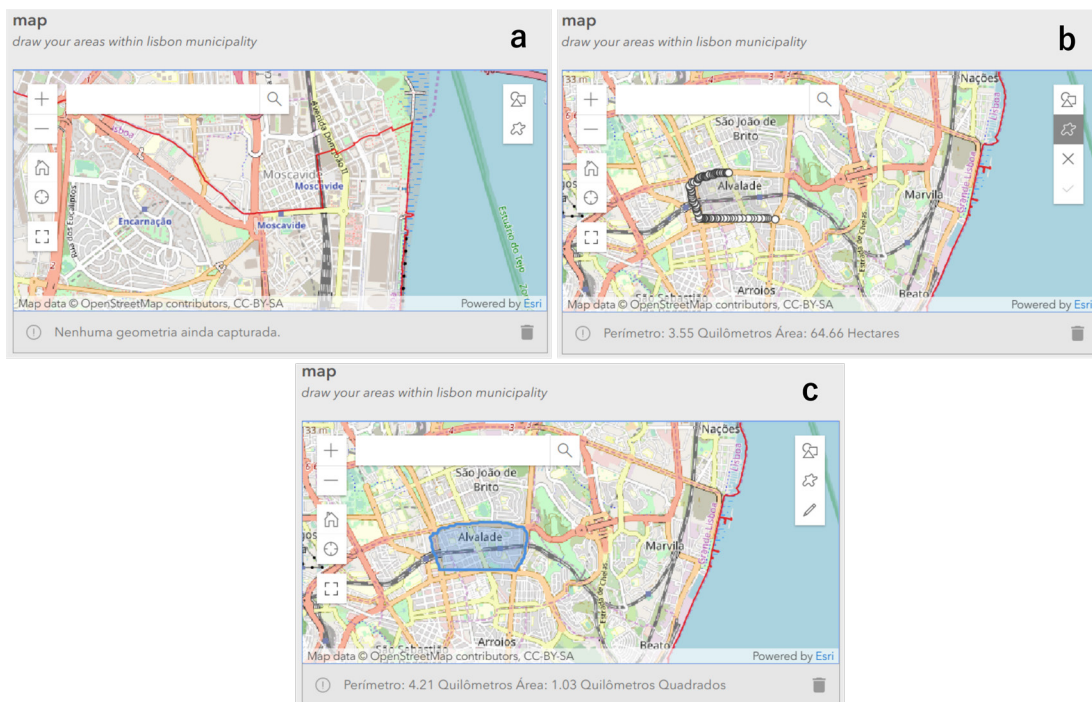
Figure 3.5. Survey steps of drawing polygons on the map: (a) red line corresponds to Lisbon's municipality boundaries; (b) area drawing using the freehand option; (c) final single polygon with enabled edition and deletion.

The desktop platform supports different base-maps for the *geoshape* questions, however, as the study area was within Lisbon's municipality, adding its boundaries on the map was important. In order to do so, a feature class of the city limits was obtained in the official city council open data website – Lisboa Aberta [47]. Then, the feature class was added to a map on ArcGIS Pro and shared online as a web-map on ArcGIS Online using OpenStreetMap as the base map. Lastly, the web-map was manually added to the survey through adjusting map parameters on Survey123 desktop files.

Succeeding the completion of the survey design, feedback was obtained through a questionnaire. The link to the questionnaire was added in the end of the survey, while the survey was shared among six people, split into participants who were either familiar with GIS platforms or not. Feedback questionnaire was split into a sequence of *likert* questions and text questions regarding suggestions, recommendations, approximate time of completion and overall feedback. The questionnaire can be found in Annexes. Following feedback collection, minor adjustments were made constrained within the limitations of the platform.

3.2.2 Survey carryout

Both versions of the survey (English and Portuguese) were first shared online with foreign students and researchers of the Information Management School of Universidade Nova de Lisboa. Throughout the process, participants were encouraged to share the survey link with friends, family and acquaintances, as long as they were foreign residents living in the city at the time. Survey was also shared with representatives of other institutions in Lisbon. Contact was made via e-mail

with representatives and coordinators of these organizations; however, only members of universities' faculties and research groups responded and shared the survey with foreign researchers, members and students of their institutions.

Survey was available online and actively shared during a time frame of 18 days. Survey123 online dashboard was constantly inspected throughout and following the sharing period. Information on the dashboard included total count of participants, count of participants per day, charts displaying question responses, attribute tables and maps with drawn polygons (example in Figure 3.6).
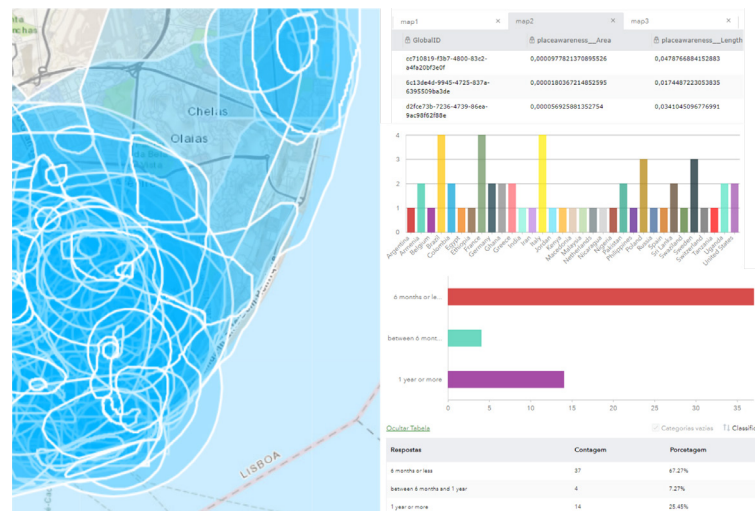
Figure 3.6. Information displayed on Survey123 online dashboard, including hand drawn polygons, attribute tables and charts.

3.2.3   Survey data retrieval

After deactivating the survey for public sharing, data was downloaded directly from Survey123 online platform as geodatabases. Each version of the survey (English and Portuguese) was exported as a geodatabase containing nine feature classes. For each dimension, four feature classes represented the layers of drawn polygons and four relationship classes connected each polygon feature class to a separate feature class containing all other participants' data.

3.2.4   Survey data pre-processing

Before starting analysis, pre-processing of data from Survey123 was carried out. All steps were done through ArcGIS Pro ModelBuilder. First, polygon feature classes from the Portuguese and English versions were merged to represent each dimension. Then, the participants' responses of each version were added to the polygon layer by joining fields through the ID of the relationship classes.

Joining two different tables into the merged feature class resulted in a table with doubled field columns with values split into the two different survey versions. Therefore, for each *dimension*, new fields were added and calculated using each versions' attributes. Reprojection was also performed as the original data was in a geographic coordinate system (EPSG: 4326) and spatial analysis was to be done. Therefore, the data was reprojected to a metric coordinate system (UTM Zone 29N).

The next step was to convert the answers of the *likert* questions from the *neutral-strongly agree* categorical scale to equal interval numerical attributes. Each layer of polygons representing a dimension for a participant would therefore have a numerical attribute. These values would then be summed and normalized in the overlay analysis to represent the collective strength of each dimension. In addition, all layers were clipped to Lisbon's municipality, disregarding areas outside the city and considering polygon portions within the boundaries. Lastly, length of residence attribute was selected to split the dimensions between two participant groups. The division was done based on a one-year threshold: short-terms consisting of participants who had been living less than a year and long-terms those who had been living more than a year in Lisbon. The one-year threshold was chosen aiming to obtain spatial distinctions between newcomers and long-terms according to the proposed theoretical framework.

3.3 Analysis

3.3.1 Overlay analysis

The overlay analysis was carried out using ArcGIS Pro ModelBuilder and its purpose was to quantify polygon overlap in order to represent polygon density. Overlapping areas would then represent different intensities of the dimensions as spatial concurrence of drawn polygons represent shared regions of *sense of place* among participants. The methodological framework characterized by using surveyed polygons and following calculation of their overlap areas was adopted in Brown's [14] study on mapping and measuring *place attachment*.

Steps of the overlay analysis were applied to each feature class representing each dimension for both participant groups – short-terms and long-terms. The first operation was to perform a *union* task followed by a *multipart to singlepart* as well as a *spatial join* in order to obtain all the polygons' intersections and the summed value of the *likert* questions according to the overlapping areas. The steps of the first operation are exemplified in Figure 3.7.
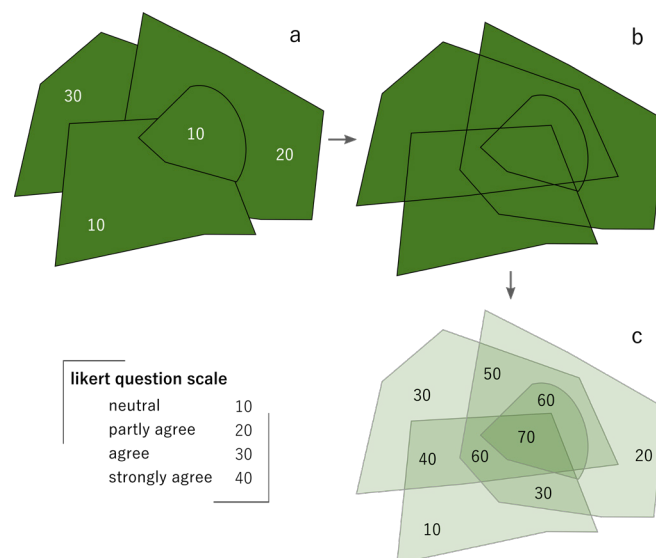
Figure 3.7. Simplified scheme of the first operation steps in the overlay analysis. (a) each polygon layer carried the categorical attribute of the *likert* question, which was converted to a numerical scale. (b) and (c) the steps were applied to quantify polygon overlap based on the numerical scale values.

The next operation was to overlay the results obtained from the first operation to a hexagonal tessellation. A hexagonal mesh was used to improve visualization of spatial patterns as well as to facilitate other operations such as creating a unified table of attributes based on the hexagons' IDs. The first step was to set the unit area value of the generated tessellation. The final mesh was clipped to Lisbon's municipality boundaries and each hexagon had an area of 10 000m^2. Chosen size was based on the approximate area of certain city blocks of the Freguesia de Avenidas Novas, near the centroid of Lisbon's municipality.

The following step consisted of performing the spatial join of the polygon overlap layer into the hexagonal mesh. In other words, transferring the summed overlap polygon values to the hexagonal tessellation. The rule used to perform the spatial join was the maximum value of intersection. Therefore, in an attempt to represent the scalar variability of to a certain extent, hexagons would attain the highest value intersected regardless of the resulted overlap area on the hexagons themselves. Figure 3.8 shows the scheme of the polygon to hexagon mesh operation.
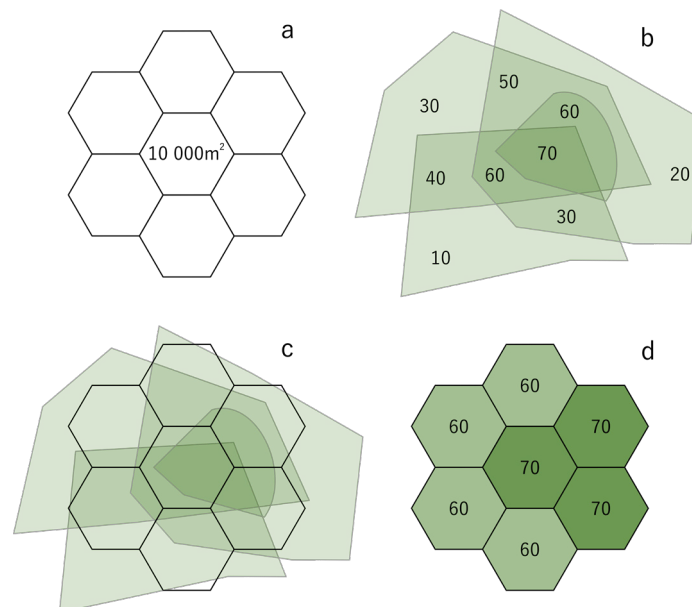
Figure 3.8. Scheme of the hexagon overlay steps. (a) generation of a hexagonal mesh; (b) results of the polygon overlap operation; (c) spatial join of the polygon overlap into the hexagonal mesh; (d) results of the spatial join using the maximum value intersect rule.

All operations were done with each dimension of each participant group, as well as with all participants' answers combined. For each dimension, polygon overlay results of short-term, long-term and of all participants were used to carry out the hexagon overlay. Polygon overlay and hexagon overlay operations were also performed combining all dimensions, resulting in the general *sense of place* picture of short-terms, long-terms and all participants. The *sense of* place combined layer did not consider unanswered dimensions by participants, as it was calculated through the overlay of all existing polygons. The final steps consisted of normalizing the hexagon overlay values based on the range of each group and dimension into a 0 to 1 scale. Lastly, final products were displayed in maps and used in the following phases of the methodology.

3.3.2 Spatial distribution

The spatial distribution of *sense of place* dimensions were displayed in three different map products. The first map products represent the spatial configuration of the scaled normalized values for each dimension and participant group in a continuous color ramp using the direct results of the overlay analysis. They were used for the initial examination of intensity distribution of *sense of place* dimensions throughout the city.

The second products were done through selecting values of *collective sense of place* for each dimension and each participant group. Collective dimensions were represented by areas which had values higher than the upper quartile (highest 25%) for each normalized distribution within short-term and long-term foreign residents. These areas therefore would represent statistically significant regions of shared *sense of place* among participants. After selecting the areas, maps of each dimension were built to visualize their spatial distribution, patterns, unique and common areas for each participant group and consequently to provide the initial interpretation and discussion of the results. The third map products were done using the outline of the selected areas, while displaying all dimensions for each participant group. Outline maps were built to provide initial insights and visual overview regarding the spatial relationships *between* dimensions. All maps were made on ArcGIS Pro.

3.3.3 Hotspot analysis and high values distribution

Hotspot analysis was performed using Getis-Ord Gi* statistics tool in ArcGIS Pro on the selected regions of the previous section. Default parameters were used and areas representing high-value hotspots with 99% confidence (p-value < 0,01 and z-score > 2,58) were selected and extracted. As for high values distribution, selected areas (higher than upper quartile) had their symbology changed to the same intervals for short-term and long-term groups in order to compare regions carrying high values of *sense of place*.

High values and hotspots distributions were displayed in maps for each *sense of place* dimension as well as the combined dimensions. Hotspots of each participant group were put onto the same map and the map composition also contained the maps of high values for each group. The final maps were used for visual interpretation of their spatial configurations and discussion regarding the location of meaningful regions and *places* in the context of Lisbon's urban landscape.

