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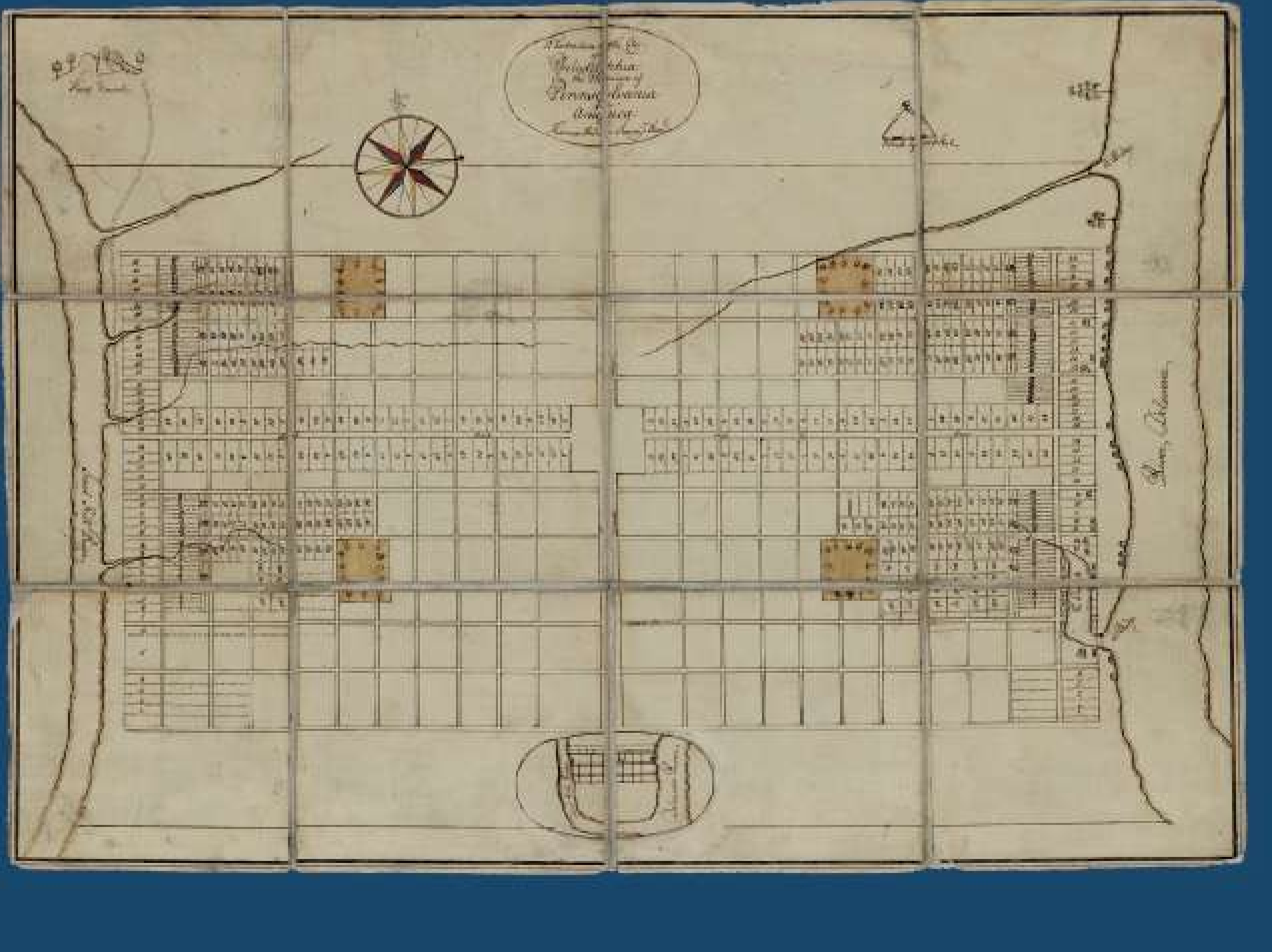
Built Environment at Fifty: Perspectives, Landmarks, and Prospects

EDITORS:
DAVID BANISTER, STEPHEN MARSHALL and LUCY NATARAJAN



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E-mail:
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The Contributors

Ronald Bisset was a research fellow at the Centre for Environmental Management and Planning, University of Aberdeen.

Jos Boys is now Co-Director of the DisOrdinary Architecture Project and an Honorary Associate Professor at Institute of Education, University College London.

Jacquelyn Broader is Research Associate at the Institute of Transportation Studies, University of California, Berkeley.

Richard Campanella is a geographer and Associate Dean for Research at the Tulane School of Architecture, New Orleans.

Maria Carrizosa is Assistant Director of the Observatory on Latin America at The New School, New York and Adjunct Associate Professor at the City University of New York and The New School.

Keith Chapman is now Emeritus Professor at the University of Aberdeen School of Geosciences.

Brian D. Clark was Professor and Director of the Centre for Environmental Management and Planning at the University of Aberdeen.

Adam Cohen is a Senior Research Manager at the Transportation Sustainability Research Center of the Institute of Transportation Studies at the University of California, Berkeley.

Seema Dave, previously Research Associate at Urban Management Centre, Ahmedabad, is now a self-employed architect.

Ken Friedman, artist and academic, is now Chair Professor of Design Innovation Studies at Tongji University.

Jan Gehl, Danish architect, professor, and consultant on urban design, is known for his pioneering book *Life Between Buildings* first published in 1971.

John Glasson is Emeritus Professor at Oxford Brookes University where he was Founding Director of the Oxford Institute for Sustainable Development and the Impact Assessment Unit.

Sachihiko Harashina is now President, Chiba University of Commerce and Professor Emeritus at Tokyo Institute of Technology.

Vincent Kaufmann is Professor of Urban Sociology and Mobility at the Swiss Institute of Technology in Lausanne.

Vinicius M. Netto is a Principal Researcher at the Research Centre for Territory, Transports and Environment, University of Porto, and an Associate Professor at the Architecture and Urbanism Graduate Programme, Fluminense Federal University, Rio de Janeiro.

Susan E. Owens is now Emeritus Professor of Environment and Policy, Department of Geography, University of Cambridge.

Attilio Petruccioli, a specialist in the revitalization of cities in the Muslim world, is Professor at Sapienza Università di Roma.

Peter A. Rickaby is now a Director and Principal Research Associate at the UK Centre for Moisture in Buildings, University College London.

Renato Saboya is an Associate Professor of Urban Planning and Design at the Federal University of Santa Catarina, Brazil.

Susan Shaheen is Co-Director of the Transportation Sustainability Research Center of the Institute of Transportation Studies (ITS)-Berkeley and Director of the UC ITS's Resilient and Innovative Mobility Initiative.

Júlio Celso Vargas is an Associate Professor of Urban Planning and Design, and Director of the Urban and Regional Planning Graduate Program, Federal University of Rio Grande do Sul, Brazil.

Peter Wathern was a research fellow at the Centre for Environmental Management and Planning, University of Aberdeen and later a Professor at Aberystwyth University.

Built Environment at Fifty
Perspectives, Landmarks, and Prospects

DAVID BANISTER, STEPHEN MARSHALL and LUCY NATAJARAN

Built Environment is celebrating its Golden Anniversary in 2024, and to mark this occasion a special double issue of the journal is being published to reflect on the changes that have taken place. The editors have identified some of the key papers published over the decades which are reprinted here, together with a commentary on whether they have stood the test of time and their relevance today. Making the selection has not been easy – but it has been rewarding.

This introduction is in three parts. First, we trace the history of the journal, from its genesis in the 1970s as a journal targeted at local practitioners working in the UK, to its current much wider brief. Today, with international contributions a readership of academics, policy makers, practitioners and consultants, each issue is devoted to a single theme and edited by an expert in that subject. We then discuss our understanding of the term 'built environment' and some of the themes that have emerged from that interpretation. To demonstrate the interdisciplinary nature of the journal and the move, over time, to an approach embracing social and environmental concerns and those of inclusion and equality, we have chosen papers devoted to seven themes which reflect the essence of the journal. Finally, we put on our 'thinking hats' to give a perspective on the future. It has been both fun and instructive putting this issue together as it has meant that we have had to delve into the past, think about the changing position of the journal, make difficult choices on the papers selected, and reflect on the contribution of *Built Environment* to urban planning.

History

As stated on Wikipedia, *Built Environment* is a peer-reviewed academic journal focused on urban planning and related fields. It began in 1956 as *Official Architecture and Planning* and was published under that name until 1972. Between 1975 and 1978 it was known as *Built Environment Quarterly* and was then edited by David Pearce, conservation activist and one time Secretary of the Society for the Protection of Ancient Buildings. Topics discussed in the journal included: 'architecture, conservation, economic development, environmental planning, health, housing, regeneration, social issues, spatial planning, sustainability, urban design, and transport'.

As might be expected, the birth of the journal was not straightforward. It emerged from *Official Architecture and Planning* in 1972, when it was rebranded *Built Environment* and published monthly starting in April of that year with about seventy pages in each issue. The authors of the short papers read like a 'who's who' of urban planning in the UK. This short-lived period ended in March 1975 (Volume 4) with the formation of the Society for the Built Environment, based at the Royal Institute of British Architects, 'bringing together of the various environmental design professions'.

Built Environment Quarterly was then published by George Godwin Ltd at Catherine Street in London, with three issues in 1975, and a new format based on themes – Housing, Transport and Urban Renewal were the first three selected. Each consisted

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Under new ownership and editorship

This is the first issue of *Built Environment* to be published by its new owners, Kogan Page, who have purchased the magazine from the Builder Group. Starting with the Summer 1978 issue, *Built Environment* will be edited jointly by Peter Hall and Tom Hancock. Peter Hall is Professor of Geography and the Dean of the Faculty of Urban and Regional Studies at the University of Reading, Member of the South East Regional Economic Planning Council and Chairman of the Planning Committee of the Social Science Research Council. He is also a Member of the Executive Committee of the Regional Studies Association, and is Editor of their journal, *Regional Studies*.

Tom Hancock is an Architect/Planner, who has worked on many important projects in Britain and abroad, including the master plan for Peterborough New Town. He has taught widely in Britain and abroad, including a spell as Visiting Professor of Planning at Columbia University, New York.

Starting with the Summer issue, *Built Environment* will have a new structure. The "Theme" section will be increased to form the major part of each issue, and will consist of a blend of expert articles and notes covering a subject of major current planning importance. The section, which may be detached if desired, will thus form one of a series that will help identify major problems in present planning and some of the solutions that are currently being offered. There will also be current practice notes, a correspondence column, and book reviews.

