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A Feminist-Driven Computational Urban Design Framework for Mapping Gender-Inclusive Urban Places

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Abstract. A significant hurdle to employing data-driven and computational methods in urban design for people-place relation analysis is when the research is driven not by in-depth knowledge and theory of the field, but by data, which could lead to data autocracy. This paper aims to develop a feminist-driven framework for computational urban design to map, measure, and analyze gender-inclusive features of urban places. The framework suggests that data requirements for a computational urban design assessment need to be initially determined from domain theory patterns. The results demonstrate that the integration of multi-type, multi-scale, and multi-source datasets is needed to address all gender-inclusive features of urban places. Finally, we conclude that by adopting a theory-driven approach, it is possible to define a research system through which the researcher can control the data flow, guide the research path, and benefit from opportunities of geospatial big data and data-driven methods for conducting computational urban design.

Keywords: Computational Urban Design, Data-driven Approach, Theory-driven Approach, Feminist-driven Approach, Gender-inclusive Urban Places.

1 Introduction

Urban places, such as urban streets, squares, and parks, are critical components of cities due to their role in supporting people's everyday ordinary activities and urban life experience which leads to more sense of belonging to the city, satisfaction, and quality of life [1]. However, the design of urban places is often hostile and exclusionary that lacks qualities for including female and LGBTQ2S+[1] users, and thus, there is a need to create more gender-inclusive urban places where everyone feels welcomed, included, comfortable, and not discriminated against by their gender [2].

For studying and analyzing urban environments, computational and data-driven methods are increasingly applied due to their capabilities for easily collecting, storing, and processing digital geospatial data [3]. However, applying data-driven methods for

[1] LGBTQ2S+ is an acronym that stands for Lesbian, Gay, Bisexual, Transgender, Queer or Questioning, and Two-Spirit [33].

socio-spatial analysis, like gender-place relations, is relatively challenging in urban design research. Such socio-spatial studies are delicate, multi-faceted and often complex which necessitate having access to a combination of diverse datasets in terms of data types, scales and therefore, sources. Relying solely on the available datasets and computational methods for conducting these studies might divert the research path [4], such that the researcher might attempt to define only the research problems that are solvable with the available data boundaries which could prevent producing inclusive knowledge of the subject.

Therefore, as an effective solution for employing computational data-driven methods in urban design research for gender-place analysis and avoiding their problematic features simultaneously, we suggest a feminist-driven computational urban design framework. In this framework, research data requirements for assessing gender inclusiveness of urban places are derived from the feminism theory patterns that allow a full understanding and knowledge of the subject before applying any data-driven and computational methods. To achieve this, by searching for feminist-driven spatial patterns with regard to gender-place relations, place qualities and physical features that promote gender inclusion will be identified from which the data requirements will be determined. The result of feminist-driven data requirements indicates the necessity of using multiple data types and data scales which can be accessed through multiple sources.

2 Data-driven Methods in Computational Urban Design

The rapidly increasing quantity and variety of geographically referenced data generated by different sources, from GPS-enabled mobile phones to airborne and satellite-based remote sensors, has led to the emergence of the phenomenon of "geospatial big data" [5]. According to Miller and Goodchild [3], geospatial big data has shifted geography and urban study research from a "data-scarce to a data-rich environment", an opportunity that did not exist before. Along with powerful computers and computational techniques, geospatial big data is the fuel for computational data-driven methods for gathering, storing, managing, and processing digital data to analyze and comprehend our world.

From an urban design perspective, Batty [6] demonstrates how attention has been shifted to the quality of small-scale urban places in the geospatial big data era, while back then, radical large-scale interventions on the urban physical body were popular. The importance of restoring attention to urban micro-spaces is due to their role in supporting people's everyday life, considering the reality that we use geotagged information on the web to make decisions about choosing and reaching daily destinations like schools, offices, shopping centers, parks, among many other places. In fact, geospatial big data and data-driven methods bridge the longstanding gap between large-scale holistic and small-scale atomistic approaches toward urban design [3].

However, a crucial challenge of using geospatial big data in urban design is when the research is driven not by profound knowledge and theory of the field, but by the data, something that could lead to data autocracy. With such an approach, data replaces human decision-making [3] which could be perilous for socio-spatial studies, as the

main focus of urban design research. Socio-spatial relations are complex and multi-faceted, and some aspects of this relationship do not easily fit into the available data boundaries. As a consequence, the socio-spatial unevenness and inequality might be amplified by relying on such uneven data [7].