3.3.4 Statistics

Descriptive statistics and comparison statistics were done for all dimensions and between groups. Descriptive statistics included *mean, standard deviation, media, mode, variance* and *kurtosis*. Comparison statistics included Pearson correlation, ratio of coefficient of variation, histogram overlap – parameters obtained in the spatial comparison metrics elucidated in the next section. In addition, kernel density distribution of values higher than 80%; calculated area of hotspots, regions with values higher than the upper quartile as well as regions with intensity higher than 75%; and lastly, Jaccard's index of the mentioned selected areas. Jaccard's index or Jaccard's similarity coefficient represents the similarity between two sets and is expressed by the

intersection divided by the union of the sets [48]. In the case of this study, it represents the intersection area divided by the union area of two geometries.

Comparison statistics were performed between short-term and long-term residents for each dimension and, with exception of kernel density distribution, *between* dimensions for each group. Jaccard's indices and area values were calculated using ArcGIS Pro. Correlograms, scatterplots and kernel density distributions graphs were done using R data visualization libraries on RStudio.

3.3.5   SPAEF – Spatial Efficiency Metric

The Spatial Efficiency metric (SPAEF) was developed and brought forward by Koch *et al*. [49]. SPAEF consists of three equally weighted parameters: correlation, ratio of coefficient of variation and histogram overlap. Their research showed that SPAEF is a "*tough criterion with three independent components that individually penalize the overall similarity score*" [49], (p. 1882). By these means, SPAEF metric was used in this study in order to assess the similarity between spatial patterns of *sense of place* dimensions' distributions between short-terms and long-terms, as well as between dimensions. SPAEF equation (modified from Koch *et al.* [49]) is expressed as:

$$\text{SPAEF} = 1 - \sqrt{(\alpha - 1)^2 + (\beta - 1)^2 + (\gamma - 1)^2}$$

$$\alpha = \rho(a\,, b), \qquad \beta = \frac{\left(\frac{\sigma_b}{\mu_b}\right)}{\left(\frac{\sigma_a}{\mu_a}\right)}, \qquad \gamma = \frac{\sum_{j=1}^{n} \min\left(K_j, L_j\right)}{\sum_{j=1}^{n} K_j}$$

Where a and b are the patterns to be compared; α is the Pearson correlation coefficient between the patterns; β is the ratio of the coefficient of variations of each pattern (spatial variability [49]) and γ is the histogram intersection, while K and L are the patterns' histograms and n the bin count. Pattern similarity is defined by the Euclidian distance to the optimal point (1,1,1), represented by the highest scores for each equally weighted component. Therefore, SPAEF metric ranges from $-\infty$ to 1. The code developed to apply the spatial metric was made available on GitHub by the authors on their paper [49]. The algorithm reads the data as a transposed array; therefore, feature classes were first converted to raster on ArcGIS Pro with cell sizes smaller than the hexagon unit. Each pixel contained the value for each *sense of place* dimension. Before running the SPAEF metric, raster files were opened and read as arrays using GDAL library. SPAEF metric and its pre-processing steps were carried out using Python language on the open source Jupyter Notebook application. Final outputs included the SPAEF score and calculated values of its parameters.

3.3.6   Cluster analysis

Cluster analysis was carried out using all *sense of place* dimensions of all participants. Hierarchical cluster analysis was performed in order to obtain additional information on patterns and characteristics of the gathered data altogether. Hierarchical analysis was chosen due to the relatively small size of the dataset (87520 instances) and flexibility in the interpretation of cluster numbers based on the resulted dendrogram [50]. Agglomerative approach with Euclidian distance and Ward's minimum variance method were used for computing the distance matrix.

Final number of clusters was defined based on visual interpretation of the dendrogram as well as the Elbow method. All steps were done using R language on RStudio platform. Steps of the algorithm and cluster analysis implementation were performed using several libraries from the *clustree* R package. Subsequently, R data visualizations libraries were used to create parallel coordinate and radar charts to aid cluster characterization together with ArcGIS Pro to display cluster spatial distribution on a map.

4   Results and discussion

4.1 Survey

The survey was answered by 81 participants in total, from which 30 were long-term residents and 51 were short-term residents. In total, people from 35 different nationalities participated in the survey. Figure 4.1 shows the participants' count based on their nationality. Brazil was the country which had the highest number of participants, consisting of approximately 30% of the total count.
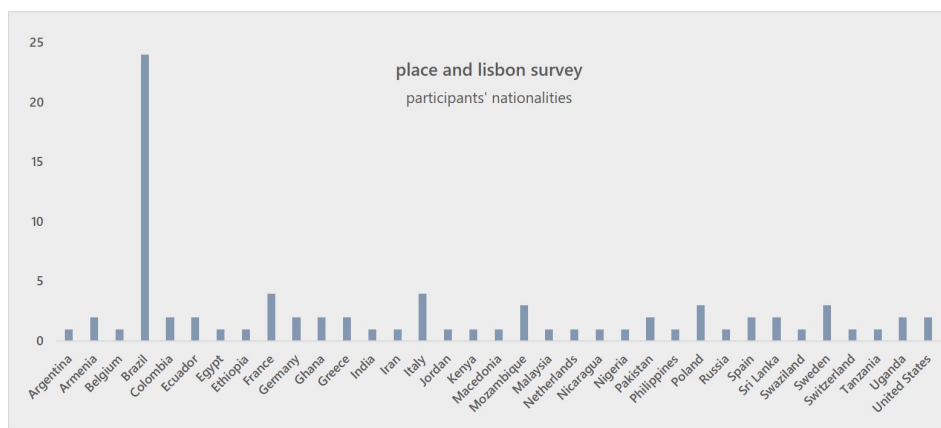
Figure 4.1. Survey participants' count based on their nationality.

For those who shared their residence location, most of their postal codes were assigned to central areas within the municipality, except for four participants whose residence were located outside the municipality, yet still in the metropolitan region. Although residence location was not implemented into the analysis, the following sections confirm the influence of residential and occupational locations in fostering *sense of place.* It was assumed here that among the participants there were graduate students, researchers or individuals who had finished their graduate studies in Lisbon, as the survey was not only but mostly shared within faculties of Universidade Nova de Lisboa and Universidade de Lisboa.

4.1.1 Survey data

Polygons outside the municipality were drawn, despite the inserted instructions guiding to delimitate polygons within the marked boundaries (Figure 4.2). Table 4.1 displays the total number of drawn polygons, the ratio of polygons per participant as well as the count of polygons drawn entirely outside the city for each dimension per participant group. Overall, total number of polygons decreased progressively from *place dependence* to *place inherited*, as well as the ratio between polygons per participant. In addition, long-terms drew relatively more polygons

compared with short-term residents for all dimensions. Another aspect observed in the responses (Figure 4.2) is the presence of polygons which either covered a considerably large portion of the city or the whole city itself. During following overlay analysis, considerably large polygons would have most of their extent represented by low intensity values of *sense of place* dimensions, as most of its area would not overlap with other participants' polygons and therefore would not represent regions with significant shared *sense of place.*
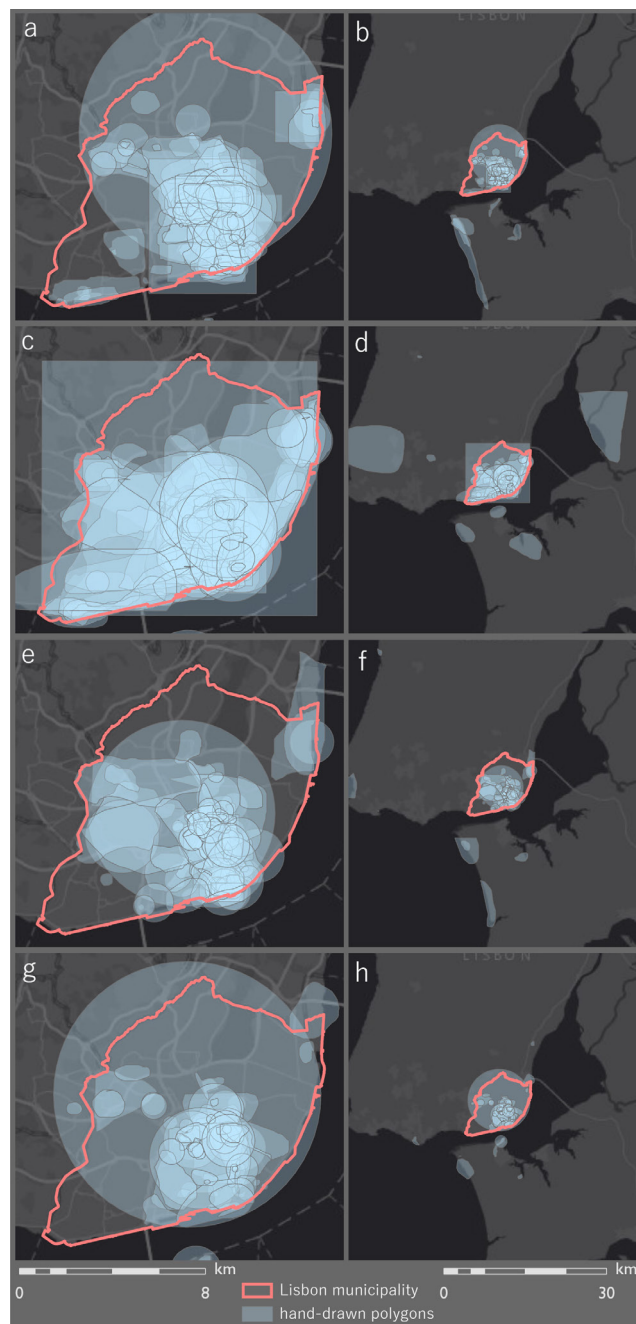
Figure 4.2. On the left side, participants' hand-drawn polygons mostly within Lisbon municipality. Maps on the right side show the polygons drawn outside the city of Lisbon. Maps a and b – *place dependence*; Maps c and d – *place awareness*; Maps e and f – *place identity*; Maps g and h – *place inherited.*

		drawn polygons	total polygons	ratio polygons/participant	polygons outside the city
place dependence	*short-term*	92	165	1,80	3
	long-term	73		2,43	3
place awareness	*short-term*	66	128	1,29	5
	long-term	62		2,07	3
place identity	*short-term*	50	108	0,98	5
	long-term	58		1,93	2
place inherited	*short-term*	35	83	0,68	2
	long-term	48		1,60	6

Table 4.1. Number of drawn polygons, polygons per participant ratio and number of polygons delimitated entirely outside Lisbon.

Information regarding the response rate for each *place* dimension is found in Table 4.2. Participants drew polygons and answered the *likert* questions for *place dependence* as it was compulsory in order to complete the survey. As for the other dimensions, participants could choose to skip questions if one did not necessarily feel the particular bond, as guided through the instructions. Long-term residents had a significant higher percentage of answered questions in comparison with short-term dwellers. In addition, long-term residents had a consistent high percentage of answered questions for each dimension, whilst short-term residents' responses had a lowering count as dimensions represented deeper connections.

dimension	short-term (%)	long-term (%)
place dependence	100	100
place awareness	80	97
place identity	69	87
place inherited	41	93

Table 4.2. Response rate of each assessed *place* dimension of short-term and long-term groups.

4.2 Spatial distribution of *sense of place* dimensions

The following subsections display the results in map format of the overlay and hotspot analysis as well as spatial features of the different dimensions assessed in this study.

4.2.1 Intensity of *sense of place* dimensions: *first map products*

The first map products built are characterized by the display of the intensity of each dimension for short-terms, long-terms and combined responses with normalized values within each dataset range.

4.2.1.1 Place dependence

Short-terms' distribution has a prominent high intensity spot, high values in the central city area as well as lower values in some peripherical zones (Figure 4.3). As for long-terms, their higher intensity zone is located in another area and in general, the central area of the city displays higher values when compared to short-terms. When combining the groups, the high intensity zones are noticeable, yet high values are found throughout the central region of Lisbon.

Figure 4.3. Distribution of *place dependence* for short-term, long-term and all foreign residents.

4.2.1.2 Place awareness

Short-terms' high intensity zones (Figure 4.4) are characterized by a larger extent when compared to *dependence* (Figure 4.3). As for long-terms, the highest strength of *awareness* is concentrated in two adjacent areas, yet its distribution of high values is similar to the one described for short-terms. As a result, when combining the two participant groups, *awareness* is encountered throughout the whole city, but bearing higher intensity across the center of the municipality.
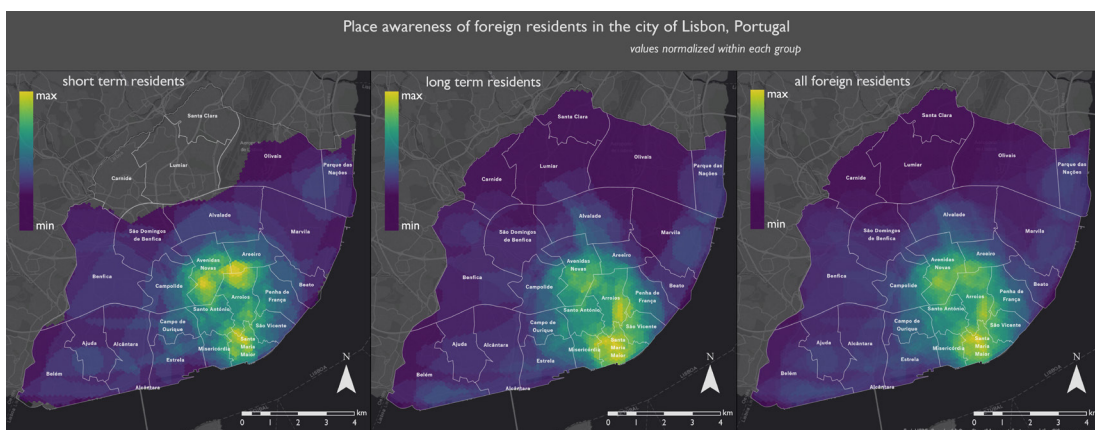
Figure 4.4. Distribution of *place awareness* for short-term, long-term and all foreign residents.