The Summer issue will be the first to be published in conjunction with the Regional Studies Association, which will contribute practice notes on regional planning subjects.

The theme for Summer 1978 will be Environmental Impact Analysis. There will be a comprehensive review of its history, its current state of theoretical development, and its application in various practical planning contexts. The next theme, for Autumn 1978, will concern the Management of the Housing Stock of the Inner City, with special attention to problems of High Rise Buildings, and a critical review of progress on Low Rise, High Density schemes.

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120 Pentonville Road, London N1 9JN. Tel: 01-837 7851.

of about six short (about five pages) papers, followed by a series of topical features and a comments section. The volume numbers were reset at Volume 1 (1975) and this has provided the baseline for the next fifty years.

The publication pattern was set with about half of each quarterly issue devoted to papers on a particular theme, and the editors seemed able to find a way of soliciting short papers from well-known experts. But it appeared this was not a robust business plan, as it was dependent on maintaining a good flow of relevant and interesting (albeit short) papers. This placed a continuous pressure on the editors to deliver and may have contributed to the sale of the journal by the Builder Group to Kogan Page in 1978 and 'Quarterly' was removed from the title.

As can be seen from the announcement above, Peter Hall and Tom Hancock took over as Editors. But what the announcement failed to mention was the format changed slightly: the theme became the focus for each issue, and less space was allocated to practice and book reviews. There was also a new link with the Regional Studies Association, with a regular section on regional planning, practice and methodology – a link that ended in 1985. Another development not mentioned in the announcement was that Louis Hellman (https://www.louishellman.co.uk/) agreed to provide a cartoon for each issue 'illustrating' the issue's theme. This he did brilliantly from Volume 4 no. 2 to Volume 39, no. 4, and we have reproduced several examples of his work in this issue.

The final piece of this complicated history of *Built Environment* was the establishment of Alexandrine Press (https://www.alexandrinepress.co.uk) in 1979 and their acquisition of the journal from Kogan Page in 1980. This change was seamless as the same editorial team continued to manage the journal. Tom Hancock left in 1980 to build the Milton Keynes peace pagoda and pursue other interests. Peter continued as editor for forty years. In 1983 he was joined by Mike Breheny who was replaced in 1993 by David Banister. Two editors became three in 2013 when Stephen Marshall joined Peter and David. Following Peter's death in 2014 David and Stephen continued as Editors until they were joined by Lucy Natarajan in 2019.

Gradually over time, members of the Editorial Board and other experts took on the role of Guest Editor for each themed issue. This took some of the pressure off the Editors to select the authors for the papers, and to provide a continuous flow of papers on each topic. Although the workload could now be spread more widely, the Editors still have the key responsibility identifying both the theme for each issue and selecting the most suitable Guest Editor. The active support of the Editorial Board is important here. Help and guidance to the Guest Editors is important to maintain the quality of the papers, the range of topics covered, the increasingly global scope of the journal, and the necessity to publish quarterly.

Built Environment has maintained its pattern of publishing quarterly, but the size of each issue has been increased substantially. For the first thirty years, the annual page count has been between 300 and 350 pages, but this expanded over the next decade to over 500 pages (+50 per cent). It now approaches 700 pages (+40 per cent), meaning that the page count has doubled over the fifty years.

Built Environment: Interpretation and Themes

The built environment is one thing, how people dwell in it another.

Richard Sennett, 2018

The term 'built environment' is complex. It is inherently inter-disciplinary and encompasses a wide range of subjects, disciplines, and professions. This in turn leads to a diversity of academic treatments, from discursive social science writing to more quantitative and analytic approaches. In *Built*

Environment, with its different theme for each issue, our aim is to address this diversity.

Further, the themed nature of the journal enables a breadth and depth of treatment of one topic in single issue, in both print and online. This is made possible with the help of our guest editors, who are specialized in a particular field – possibly a field or fields at the margins of or outside the traditional territory of the built environment *per se* (e.g. geography, economics, public policy).

Examples of typically inter-disciplinary issues include 'Marketplaces as an Urban Development Strategy' (Volume, 39, no. 2): a market is more than a building, more than a public space; it is also a land use and locus of economic activity, housed in a particular kind of physical setting. Another example is commuting, which is not just about travel, but also separation of land uses, about cities and suburbs, home and work (Changing Patterns of Commuting, Volume 45, no. 4); while 'Homes that Work' (Volume, 49, no. 3) is additionally concerned with the intimate spaces of home working, a fusion of architecture, society and culture.

Indeed, the themed approach allows us to include topics that are not normally regarded as within the built environment sphere, but intersect with it, such as violence (Volume, 40, no. 3), big data (Volume 42, no. 3), cognition (Volume 44, no. 2), arts (Volume 46, no. 2), and liveability (Volume 48, no. 3).

The last ten years have seen a renewed prerogative for a geographically diverse treatment, addressing the Global South as well as the Global North. This is seen explicitly in cases such as 'Public Space if the Global North and South' (Volume 48, no. 2), and geographically focused issues such as 'Arab Cities after "The Spring"' (Volume 40, no. 1) and 'Urban Land Grabs in Africa' (Volume 44, no. 4), but also in themes that are 'universal' in applicability but that have a substantial representation from the Global South, such as 'Homes that Work' (Volume 49, no. 3) and 'Planning for Equitable Urban and Regional Food Systems' (Volume 43, no. 3).

In addition, issues of inclusion have also received increasing attention, through 'Inclusive Design: Towards Social Equity in the Built Environment' (Volume 44, no. 1), 'Women-led Urbanism' (Volume 49, no. 4), and participatory approaches to planning (Volume 45, nos. 1 and 2).

Our Seven Chosen Themes

For this anniversary issue we have chosen seven themes we regard as emblematic of *Built Environment* over the last fifty years:

Sustainability and the Environment
Urban Design
Inclusion
The Compact City
Technology
Regional Perspectives
Transport

For five of these themes we reproduce two papers (one earlier and one later) while in the case of *Technology* there is just one paper and for *Sustainability and the Environment* three papers. Each theme is introduced with a brief commentary.

To represent *Sustainability and the Environment* we have chosen *Environmental Impact Analysis*. This seemed particularly appropriate as it was the first issue edited by Peter Hall and Tom Hancock.

There has always been a well-grounded critique of cost benefit analysis (CBA) for project assessment, as it necessitates making monetary valuations of the costs and benefits so that alternatives can be ranked. *Environmental Impact Analysis* (EIA) was developed to measure a much wider range of costs and benefits, using mainly non-monetary valuations. *Built Environment* has devoted three issues to this topic, and those papers selected reflect the basic methodology, progress made (over the intervening fifteen years), and the transition to strategic environmental assessment (in Japan). Analysis has made substantial progress from the classic

Leopold Matrix (Leopold *et al*., 1971) to a much wider range of approaches monitoring, valuation, and participation (Glasson and Therivel, 2019). EIA has come of age, and it is now an essential part of project assessment, including the wider issues related to policies and programmes (Sadler and Verheem, 1996).

Urban Design has been a periodic theme in *Built Environment*. Two issues have explicitly addressed Urban Design (Theory and Practice in Urban Design, Volume 22, no. 4 and Urban Design Strategies in Practice, Volume 25, no. 4); other issues have significant urban design content (e.g. New Urbanism, Volume 29, no. 3; Urban Morphology and Design, Volume 37, no. 4). For this issue, we chose a pair of papers that focus on the more specialized sub-theme of *Streets*: Jan Gehl's paper 'The residential street environment' (Volume 6, no. 1, 1980) and Vicinius Netto *et al*.'s paper asking 'Does Architecture Matter to Urban Vitality?' (Volume 48, no. 3, 2022).

Inclusion has been a feature of a wide range of issues from those touching on inclusive urban design and spaces and ways to greater equity to the violence of exclusive practices and spaces. This theme is represented here by papers from 1990 and 2023 that show the evolution of premises of diversity through studies of gendered lived experience of environments. That line was reprised to question institutions and practices in 'Women and the Environment' (Volume, 22, no. 1, 1996) and more recently 'Women-led Urbanism' (Volume 49, no. 4, 2023). Issues from other years focus on different social groups including children, with studies of younger people's relationship with built space (Playgrounds in the Built Environment, Volume 25, no.1, 1999; and Children, Young People and Built Environments, Volume 33, no. 4, 2007).

In the 1990s the *Compact City* became a central concern in Europe as part of the sustainability debate as it was an issue where the EU could make a real contribution. Compactness and mixed use became symbolic of that process, which seemed viable in the smaller historic cities, typical of Europe, but not so appropriate for rapidly urbanizing global cities. Two issues of *Built Environment* have been devoted to the compact city (The Compact City, Volume 18, no. 4, 1992 and The Compact City Revisited, Volume 36, no. 1, 2010), and the papers selected here represent the original thinking and concerns, even at that time, on the advantages of compactness, and the situation later where the concepts have been applied in a megacity in the developing world (Mumbai). The original optimism has been tempered with the reality of the megacity, suggesting that new thinking is now needed to understand the complex structures of global cities, not just in terms of their physical form, but also their rationality, inclusiveness, and opportunity (Breheny, 1992; Jacobs, 1961; Jenks *et al*., 2008).

For *Technology* we chose one aspect, *Cyberspace*, and reflect on a single piece: Ken Friedman's seminal paper 'Building cyberspace: information, place and policy' (Volume 24, nos. 2/3, 1998) which was published roughly halfway through *Built Environment*'s fifty-year history.

Regions attract a distinctive perspective on built environments, and this theme has enormous relevance to international thinking on design and planning for sustainability. The papers from 2002 (Volume 28, no. 3, Islam and Built Form: Studies in Regional Diversity) and 2014 (Volume 28, no. 2, Delta-Urbanism: New Challenges for Planning and Design in Urbanized Deltas) reproduced here represent some of the research that used a *regional perspective* to explain how humans re-shape the world. Multiple issues, too many to list, have employed a regional perspective to delve into changing urbanisms, cultures, and 'spatial development' work of particular regions. These explorations provide a wealth of evidence on the shape of regions, for instance of those that shrank (Understanding Shrinkage in

European Regions, Volume 38, no. 2, 2012) and those that expanded upwards (High-Rise Urbanism in Contemporary Europe, Volume 43, no. 4, 2017) and outwards (Suburban Cultures, Suburban Spaces, Volume, 41, no. 4, 2015) over the years.

