Understanding walkability and walking rates in Berlin: an urban form and street pattern comparison

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Keywords

Walkability, urban planning, health behaviour

Summary

Background: This descriptive study provides information indicative of the interaction between physical features of neighbourhood environments with health behaviours such as walking and biking which consequently affect disease rates related to lifestyle. **Aim:** Through a summary of systematic observations at two urban scales, the macro and meso-levels, a neighbourhood comparison was realized in Berlin, Germany, to explore how urban forms and street patterns can support walking or biking, or not, despite seasonal variations, socio-economic status, cultural backdrop or individual decisions to walk. For this study, a conceptual evaluation framework was conceived and structured to assess secondary data from public databases, conveniently decreasing time and costs. **Result:** The framework and preliminary results of the work aim to be a significant endeavour in promoting transdisciplinarity among researchers and practitioners mainly from public health, architecture, urban planning and design fields.

Schlüsselwörter

Begehbarkeit, Stadtplanung, Gesundheitsverhalten

Zusammenfassung

Hintergrund: Diese deskriptive Studie liefert Informationen darüber, wie die Interaktionen zwischen den realen Eigenschaften eines Stadtteils mit Gesundheitsverhalten wie Wandern und Radfahren sind, die folglich Krankheitsraten im Zusammenhang mit Lebensstil beeinflussen. **Ziel:** Durch eine Zusammenfassung der systematischen Beobachtungen an zwei urbanen Skalen, die Makro- und Meso-Ebene, wurde ein Stadtteil-Vergleich in Berlin, Deutschland, realisiert um zu erforschen, wie urbane Formen und Straßenmuster die Fortbewegung zu Fuß oder mit dem Fahrrad unterstützen können, oder nicht – trotz der jahreszeitlichen Schwankungen, sozioökonomischem Status, kulturellem Hintergrund oder individueller Entscheidungen, zu Fuß zu gehen. Für diese Studie wurde ein konzeptioneller Bewertungsrahmen konzipiert und strukturiert, um Sekundärdaten aus öffentlichen Datenbanken beurteilen zu können und um bequem Zeit und Kosten zu verringern. **Ergebnis:** Der Rahmen und die vorläufigen Ergebnisse der Arbeit beabsichtigen den Versuch, die Transdisziplinarität unter den Forschern und Praktikern vor allem aus der öffentlichen Gesundheit, Architektur, Stadtplanung und Design-Felder.●●●●●●●●●●●●●●●

Fußgängerfreundlichkeit und Gehraten in Berlin: ein Vergleich der urbanen Form und der Straßenmuster

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Through a summary of systematic observations at two urban scales, the macro and meso-levels, a neighbourhood comparison was realized in Berlin, Germany to explore how urban forms and street patterns (physical features at pedestrian-level) can support walking or biking, or not, despite seasonal variations, socio-economic status, cultural backdrop or individual decisions to walk. For this study, a conceptual evaluation framework was conceived and structured to assess secondary data from

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public databases, conveniently decreasing time and costs.

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A brief throwback

The interplay between the built environment, health and wellbeing is not new. It was crucial in the history of Europe and North America from the 19th century to the early 20th when urban planning and public health once worked cooperatively in tackling contagious diseases (such as cholera and tuberculosis) and safety risks (2). Landscape architecture aimed for physical activity; city infrastructure design battled infectious diseases (e.g. water and sewage systems) and zoning meant to separate hazardous functions from living (6).

After last century´s planning success on battling contagious diseases and other threats, today the need is to tackle the increasing burden of non-communicable diseases (NCDs) globally and locally responsible for 63 percent of annual deaths, considered being the new global crisis in public health (12). A reality especially present in Europe, considering that diseases such as diabetes, cardiovascular diseases, cancer, chronic respiratory diseases and mental disorders sum 86 percent of the deaths and 77 percent of the disease burden of the region (15). These NCDs, mostly related to overweight and obesity heavily influenced by modern lifestyle and urban environments (16) and, a growing ageing society with its own health issues, remain as top priorities to attend.

Earlier planning and design disciplines have reemerged and with renewed knowledge towards a more sustainable human development revolving around healthy urban planning[1]. In this effort, to promote walkable neighbourhoods is a strategy that largely relates with our health behavior, whether because it influences our travel mode preference, or because it reduces risk-related environmental exposures such as traffic noise and pollution (3). A recent example we find with older adults is that when engaging neighborhood walking -even with existing cognitive impairment and dementia- a significant enhancement of cognitive outcomes such as improved memory are achieved (14).