4.2.1.3 Place identity

Maps show a larger extent of the highest intensity zone for long-terms while short-terms' distribution of higher values seems to be more homogenous (Figure 4.5). In addition, similar to the previous dimensions, *identity* is concentrated in the central area of the city. When analyzing all residents, the higher intensity zone for long-term dwellers is a salient feature.
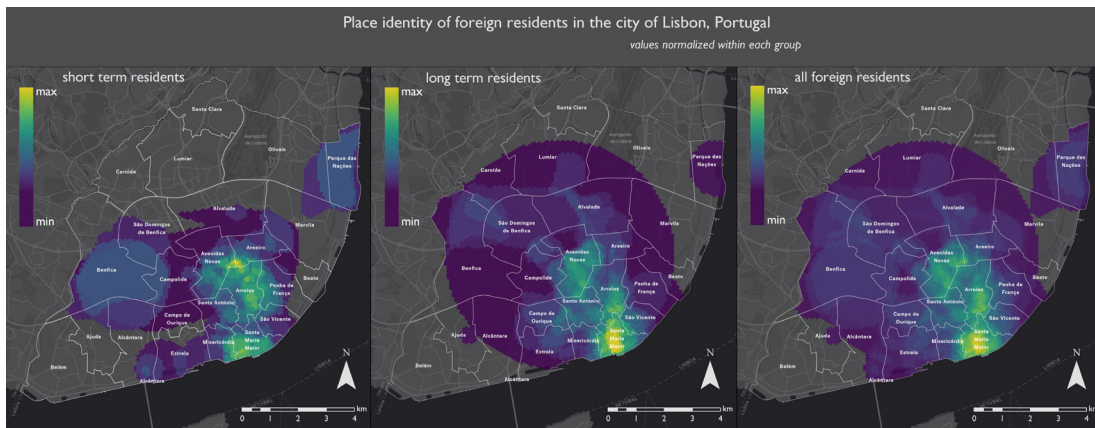
Figure 4.5. Distribution of *place identity* for short-term, long-term and all foreign residents.

4.2.1.4 Place inherited

Both groups' distributions have a distinct high strength spot (Figure 4.6). However, high intensity values are distributed more evenly for long-terms whilst short-terms' high values are concentrated in one zone. As for all participants, highest values for *inherited* are represented by the highest value spot of short-term residents. Values of *inherited* appear to be analogous to the distribution of *dependence* for both participant groups (Figure 4.3). Therefore, based solely on visual interpretation of the first maps produced, dimensions' distribution suggests some degree of correlation within each group.
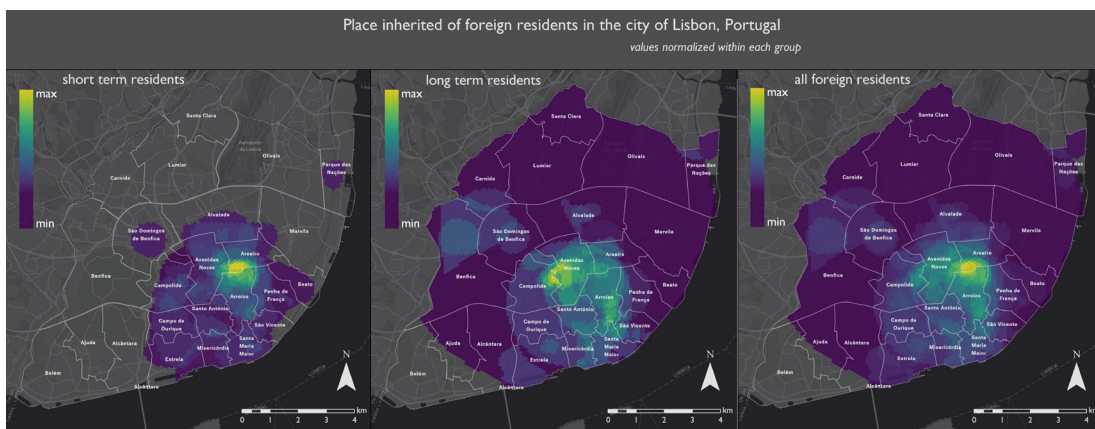
Figure 4.6. Distribution of *place inherited* for short-term, long-term and all foreign residents.

4.2.1.5 *Sense of place*: combined dimensions

Differences between short-term and long-term foreign residents are evident (Figure 4.7). Short-terms' highest values are aggregated in one main spot and together with their overall spatial pattern, the distribution is heavily influenced by *place dependence* distribution (Figure 4.3). For long-term residents, distribution is mostly similar to the spatial pattern found in *awareness* (Figure 4.4). High values of *sense of place* are found in the central area of the municipality for both groups, however, long-terms carry stronger values across a broader region of Lisbon.
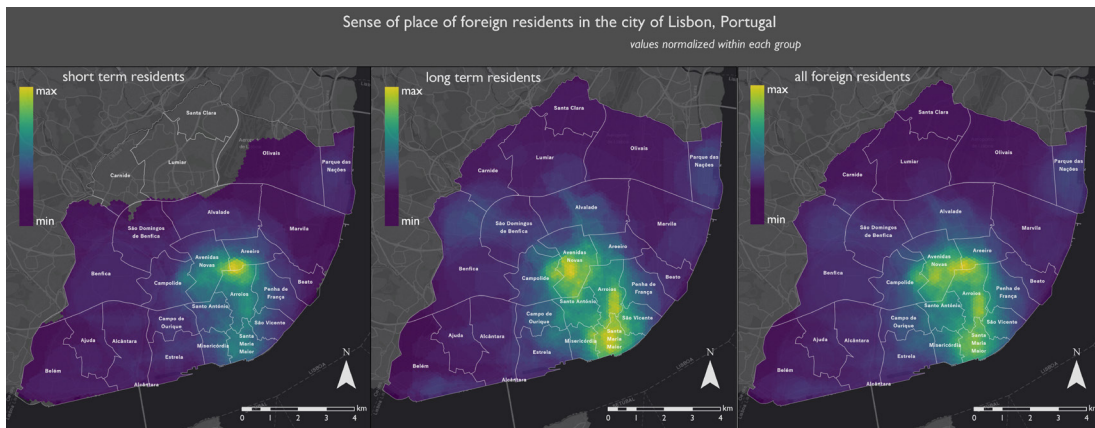
Figure 4.7. Distribution of *sense of place* for short-term, long-term and all foreign residents.

4.2.2 Regions of collective *sense of place: second map products*

The following subsections display the results and respective discussion of the map products built based on the spatial configuration of values higher than the upper quartile. Common areas as well as unique areas for each group are highlighted to visualize properties, distinctions and characteristics. Throughout the next sections and subsections, areas in the city of will not only be referred as their official administrative units – *Freguesias* – but also by names of regions of smaller extent corresponding to historical neighborhoods, *locales*, landmarks, as well as *places* that carry importance in defining the urban landscape of Lisbon. This is mainly due to the fact that official administrative units are larger than neighborhoods interpreted by the residents on the basis of intricate aspects of the social and geographic nature of the city landscape continuum [51],[52].

4.2.2.1 Place dependence

The map in Figure 4.8 displays the selected areas of *place dependence*. Common areas for both groups mainly encompass the Freguesia de Arroios; Frequesia de Santa Maria Maior; Freguesia de Avenidas Novas; Freguesia de Areeiro as well their surrounding areas. Long-terms' area cover most of the respective short-terms', with the exception of a unique area of *dependence* for short-terms, which corresponds to the Freguesia Penha de França and Freguesia de Areeiro. Unique areas of *dependence* of long-terms cover a larger extent within the city, not only around the short-terms' area but also across other peripherical neighborhoods.

Within the unique region of *dependence* for long-term residents, some specific places can be listed such as the Benfica stadium and the Colombo shopping mall; Lisbon Oceanarium, Vasco da Gama shopping center; the Expo '98 area (1998 Lisbon World Exposition) in Parque das Nações; and neighborhoods such as Santa Apolônia, Graça, Estrela, São Bento, Campo de Ourique, Entrecampos, Sete Rios, Roma and Alvalade.
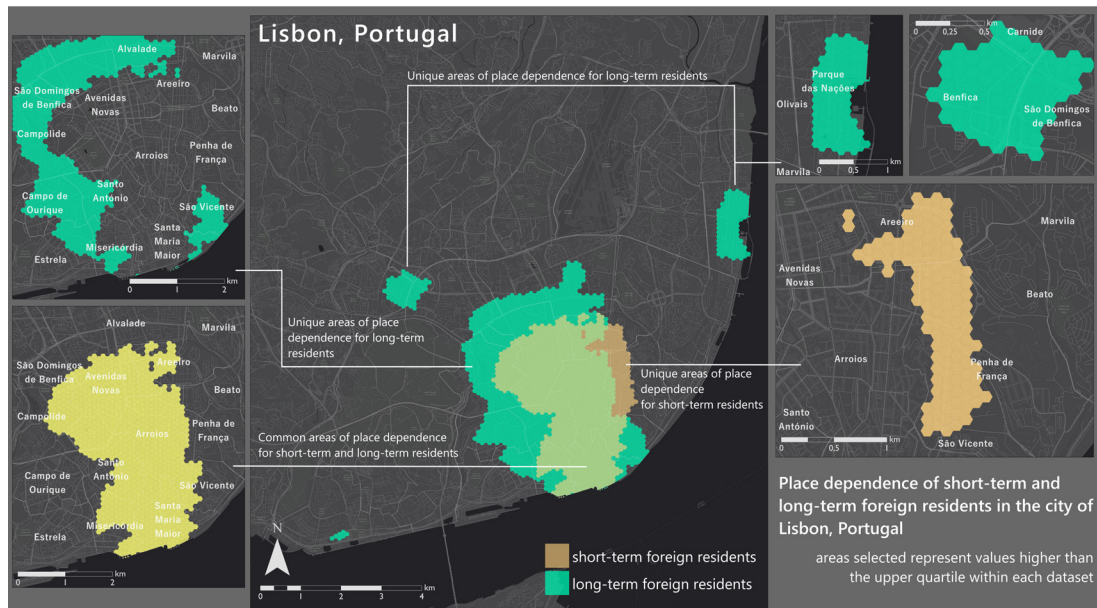
Figure 4.8. Maps of common and unique areas for *place dependence* of short-term and long-term foreign residents.

According to the resources that features of the urban setting can provide in order to create *dependence*, length of residence seems to influence the extent to which this dimension is found when comparing the two groups [44]. As *dependence* is developed through everyday activities such as work, study and leisure in regions which can fulfill these behavioral tasks, the distinction between short-term and long-term dwellers can provide initial insights. Long-terms carry *dependence* at a larger extent within the city compared to short-terms, suggesting that length of residence spatially broadens the dimension within the city context. Moreover, the common area of *dependence* is mainly located in the central region of the city, where higher density of educational institutions, points of interest, housing and entertainment related localities is found.

4.2.2.2 Place awareness

The selected areas for each group are similar (Figure 4.9); and its common area encompasses a large area within the center of the municipality. Most of the common area corresponds to short-terms' *awareness*, while their unique area is mainly located in the Freguesias de Areeiro, Alvalade and Beato. In fact, unique areas of *awareness* of short-terms are similar in extent and location when compared to their unique areas for *dependence* (Figure 4.8).

Unique areas of long-terms are mostly found in the Freguesias de Belém, Marvila, Parque das Nações, Estrela and Misericórdia. In Freguesia de Belém, *awareness* encompasses the area where touristic spots and landmarks are concentrated. Other places where *awareness* is found only for long-term residents are Cais do Sodré, Campo de Ourique, Campolide, Campo Grande and Alvalade. When observing the common areas for *awareness* and *dependence* dimensions (Figure 4.8 and Figure 4.9), *awareness* is characterized by a larger extent, expanding outwards *dependence.* The same pattern is encountered when comparing *awareness* between the two groups, as unique areas of long-terms are spread around the short-term counterpart.
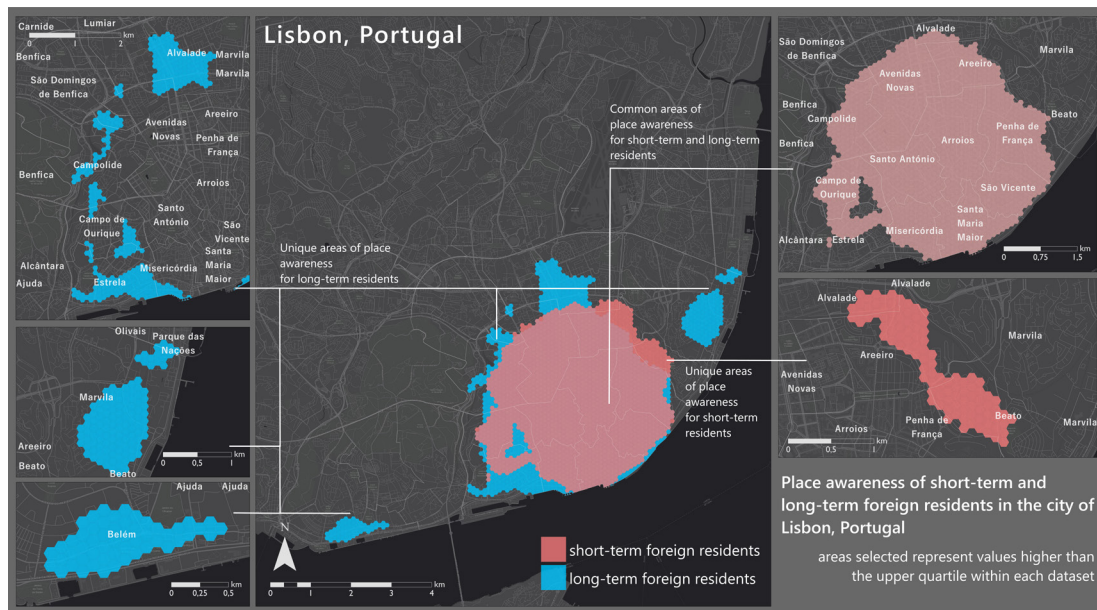
Figure 4.9. Maps of common and unique areas for *place awareness* of short-term and long-term foreign residents.

The dimension of *awareness* in this study is a combination of familiarity, knowledge and discovery. Since the formulated survey questions for *awareness* were broad, answers carry multiple meanings, relationships and feelings which constitute *awareness*. Consequently, its multi-dimensionality may have contributed to a similar spatial pattern between groups. Nonetheless, long-terms' area of selected values of *awareness* is broader than short-terms', although the difference is not as large as the one found in *dependence* (Figure 4.8).

4.2.2.3 Place identity

Common areas are located in the Freguesias de Avenidas Novas, Campolide, Penha de Fraça, Areeiro, Arroios, Santo António, São Vicente e Santa Maria de Maior (Figure 4.10). Selected values of short-terms' *identity* are mainly distributed in two areas: the historical downtown and the northern portion which consists of areas such as Marquês de Pombal, Picoas, Saldanha, Anjos, Areeiro, Arroios, Alameda and Graça. Resembling the distribution of previous dimensions, the unique area of *identity* for short-terms is located in Alameda and Penha de França.