Finally, *Transport* has always been prominent in the themes explored by *Built Environment*, often seen as a problem issue in urban planning, but more recently as a solution to improving quality of life and the urban environment. The early views were primarily concern with 'civilizing' the car, as it was realized that cities would have to adapt to the car or *vice versa* (Buchanan, 1963). Since then, the wheel has turned through interest in traffic management, demand management, and pricing. But even then, the car continued to dominate, and city planners then promoted high-quality public transport, and this provides the theme for our first transport paper, building on the Swiss Cities model (Kaufmann, 2004). Over the most recent past, with new debates on climate change, sustainability, accessibility, and the rights of citizens over the ownership of city space, the debate has become richer with the advent of cleaner, rented, low-speed personal transport. Our second transport paper examines the potential looking at North America (Shaheen *et al*., 2021).

Prospective – The Next Fifty years

To complete the picture given in this Golden Anniversary celebration, we give a perspective on the future direction for the journal. The most important urban planning issue is the growth in human population and the consequent impact on the environment and consumption. This population growth will not be distributed evenly across the globe: most growth will take place in Africa, and to a lesser extent in South America and South East Asia. That population will be increasingly living in cities and become 'urban', working in the service and technology sectors. Such a future seems clear, but the implications are less transparent with huge uncertainties. For *Built Environment* this means that the scope for new themes becomes vast, as population growth has substantial direct and indirect impacts on urban areas and their hinterlands.

Cities will become larger with the megacity and the megacity region, leading to complex structures and linear cities along public transport axes or in rings linked by high-speed rail – this is already happening in China and Brazil. City regions may develop more amorphously without strong planning interventions. But it not just city form and our understanding of the advantages of different 'city types', but also the value of open and green spaces, the functions of those cities, and the value of face-to-face contact – it could be argued that if cities cease to be places where people get together and socialize, then do they have any value? If the future is one of remote working, and online recreation and shopping, then the city population can be dispersed. An essential element here, and one that has not been addressed by *Built Environment*, is the importance of migration to the city and the wider trends of international migration. The city is often seen as being attractive, offering well-paid jobs and a higher standard of living. There are strong pull factors and historic associations play a part, but equally people are pushed from rural areas and from overseas whether from man-made or natural disasters or in search of a better life. Conversely, remote working enabling people to live *and* work in villages and the rural hinterland could blur the sense of self-containment of both cities and peripheral settlements, so that the concept of 'town–country' becomes a hybrid of the two in distinct locations rather than an intermediate blend of the two in a single place.

Related to these issues are the huge inequalities between and within nations, cities, and smaller urban areas, not just in terms of income levels but also of perceived opportunities. In general, those living in cities are better off, they are better educated, and they have better access to health and other public services. They are also more engaged in and knowledgeable of the rapid changes in technology in all its forms, and they are also better connected and have a higher quality infrastructure (transport, energy and water). This image of the city makes them attractive, but cities are also places of huge inequality that include maldistribution of the same factors mentioned above, together with the added disadvantages of poor quality but expensive housing, high levels of pollution, loss of community, and high levels of crime. These issues will provide a rich source of material for *Built Environment* and some of them need to be revisited to determine whether city life is improving for all, both in established historical cities and in the controlled and uncontrolled expansion of megacities globally.

Cities are growing and the inequalities are becoming more apparent. But cities are also dependent on the global environment due to their enormous 'footprints'. Cities need feeding and they need (clean) energy, green spaces, and water. But they produce huge amounts of waste (and pollution) – they are centres of consumption. That consumption is best illustrated by these needs plus the ubiquitous availability of internet connectivity. City demand for these essentials is increasing exponentially, yet the necessary investment in providing them is not keeping pace. At the same time, the expansive trends are problematic and alternative planning responses will be highly significant. These topics are all suitable themes for future issues of *Built Environment*.

The global climate crisis also has both direct and indirect impacts on the city. As sea levels rise, many coastal cities become vulnerable to flooding, and this together with the growing frequency and severity of weather events have increased the costs of mitigation and adaptation. Cities also act as 'heat islands' with the built form absorbing heat, making them warmer than the surrounding areas, and they have levels of pollution that exceed the WHO safe limits. Higher temperatures and pollution have health implications for the elderly and the young, and they increase the numbers of premature deaths, as well as overall levels of sickness and disease. Cities were unhealthy places to live 150 years ago, and they may increasingly become so again in the next fifty years. This underscores the importance of research around potential spaces and technologies for future living environments.

In the coming years we can expect increased attention to nature-based solutions, ecosystem services, and biophilia, which could also lead to new relationships between the natural and built environments, as concepts of 'nature' and different species cohabiting with humans are taken into consideration.

We can also expect advances in technology to bring further innovations driving change in the built environment, building on recent trends, from transport technologies (e.g. alternative fuels; drones) and operations (e.g. mobility as a service) through the exploitation of artificial intelligence and 'urban science' to social media (both as a behavioural setting and use as a research resource). As ever, the connectedness of these things is more difficult to predict than the individual advances; while fifty years ago one might have predicted advanced computation or 'flying cars', it would have been less easy to predict the use of a pocket-sized computer (smart phone) to gain real-time public transport information or order a cab from on board a delayed train, or to use data from social media postings to gain insights into the differential perception of place in the built environment.

Indeed, the next fifty years could even see the establishment of new off-world human-built environments, whether in space or on the Moon or Mars. Such developments could pioneer new kinds of building format, settlement unit, and structure – underground and/or enclosed urbanism – according to the environments, their socio-political structure, and construction technology. The prospect of 3D printing of buildings could be synergistic with the creation of built environments in hostile environments where remote construction minimizing human labour is the priority.

There is no shortage of critical topics for future issues of *Built Environment*, some of which are mentioned here, but others will naturally emerge over time. The difficulty may be in identifying relatively self-contained, yet interesting themes that can be addressed with a set of internationally sourced papers. The complexity and interconnectedness of global topics related to urban policy and planning issues provide challenging but interesting opportunities.

And complexity and interconnectedness feature in our first issue for 2025 devoted to Postgrowth Planning. Edited by Dan Durrant, Yvonne Rydin and Marjan Marjanovic, the issue will address the implications of a built environment where economic growth is no longer the desirable aim of planning, where resources are limited, and where their allocation cannot be driven purely by financial returns on investment. The contributors come from the range of disciplines involved in constructing, designing, managing, and governing the built environment and the issue will be published in late January/early February, a little earlier than our usual schedule.

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Enabling Vital Streets

STEPHEN MARSHALL

This commentary revisits Jan Gehl's 1980 paper on 'The residential street environment' and Vicinius Netto et al.'s 2022 paper asking 'Does Architecture Matter to Urban Vitality?' reflecting on the development of built environment studies in the meantime.

We may nowadays take it for granted that urban streets should be vital places, and that the design of the built environment can positively encourage that vitality, but the former was not always championed, while the latter was not always corroborated. Although Jane Jacobs famously highlighted the benefits of street vitality as early as the 1960s (Jacobs, 1961), it was only much later that professionals seriously aimed to positively encourage pedestrian activity by design, and for built environment studies to systematically evaluate the effect of built form on that vitality. This commentary revisits two papers from *Built Environment* that reflect this shift, from 1980 to the 2020s.

Jan Gehl's paper 'The residential street environment' (1980, p. 51) argues that lively streets depend to a large extent on 'the design of the interface between public street and private houses', reporting on findings from a number of studies of residential streets in Ottawa, Melbourne, and Copenhagen. It suggests that lively streets are those that allow for 'staying and playing' activities and not just catering for 'come and go' activities. The paper presents a series of statistics about the proportions of different activities, noting that the 'coming and going' activities, while more frequent, are shorter in duration, whereas the 'staying and playing' activities occupy more time overall. These findings are presented via a series of charts, including a plot showing a correlation between the occurrence of outdoor activities and the number of interactions on the street.

It is implicit here that a lively street is a good street. Also underpinning the prerogative of the paper, more explicitly, is the power of the built environment to influence and support the street activities, especially by the framing of public space and treatment of interfaces. This is in effect treating the design of the residential street as an outdoor room. Here, rather than the building or plot, it is the street that is the unit of design (comprising as it does the public street proper and the semi-private front yard or garden and building interface).

Compared with the typical content of today's *Built Environment*, Gehl's paper is perhaps on the short side (eleven pages); it gets straight to the survey content in the first paragraph, which would have been in the spirit of the journal's practical orientation in those days (Banister *et al.*, 2024). The paper could be regarded as providing evidence-based findings for urban design, although the author himself acknowledges that not all the suggestions are yet fully proven; but it is inferred that they are drawn from established experience and prior studies.

While many of the propositions and findings of the paper may seem obvious today, we have to remember that such things were not necessarily so well-established back then. Gehl's work as a pioneer of 'life between buildings' (1976) is now considered classic, almost essential reading forty years on, but at the time it was not so obviously destined to become the mainstream view.

We can recall that, following Le Corbusier's 'death sentence' for the street, the residential street had been at the time under threat. Modernist town planning had encouraged open plan layouts with stand-alone apartment blocks, or houses set in open space, and not necessarily enclosing public space. In particular, 'Radburn' type layouts in a sense turned the traditional street inside out: instead of a public front and private back, houses would front on to a public green space, and back onto vehicular roads with garages and lock-ups: there was no integrated public street as such (Marshall, 2005).

Even in design guidance, the term 'street' had disappeared from some official nomenclature: in the UK, the residential layout manual eschewed the term 'street' but was about 'residential roads and footpaths' (Department of Environment/Department of Transport, 1977). It took over twenty years before the pendulum swung back towards designing building-fronted streets as a positive enterprise, with *Places, Streets and Movement* in 1998 (DETR, 1998) and later the *Manual for Streets* in 2007 (Department of Transport, 2007). More broadly, the renaissance of the street was taking place from the 1990s and 2000s in many countries round the world during this period (Marshall, 2005).

Gehl's work was a persuasive part of urban designers fighting back against the more traffic-engineering dominated approaches to urban layout (Hebbert, 2005). We now take it for granted that 'streets are for people' (not just vehicles); and indeed, the streets most adapted for vehicles are the least street-like in terms of their qualities. But, as with Gehl's paper in *Built Environment*, this renaissance was not just planning ideology for its own sake, nor a swing in architectural fashion; it was grounded in empirical studies, or at least evidence-based observation, focused on people and their activities. In other words, it was not just concerned with the framing shell that is the built environment, but its living contents, and their synergistic relationship. It is no accident that the theme of the journal issue in which it appeared in was 'Architects, Space and People' (Volume 6, no. 1), signifying these relationships beyond just the built environment of itself, but the creation of the environment for a wider societal purpose.