[1] Healthy urban planning means planning for people. It promotes the idea that the city is much more than buildings, streets and open spaces, but a living, breathing organism, the health of which is closely linked to that of its citizens. For more information, see http://www.euro.who.int/en/publications/abstracts/healthy-urban-planning

Walkability

Walkability, both a concept and measuring tool is used to score how friendly an area is for walking and/or biking (including variations such as canes, walkers and wheelchairs). The Center for Disease Control & Prevention (CDC) defines walkability by quantifying safety and desirability of walking routes. More comprehensively, the Transport for London Agency (2004) states that walkability beyond measuring safety, is the extent to which walking is readily available as a connected, accessible and pleasant mode of transport. Either way, WHO and CDC advocate for increasing neighbourhood walkability to primarily promote fitness, combat obesity, and enhance sustainability (10). Transportation expert Todd Litman (8) also sustains this promotion, finding neighbourhoods with high walkability also likely to increase community cohesion and social capital[2].

Walkability in many ways has been linked to quality of life by improving accessibility and access in obtaining daily needs, reducing isolation and reducing transportation costs especially those related to car usage (11). In addition, researcher Kevin Leyden (West Virginia University) affirms that dwellers from pedestrian-oriented neighborhoods significantly feel to be part of or connected to the community; know and trust neighbors; and are more likely to contact their elected officials, than those dwellers from car dependent ones (7).

If walkable neighbourhoods are healthier and more sustainable, then what makes a neighbourhood more walkable and less car dependent than others?

Factors for walkability

"For routine physical activity, no element of the urban environment is more important than streets. This is where the active travel to work, shop, eat out, and engage in other daily activities take place, and where walking for exercise mostly occur" (Ewing et al. 2006).

Since the mid-90s walkability research has incessantly tried to determine what built environment factors stimulate pedestrian activity and trigger path preference giving

[2] Social capital („community connectedness") refers to social networks and the norms of reciprocity that arise from them. A growing body of literature over the last several years shows that social capital, and the trust, reciprocity, information, and cooperation associated with it, enables many important individual and social goods. Communities with higher levels of social capital are likely to have higher educational achievement, better performing governmental institutions, faster economic growth, and less crime and violence. And the people living in these communities are likely to be happier, healthier, and to have a longer life expectancy. For more information, see (17).

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special importance to those at the macro-level scale of the city. Macro form factors primarily impact proximity of destinations and directness of travel between destinations (5). Macro factors describe how evident geographical characteristics may influence the choice to walk, commute or drive, as whether the city is divided by waterways, has a steep topography or is built intrinsically into mountains or forests. In addition to these given factors, a city may also be described at this scale according to its level of dispersal or compaction and overall size (urban density), the formation of its major infrastructure (diversity), as well as its general shape (design) which includes recognizable stages of development (1).

From this decade on, many rating and auditing instruments characterizing the built environment proliferated. Some addressed a more pedestrian-level scale (meso-level) such as NEWS (Neighbourhood Environment Walkability Survey) promoted by the Active Living Research organization and PERS (Pedestrian Environment Review System) -a walking audit that collects both quantitative and qualitative data on six types of facilities in the street environment- developed by the Transport Research Laboratory of London, UK. These tools and similar ones still in use, mainly assess physical features that can be easily measured, such as sidewalk width, number of bike lanes, presence of marked crosswalks and other physical street components which directly aid pedestrians and bikers (9).

Since the early 2000s, walkability research aimed at assessing more subtle qualities dependent on individual reactions (micro-level) therefore becoming more subjective and difficult to measure. For example, the Illustrated Manual to Measure Urban Design Qualities from the Active Living Research Program which seeks to link walking behavior with effects of transparency, complexity and enclosure of facades and the human scale and image of streets elements (4).

This study examined macro-level form factors and meso-level street design variables to determine active transportation (biking and cycling) path continuity along street segments (several blocks) and connectivity from the pedestrian environment towards other transportation networks especially public ones. Micro-level variables to street components that also affect pedestrian quality experience were assessed but not included in this study.

Material and Methods

To explore how a neighbourhood built environment can support walking or biking or not, a comparison was realized between Karl-Marx-Allee Viertel, a highly car-dependent neighbourhood located in Alexanderplatz (Mitte District) and Boxhagener Viertel, a neighbourhood located in the Friedrichshain District which presents very high walking rates regardless of seasonal variations.