Long-term dwellers' *identity* embodies most of short-terms' *identity*, yet it has a considerably larger extent. Long-term residents also feel *identity* towards areas such as Alfama; Campolide campus of the Universidade Nova de Lisboa in the Freguesia de Campolide; as well as more peripherical areas such as regions around the Benfica stadium and Colombo shopping center; Campo Pequeno and the Campo Grande Garden.
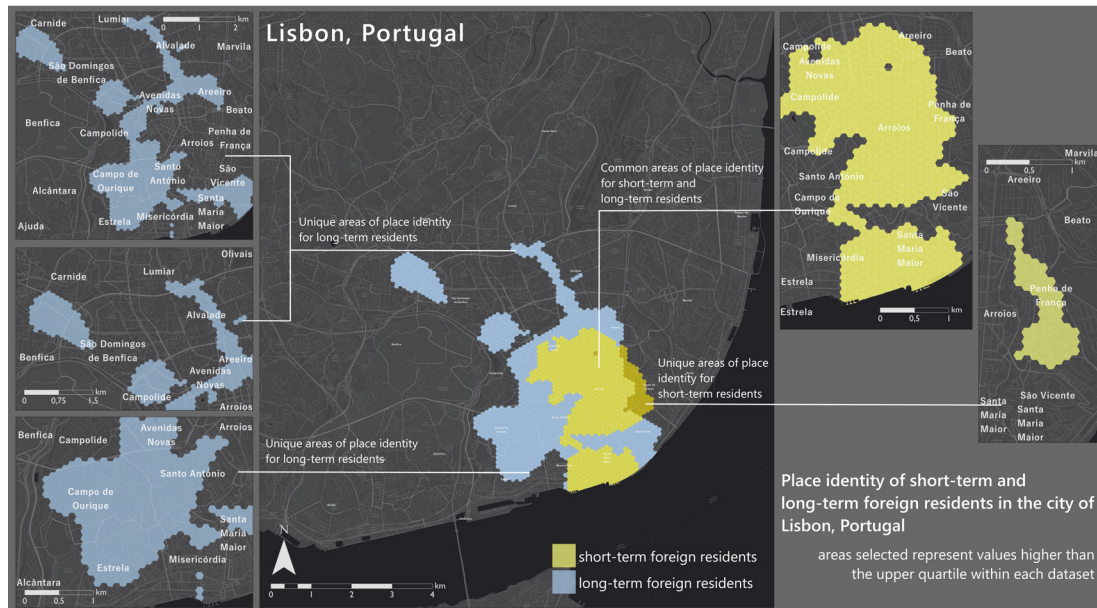
Figure 4.10. Maps of common and unique areas for *place identity* of short-term and long-term foreign residents.

When comparing groups, *identity* exhibits higher dissimilarity in contrast to *dependence* and *awareness* dimensions (Figure 4.8 and Figure 4.9). Long-terms' *identity* spatial extent is significantly larger than short-terms', and as mentioned before, short-terms' *identity* can be split into two portions. This dimension represents the affective bond that stem from constant interactions with *places* which might eventually become emotional attachment. The time constraint of interaction can explain why length of residence might result in different spatial extents of the bond [53] *apud* [16].

4.2.2.4 Place inherited

Common areas of *place inherited* are characterized by detached individual areas as well as one main region of larger extent (Figure 4.11). The smaller regions are represented by the Campolide campus of the Universidade Nova de Lisboa and Jardim Amália Rodrigues; areas in Baixa and around Castelo de São Jorge; and Príncipe Real. The common area is spread through the regions of Anjos, Intendente, Arroios, Saldanha, Praça da Espanha and Alameda.

Some unique *inherited* areas for short-terms are: Alfama; Campolide neighborhood; Entrecampos and Roma neighborhoods in the Freguesias de Alvalade; Areeiro, Alameda and Arroios in the Freguesias de Areeiro and Penha de França. As for long-terms, some unique areas are: Benfica neighborhood; Campo Grande and Alvalade neighborhood in the Freguesia de Alvalade; Rato, Marquês de Pombal; Avenida da Liberdade; and neighborhoods in the historical downtown.

Selected areas of *inherited* and *identity* (Figure 4.10) spatially display the largest differences between the groups. *Place inherited* represents the relationship with *places* regarding aspects of rootedness, belongingness and social ties. Therefore, the dimension is at the *slow* end of the *fast-slow* spectrum of *sense of place* development, as length of residence is highly correlated with the emerge and strength of this dimension [43],[44]. In the case here, the spatial extent of *inherited*

for long-terms is considerably larger than for short-term participants, suggesting that length of residence might impact its spatial distribution
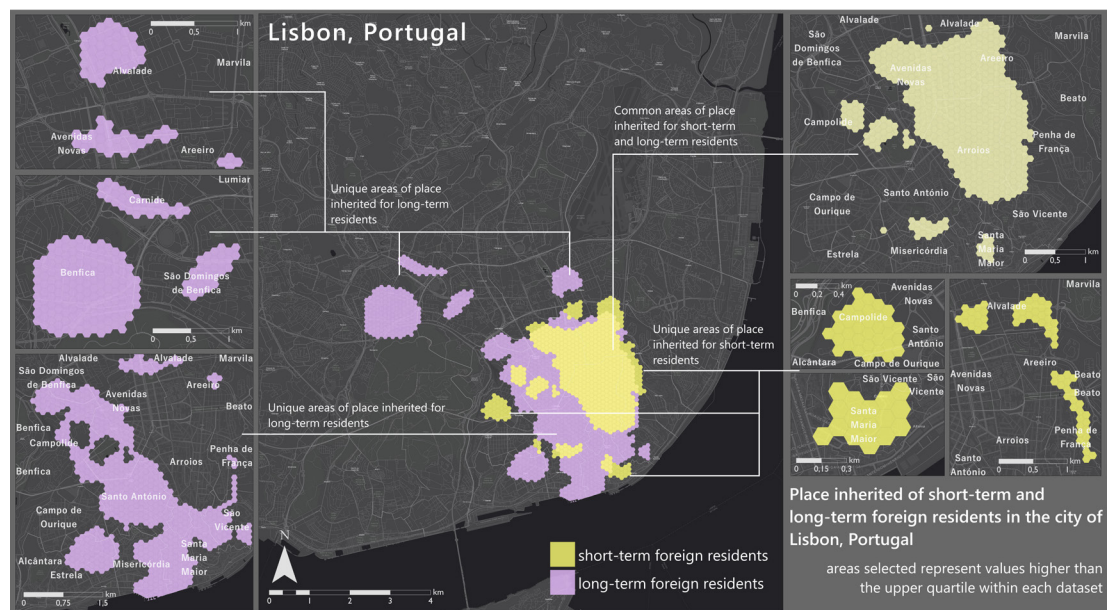
Figure 4.11. Maps of common and unique areas for *place inherited* of short-term and long-term foreign residents.

4.2.2.5 *Sense of place*: combined dimensions

The distinctions between short-terms and long-terms (Figure 4.12) have a similar pattern found throughout all dimensions, in which long-terms display a larger extent with their unique regions distributed mainly along the western portion of the common areas.
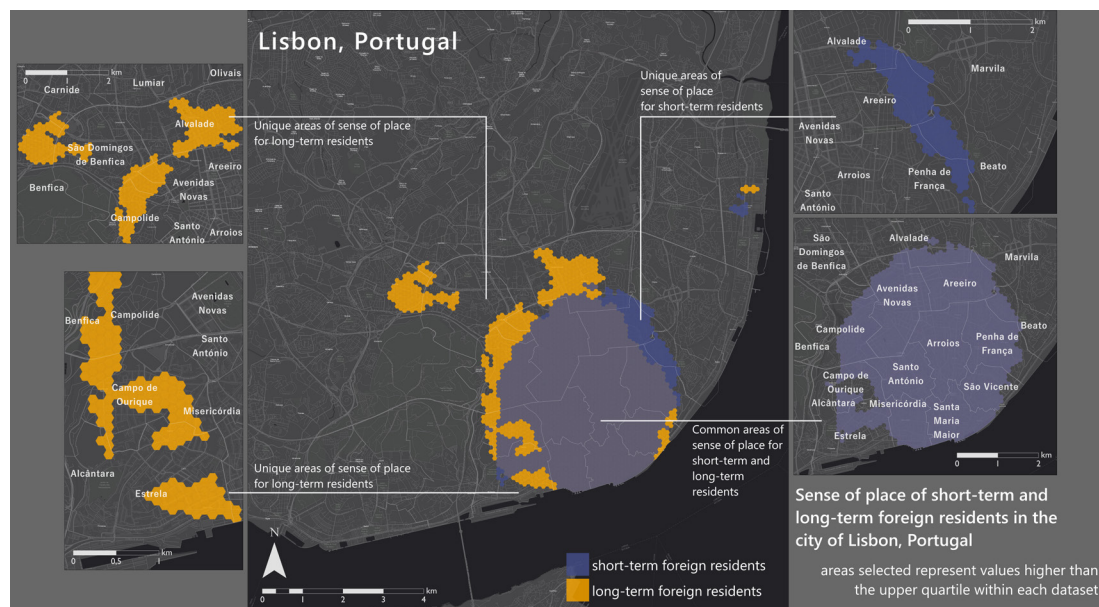
Figure 4.12. Maps of common and unique areas for *sense of place* of short-term and long-term foreign residents.

Collective *sense of place* for both groups is spread across the central region of the city of Lisbon. Long-terms' *sense of place* unique regions are encountered in Campo de Ourique, Lapa, Campolide, Estrela, Sete Rios, Benfica, Campo Grande and Alvalade. As for the short-term group, unique areas correspond to Areeiro, Olaias and Penha de França.

4.2.3   Areas of *sense of place* dimensions within groups: *third map products*

Selected areas of *place* dimensions have a larger extent for long-term residents; and short-terms' dimensions are more spatially distinct between each other in comparison to long-terms' distribution. Long-term residents' outlines of their selected areas appear to have a higher convergence between themselves. This suggests that *sense of place* dimensions might spatially converge over time. However, following sections cover the statistical analysis performed in order to obtain insights regarding the correlations *between place* dimensions.
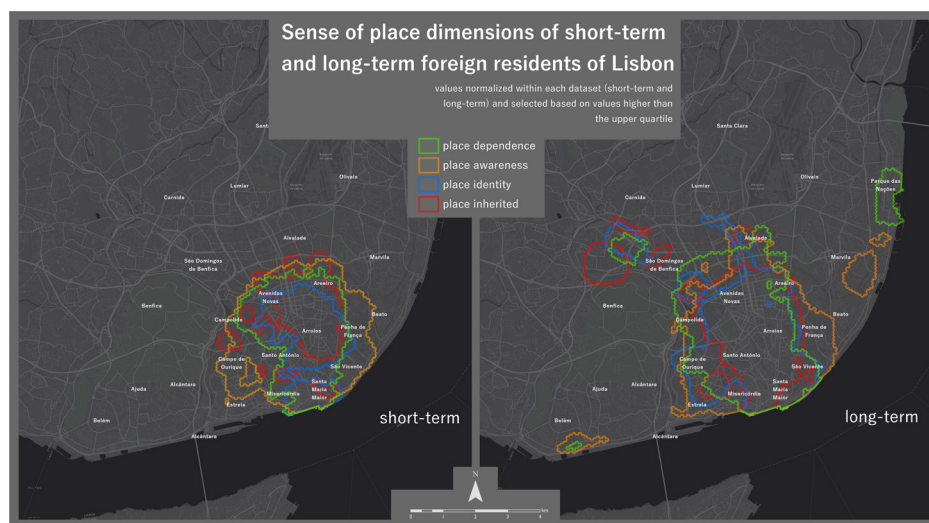
Figure 4.13. Maps displaying the outline of areas representing values higher than the upper quartile for each *place dimension* within the same group of participants.

4.3 Map products of hotspots analysis and high values distribution

The following subsections display the maps containing the results of the hotspot analysis as well as the scaled values distribution within the selected areas.

4.3.1   Place dependence

High values – Figure 4.14

Values higher than 60% of *dependence* for short-terms completely embodies the Alameda campus of the Instituto Superior Técnico (IST) – institution part of the Universidade de Lisboa. This suggests that a significant number of short-terms either study or work at the IST, as not only the campus carries high *dependence*, but also its surroundings such as the Alameda Garden, the Arco do Cego Garden and Saldanha. Areas with *dependence* between 40 and 60% are also found surrounding the IST campus as well as other regions: the Campolide campus of Universidade Nova de Lisboa, and the areas alongside the Avenida Almirante Reis in the Freguesia de Arroios.
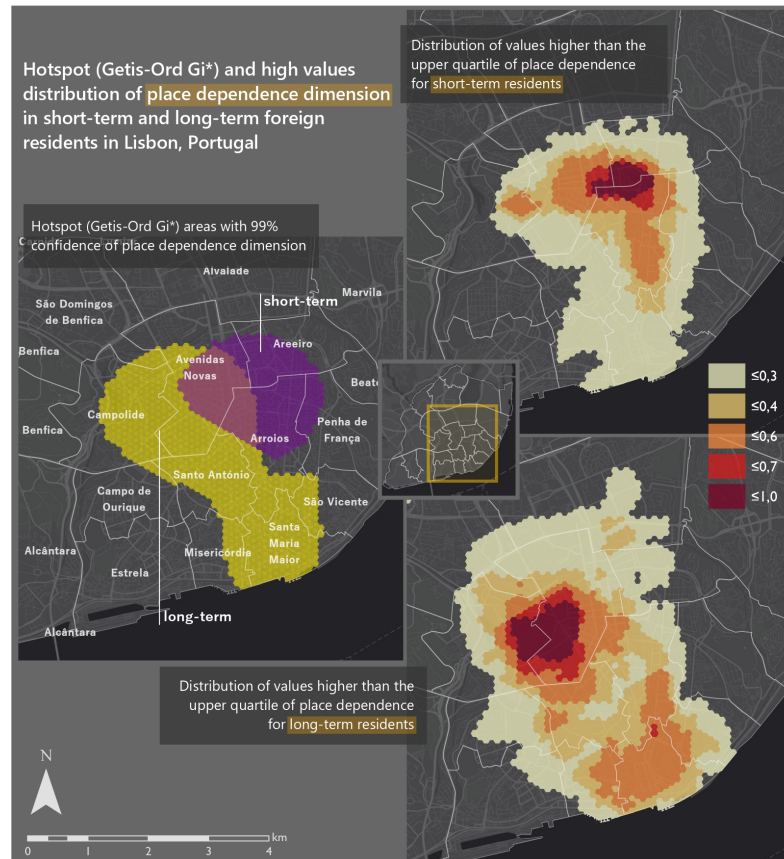
Figure 4.14. Distribution of hotspots areas and values higher than the upper quartile of *place dependence* in short-term and long-term foreign residents of Lisbon.