We can then fast-forward forty-two years to the paper by Vicinius Netto, Renato Saboya and Júlio Celso Vargas that asks more explicitly, 'Does Architecture Matter to Urban Vitality?' This paper was published in 2022 as part of the *Built Environment* special issue on Urban Form and Liveability (Volume 48, no. 3). It asks a question of fundamental significance to architecture and the built environment, or the contribution of architectural form and features to urban performance. The authors further ask: 'Would different building types have different effects on the social life of streets and neighbourhoods?' and 'what is the extent of that effect?' (Netto *et al.*, 2022, p. 319). This is a consciously bolder and more pointed agenda than simply studying the residential street environment and observing what could be seen: it implies committing upfront to establish the relationship between the object of study – the architecture – and the urban effects.

This the authors do by undertaking a systematic study of streets in Rio de Janeiro; more specifically, a study of over two hundred street segments and over four thousand buildings, including their morphological and architectural features (such as presence of windows or setbacks), and related to the presence of moving or stationary pedestrians. A distinctive feature of the study is controlling for effects of density and accessibility, so that the analysis takes into account whether the street segments have low, medium, or high density and low, medium, or high accessibility.

The study is meticulously set up and

executed with statistical testing, including typological clustering, box plots and tabulations of correlations and statistical significance. The authors set up two basic types of building – 'continuous' and 'detached' – and carefully set out nine 'hypothetical lines of causality' which could explain why one might expect the 'continuous' building type to lead to more pedestrian activity.

The authors duly find that the 'continuous' type of building is correlated with greater pedestrian activity, and that buildings with continuous frontages and greater density of windows and doors are positively correlated with pedestrian activity, while setbacks and barriers are negatively correlated. The authors conclude that 'urban vitality relates intimately to urban form' and (hence) that 'the built environment matters' (Netto *et al.*, 2022, p. 337).

In a sense, this paper echoes some of the spirit of Gehl's, but also reflects a shift in the type of treatment in urban design research – and *Built Environment* – between 1980 and the 2020s. Netto *et al.*'s paper is over twice the length of its predecessor, and is set out more systematically and consciously as a scientific method with explicit hypothesizing and statistical testing. As the authors themselves say (*ibid.*, p. 320), their approach builds on the trend for studies since the 1990s to seek 'empirical robustness' with 'increasingly larger samples' associated with the 'new science of cities' (after Batty, 2012).

While Netto *et al.*'s paper does not directly observe Gehl's fine-grained categorization of pedestrian behaviour, nor detailed depictions of the residents interacting with particular built environment features such as steps and railings, it is clear that future studies could combine the strengths of both papers, to gain as complete a picture as possible, from which to draw lessons. In both papers, we see the value of the authors presenting their insights backed by empirically observed behaviour, offering insights into how people interact with, and benefit from, their built environment.

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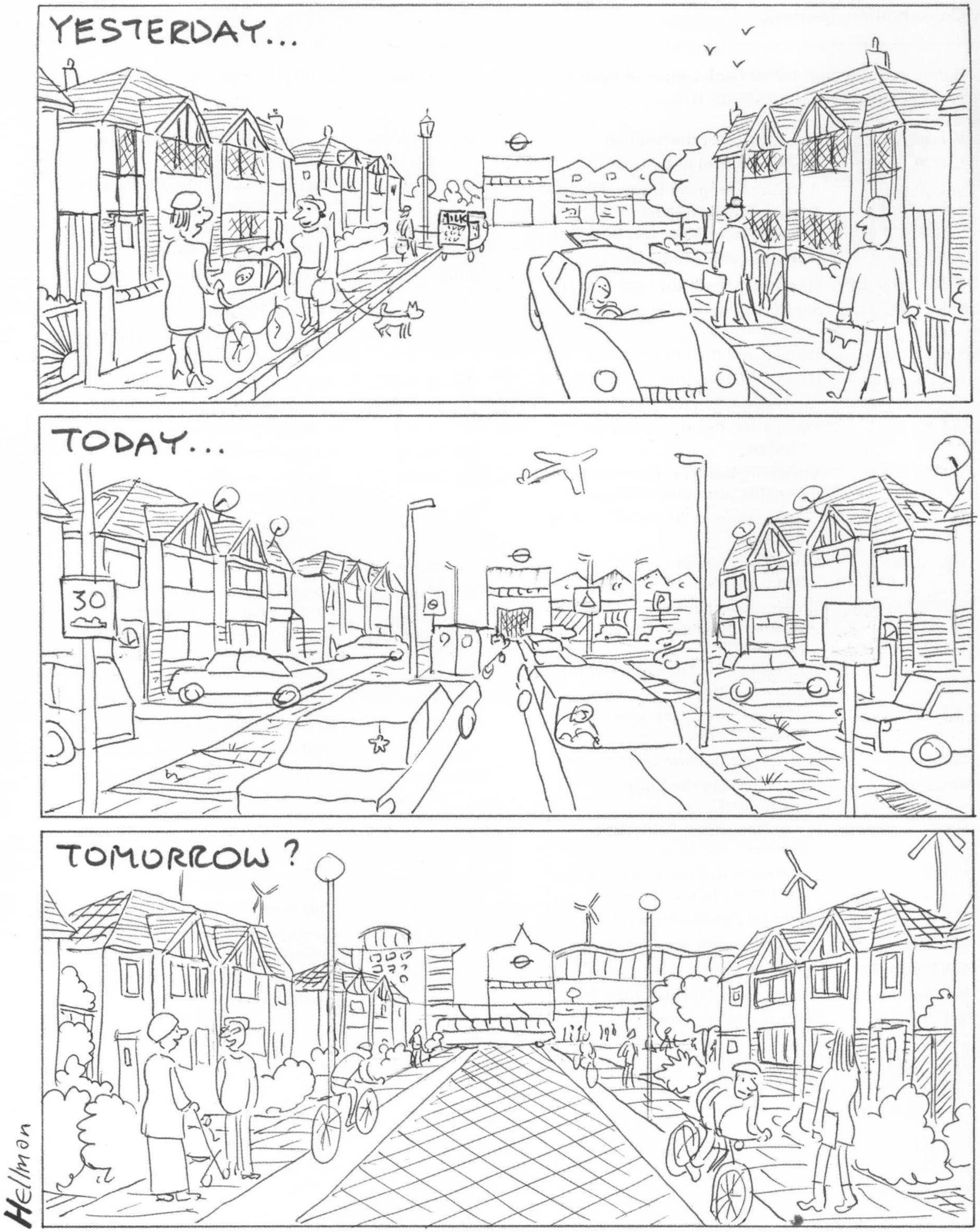

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The Residential Street Environment

Jan Gehl

Lively residential streets are those where the people meet easily and enjoy leisure and chores outdoors. To a large extent this may depend on the design of the interface between public street and private house.

In a number of studies in various parts of Europe, in Canada, and in Australia, the division of street activities into seven categories has proved useful in obtaining an understanding of the character and subtleties of residential street life. The categories used are:

Staying activities which include all types of outdoor activity where people stay where they are — sitting, lying or standing about. This category includes all age groups.

Doing activities which include people of all ages engaged in a great variety of daily chores — gardening, working on cars, repairing or working on the upkeep of houses, fences, sidewalks and streets.

Strolls within the area which take account of all those going from one house to another or just walking for leisure in the street.

Interaction activities which cover all people, with the exception of children, engaged in any form of interaction from brief greetings and waving, to short chats, to long conversations.

Playing activities which include children playing together (child interaction).

Coming and going on foot or bicycle which includes anyone entering or leaving houses in the area on foot or on a bicycle.

Coming and going by car which includes all people present in the street as part of the process of entering or leaving the area by car, i.e. all persons passing to and from cars parked in the street. This does not include activities concerning cars parked in garages or carports since in this case one might say that it is only the car which eventually uses the

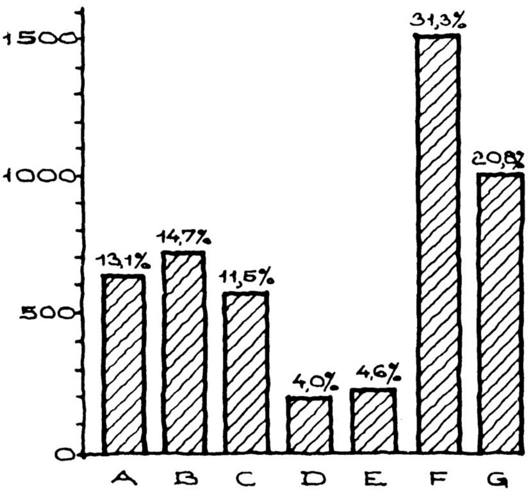

Figure 1. Total number of activities. A: interaction activities, B: staying activities, C: doing activities, D: playing activities, E: strolls within the area, F: coming and going on foot or by bicycle, G: coming and going by car

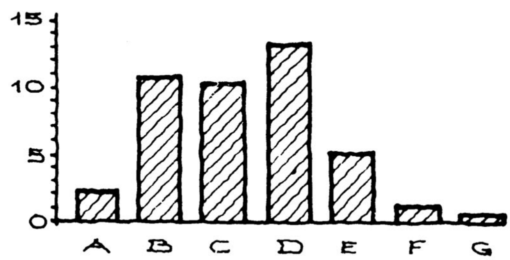

Figure 2. Average duration of each type of activity in minutes. A, B, C, D, E, F, G have the same meaning as in Figure 1

street proper and not people.

People merely passing through the area on foot, bicycle or in a car are omitted from these categories, since we included only those activities generated by households in the study area.

Frequency and Duration of Street Activities

The frequency and duration of the various categories of street activity described above were investigated in a study carried out in summer 1977 in the cities of Waterloo and Kitchener, Ontario, involving students from the Architecture School, University of Waterloo. Twelve different streets of terrace and detached houses were selected, and in each case a stretch of 100 metres containing between 10 and 22 houses was studied. In the course of an ordinary weekday all activities during daylight hours were observed and recorded.

Figure 1 shows the number of activities in each category for the 12 streets, and that 52 per cent of the total number of activities is taken up with 'come and go' activities. On the other hand, such activities are of very short duration compared to 'staying', 'doing' or 'playing' activities (Figure 2).

However, the real picture of street life does not emerge until the number of activities and their average duration is combined (Figure 3). In fact the numerous 'come and go' activities only account for a little over 10 per cent of the total outdoor time, while 'stay and play' activities account for nearly 90 per cent.