Though, the existence of such a challenge does not mean discrediting and discarding data-driven and computational methods in urban design research, but defining a mechanism within which the helm of research can be returned to the researcher to control the data flow and benefit from its positive sides. To fit data-driven approaches into urban design, starting from a theory-driven approach and then using its output as the input for a computational approach is viewed as helpful [3], [4]. Such that the domain theory drives the search to find patterns by identifying the constructs and relationships that can be used to determine data requirements [8]. Data requirements derived from the theory patterns specify what data (data type), at what scale (data scale), and where (data source) we should look for, and in the next phase, will be utilized to control and guide a computational urban design.

3 Feminist-driven Computational Urban Design Framework

The link between gender and place is one of the delicate and multi-faceted socio-spatial issues that has been long explored [9], [10]. Gender-based division of labor, as a consequence of the industrial revolution in the 19th century, led to a dichotomy of public-private spaces in which women belonged to the private sphere of home and family and men dominated the public sphere [11], [12]. The male-female spatial separation has been a product and driver of gender inequalities and caused sexual discrimination in the design, construction, and use of urban places [13]. This patriarchal method of building and using urban places was challenged in the 1970s by feminist researchers who started to highlight how men and women understand and use the space differently and how planning and design had ignored women's demands in urban places [14].

Urban place, as the material container for social behaviors and interactions, shape the ways gender identities, relations and practices are acted out, reinforced, or modified and plays a role in shaping power relations [15]. In this research, therefore, we suggest a feminist-driven framework for computationally urban design analysis of this complex delicate social-spatial construct (Fig. 1). Adopting this framework, adequate knowledge of feminism theory patterns about gender-place relations determines the research data requirements for evaluating gender inclusiveness of urban places. The data requirements result will ultimately be used for a computational urban design analysis to evaluate gender-inclusive urban places.

The data requirements are determined through a three-step process. Fig. 1 depicts the process steps and shows how the output of each step is an input for the next step. The first and second steps are global, which means can be applied to any study area, but the third step is place-based, which needs to be carried out specifically for each study area. A detailed description of each step of data requirements determination is given in the following.

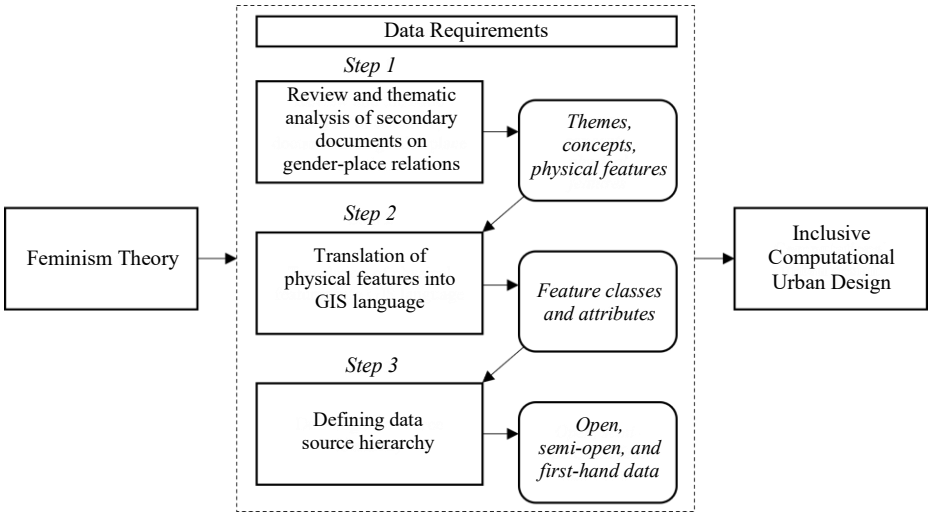

Fig. 1. Feminist-driven computational urban design framework.

3.1 Gender-inclusive Urban Place Physical Features

Gender inclusiveness of urban places is mainly relevant to the notion of "the right to everyday life", in which urban places are locations that all people need to use for ordinary practices like walking, sitting, shopping, recreating, and interacting on a daily basis, regardless of their gender [16]–[18]. Accordingly, urban places must facilitate ordinary daily practices and provide a pleasant urban life experience to enhance the sense of comfort, belonging to the place, satisfaction, and quality of life.

Place, as human and environmental relations, is a combination of tangible and intangible aspects [19]. While intangible aspects include personal and social relations of people with the place, tangible aspects are natural and human-made physical settings of the place [20]. Focusing on place tangible elements in this research, urban places need to have specific physical qualities to support ordinary everyday practices for all genders. Table 1 is a review of some previous studies on gender and place relations. Conducting a thematic analysis of these studies, the perception of spatial "safety" and "equity" are two main themes representing qualities of a gender-inclusive urban place.