Criteria

The comparison was possible since both neighbourhoods present: (1) car-scale characteristics such as a diverse street grid which includes at least one arterial, one collector and various local streets and (2) pedestrian-scale characteristics such as: sufficient public spaces and greenery (more than 12.5 m^2 per capita); proximity to uses and services for common daily errands and; proximity to public transportation (within 600 m) from the far most housing units to the city's bus, underground metro and regional train systems. Additionally, both have similar surface area of approximately 1 km^2 with a high population density over the Berlin average and most importantly, both are located within the inner center city ring.

The study was realized using only secondary data from public databases. It required conceiving and structuring a systematic observation method derived from urban walkability theory and walkability methods or tools that link the built environment with travel mode choice.

The method met the following criteria:

- Field measurements should not be required (decreasing time and cost)
- Measurements should be taken with a minimum of training and/or expertise
- Measurements should be objective to avoid inter-rater disagreements
- Measurements should capture key factors only for walkability not for walking (e.g. individual decisions)
- Measures should be based on reliable sources that ensure updated data

Table 1
Results – Macro Form Factors – Density

		Karl-Marx-Allee	Boxhagener
Density	Population (Fis-Broker)	15,657.74 / km^2 (Population Density 2014)	28,067.2 / km^2 (Population Density 2014)
	Uses (Fis-Broker)	5 uses (Actual Use of Built-up Areas 2010)	5 uses (Actual Use of Built-up Areas 2010)
	Street (Google Maps)	T-junctions: 45	T-junctions: 44
		Crossroads: 22	Crossroads: 47

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			Karl-Marx-Allee	Boxhagener
Transportation Availability	Active	Walking	Yes	Yes
		Biking	Yes	Yes
	Public	Regional Trains	Yes	Yes
		S-bahn	Yes	Yes
		U-bahn	Yes	Yes
		Trams	No	Yes
		Buses	Yes	Yes
	Private	Car-sharing	Yes	Yes
		Taxis	Yes	Yes
		Privately-owned vehicles	Yes	Yes

Table 2
Results – Macro Form Factors – Diversity Provision

- The method should be applicable to various neighborhood typologies
- The method should be able to evaluate built environment design proposals aiming to improve walkability

Data collection process

The observation method was designed to systematically assess information at three urban scales, the macro, meso and micro. In this study only macro and meso-levels are considered.

Table 3 Results – Macro Form Factors – Diversity Coverage

	Karl-Marx-Allee	Boxhagener
Public Transportation coverage	100%	100%

Macro Form Factors – density

At the macro-level, density (population density, density of uses, and street density) was assessed to determine proximity of destinations and the spatial distribution of different land uses such as residential, educational, recreational, office, retail, and industrial among others (Table 1).

Population density (people/area) and (b) density of uses (uses/area) were assessed using a GIS database from the Berlin Senate called Fis-Broker (see http://www.stadtentwicklung.berlin.de/geoinformation/fis-broker/).

Street density (number of street crossings in the area) was estimated using Google Maps. Intersections and T-junctions were identified and counted manually by an evaluator.

Macro Form Factors – diversity

The diversity of transportation modes available (all motorized and non-motorized, private and public means of

Table 4 Results – Macro Form Factors – Diversity Allocation; *No public transportation lines; **Includes on-street parking

			Karl-Marx-Allee			Boxhagener		
			Arterials	Collectors	Local Streets	Arterials	Collectors	Local Streets
Street Space Allocation	Active	Walking	19%	44%	10%	32%	26%	30%
		Biking	9%		0%	6%	12%	
	Public	Trams	N/A	N/A	N/A	28%*	62%**	N/A
		Buses	45%**	16%* (shared street with biking)	30%			35%** (shared street with biking)
		Taxis						
	Private	Privately-owned vehicles						
	Parking area and lanes		27%	40%	60%	34%		35%
	Total		100%	100%	100%	100%	100%	100%