Thus the findings of this study underline the fact that a lot of 'come and go' activity does not create a lively street. Lively streets are much more dependent on whether the longer lasting 'stay and play' activities have a chance to develop — and this to a very large extent is dependent on careful street design. In other words, if designers are to create lively residential streets they must cater for

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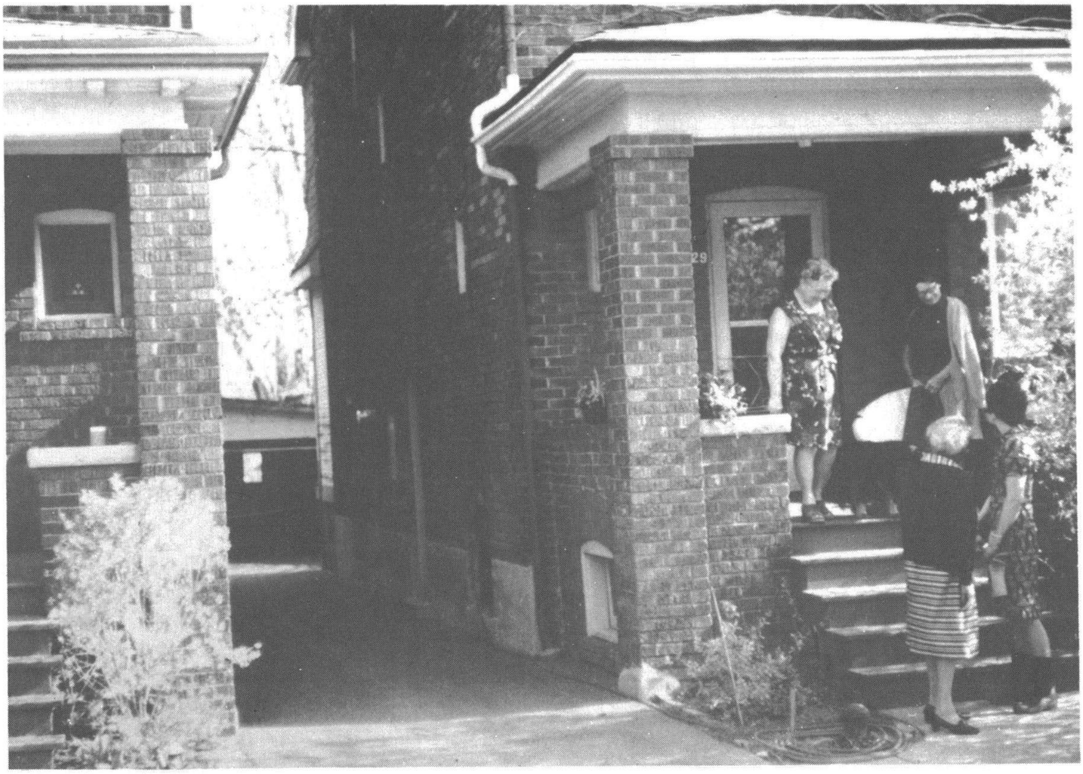


Opposite and above, Canadian residential streets similar to those investigated. The houses are detached, but close together; each is provided with a porch (Toronto)

'stay and play' activities.

From even a cursory look at the residential streets of Western industrialized countries, it is evident that the majority do not cater for such activities, or at best pay only lip service to their existence. For the most part they are seen only as traffic corridors — 'come and go' streets. Where provision is made for anything other than through movement, it is likely to be directed towards play facilities for children. However, while playgrounds can create places for children to meet and 'do things', the opportunities for 'stay and do' activities for other age groups are almost non-existent. A closer look at street design and facilities which would cater for the 'stay and do' activities of all age groups could perhaps help to make residential streets more lively, more useful and more liveable.

A series of street studies from Australian cities may suggest ways of giving other age groups, and not just children, the chance to participate in residential street life.

Street Studies in Melbourne

The traditional building form in the older parts of Australian cities is the low-rise terrace house, provided with a veranda and small front yard giving access to the street, with a private garden behind the house.

This set-up, and in particular the role of the verandas and front yards in relation to the street and street life, were the subject of a study carried out in spring 1976 with students from the School of Architecture, Melbourne University. The study, which was of 17 streets, all with only local traffic, was carried out on lines similar to the Canadian studies. Street sections of 100 metres were

Australian terrace houses with semi-private front yards (Paddington, Sydney)

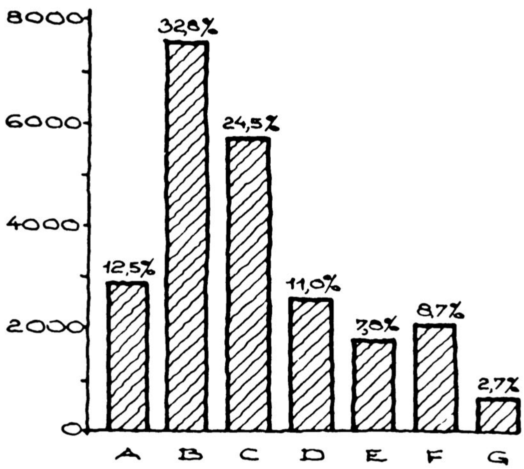


Figure 3. Combination of the duration of each activity and the total number in category. A, B, C, D, E, F, G have the same meaning as in Figure 1

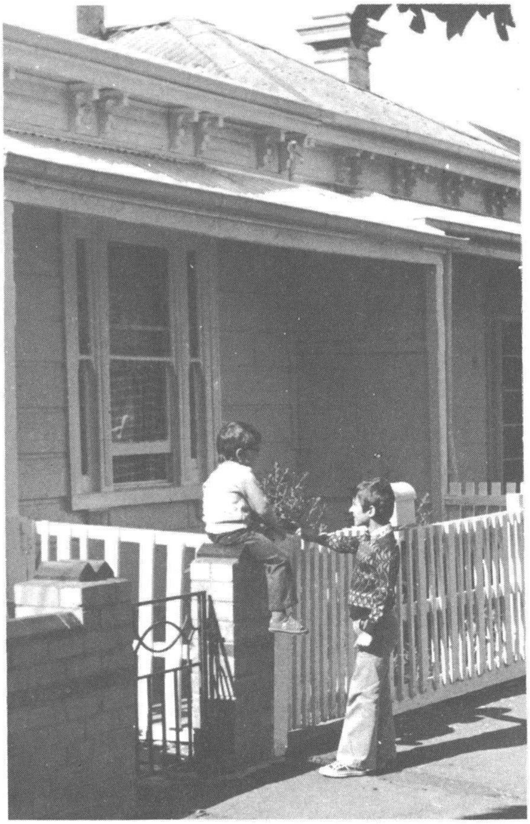
observed during daylight hours, both on Sundays and weekdays, and these observations clearly established the very important role of the semi-private front yards.

CHILDREN USE THE STREETS — ALL OTHER GROUPS USE THE FRINGE ZONES

During the study it was found that children used the front yards as a base, a starting point for outdoor activities and for resting and interludes between more extensive play activities. However, most actual play occurred in the street itself.

This was in marked contrast to the activities of other age groups: an impressive 76 per cent of their 'stay' activities took place — or were related to — the front yards (Figure 4). ('Related' in this sense means that at least one of the people involved in an activity was in the front yard or in some other way 'holding on to his or her own

THE RESIDENTIAL STREET ENVIRONMENT



Child play starts right next to the houses; the semi-private territory can serve as a safe home base from which to set out into the more public territory

territory'.)

In the case of 'doing' activities, 58 per cent took place in and around the front yards (the relatively higher proportion of activities of this category in the street was mostly accounted for by activities centred around the cars parked there).

Finally, 69 per cent of the interactions occurred in or around the front yards (Figure 5).

THE EDGE EFFECT

Having concluded that the children's activities were mainly in the street, while they used the front yards 'to get things started', the study shows very clearly that the activity area for all other age groups was definitely the edge of the street, in the semi-private areas directly adjacent to the buildings. Sixty-nine per cent of all 'staying',

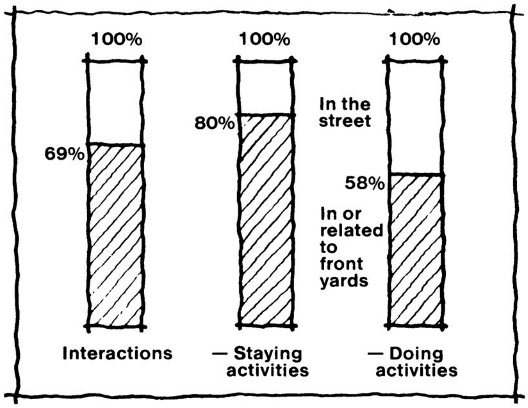


Figure 4. Where interaction, staying, and doing activities occur

'doing' and 'interaction' activities occurred in these 'edge' areas.

Several studies and several environmental psychology writers have pointed to the 'edge effect' and the importance of careful edge design in public spaces. Alexander *et al.* (1977) state in *A Pattern Language* that 'the life of a public space forms naturally round the edge. If the edge fails, then the space never becomes lively.' Here, in the low-rise residential streets we studied, is obviously another case where the edge design is the all-important factor for street life.

If the edge does not work, the street will tend towards being a 'come and go' street — merely a

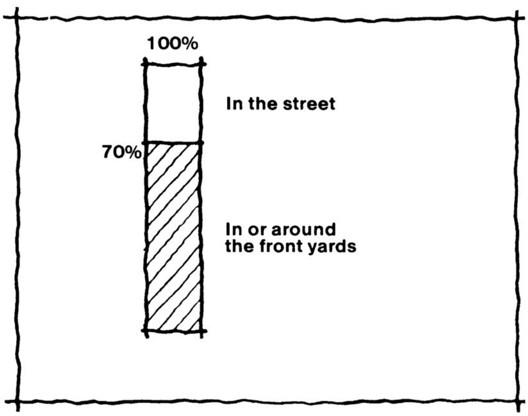


Figure 5. Division of all recorded adult activities between the street and in and around the front yards

Above and opposite, two streets in the same area of Copenhagen: one with front yards and gardens and the middle section laid out for recreational activities, the other with the front yards removed to cater for traffic. One is a 'stay and play' street, the other merely a 'come and go' street

traffic corridor. If the edge does work, it may tend towards being a 'stay and play' street as well, and thus a much livelier place with a potential for a much higher level of interaction between neighbours.