The issue of perceived safety in urban places is the planning and design of the physical environment in which design elements can enhance or decline the level of safety that people feel [21]. Accordingly, design factors like adequate lighting, open design layouts, adequate windows and entrances, diverse and feminine functions, mixed-use spaces, and feminine symbols that enhance the space visibility and diversity could affect the perception of safety for women effectively [16], [21]–[24].

Moreover, the urban place needs to provide equal services to all genders to enhance spatial equity. The issue of spatial equity lies in different patterns of urban space use by men and women. Women have less access to private automobiles and are more dependent on public transport. At the same time, women, especially female caregivers, need to access different destinations during the day due to their multi-dimensional

responsibilities (for example taking kids to school, going to the office, picking kids up from school and taking them to the park, shopping, going home, etc.) [25]. In this regard, place physical features like easily accessible public transportation, walkable and mixed-used neighborhoods, diverse forms of transportation (walking, cycling, scootering, etc.), diverse and flexible urban benches, and easily accessible public toilets with caregiver-supportive facilities will enhance urban place gender equity [21], [25], [26].

Table 1. Qualities of gender-inclusive urban places.

Place physical qualities	
Lighting, openness, visibility, and proximity to public transport	[22]
Observation and diversity	[27]
Observability, lightning, familiar places, accessible public transportation	[16]
Safety, visibility, diversified zones, see-through space design	[28]
Safety, feminine theme, greater public presence, informal surveillance	[24]
Lightning, no empty lots, adequate signages, visibility, no solid walls, green space, adequate windows and entrances, functional diversity, accessible public toilets	[21]
Multifunctional space, mixed-use spaces, short travel distances, proximity to public transport and public toilets, safe pedestrian environment	[25]
Accessible public toilets, adequate lighting, accessible public transportation, formal surveillance, accessible urban furniture, diverse forms of transportation	[26]

According to the thematic analysis results, each theme of safety and equity includes some concepts. Concepts relevant to place safety include *observability* (a place feature in which a person can observe and be observed, e.g., Jane Jacobs' idea of "eyes on the street", like a façade with adequate and active windows [29].), *familiarity* (a place feature in which the place is familiar and known to a person, e.g., using local design patterns containing shared meaning.), and *nature integration* (a place feature in which natural elements are combined in the space design, e.g., using vegetation and plants in the place design.)

Likewise, concepts relevant to place equity are *accessibility* (a place feature in which access to and use of public facilities and amenities is possible for all genders, e.g., adequate number and caregiver-supportive public toilets.) and *diversity* (a place feature in which there are varied functions and physical details that support the diverse needs of all genders, e.g., adequate, accessible, and flexible benches.)

Also, each concept includes some place physical features (Table 2). Additionally, literature in the urban planning and design field is helpful in finding more physical features that enhance place perception of safety and equity in regard to the concepts. For instance, Jacobs' idea of eyes on the street and mixed-use urban places [29], Lynch's idea of urban legibility through five elements of paths, edges, districts, nodes, and landmarks [30], Oscar Newman's CPTED (Crime Prevention through Urban Design) theory and its five principles including access control, territoriality and maintenance, supporting social activities, and surveillance [31], and Harvey's idea of skeletal streetscape design effect on perceived safety [32]. Finally, the place physical features

are listed in three categories of ground, façade, and design details as a way to deal with the type and scale variety.

Table 2. Gender-inclusive urban place physical features.

Themes	Concepts	Physical Features	
Safety	Observability	Ground	– no visual barriers – no dead-end routes – no empty lots with no defined function
		Facade	– adequate number of windows on facades – active ground floor especially during dark hours
		Design details	– adequate number, illumination, and location of streetlights
	Familiarity	Ground	– proper spatial enclosure (i.e., ground width proportional to the facade height) – gender-inclusive and familiar patterns for pavement design
		Facade	– proper spatial enclosure (i.e., facade height proportional to the ground width) – gender-inclusive and familiar patterns for buildings design
		Design details	– local trees and plants – gender-inclusive and familiar patterns for landmark design
	Nature Integration	Ground	– use of grass as a material in pavement design
		Facade	– climbing plants for building facades, especially those with no windows and active ground floor
		Design details	– trees, plants, flowerpots, etc.
Equity	Accessibility	Ground	– proper and well-maintained pavements supporting walking, running, cycling, scootering, wheelchair riding, and stroll riding activities – frequent and easily reachable public transportation stations – the same height of the access from the public transportation stations to the buses and trains
		Facade	– frequent and easily reachable gendered and genderless public toilets with diaper changers available to caregivers
		Design details	– proper number, type, and location of benches – proper number, type, and location of trash bins – proper number and location of bicycles and scooters racks
	Diversity	Ground	– integrated pavement form and material with minimum ups and downs to support events like gender-inclusive gatherings and festivals
		Facade	– mixed-used buildings/ neighborhoods
		Design details	– gender-inclusive landmarks (like rainbow flags, feminine monuments, mother monuments, etc.)