Long-terms' *dependence* higher than 70% fully encompasses the area corresponding to the Campolide campus of the Universidade Nova de Lisboa, suggesting that most participants of this group study or work at this campus. In fact, according to the survey answers, some long-term participants reported living within the Campolide campus, more specifically at the university student accommodation. In addition to the campus, the higher intensity region also includes the Amália Rodrigues Garden, part of the Eduardo VII Park, El Corte Inglés commercial center, Bairro Azul neighborhood and the Gulbenkian Park.

Regions between 40% and 70% are found in two distinct regions: the surrounding areas of Campolide campus and areas encompassing the historical Lisbon downtown as well as along Avenida Almirante Reis up until Anjos. While short-term residents' higher values of *dependence* are found mostly around one main area, long-term residents' higher values are found in two areas of the city, suggesting a bimodal spatial distribution and therefore might represent different subdimensions of the construct. For instance, *work* and *entertainment;* or *daily tasks* and *leisure*.

Hotspots – Figure 4.14

The area of intersection between the hotspots is mainly represented by Saldanha, Gulbenkian Park and Largo Dona Estefânia in the Freguesias de Arroios and Avenidas Novas. The most prominent characteristic of their distributions is the significant difference in spatial extent within

the city of Lisbon, showing that long-term participants feel *dependence* towards a greater region in comparison to short-terms.

4.3.2   Place awareness

High values – Figure 4.15

Both long-term and short-term residents' areas bearing high values of *place awareness* are concentrated in three distinct stretches. For short-terms, the area corresponding to the historical downtown has values higher than 80% at Largo do Intendente, Chiado, Rossio, Baixa and Martim Moniz; and values between 70 and 80% are located in Baixa and along Avenida Almirante Reis. The other two main regions containing values higher than 70% for short-term participants include the Alameda Garden, the IST Alameda campus, Saldanha, Gulbenkian Park, Amália Rodrigues Garden, Eduardo VII Park and Marquês de Pombal.
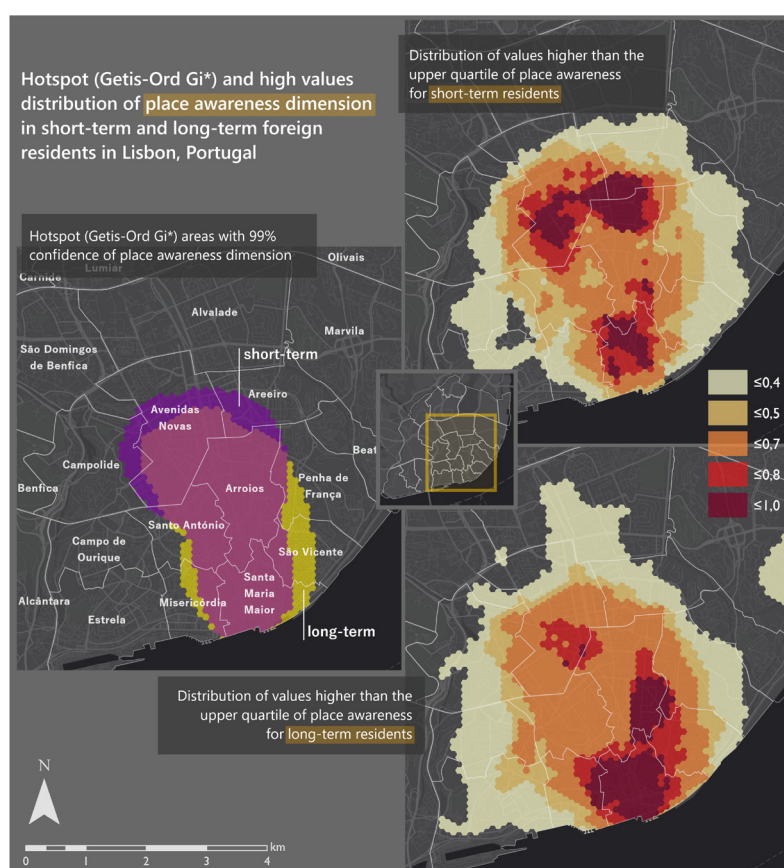
Figure 4.15. Distribution of hotspots areas and values higher than the upper quartile of *place awareness* in short-term and long-term foreign residents of Lisbon.

Long-terms' *awareness* higher than 70% represents most of the historical downtown area of Lisbon, together with Anjos and Intendente areas alongside Avenida Almirante Reis. In addition, high values are also found between Saldanha and the Corte Inglês commercial center, in the neighborhood known as Picoas. The underlying reason why both groups had distinct areas of high intensity of *awareness* could be explained by the questionnaire. The dimension was shaped using facets of familiarity, knowledge and discovery, which in turn can represent different regions within

the city. For each participant group, each facet of the *awareness* dimension might have corresponded to different areas. For both groups, areas with high *dependence* (Figure 4.14) are coincident with high values of *awareness*, suggesting that these regions could indicate familiarity. However, short-terms carry high values in the historical downtown where *dependence* is not strong. This might indicate the connection regarding discovery and the feeling of pleasure from exploring the urban landscape [43].

Hotspots – Figure 4.15

Hotspots have a similar spatial extent in the city for both participant groups. Short-term residents' *awareness* is more spread inwards the city in the Freguesias de Campolide, Areeiro and Avenidas Novas. As for long-term dwellers, their unique hotspot extent is represented by areas of the Freguesias of Misericórdia, Santo António, São Vicente and Penha de França.

4.3.3 Place identity

High values – Figure 4.16

Areas with *identity* higher than 80% for short-terms are found in a small area around the Praça do Município, in the historical downtown, as well as near the Alameda campus of IST corresponding to the Arco do Cego Garden. The Arco do Cego neighborhood was designed as a social housing district and it was officially inaugurated in the 1930's [54]. Within the neighborhood lies the Arco do Cego Garden, a green area near the IST campus opened in 2005, renewed in 2017, and which in recent years has been a *hotspot* of the university students' night life, constituting an important place of students' social life [55],[56].

Values between 60 and 80% of *identity* for short-terms can be found surrounding the IST campus and in the historical downtown of Lisbon. In addition, high values are found around the Avenida Almirante Reis in the areas of Anjos and Intendente. This region is composed of a multilayered urban landscape characterized by a complex urbanistic history, a diverse multicultural environment due to high concentration of immigrants, public policies that take into consideration the multiethnicity of the region, as well as a *hotspot* for cultural events, bars and nightlife in general [57]–[59]. Long-terms also carry *identity* in this region, although values with higher than 60% of *identity* are also found in the area of Martim Moniz and Mouraria, places that have a similar urban identity to Anjos and Intendente [59].

Nevertheless, *identity* higher than 80% for long-terms are only found in Rossio, Baixa and Praça do Comércio, characteristic places of the historic downtown. In addition, Gulbenkian Park also carries high *identity* for long-terms. The Gulbenkian Park is located in the Fundação Calouste Gulbenkian, where gardens, museums, libraries, cafés and cultural spaces are found within the Freguesia de Avenidas Novas. The main museum and its surrounding garden were officially inaugurated to the public in 1969 and since then they have been an important landmark in the city of Lisbon not only due to its cultural aspects but also due to the large green space [60].
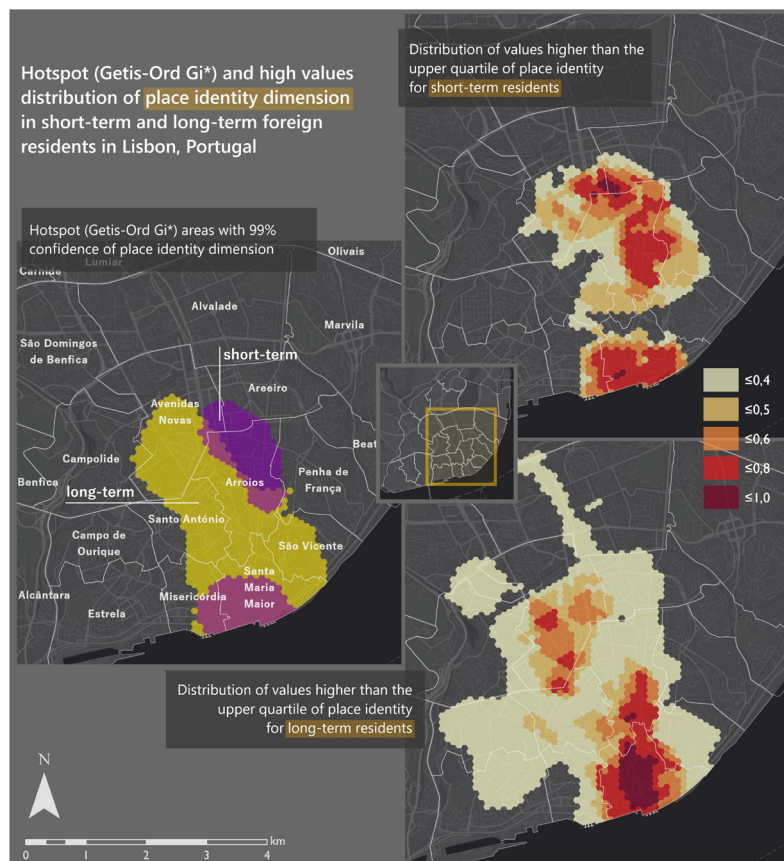
Figure 4.16. Distribution of hotspots areas and values higher than the upper quartile of *place identity* in short-term and long-term foreign residents of Lisbon.

Hotspots – Figure 4.16

Short-terms exhibit two disconnected areas while long-term residents exhibit one large continuous area. Hotspot of long-terms is similar to the one found for *dependence* (Figure 4.14), whilst for short-terms, *identity* is separated into the historical downtown and the area surrounding and including IST campus, the latter coincident with their *dependence* hotspot. This suggests that time of residence might be a significant factor in developing the *identity* relationship, since constant interactions with the urban settings where *dependence* is developed might ultimately evolve to an emotional attachment. In other words, functional attachment eventually evolves to emotional attachment spatially over time through continuous usage of the urban affordances [44].

4.3.4   Place inherited

High values – Figure 4.17

The *inherited* relationship for short-terms has its highest values at the IST Campus, the Alameda Garden as well as the Arco do Cego Garden. Only 41% of short-term participants responded the *inherited* section, and, according to the *dependence* and *identity* dimensions of this group as well as the survey sharing procedure, most of short-terms either live, work or study in or around the IST campus. Therefore, collective *inherited* of short-terms is mainly located where most of the participants perform their daily tasks. Nonetheless, there are values higher than the upper quartile

distributed throughout other regions in the city, yet compared to long-terms, the *inherited* dimension has a smaller and more fragmented extent.
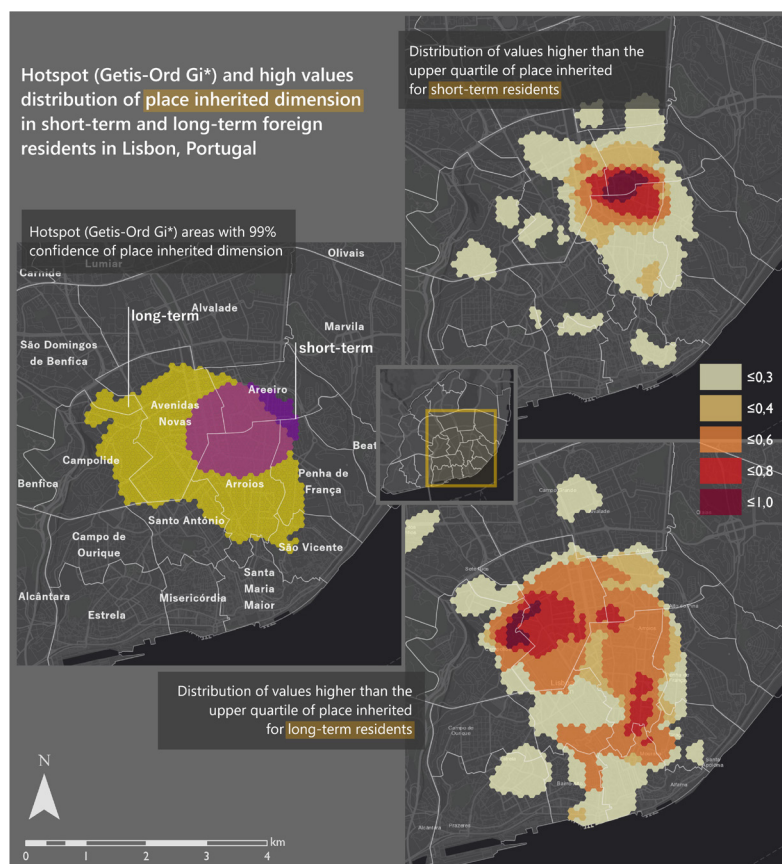
Figure 4.17. Distribution of hotspots areas and values higher than the upper quartile of *place inherited* in short-term and long-term foreign residents of Lisbon.

Values higher than 80% for long-terms can be found within the Campolide campus of Universidade Nova de Lisboa and surrounding areas such as Bairro Azul, Praça da Espanha and Gulbenkian Park. Values higher than 40% are found in a much larger extent when compared to short-terms, and they take place at Marquês de Pombal, Eduardo VII Park, Saldanha, Campo Pequeno, IST Campus, Alameda Garden, Arroios – Anjos – Intendente region, Mouraria, Graça, Estefânia, Jardim do Torel, Avenida da Liberdade and Bairro Alto. Most of these places are landmarks of Lisbon's urban landscape. Created symbols and constant interaction could be associated with other factors such as social capital, which fosters the feelings of rootedness and belongingness.

Hotspots – Figure 4.17

Hotspot of short-terms has a smaller extent when comparing to long-term participants. According to results, *place inherited* is the less developed dimension for short-term residents and it is, together with the previous dimensions, concentrated in one area: around the IST Alameda campus. Therefore, long-terms' *inherited* is larger in extent because they might have matured this sentiment towards more places.