THAT LIFE FLOWS OUT — AND IN

There are many obvious reasons explaining the intensive use of the semi-private front yards — one is simply that they are very easy to go in and out of.

A striking finding from the Melbourne study was that a large proportion of outdoor 'stays' were of very short duration. Forty-six per cent of all 'staying' activities lasted less than a minute (Figure 6). People of all age groups frequently drifted out into the front yards, standing for a few moments on the doorstep or walking up to the fence for a quick look up and down the street. Sometimes, if nothing was happening, they would walk back inside; sometimes they would be attracted by people or activities elsewhere and hang around for a while, participating or just observing.

Life inside the houses tended to flow freely out — and in — in a very relaxed, unpretentious way. Many recreational activities tended to develop as gradual processes — as spur-of-the-moment 'impulse' activities rather than preplanned ones. Under these conditions all forms of outdoor activity are given a substantially better opportunity to develop. Larger-scale events can grow spontaneously from a starting point in many little visits outdoors.

THAT THERE ARE PLACES TO 'STAY'

Another important factor is that the edge zone, particularly where semi-private front yards are provided, offers attractive opportunities for 'stay' activities. Comfortable seating of one's own choice can be placed right by the door. One can sit there for a minute or two or a longer period, and while sitting there it is possible to follow what is going on in the house — look after children asleep,

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kettles boiling, telephones ringing — and at the same time follow what is happening in the street. One can bring out transistor, book or coffee-cups and leave them all while attending to something in the house. And if an extra sweater is needed, one can just fetch it.

This close relationship between the outdoor 'staying' zone and indoors is a most valuable combination, which invariably will give the seat right next to the house many more 'use-hours' a year than any public seating arrangement further away. Sitting next to the house provides the best of two worlds — house and street. And furthermore one is present in the street in a very modest, unpretentious way, sitting comfortably at the edge, partly hidden by one's own fences, screens, shrubs or garden umbrellas.

No wonder this is a very attractive proposition for adults and especially for the elderly; and no wonder the public street benches are used so much

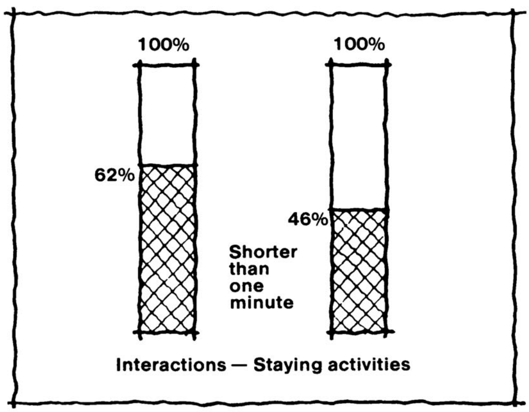

Figure 6. Duration of activities

If the planners 'forget' to provide semi-private areas, they may find that the inhabitants take matters into their own hands. A new housing area in Copenhagen where the bushes and shrubs provided by the landscape architect have been removed to make way for semi-private front yards

less — they can provide only a fraction of the opportunities which semi-private seats offer.

THAT THERE IS SOMETHING TO DO

Another quality of the semi-private front yard is that it provides residents with a number of meaningful activities on the 'public side' of the house, in particular in the small gardens there. One may want to enjoy the sunshine and the street scenery and decide it is time for a bit of gardening. Thus one may experience enjoyment while doing something meaningful at the same time — not being idle and not being too curious about the street life. Indeed it was found that many of the 'doing' activities served a fascinating double function of providing meaningful activity as well as a pretext for being in the street environment for considerable periods of time.

Generally, front yard gardening was found to occupy much more time and attention than could possibly be justified from a strictly horticultural point of view. Tiny lawns were mowed and gardens watered again and again with many pleasant interruptions from passing neighbours or children playing. Events were immensely interwoven and intricate, and none could tell precisely whether the people were out to enjoy the street, chat with neighbours or to do their planting, maintenance or gardening. Obviously the answer is that people were out for a multitude of reasons, and that it was exactly this complexity of opportunities which created the real attraction of being in the street environment and not in the private gardens at the back of the houses.

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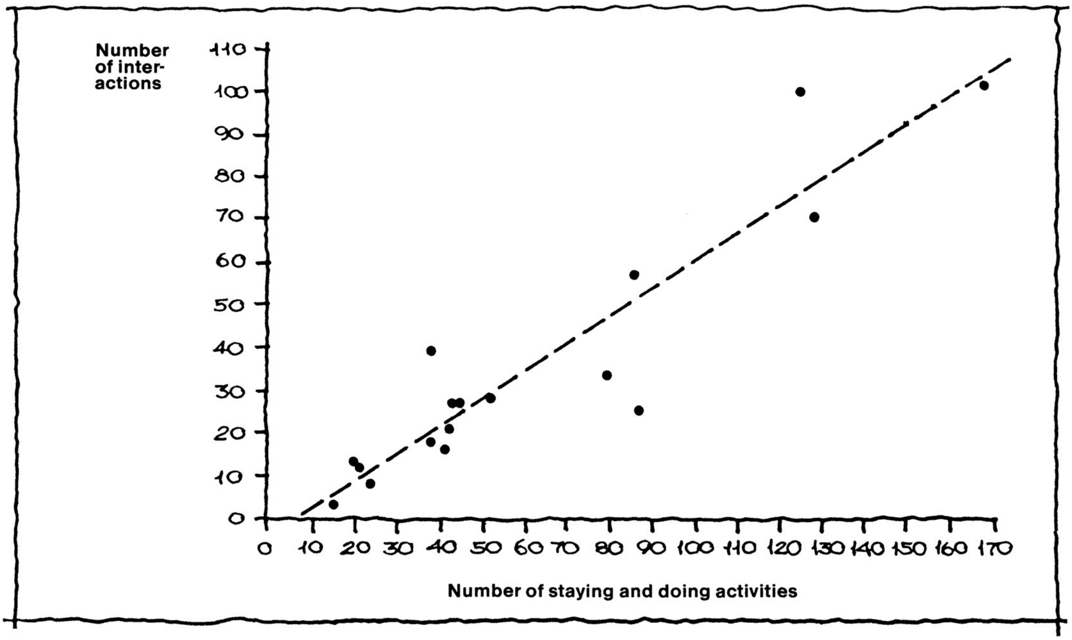


Figure 7. Relationship between number of outdoor activities and number of interactions

THAT OPPORTUNITIES FOR PERSONALIZATION ARE PROVIDED

Before leaving the subject of semi-private front yards, two other qualities should be mentioned. One is that the front yards, especially if they include a small planting area, do provide an excellent opportunity to personalize one's home environment, making the house and front area more attractive, and the street more diverse, greener and more friendly.

THAT NEIGHBOURS ARE KEPT AT ARM'S LENGTH

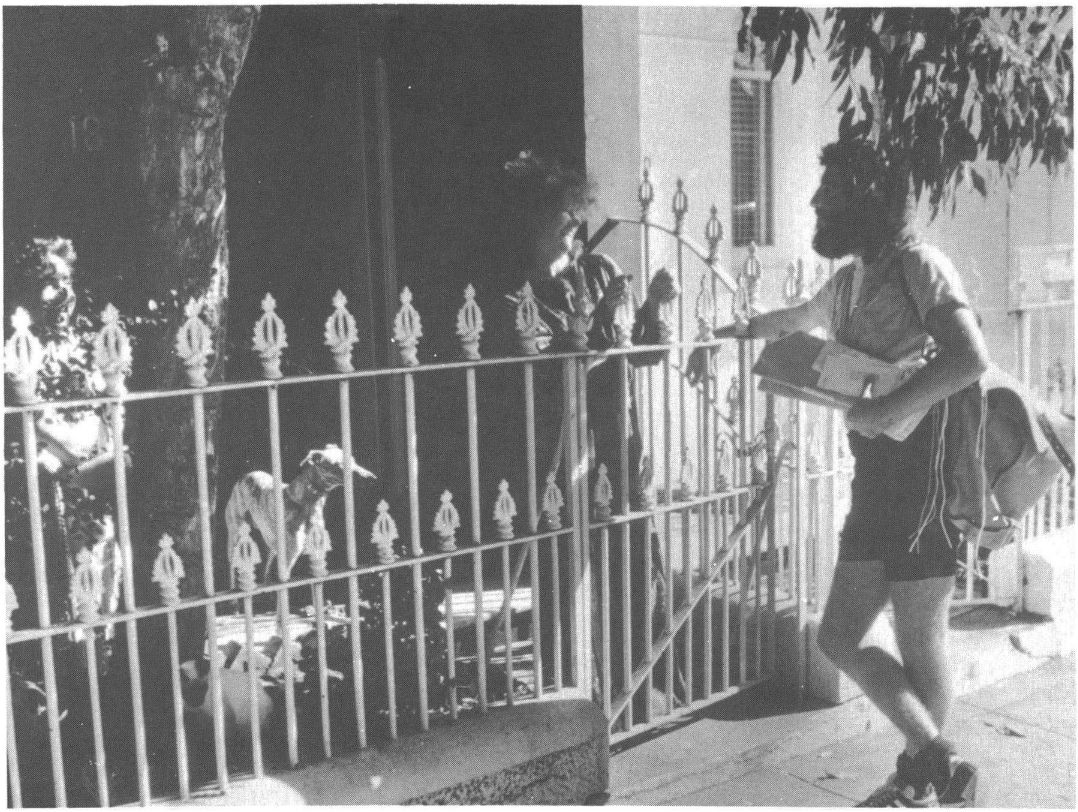
The other quality is the fact that semi-private front yards create a buffer zone between the public street and the private house — a gradual transition from private to public, which enables the residents to control the degree of interaction and intimacy in each case as they wish.

This indicates that the front yard should be narrow enough to enable a quick chat between sidewalk and house, yet wide enough to enable people sitting in front of the houses to stay back from unwanted intrusions. Very narrow buffer zones of just 1 or 1.5 metres were found to be definitely too narrow, while front yards in excess of 4 metres tended to be too wide.

Though this has not actually been proven from the limited scope of the street studies described here, it can be assumed that the buffer zones and the freedom to choose in each case the desired degree of interaction will actually have a positive effect on the total neighbourhood environment. It is easier to 'come forward', to participate, when you have a very clear territorial layout in which to operate.