3.2 Gender-inclusive Feature Classes and Attributes

This step is necessary before carrying out the computational urban design analysis. In this phase, the result of the previous step is translated into GIS database language by defining a mutually exclusive classification system for saving gender-inclusive feature classes and attributes.

Table 3. Gender-inclusive feature classes and attributes.

Feature	building	ground		vegetation	streetlight	bench
Feature Class Type	*line **	*line ***	*Polygon ***	*point*	*point*	*point*
Attribute	– function – ground floor function – height – window – façade material – green wall	– width – length – height – pavement material – pavement design pattern – pavement condition – surface consistency – dead-end route	– width – length – height – pavement material – pavement design pattern – pavement condition – surface consistency	– type – height – deciduous/ evergreen	– type – height – illumination – meaningful pattern	– type – height – length – width – material – form – flexibility

Feature	trash bin	landmark	transport station	public toilet	visual barrier	empty lot
Feature Class Type	*point*	*point*	*point*	*point*	*point*	*polygon*
Attribute	– type – height	– meaning – visibility	– type	– type – caregiver supportive	– type	– function

* Since dealing with the building facade that is located on the urban place, and not the entire building, the feature class type is considered as "line" for the "building" feature, not polygon.
** Since dealing with urban places in two forms of mobility spaces (urban streets and walkways) and destination spaces (urban squares and parks), two feature class types of "line" (mobility spaces) and "polygon" (destination spaces) have been defined for the "ground" feature.

Therefore, based on physical features found in the first step (Table 2), feature classes of "building", "ground", "vegetation", "streetlight", "bench", "trash bin", "landmark", "transport station", "public toilet", "visual barrier", and "empty lot" along their types (point, line, or polygon) are identified and attributes related to each feature class are listed (Table 3). Thus, the result of this step makes it possible to map, store, organize, and analyze the data within a GIS geodatabase.

3.3 Data Source Hierarchy

In order to collect and analyze geospatial data on gender-inclusive feature classes and attributes (Table 3), in the third step of determining data requirements, it is necessary

to find out how and where these data could be found. There are a variety of features and related attributes like building's facades and functions, ground pavement material and condition, bench dimensions and material, streetlight dimensions, etc., each of which is at a different scale, from coarse to fine scale. These multi-type and multi-scale datasets could be accessed and collected only through multiple sources.

The result of this phase is specific to each study site. Some areas may have rich open and semi-open data sources, and some other areas may have various data blind spots. The main approach here is to try to find as much data as possible on the study area from open and then semi-open sources in order to reduce costs and increase the scalability of the research. Then, if a data type with an appropriate scale and quality is not found in such sources, it would be generated directly with the most effective method possible. Therefore, a hierarchy of open to first-hand data sources needs to be defined specific to each study area in which each source can provide data for a feature attribute.

4 Conclusion

In this research, we suggest a feminist-driven method for assessing gender inclusiveness of urban places in which the data requirements for a computational urban design assessment were initially determined from the feminism theory patterns. Focusing on place physical settings, the feminist theory patterns for gender-place relations revealed that those physical features that enhance the perception of safety and equity would make urban places more inclusive for all genders, and therefore, the data on these gender-inclusive physical features are required to analyze and evaluate the place. In this regard, the data requirements result demonstrated that multi-type, multi-scale, and multi-source datasets are needed to address all gender-inclusive physical features.

Finally, we conclude that for addressing delicate and multifaceted people-place relations, relying solely on whatever data is available in the ocean of geospatial big data, might lead to a data autocracy, research deviation, and production of superficial knowledge. Instead, by adopting a theory-driven approach to generate data requirements, it is possible to define a research system through which the researcher can control the data flow, guide the research path, and benefit from opportunities of geospatial big data and computational data-driven methods for conducting socio-spatial analysis.

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