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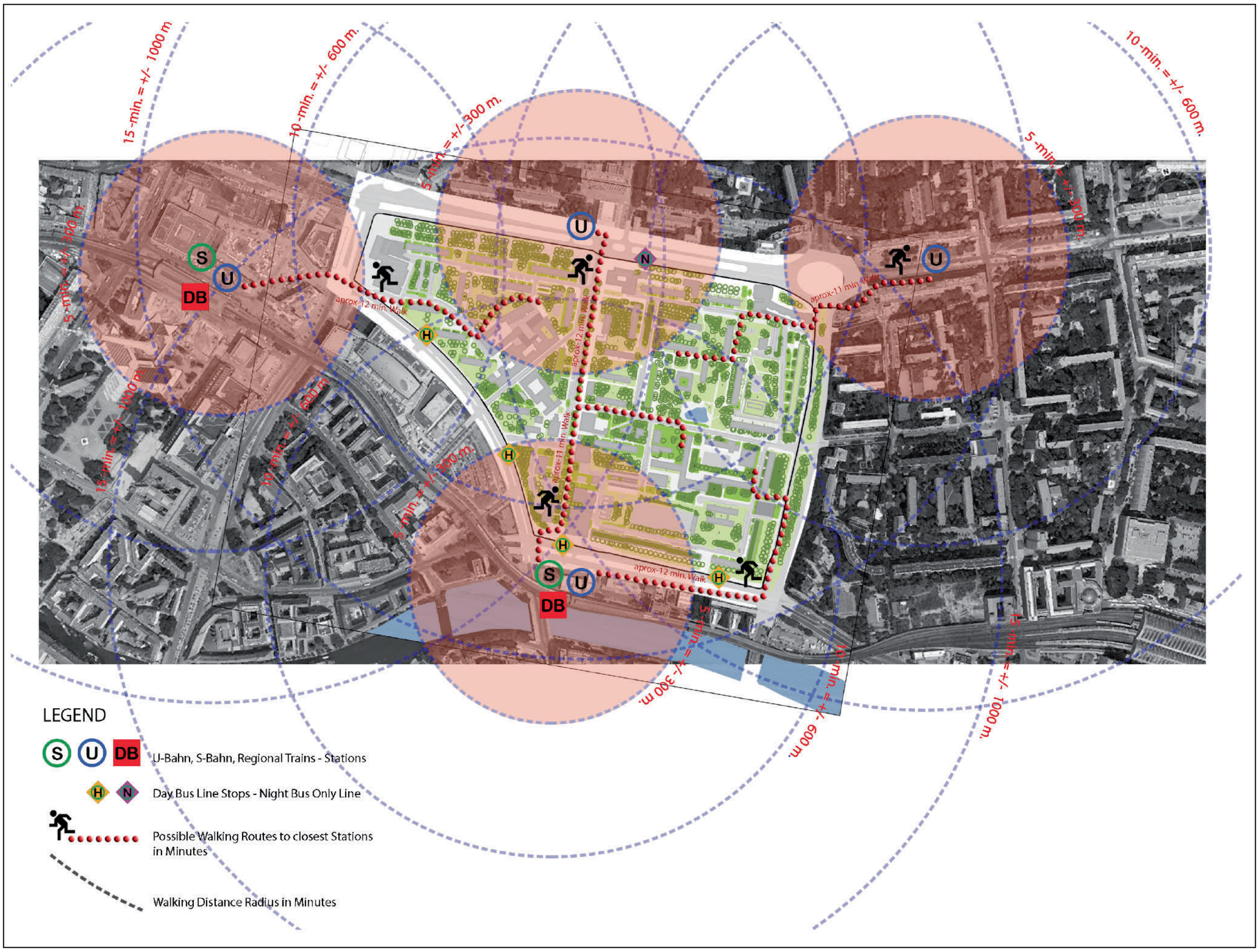

Figure 1 Circular Buffer Approach Diagram

urban transportation) and its coverage (pedestrian catchment areas, street space allocation, and number of stations and stops) was described to determine the level of provision and access opportunity to active transportation and public transportation networks (Tables 2–4).

Availability of transportation modes was described by using network maps form the BVG (Berliner Verkehrsbetriebe), Berlin's main public transportation company, which included regional train lines, train lines (S-bahn), underground lines (U-bahn), tram lines, and bus lines.

The coverage of the public transportation network was estimated using the circular buffer approach method which is able to calculate pedestrian catchment areas at 600 m and 300 m radius from stops and stations (Figure 1).

Street space allocation percentages were estimated by measuring lane widths of street sections using google maps and its measuring tools (Figure 2).

Macro Form Factors – design

The design of the street layout was described considering two important street geometric characteristics that discourage active travelling: (1) the amount of dead ends or cul-de-sacs which interrupts path alternatives and possibilities of interconnecting destinations and; (2) the amount of road deviations which translates into unnecessary longer trips (Table 5).