RELATIONSHIP BETWEEN INTERACTIONS AND ALL OTHER OUTDOOR ACTIVITIES

The above viewpoint may be underlined by the finding — in both studies — of a direct relationship between the number of interactions and the extent of all other activities (Figure 7). The livelier the streets, the more time spent outdoors, the more interactions were found to occur. This, of course, does not tell us anything about the character of the contacts or the extent of more intensive personal contacts between neighbours in the streets. The findings only point towards the *quantity* of interactions and actually demonstrate a very logical relationship. The more time neighbours are out in the streets, the more frequently they will actually see and meet each



Forty-eight per cent of all interactions take place 'over the fence' (Paddington, Sydney)

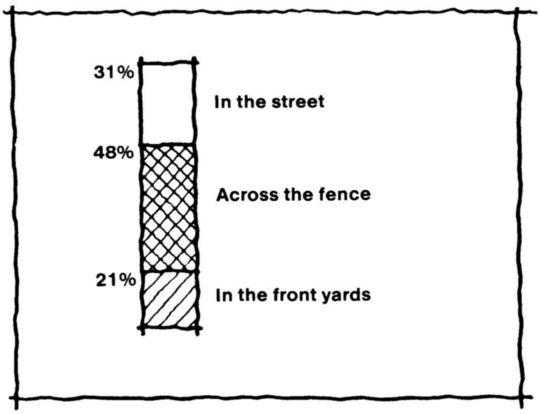


Figure 8. Where the interactions take place

other, and, logically, over the years, greetings and short chats will develop — and probably long conversations as well if mutual interests are established.

The role of the semi-private front yard in relation to interactions is quite obvious from the figures showing where they occurred in the studies of the Melbourne streets (Figure 8): 31 per cent on the street, 21 per cent in the front yards, and 48 per cent 'over the fence' in the border zone between street and front yard. In these most frequent cases the situation would typically be that someone passed by a front yard where a neighbour was. If the neighbour was interested beyond exchanging greetings, he or she would come up to the border zone, perhaps lean towards the fence for a longer chat at the end of which one or other would 'back out' either by continuing down the street or gradually retiring into the semi-private area.

Conclusions

The main purpose of this article has been to point out that it is the 'staying and playing' activities which create a lively street environment, and that residential streets may be divided into two highly contrasting categories: the *'come and go' streets* and the *'stay and play' streets.*

Also it has been pointed out that while the 'come and go' street sometimes can be used by children and occasionally by other age groups, these other age groups are generally left with very few real opportunities for 'being in the street'.

If all age groups are to be provided with attractive opportunities for using the street environment, then the street design must cater for 'stay and play' activities, and in this context the street edges, the areas immediately adjacent to the dwellings, would be the obvious areas to be developed, because *1 square metre next to the houses is invariably more useful than 10 square metres round the corner.* At least this applies for adults and particularly for the elderly, and perhaps helping these age groups to make much greater use of the street environment would in itself be one of the best ways of improving the children's environment.

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Does Architecture Matter to Urban Vitality?

Buildings and the Social Life of Streets and Neighbourhoods

VINICIUS M. NETTO, RENATO SABOYA, and JÚLIO CELSO VARGAS

Since Jane Jacobs's seminal insights in the 1960s, one of the most emphasized notions in urban studies is the role of architectural and urban form in the 'vitality' and 'liveability' of cities, understood as sets of social and economic qualities such as people's co-presence in public spaces and diversity in local activities. However, can buildings affect their urban surroundings? Would different architectural types have different effects on the social life of streets and neighbourhoods? These questions are all the more important once we observe a trend in developing countries and other regions – a form of urban growth shaped by detached vertical buildings and gated communities surrounded by setbacks, replacing traditional buildings and creating fragmented urban fabrics. We develop an approach to recognize empirically the urban effects of buildings while controlling for systemic factors such as street network effects. We apply this method in a large-scale empirical study with twenty-four areas randomly selected in Rio de Janeiro, Brazil. Statistical results suggest distinct effects of building types and their features on pedestrian behaviour and land use diversity, helping answer a question that puzzles the spatial imagination: does architecture matter to urban vitality?

… there are two types of density… 'Raw density' is found in areas filled with taller and taller buildings that alone do not generate innovation or economic development. In contrast, the 'Jacobs density' encourages street-level interaction and expands the potential for informal contact between people in public spaces at any time. It makes encounters and building [social] networks more likely.

Richard Florida (2012, p. 1)

One of the most central and perhaps least examined ideas in architecture and urban studies concerns the role of buildings in the 'vitality' and 'liveability' of cities. Understood as a set of social and microeconomic conditions found in areas with an intense presence of people on the streets, interacting groups, and diversity in local activities and material exchanges, urban vitality has been discussed since the seminal theory and ethnographic observations of Jane Jacobs (1961). Indeed, a number of authors have looked into which aspects of *built form* have the capacity to stimulate vitality. More recently, the role of urban form and a particular way of arranging densities – namely, low-rise buildings with high ground cover-

Contact: Vinicius M Netto ✉ vmnetto@fe.up.pt

age dubbed 'Jacobs densities' by economists Gordon and Ikeda (2011) – returned to attention in spatial economics, primarily associated with the promotion of random interactions seen as the engine of innovation. Features of the built environment, urban design, and land use mix have also been related to walking in travel behaviour (see Ewing and Cervero, 2010), an essential component of street life. Pedestrian movement, in turn, has been connected with accessibility in street networks in space syntax approaches (e.g., Hillier *et al*., 1993) and, more recently, to types of urban form (Berghauser-Pont *et al*., 2019). However, most of these works have not brought to the forefront the precise role of *buildings* as discrete spatial entities, their types, and distributions along streets, along with the role of associated features like the density of doors and windows, setbacks, and building-street interfaces on street life – especially as a way to disentangle their possible effects from overlapping multiplier effects of systemic properties such as accessibility.

The present work develops a method to identify and assess the existence and extent of the effects of buildings on the states of local social and economic variables like the presence of pedestrians in streets and street-level microeconomic activities and diversity. It does so to distinguish the effects of buildings – their types and features – from those of accessibility patterns. Buildings seem taken for granted as a primary condition of social life in architectural and urban design. Their social effects are by far less discussed than their aesthetic effects. First and foremost, we may hypothesize the role of buildings in triggering co-presence in public spaces. Co-presence is an elementary form of social experience and awareness of others (Goffman, 1972), a key feature in social integration, fundamental to even the most elaborate forms of societal organization (Giddens, 1984). However, the role of buildings in urban life goes further than a material condition for bodily interaction: it includes the materialization of networks of actions and activities that extend well beyond our visible surroundings. The actions carried on in buildings and their interfaces with public spaces trigger activities that create and sustain extensive chains of actions and flows of circulating artefacts and information. Moving across scales, such networks are completed when we interact within and between buildings. What we do when we search for local activities and achieve when we access their locations is a crucial reason for and drive in the workings of cities and how social and economic systems reproduce.

The role of buildings in the life of public spaces and microeconomies is all the more important once we observe a trend in developing countries and other regions (e.g. Oliveira *et al*., 2020) – a form of urban growth shaped by *detached* vertical buildings and gated communities surrounded by setbacks and parking lots, railings and walls. Decades after the first modernist postwar wave of urban block dissolution (Panerai *et al*., 2004), a new wave of spatial transformation seems to be hitting cities. Real estate marketing trends have evolved into architectural solutions oriented to individualistic, car-dependent lifestyles and private open spaces. Urban policies followed, loosening building height and requiring setbacks, allowing the construction of high-rise buildings even in low-density residential areas. The traditional fabric of adjacent buildings close to the public space has been replaced by a detached architecture marked by disconnection from neighbours and distance from the street and each other. These buildings do not configure compact ensembles but fragmented distributions (Gehl, 1976). A few decades of replicating this architectural pattern have left their mark on the landscapes of larger cities in Brazil. Our focus in this study is vertical growth and a radical discontinuity in the urban form at the ground level of buildings, along with three-dimensional fragmentation. Importantly, this trend seems to coincide with decreasing levels of social appropriation of the streets, understood by many as a 'crisis of public spaces' in Brazil.

These trends are particularly relevant in the light of ongoing urban sustainability debates around the need to reduce car dependence and increase compacity in cities (Ewing and Cervero, 2010). The coexistence of these different architectural and urban patterns and their seemingly radically different performances in urban vibrancy, microeconomic diversity, and pedestrian appropriation of public spaces begs the question that never seemed to leave the spatial imagination: *does architecture matter to urban vitality?* More specifically, would different building types have different effects on the social life of streets and neighbourhoods? If buildings have this kind of effect on their surroundings, what is the extent of such an effect?

Of course, a major challenge in answering such questions is identifying the effects of a particular entity – buildings – within a complex system like a city. Cities involve vast numbers of different entities caught in interactions which may or may not include causality and linearity. In fact, powerful effects of properties like density and accessibility and entities like street networks over the workings of cities, like the distribution of activities or even pedestrians in urban space, have been predicted and empirically detected in different fields – from Alonso (1964) in spatial economics to Hillier *et al*. (1993) and beyond in urban configurational studies. Any approach to the effects of buildings on the social life of streets and neighbourhoods must be aware of the challenges in distinguishing the effects of other entities and structures that run simultaneously, immersed in spill-overs, and multiply impact at different scales.

This article has the following structure. The second section engages with the literature and state of the art regarding the problem. The third section sets up hypotheses concerning the proposition of a binary building typology and associated social and spatial features as a means of approaching the problem. The fourth section deals with the issue of how to identify the effects of buildings controlling for urban densities, accessibility, and street network effects. In the fifth section, we apply this method in a large-scale empirical study with twenty-four areas randomly selected in Rio de Janeiro, Brazil. The sixth section brings together statistical results and discusses what they mean regarding the effects of building types on pedestrian behaviour and their relation to microeconomic diversity. The concluding section summarizes our findings and their implications for planning. It discusses systematic losses of urban vitality as a large-scale consequence of architectural choices in contexts locked in detached buildings as the dominant feature of urbanization.