4.3.5   *Sense of place*: combined dimensions

High values – Figure 4.18

When assessing the combined dimensions, values higher than 70% are found in the IST Alameda campus, Alameda Garden, Arco do Cego Garden and Saldanha areas for short-terms. As for long-terms, high values are found in two distinct regions: one that encompasses the Campolide campus of Universidade Nova de Lisboa, Saldanha, Gulbenkian Park and Eduardo VII Park; and another area in the historical downtown that stretches to the Anjos-Intendente region.
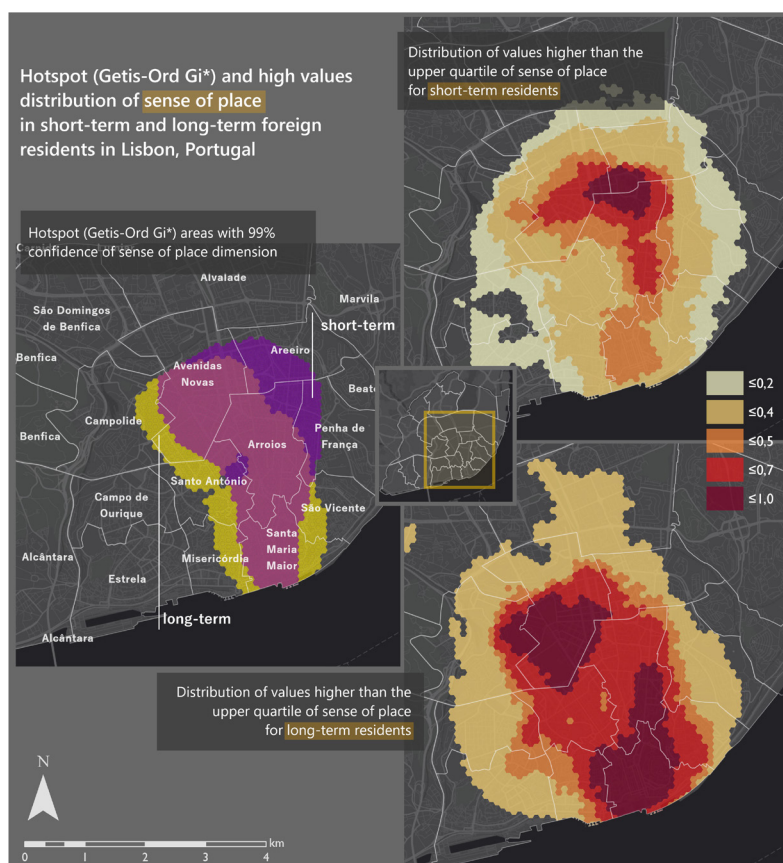
Figure 4.18. Distribution of hotspots areas and values higher than the upper quartile of *sense of place* in short-term and long-term foreign residents of Lisbon.

Values higher than 50% for short-term dwellers only expands around IST campus into the Anjos-Intendente region alongside Avenida Almirante Reis and into Saldanha and Gulbenkian Park. As *sense of place* here is the combined polygons for all questions, its spatial distribution is influenced by each dimension of each group. Despite each group's particularities, *sense of place* of long-term participants is stronger towards a considerably larger extent of the city.

Hotspots – Figure 4.18

The areas for both groups are relatively similar. However, long-terms' *sense of place* in the downtown part of the city has a larger extent towards the Freguesias de Misericórdia and São Vicente. Hotspots of long-term participants also include the Freguesia de Santo António and

Campolide. As for short-term participants, the area extends to Freguesias de Areeiro and Penha de França, including the IST Alameda campus.

4.4 Descriptive statistics

Descriptive statistics are found in Table 4.3. Mean, variance and standard deviation values yielded by *dependence* is more than two times higher for long-terms. Kurtosis of *place dependence* distribution is almost three times lower for long-term participants. Therefore, values for *dependence* in long-term are higher, less concentrated and more distributed when compared to short-terms.

Statistics of *awareness* yielded rather similar results for both groups. As for *identity*, the mean is approximately 20% higher for short-term residents, while values for other parameters are considerably similar. In addition, the spatial extent of *identity* for long-terms is larger, resulting in larger areas carrying lower collective *identity* values, contributing to a lower mean.

		mean	std. dev.	median	mode	var.	kurtosis
place dependence	*short-term*	0,0514	0,1156	~0	~0	0,0134	16,04
	long-term	0,1018	0,1473	0,0164	0,0164	0,0217	6,17
place awareness	*short-term*	0,1679	0,2016	0,0968	~0	0,0406	3,02
	long-term	0,1768	0,2068	0,1013	0,0253	0,0428	2,63
place identity	*short-term*	0,0925	0,1547	~0	~0	0,0239	4,46
	long-term	0,0764	0,1522	~0	~0	0,0232	8,93
place inherited	*short-term*	0,0406	0,1038	~0	~0	0,0108	28,11
	long-term	0,0817	0,1532	~0	~0	0,0235	5,91
sense of place	*short-term*	0,0977	0,1391	0,0571	~0	0,0194	7,61
	long-term	0,1761	0,2031	0,0984	0,0346	0,0413	3,20

Table 4.3. Descriptive statistics for all assessed *sense of place* dimensions by each participant group.

For *place inherited*, the mean and variance values are two times higher for long-terms, while *kurtosis* is almost six times higher for short-term residents. Maps of spatial distribution of the *inherited* dimension confirm this as for short-terms, collective *inherited* is concentrated in one small area. As for the combined dimensions, the mean is twice as high for long-terms, as well as the standard deviation, median and variance. In addition, kurtosis is more than two times higher for short-terms. Therefore, *sense of place* for long-term dwellers is stronger and sparser distributed across the city of Lisbon.

4.5 Comparison statistics and Spatial Efficiency metric

Following subsections display the results of analysis carried out to compare each dimension of *sense of place* between as well as within each participant group.

4.5.1 Comparison between groups

Results of the SPAEF metrics are found in Figure 4.19, together with associated parameters as well as scatterplots. Kernel density functions values higher than 80% are displayed in Figure 4.20. Lastly, Table 4.4 shows the values of selected areas for each dimension and participant group as well as Jaccard's similarity indices.
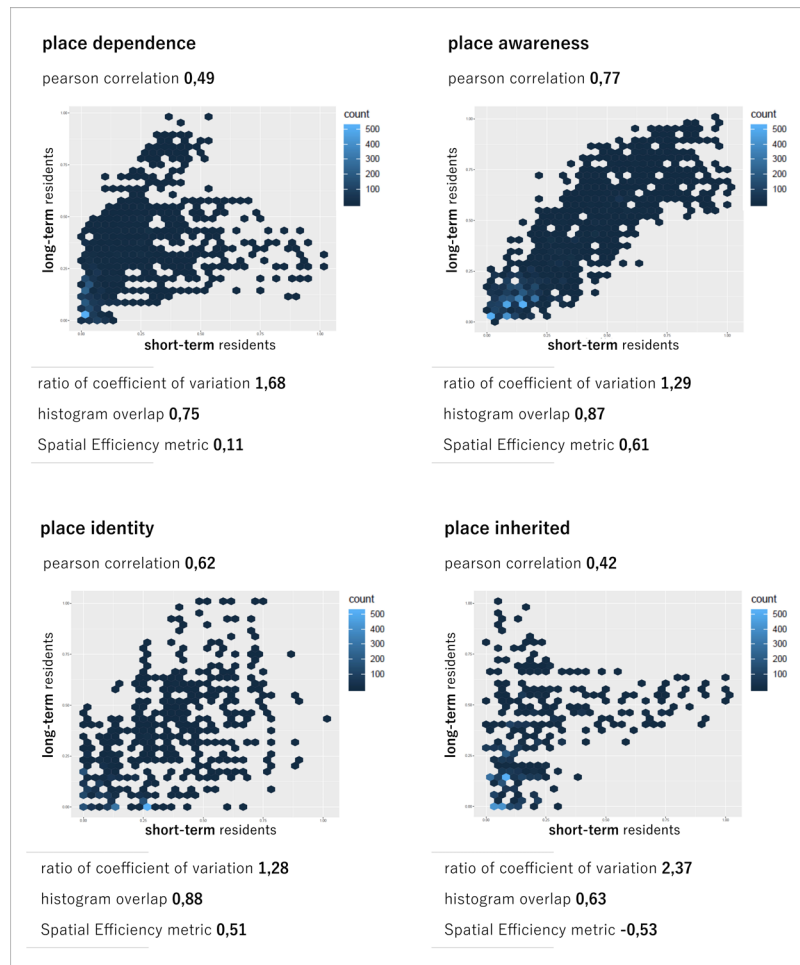
Figure 4.19. Scatterplots and SPAEF results together with its associated statistical parameters between each participant group for each dimension.

The dimension with the highest correlation value was *awareness* (0,77), which displays a strong non-linear positive correlation between the two groups. Value of SPAEF for *awareness* is also the highest between the dimensions (0,61) and kernel density functions have the most similar distribution between groups. In addition, area properties of *awareness* show high similarity between short-term and long-term dwellers. Therefore, *awareness* was the most similar dimension between the two participant groups.

The *place identity* dimension scored 0,62 for Pearson correlation and 0,51 for SPAEF metrics, both being the second highest values in the analyzed dimensions. However, Jaccard's index values and kernel density functions suggest a considerable dissimilarity of *identity* between short-term and long-term dwellers. This is confirmed by the map products displayed in the previous sections and suggests that although the overall pattern and intensity of *identity* for both groups are similar, the spatial extent and location of high values are distinct. Values higher than 80% for long-term dwellers exhibit a sparser distribution when compared to short-term residents.
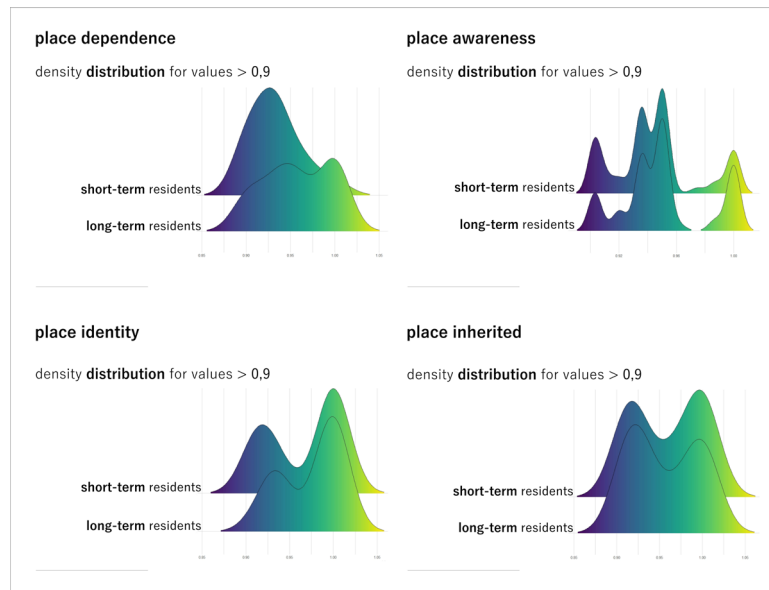
Figure 4.20. Kernel density functions of the distribution of values higher than 80% for each participant group and dimension.

As for *place dependence,* the dimension scored the second lowest Pearson correlation value (0,49) and SPAF metrics (0,11). Density function of long-terms displays a stronger bimodal distribution and the scatterplot shows two distinct trends. The selected areas' values of long-terms are twice as high as short-terms, but Jaccard's index for hotspots yielded 0,14 while for areas higher than upper quartile 0,85.

Place dependence

selected area values in km²	short-term	long-term
higher than upper quartile	10,18	18,30
99% confidence hotspots	3,44	7,80
higher than 75% intensity	0,34	0,62
area similarity (Jaccard's index)		
between hotspots		0,14
between upper quartile		0,85

Place awareness

selected area values in km²	short-term	long-term
higher than upper quartile	16,53	20,55
99% confidence hotspots	7,95	7,67
higher than 75% intensity	2,29	2,25
area similarity (Jaccard's index)		
between hotspots		0,71
between upper quartile		0,71

Place identity

selected area values in km²	short-term	long-term
higher than upper quartile	6,73	15,15
99% confidence hotspots	2,63	6,64
higher than 75% intensity	0,22	0,70
area similarity (Jaccard's index)		
between hotspots		0,20
between upper quartile		0,39

Place inherited

selected area values in km²	short-term	long-term
higher than upper quartile	6,60	14,00
99% confidence hotspots	2,28	7,06
higher than 75% intensity	0,31	0,52
area similarity (Jaccard's index)		
between hotspots		0,27
between upper quartile		0,35

Table 4.4. Values of selected areas and their area similarity indices for each dimension.

Scoring the lowest SPAEF (-0,53) and Pearson correlation (0,42), *place inherited* is the most dissimilar dimension between the groups. Respective values for areas and Jaccard's index also confirm the significant difference between long-term and short-term dwellers. Histogram overlap

(0,63) is also the lowest. Overall, selected area values are consistently higher for short-term residents and Jaccard's index for upper quartile selected areas progressively lowers from *place dependence* to *place inherited*.

4.5.2   Comparison within groups

Figure 4.21 displays the color scaled correlograms of all dimensions as well as split into each group. Table 4.5 shows the results of the SPAEF metrics and values of Jaccard's index between dimensions within each participant group. The dimension of *place inherited* yielded the lowest values of correlation between dimensions for both groups. When observing the correlograms separated by group, *place inherited* do exhibit lowest values when compared to other dimensions for both groups, yet for long-term dwellers the correlations are higher.

Figure 4.21. Color ramp correlograms with all dimensions as well as within each participant group (Pearson correlation).

short-term

Spatial Efficiency metrics of sense of place dimensions within short-term residents

SPAEF *cc* / *CV ratio* *hmatch*	place dependence		place awareness		place identity		place inherited
place dependence							
place awareness	**0,47** 0,67	0,64 0,81					
place identity	**0,61** 1,00	0,61 0,99	**0,48** 1,36	0,63 0,89			
place inherited	**0,50** 1,37	0,68 0,89	**-0,20** 2,05	0,49 0,70	**0,48** 1,36	0,63 0,89	

SPAEF	Spatial Efficiency metric
cc	coefficient of correlation
CV ratio	ratio of coefficients of variation
hmatch	histogram match

Jaccard's index of hotspots' and upper quartile areas of sense of place dimensions within short-term residents

upper quartile *hotspots*	place dependence		place awareness		place identity		place inherited
place dependence							
place awareness	0,61	0,36					
place identity	0,61	0,30	0,40	0,31			
place inherited	0,32	0,63	0,36	0,23	0,42	0,30	

long-term

Spatial Efficiency metrics of sense of place dimensions within long-term residents

SPAEF *cc* / *CV ratio* *hmatch*	place dependence		place awareness		place identity		place inherited
place dependence							
place awareness	**0,80** 0,87	0,86 0,93					
place identity	**0,55** 1,32	0,71 0,86	**0,47** 0,66	0,66 0,79			
place inherited	**0,90** 0,97	0,90 0,98	**0,83** 1,12	0,89 0,95	**0,59** 0,74	0,72 0,85	

SPAEF	Spatial Efficiency metric
cc	coefficient of correlation
CV ratio	ratio of coefficients of variation
hmatch	histogram match

Jaccard's index of hotspots' and upper quartile areas of sense of place dimensions within long-term residents

upper quartile *hotspots*	place dependence		place awareness		place identity		place inherited
place dependence							
place awareness	0,58	0,52					
place identity	0,63	0,59	0,59	0,75			
place inherited	0,51	0,38	0,49	0,42	0,57	0,31	

Table 4.5. SPAEF and Jaccard's indices comparing *sense of place* dimensions within each participant group.