Both operations were graphed and counted in similar way. Using Google Maps as a base image, the evaluator manually counted the number of streets which presented dead ends, and road segments with detours or deviation in its geometry.

Meso-level Patterns – continuity

Street segments of arterials, collectors and local streets in both study sites were surveyed with Google Maps street

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Figure 2 Street Space Allocation Diagram

Table 5 Results – Macro Form Factors – Design

	Karl-Marx-Allee	Boxhagener
Deviations	20	2
Dead Ends	12	5

views and hi-resolution satellite images from Google Maps to determine the degree of travel continuity pedestrians and bikers may experience along bike and sidewalk networks.

Street segments were defined as one street-block unit, ranging from one street intersection to the next street intersection, including both street sides and sidewalk zones (Table 6).

To determine path continuity, it was important to verify block by block if pedestrian-scale elements (including important components) were present in the street segments assessed (Table 7). Street segments presenting similar pedestrian-scale elements were color coded and mapped using Adobe Photoshop (Figure 3).

Meso-level Patterns – connectivity

Pedestrian and bike environment connectivity was defined by describing main characteristics of pedestrian and bike-lane crossings at street intersections.

Connectivity levels were determined by assembling a street segment colour map for both neighbourhoods using adobe Photoshop and Google Maps street view images. The evaluator proceeded to:

1. verify number of blocks,
2. locate street intersections both 4-way crossings and T-junctions and
3. describe if crossings at intersections were unmarked, marked, fully marked or pedestrianized (leveled-up at curb height) (Figure 3).

Results

The results show quantitative data in six Tables: Tables 1 to 5 for the macro-level and Table 6 for the meso-level path continuity. Meso-level path connectivity results are not shown in this study. The neighbourhood names are abbreviated as Karl-Marx-Allee and Boxhagener.

Discussion

Although Karl-Marx-Allee has nearly 56% of the population density than that of Boxhagener, both neighbourhoods present the same density of use types (five), anyhow, Boxhagener doubles Karl-Marx-Allee in street density.

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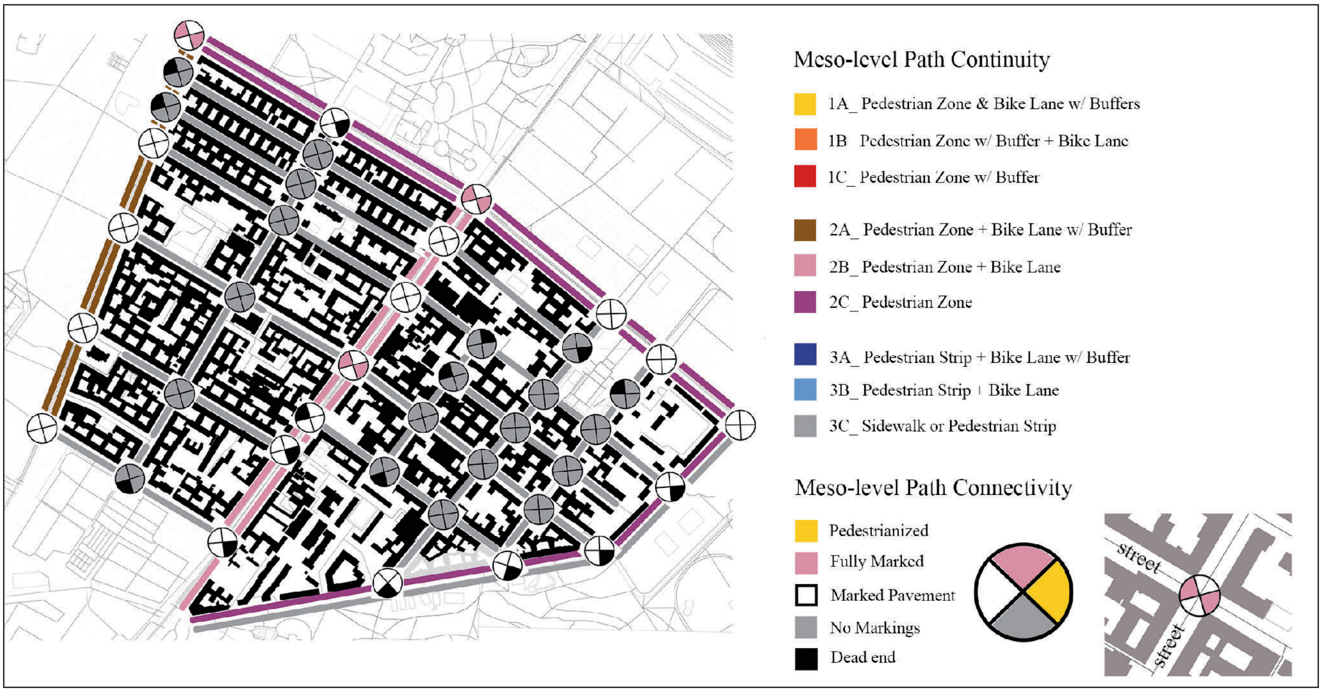

Figure 3 Path Continuity and Connectivity Diagram

Table 6
Result – Meso-level pattern – Continuity

		Karl-Marx-Allee	Boxhagener
	No. of blocks	27	40
Street zone	Bike lane availability (at two block sides at least)	6	17
Sidewalk zone	Building entrance area	27	38
	Pedestrian strip	9	40
	Curb extension	6	10
Crossings	Pedestrianized	0	0

Table 7
Street Environment Main Elements (without components and parts)

Street Environment Elements	**Car-scale**	**Pedestrian-scale**	
	Street lanes	1_ Bike lanes 2_ Public transportation strip 3_ Central medians	Street Zone
	Driveways	4_ Building entrance area	Sidewalk Zone
	Sidewalks	5_ Frontage or building strip 6_ Pedestrian through strips or pathways 7_ Street furniture strip	
	Parking lanes and zones	8_ Curb extensions or enhanced buffer 9_ Storm management strip	
	Road intersections	10_ Crosswalks 11_ Safety islands 12_ Midblock crosswalk	Crossings

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The difference of public transportation provision between both neighbourhoods is that Karl-Marx-Allee does not possess tram lines while Boxhagener does. Although when considering other public transportation modes, Karl-Marx-Allee counts with a 100% coverage.

Despite the similarity of both neighbourhoods' transportation mode street-space allocation, its median on-street parking makes Karl-Marx-Allee wider. Regarding collectors, Karl-Marx-Allee does not have bike lanes and dedicated parking spaces in contrary to the presence of Boxhagener's bike lanes and on-street parking buffers. The absence of biking lanes on local streets in Karl-Marx-Allee and its 60% allocation of surface for on-street parking also differs from the nearly even distribution of surface in local streets in Boxhagener, i.e., cars and bicycles take up 35%, on-street parking 35%, and pedestrian path 30%.

Street blocks of Karl-Marx-Allee are very regularly and rectangularly shaped, but multiple deviations (20) and dead ends (12) are also found in its street layout. On the other hand, even with its irregular block forms, Boxhagener presents a highly consistent grid of streets almost without deviations (2) and dead ends (5).

For Karl-Marx-Allee, there is an inconsistent pattern in most elements that support pedestrian network continuity and connectivity, especially in its local street grid where elements in favour of biking are absent in most of its blocks. The local streets between Karl-Marx-Allee's blocks along collectors, which do have consistent pedestrian and bike elements, are hardly connected to the biking network, at most in two sides of the block.

Conclusions

This study showed that besides both neighbourhoods having dissimilar population densities that may explain higher walking rates for Boxhagener, the results for many assessed built environment factors do indicate poor levels of walkability for Karl-Marx-Allee. Among the most relevant factors that impact walkability levels are (1) the discontinuities of bike lanes in local streets and (2) excessive allocation of parking surface in all three street hierarchies: arterial, collectors and local.

Anyhow, further adaptation, evaluation, and application of the framework is necessary in order to carry out proper evaluations and forward evidence-based recommendations that may lead to creating sustainable healthy neighbourhoods.

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Author Contributions

Alvaro Valera Sosa conceived and designed the study; and created study protocols; Alvaro Valera Sosa and Christine Nickl-Weller reviewed study methods and protocols; Alvaro Valera Sosa conducted the study and supervised research assistants in the field for data collection; Alvaro Valera Sosa and Christine Nickl-Weller analyzed the data collected; Alvaro Valera Sosa interpreted the results; and wrote the manuscript; Alvaro Valera Sosa and Weng Ian Au reviewed and edited the manuscript.

Conflict of interest

The authors declare no conflict of interest. No funding was necessary in the design of the study, in the collection, analyses, or interpretation of data, in the writing of the manuscript, and in the decision to publish the results. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Technische Universität Berlin.

Compliance with ethical guidelines

This article contains no studies on humans or animals.

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