In general, results of SPAEF for long-term residents' dimensions are consistently higher than short-terms, showing that spatial patterns between dimensions are more similar for long-terms. In addition, Jaccard's indices for long-terms are also consistently higher. When analyzing the Jaccard's index specifically for hotspots' areas, the highest value within short-terms is found between *inherited* and *dependence*. Short-terms reported experiencing *inherited* where they feel *dependence*, mostly around the IST Alameda campus. The highest value of area similarity of hotspots for long-terms is found between *identity* and *awareness*. Both hotspots (Section 4.3) represent a coincident large area within the city.

4.6 Cluster analysis

Results of hierarchical cluster analysis are found in Figure 4.22 and Figure 4.23. Cluster 5 is characterized by having the smallest extent and the highest values for all dimensions of short-term residents. Cluster 4 corresponds to the area around Cluster 5 which encompasses the inner regions of the central zone of the city, including the historical downtown. Dimensions of *dependence*, *awareness* and *identity* have the highest values for long-term residents in Cluster 4, and consistently higher values for all dimensions when comparing to Cluster 1, 2 and 3. Cluster 3 is found around Cluster 4 and carries relatively higher values of *sense of place* dimensions in comparison to Cluster 1 and 2. Surrounding Cluster 3, Cluster 1 is found also in peripherical zones and carry the second lowest values of *place* dimensions.

Cluster 2 has the lowest values of all dimensions, and it is found mainly in the outskirts of the city. This cluster represents the areas in the city which collective *sense of place* scored the lowest as overlapping polygons were scarce. Lastly, Cluster 1 represents a region in which *sense of place* is relatively higher than Cluster 2, but still considerably lower than the other clusters. Therefore, clusters represent a spatial intensification of collective *sense of place* towards the central regions of the city of Lisbon with Cluster 5 being the *hotspot*. This is mainly due to most of the participants living within central regions of the city, including participants that live, work or study at the IST Alameda campus (Cluster 5). The spatial patterns of the dimensions and cluster configurations show the influence of functional in spatially shaping *sense of place*.

5 Final discussion

5.1 Short-term vs. long-term foreign dwellers

In the case of *place awareness,* the multidimensional character of the defined dimension can be observed in its trimodal density distribution for both groups, confirmed by the high value distribution maps. In this case, the areas of collective *awareness* can represent individual or a combination of subdimensions of *familiarity, knowledge* and *discovery*. Therefore, although subdimensions might have yielded distinct high value spots, short-terms and long-terms developed a similar strength and spatial pattern of *awareness* across the city of Lisbon.

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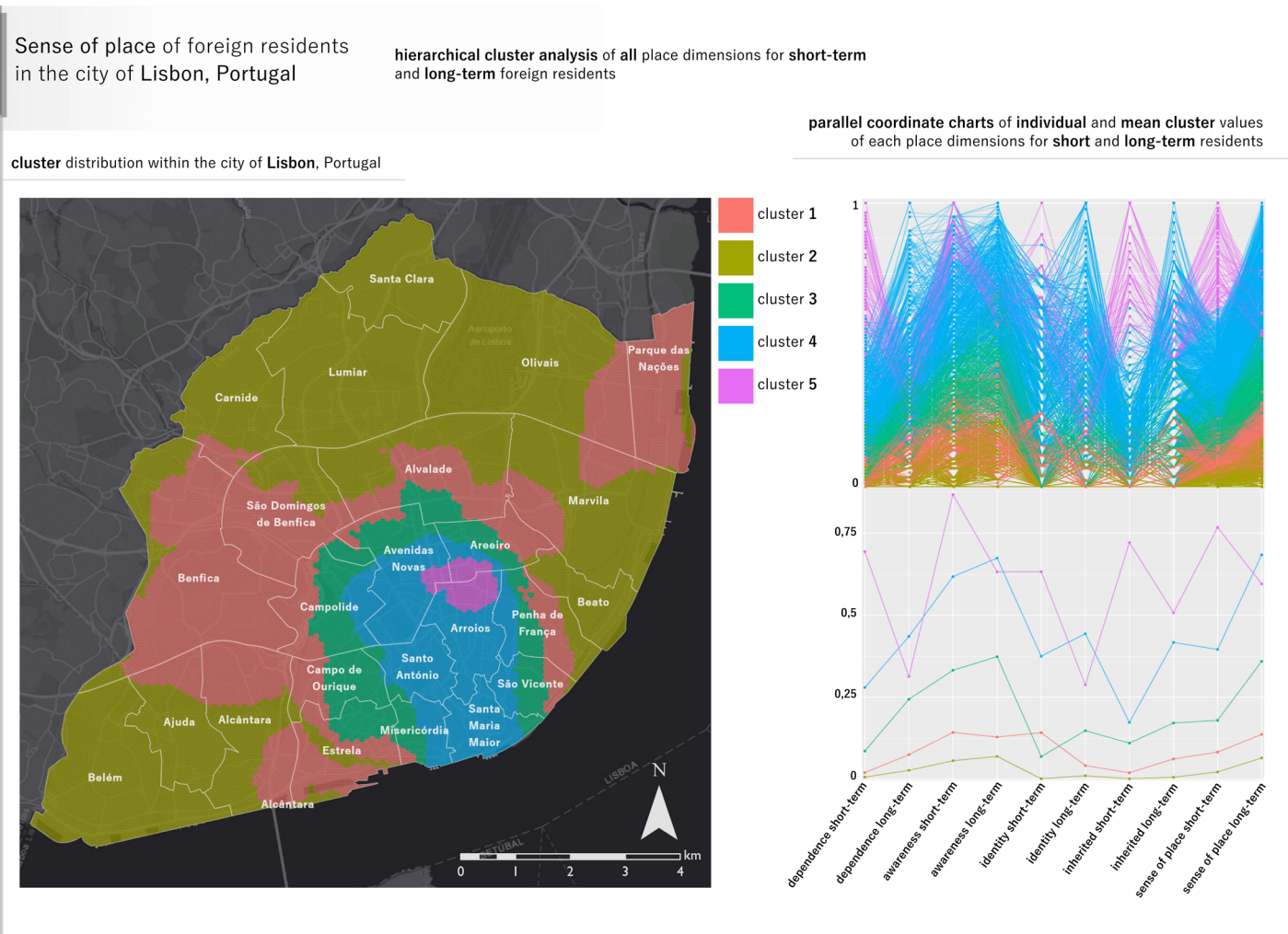
Figure 4.22. Results of hierarchical cluster analysis. On the left, the spatial distribution of each cluster within the city of Lisbon. On the right, parallel coordinate charts of the clusters with respect to each dimension.
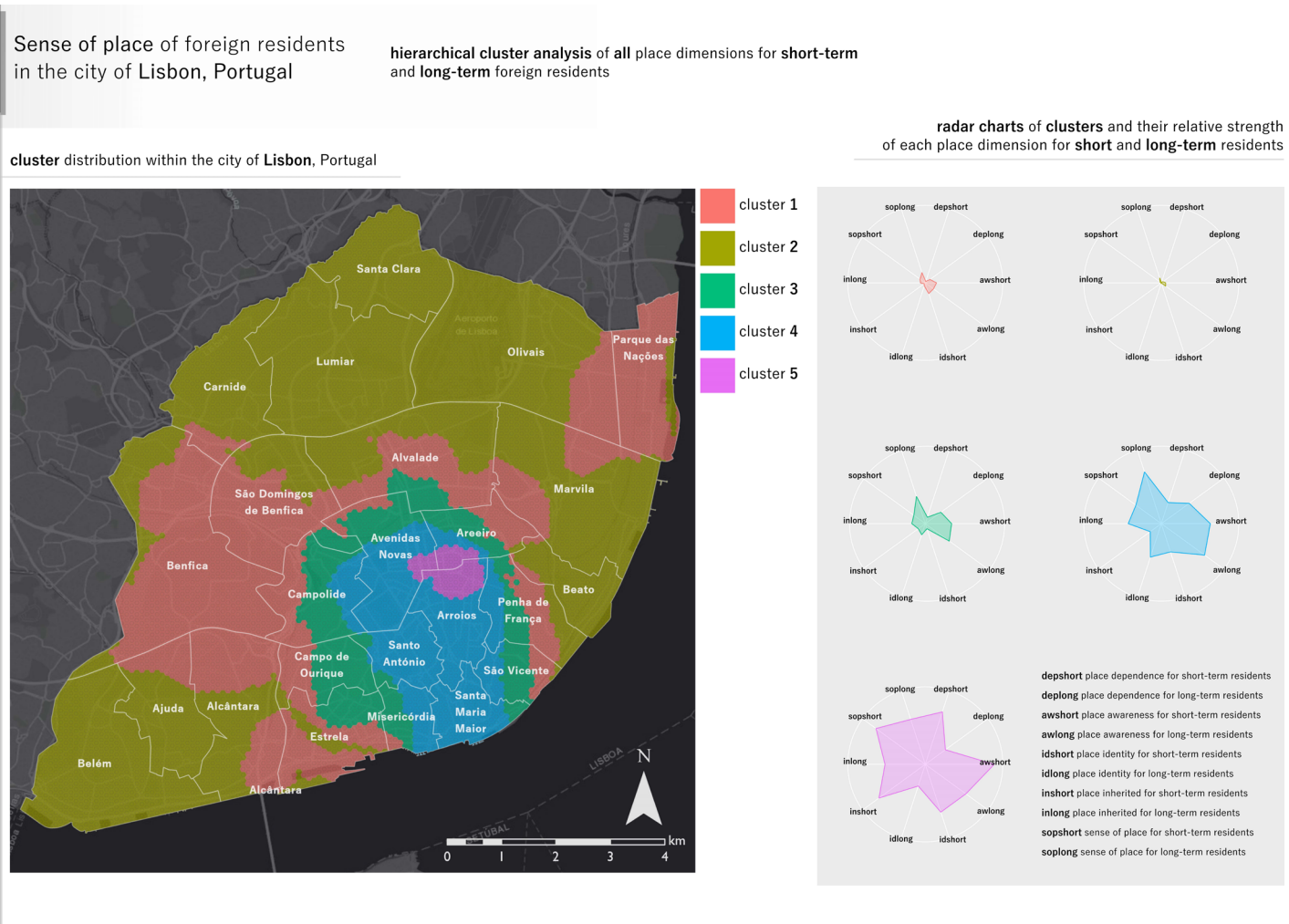
Figure 4.13. Results of hierarchical cluster analysis. On the left, the spatial distribution of each cluster within the city of Lisbon. On the right, radar charts of the clusters with respect to each dimension.

Place awareness subdimensions can act as a proxy for *sense of place* distribution because each subcomponent could be associated with other dimensions. Familiarity with a region is usually established by constant visits and interactions, mostly within one's home range [61]. Hence, familiarity can be closely associated with *place dependence*. Subdimension of discovery is defined by the desire to explore and get to know places, and therefore represent personal preferences that could be correlated with *place identity.*

Results show that *place identity* is felt with similar intensities for both groups, yet in different areas with different spatial features within the city. The comparison results for *place identity* between groups suggest that the time threshold used to split the participants yielded differences in spatial configurations but not in overall intensity. All in all, results indicate that length of residence can potentially shape *place identity* into broadening or molding its geographic dimensions. Selected areas of *identity* displayed in Section 4.2.2 show that for short-terms, *identity* is encountered in two distinct areas while long-terms' *identity* is broader and contiguous. This suggests that *identity* for short-term residents is spatially split within the city possibly associated with the two aspects used here to build the dimension: *self-identity* relationship and affective bonds. Although the differentiation of the bonds might also exist for long-terms, length of residence may influence the spatial *imprint* by converging these specific bonds within the dimension. Therefore, long-term dwellers' specific affective attachments might overlap more or represent a more consolidated sentiment.

As for *place dependence*, the distinction between groups is represented by different regions: the Campolide campus of Universidade Nova de Lisboa and the Alameda campus of Instituto Superior Ténico. Hence, high values of these areas are a direct result of the main places of routine (education, work or residential) between the groups. Nonetheless, results also show that length of residence might expand *dependence* across the city, as people who had been living longer reported higher values at a broader level. Long-terms might take part in activities in more *places* as time allows to physically explore and interact with a larger area of the city. In their case, *dependence* is also significant in more peripherical zones of the city, meaning that long-terms might live further from the center but also might have developed a functional attachment to further regions as time aids establishing more places of interaction according to one's interest or needs.

An interesting remark of the distribution of high values of *dependence* across the city between short-terms and long-terms is that although high values are found around the two university campi, long-terms feel stronger *dependence* towards the historical downtown while short-terms' high values mainly spread around IST campus. Long-term dwellers might engage in activities regarding leisure or entertainment based on more matured preferences, and therefore areas of recreation might not necessarily match with areas of routine behavioral tasks, opposed to what the characteristics of short-terms' *dependence* distribution suggest.

As *place inherited* represents the deepest person-*place* bond, the threshold of length of residence used to separate groups yielded noteworthy distinctions. Similar to *dependence*, *inherited* for long-term residents is spatially pictured by a broader and higher intensity area within the city that might suggest the strenghten of the bond towards larger areas.

Differences in response rates of *inherited* for short-term residents (41%) and long-term residents (93%), higher ratios of drawn polygons per participant, spatial configurations and statistics allow to affirm that length of residence not only intensifies this relationship with places in a new urban setting, but also spatially broadens it. Foreign residents' social capital and feeling of belongingness can be fostered in various ways, yet in most cases these constructs are *place*-mediated and therefore the experiences, preferences and activities are physically dependent on *places*.

5.2 Comparison between *sense of place* dimensions

Short-terms' lowest SPAEF value for *inherited* was when compared to *awareness* (-0,20). However, this comparison yielded a value of 0,83 for long-terms. This significant difference can be explained by another comparison: *inherited* and *dependence*. When looking at *inherited* and *dependence*, long-terms exhibit the highest spatial similarity and short-terms the second highest. Hence, deeper bonds with *places* in the city (*inherited*) are *place*-mediated at regions of high *dependence* for both groups. However, long-term dwellers' deeper bonds might stem from the combination of continuous interaction and matured familiarity (*dependence* and *awareness*), while short-terms' might stem primarily from *dependence* as familiarity may not be well developed. While long-terms might have developed familiarity in places of *dependence*, short-terms may have expressed the feeling of discovery in *places* outside their *dependence*. By these means, the discovery aspect is the *place awareness* subdimension which is not correlated with *place inherited.*

Through this logic, *place awareness* for short-terms would have a relatively higher SPAEF when compared to *identity* since choices of exploring and discovering places in the city are related to self-expression and personal preferences (*identity*). Results confirm this assumption because SPAEF values for this relationship yielded the lowest value within long-terms and the highest value within short-terms. Furthermore, *identity* is most similar to *dependence* for short-terms and to *inherited* for long-terms. In addition, *identity* for long-terms is the one with the lowest match of spatial pattern between other dimensions within the group. These mentioned relationships suggest that long-term residents identify themselves with *places* that do not necessarily match with other *place*-bonds, yet to some extent these *places* have more in common with areas where feelings of rootedness and belongingness is felt (*inherited*), whilst for short-terms these places are more coincident with areas of functional attachment. This might suggest that length of residence might spatially shape *dependence* and *identity* areas to *identity* and *inherited* areas.

Jaccard's indices for short-terms are overall lower in comparison with long-term dwellers, which in combination with SPAEF results, strongly suggests the higher convergence and overlap between dimensions for residents that had been living longer in the city. As for the combined

dimensions (*sense of place*), results displayed in the correlograms (Figure 4.20) suggest that all dimensions are correlated with each other yet *place inherited* is the dimension with lower correlations and therefore the most distinct for both groups.

5.3 Limitations

First, the main theoretical framework used in this study was drawn from Trąbka [43], who built the dimensions based on interviews through an inductive approach in a specific case study. This together with the high degree of intertwinement between dimensions made the interpretation of the analysis more complex. In addition, the survey questionnaire had two questions to address one dimension, which according to the results, output another degree of complexity. Furthermore, the spatial *imprint* of the dimensions represents a static picture of the people-place relationships, which in reality is dynamic in time and space.

Another limitation of the study was the participant sampling, as ideally a higher number of participants would mean more representativeness. In addition, length of residence was used to compare two different groups and not the same group over time. The results were biased by high values of *place dependence* mainly in the IST and Universidade Nova de Lisboa campi. Although meaningful *places* were identified, this study did not carry out a more in-depth qualitative analysis regarding the connection between dimensions and processes of meaning creation towards Lisbon's complex urban landscape context. Moreover, socio-economic, demographic and physical variables as well as reasons underlying mobility were not considered in this study.

Technical aspects of the survey were also a constraint due to the usability of the platform, restricted by the limitations of ArcGIS Survey123. Lastly, representational vagueness is an inheritable characteristic of this kind of analysis and literature on methodological frameworks in this scope of research is poorly consolidated [62]. In this case, uncertainty not only stems from the qualitative-quantitative symbioses and complex theoretical background, but also from the attempt to collect representative spatial data on the survey platform. Representational variability therefore can be derived from three factors: (i) conventional GIS platforms are not developed to embed cognitive functionalities based on *place*-based approaches; (ii) analysis performed did not quantitively consider uncertainty, vagueness or fuzziness of *sense of place* spatial distribution; (iii) polygons could be freely drawn according to individual perceptions of places, boundaries, edges, nodes and areas; resulting in scalar variability.

6   Conclusions

Outlined objectives were successfully achieved since spatially examining the distributions, patterns, characteristics and relationships of *sense of place* dimensions allowed to identify meaningful *places* in the city, confirm that short-term dwellers have developed *place*-bonds, find distinctions between short-term and long-term residents and discuss processes through which these distinctions have emerged.

6.1 Short-term residents' *sense of place*

Analysis demonstrated that bonds with *places* in the city can be built in a relatively short time-frame through immediate and new perceptions in line with Raymond *et al*. [44] research employing affordance theory. Therefore, *sense of place* does not require a long time frame to develop as residents can carry and establish *place*-bonds with both their home countries and new environments. On the other hand, length of residence not only intensifies the bonds developed towards *places* but also spatially broadens them within the city. The different intricate relationships between dimensions for each group suggest that meaning creation evolves over time based on a spectrum that starts from physical settings and functional affordances to abstract symbols, social capital and profound sentiments.

6.2 Length of residence and *sense of place* dimensions

The differences between groups confirm that length and location of residence impacts directly the spatial *imprint* of the concepts since distinctions were found between *locales* in the urban setting, in their spatial extent, as well as in the relationships between the dimensions themselves. According to the results, length of the residence also shapes dimensions into being more spatially coincident and correlated. Overall, *sense of place* for both groups was mainly concentrated in Lisbon's central area, where a higher density of resources and amenities are found, even though most of the participants reported living in this region.

Spatializing *place* dimensions revealed relationships between them. For instance, *place identity* for short-term dwellers was found to be more correlated to *dependence*, which means they identify with places where perception-action affordances and constant use of amenities in day to day life occur. People who had been living longer had *place identity* more similar to *place inherited*, showing that *places* of identification are correlated with *places* where they also feel belongingness and rootedness. Nonetheless, both groups showed high correlation between *inherited* and *dependence*, which means that constant interactions with *place*s are associated with eventually fostering deeper feelings towards them. Furthermore, spatial analysis and statistical results show that *place awareness* acted as a proxy for *sense of place* distribution, as components of *awareness* can be correlated to the cognitive, behavioral and affective components of attitude theory used by Jorgensen and Stedman [24] to define *sense of place*.

6.3 Final considerations and future work

This study puts forward the potential of obtaining valuable information when spatializing social-psychological constructs. Due to the survey sharing procedures, it was assumed most of the participants either study or work at Instituto Superior Ténico and Universidade Nova de Lisboa, two esteemed high education institutions of the city of Lisbon. Therefore, the analysis and results here brought forward could be integrated in frameworks of transferring the acquired information into real-life applications. For instance, mobility centers of these two universities can understand how their foreign students and staff perceive different places in the city and therefore target and shape marketing waves, integration events, housing advertisement and city information found on

their websites according to the combination of survey answers and data on nationalities, age and faculties. New frameworks could also be applied to new students and researchers in order to follow up with their *place* bonds' evolution.

Future work could be developed in order to attain a more representative picture of *sense of place* of foreign residents in the city through broadening participant sampling. Survey procedures should then aim to obtain more participants, therefore expanding both place and time of residence sampling. Regarding analysis, future work could quantitively consider residence location, *home range*, multiple thresholds of length of residence, nationalities as well as socio-economic, physical and demographic variables. In addition, future studies could also incorporate more qualitative aspects of the urban landscape in an attempt to obtain a more comprehensive holistic approach of the results. Lastly, the framework used in combination with mentioned suggestions can be employed not only with other participant groups, but also with the same group throughout time.

The analysis carried out asserts participatory GIS as a critical tool in integrating quantitative and qualitative approaches in order to operationalize concepts that are rarely dissected using spatial analysis. In a broader picture, the next step would be to unfold a dynamic, time-dependent, citizen-centered *place*-based layer of the city which can aid geomarketing, local tourism, place branding, location-based services, urban planning and public policies aimed to any target public.

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Annexes

Surveys in English (left) and Portuguese (right).

Figure 1. Introduction page of the survey.

Figure 2. Time of residence question.

Figure 3. Residence location question.

Figure 4. Country of origin question.

Figure 5. Brief explanation about following questions.

Figure 6. Introduction to *place dependence* section.

Figure 7. Map-based question for *place dependence*.

Figure 8. *Likert* question for *place dependence*.
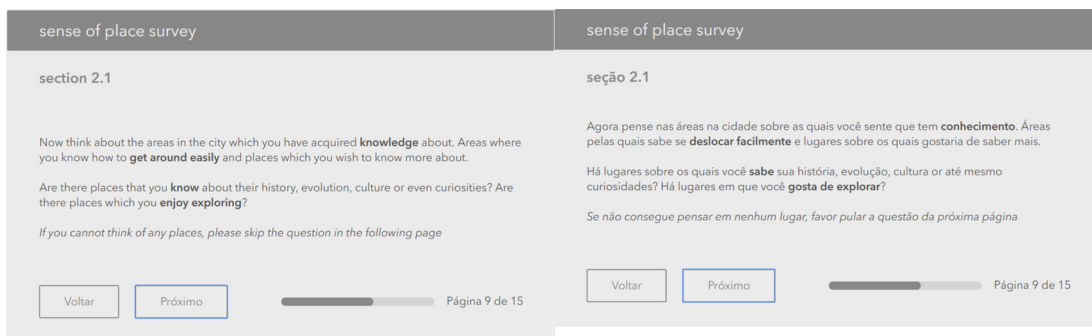
Figure 9. Introduction to *place dependence* section.
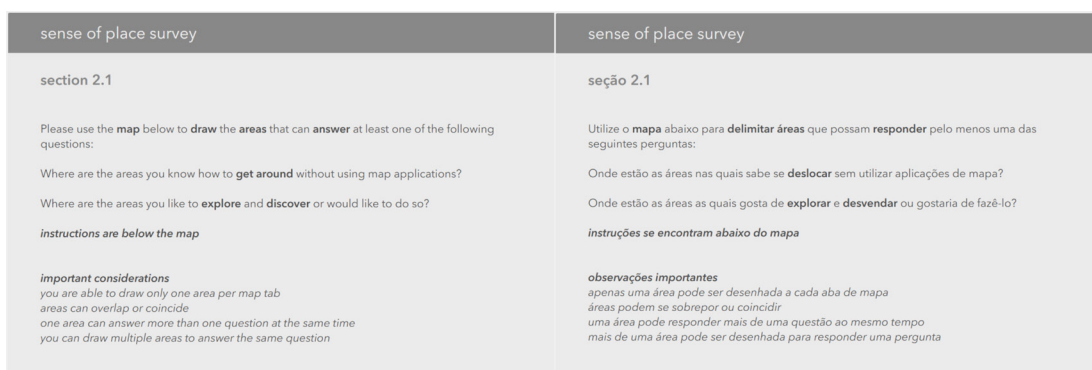
Figure 10. Map-based question for *place awareness.*
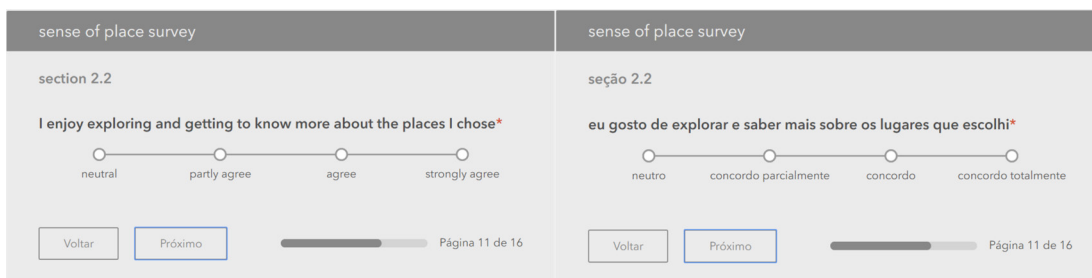
Figure 11. *Likert* question for *place awareness.*

Figure 12. Introduction to *place identity* section.

Figure 13. Map-based question for *place identity*.

Figure 14. *Likert* question for *place identity*.

Figure 15. Introduction to *place inherited* section.

Figure 16. Map-based question for *place inherited*.

Figure 17. *Likert* question for *place inherited*.

Figure 18. End of the survey.

Feedback questionnaire in English (left) and Portuguese (right).

Figure 19. Introduction page of the feedback questionnaire.

Figure 20. *Likert* questions of the feedback questionnaire.
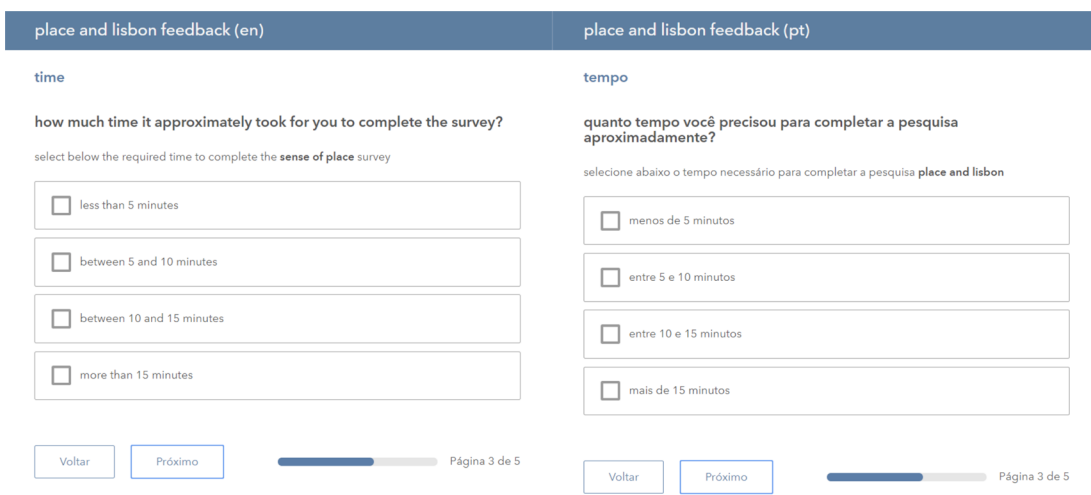
Figure 21. Question regarding approximate time of survey completion.

place and lisbon feedback (en)

suggestions

what do you think it could be improved in the survey? do you have any suggestions or recommendations?

write your answer below

1000

what did you not like about the survey? do you have any suggestions for adjusting or fixing this problem?

write your answer below

1000

Voltar   Próximo   Página 4 de 5

place and lisbon feedback (pt)

sugestões

o que você acha que poderia ser aperfeiçoado na pesquisa? você tem alguma sugestão ou recomendação?

escreva sua resposta abaixo

1000

o que não te agradou na pesquisa? você tem alguma sugestão para consertar ou contornar este problema?

escreva sua resposta abaixo

1000

Voltar   Próximo   Página 4 de 5

Figure 22. Text questions regarding improvements, suggestions and recommendations.

place and lisbon feedback (en)

thank you!

thank you for your feedback!

confirm by clicking send

Voltar   Enviar   Página 5 de 5

place and lisbon feedback (pt)

obrigado!

obrigado pelo seu feedback!

clique enviar para finalizar

Voltar   Enviar   Página 5 de 5

Figure 23. End of the feedback questionnaire.

Investigating the *spatial imprint* of *sense of place* dimensions among foreign residents of Lisbon

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