Urban Vitality as an Effect of Buildings: An Overview

Decades of attention have been devoted to the possibility of buildings and built forms having effects beyond aesthetics. These effects have to do with the events that occur at street level, such as allowing for certain ground floor activities to emerge and the presence of people in their surroundings, particularly the public space of streets – the 'life between buildings', as in Gehl's (1976) insightful book title. Most of these works reflect a previous historical trend within urban studies of relying on limited scientific foundations, particularly regarding the robustness of empirical support (see Marshall, 2012). Jacobs's (1961) powerful descriptions of the impacts of traditional and modern architectural forms along with subtle spatial features like façades and openings upon street life were based on a rather latent urban ethnography whose empirical systematicity remained unclear. Gehl's (1976) emphasis on visual and physical connections between buildings and public space through transitional spaces, or Alexander *et al*.'s (1977, p. 593) conclusions that 'the setbacks have destroyed the cities' did not engage with efforts to verify theoretical claims as part of the scientific workflow empirically. That said, these works should not be blamed for lacking such foundations or concerns. Scientific standards have been evolving in urban studies, and only more recently – particularly since the 1990s – have searched for the missing empirical robustness. They did so through problem definitions able to render empirical factors at hand identifiable in more rigorous ways (e.g. Hillier *et al*., 1993; Cervero and Kochelman, 1997). Methods have engaged with increasingly larger samples – i.e. larger and more numerous urban areas or cities – but they continue to face challenges in scaling up empirically.

Many urban research problems happen at fine-grained scales. Social behaviour and spatial features can hardly be grasped at these scales by data structures like demographic census and other large-scale surveys associated with broad research interests, as crucial as they are. This status has been changing quickly over the last two decades, when research techniques based on digital data, including real-time phenomena, have been incorporated into theoretical and empirical work, revolutionizing the discipline and leading to a *new science of cities* (see Batty, 2012). For instance, new data sources and analyses have allowed researchers to tackle fine-grained spatial behaviour associated with mobility and other high-frequency dynamics. They have also allowed researchers to grasp and analyse large-scale urban forms through automated datasets like Google Maps and Open Street Maps (e.g. Law *et al*., 2019). At the same time, these new sources have not yet reached the full spectrum of urban processes and what happens in cities – for instance, real-time bodily-based interaction in public space and individual buildings' morphological and typological features. Whether these methods will be able to do so is an open question. Today, researchers still might be required to go to the field to gather systematic observations – which are costly in time, effort, and resources, even if the resulting datasets are complemented with digital ones.

Interesting empirical work on the *urban effects of buildings* has been done, nonetheless. Fanning (1967) analysed the records of 558 families in Germany and found that those living in high-rise buildings had fewer interactions with neighbours and spent less time in adjacent public spaces. Amick and Kviz (1975) found that social interaction improved in public housing consisting of low-rise buildings with high site coverage compared to high-rise buildings with low coverage ratios (Talen, 1999). In Brazil, ethnographic observations showed a decreasing level of opportunities for face-to-face contact in the streets in areas shaped by modern vertical buildings featuring railings and setbacks as opposed to a traditional, compact neighbourhood in Rio de Janeiro (Vogel *et al*., 1985).

In a tradition relating the *built environment design* to *travel behaviour* established since the 1990s (e.g. Cervero and Kochelman, 1997; Moudon *et al*., 1997), Lund (2003) analysed pedestrian behaviour comparing four inner-city neighbourhoods and four suburban developments in Portland, Oregon. Lund observed that direct routes to shops within 400 m were positively correlated to destination trip frequencies, and residents were more likely to engage in unplanned interactions and form social ties with neighbours. In a study about walkable new urbanist neighbourhoods, Rodríguez *et al*. (2006) found that inhabitants had significantly higher rates of walking and cycling than their counterparts living in conventional suburban neighbourhoods in North Carolina. Mehta (2009) analysed stationary and moving pedestrian behaviour in neighbourhoods and commercial streets in three towns in the Boston, Massachusetts's metropolitan area, and concluded that among the essential physical features were articulated building façades (small recesses and setbacks) and, to a lesser degree, building permeability to the street. Zook *et al*. (2012) found a positive correlation between shop entrances and the number of pedestrians in mixed-used areas in Atlanta, Georgia. Other lines of work focused on potential factors of urban vitality, breaking down Jacobs's categories but still requiring validation through empirical correlations with dependent variables, such as people's presence in public spaces (e.g. Gómez-Varo *et al*., 2022; Garau and Annunziata, 2022).

Certain large-scale empirical studies attempted to do just that. Ewing and Clemente (2013) found a positive relation between façade transparency at the street level and pedestrian movement, namely between the proportion of first floors with windows and pedestrian counts for 588 urban block façades in New York. Berghauser-Pont *et al*. (2019) proposed a rigorous morphological typology relating street types based on scale, from long 'city streets' to shorter local and background streets to built forms based on combinations of Floor Space and Ground Space Indexes, resulting in seven types of built form, which are not qualitatively predefined discrete building types as individual entities but areas in a graph of density combinations able to grasp differences and patterns of the urban fabric. The pedestrian movement was estimated through the intensity and fluctuations in wi-fi signals from mobile phones in street crossings in three European cities. This approach found significant correlations between compact and dense built forms and pedestrian movement. Scepanovic *et al*.'s (2021) fully-fledged digital method used satellite imagery to analyse built-form features associated with urban vitality. Aiming to test the Jacobsian theory, they extracted information such as the size of urban blocks, intersection density, and building heights, along with inferences on land use diversity, and correlated them with mobile phone internet density as a proxy of urban vitality in six Italian cities. However, this interesting approach seems unable to differentiate between people's activity within and outside buildings. To be sure, these different approaches succeed in exploring the effects of built form on factors of urban vitality. That said, they seem not fine-grained enough to identify buildings as discrete spatial entities, rendering the precise measurement of *building type variations* along sequences of buildings and the effect of such variations on urban vitality more difficult. Architectural features that might have their own multiplying or mitigating effects are not brought to the forefront. Furthermore, they tend to either ignore the problem of overlapping, multiplying effects of graduations of accessibility in street networks and architectural types and features or, except for Berghauser-Pont *et al*. (2019), do not clearly disentangle these effects.

Accordingly, we developed an approach to deal more directly with these issues. By sampling streets and areas for empirical study within specific accessibility levels, we expect to go beyond associative relationships between buildings and other properties like densities and mixed uses in creating urban vitality. In short, our method will focus on the urban effects of *buildings*, searching for connections between building types, specific architectural features related to façades, and interfaces to the street and surrounding context, and urban vitality variables related to pedestrian presence – namely, moving and stationary behaviour on sidewalks.

A Binary Typology, Architectural Features, and Hypothetical Effects

The spatial fabric of cities contains different degrees of continuity and discontinuity, proximity, and distance between buildings, triggering potentially different relationships between them and what we perform in surrounding open spaces. The immense variety of the built form is usually reduced to typologies in scientific work (e.g., Caniggia and Maffei, 2001; Berghauser-Pont *et al*., 2019) and urban planning codes. We propose a clear-cut, binary typology focused on buildings as discrete individual entities, able to represent *univocal features of architectural and built form systems*: the fact that a building is spatially either continuous to or detached from the neighbouring buildings. In other words, we have (*a*) the building whose limits coincide with the boundaries of the urban plot, including but not limited to aligned frontages, rendering it adjacent to at least one of its neighbouring buildings: the *continuous type*; and (*b*) buildings standing alone within the plot boundaries, characterized by lateral setbacks: the *detached type*. These two types, defined by their position in the plot and the continuity of façades (or lack thereof), represent the basic states of buildings as part of urban ensembles (figure 1).

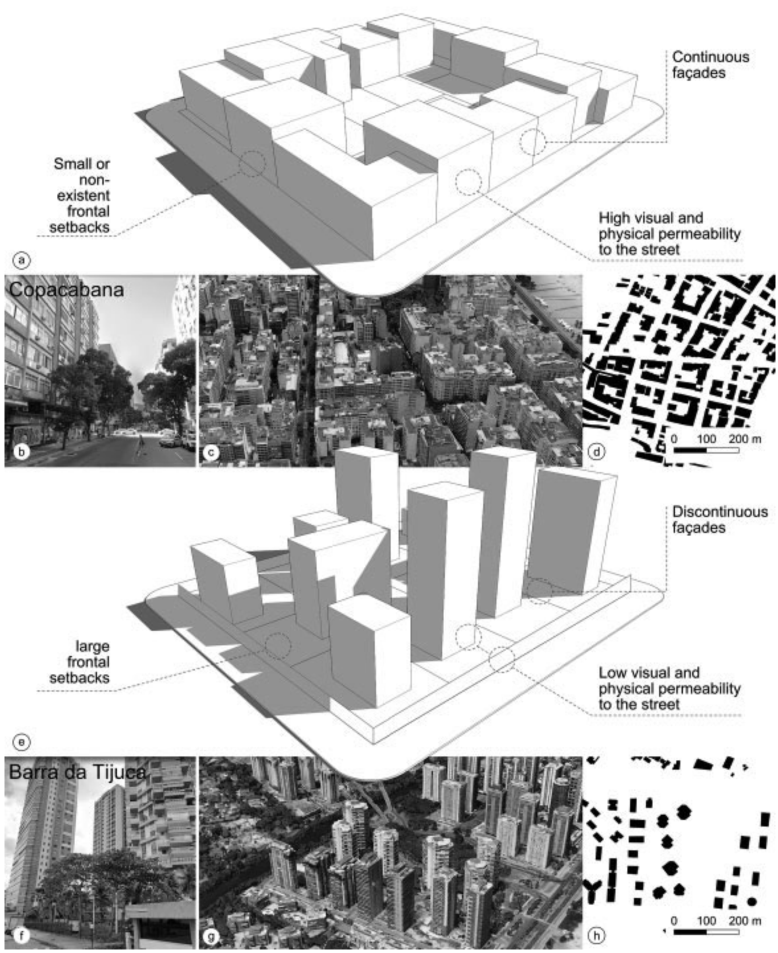

Figure 1. Different building types and radically different urban forms. (*a*) The continuous type leads to compact blocks, seen in Copacabana, South Rio: (*b*) Street view; (*c*) Aerial view; (*d*) Nolli map. In turn, (*e*) The detached type is associated with varying setbacks and other features seen in Barra da Tijuca, West Rio: (*f*) Street view; (*g*) Aerial view; (*h*) Nolli map. Combinations of these basic types create a plethora of built forms (*Sources*: Google Street View; Google Earth; OpenStreetMap).

Certain *architectural features* might be more frequently associated with a particular type (e.g. window density and the continuous type). Still, they do not univocally define a type (i.e. detached types also have windows). Combinations of these two basic building types will give rise to an enormous array of possible architectural and urban complexes and should sufficiently describe the built form in cities. Our method will identify the quantities and variations of building types along sequences in urban block façades and streets. However, typologies are theoretical constructs – simplifications useful to understand and approach a complex problem. Subtle variations in architectural features must also be accounted for, like the density of doors and windows in façades, distances between buildings and streets, building-street interfaces such as railings and open plots, or plot density. These aspects of buildings and their position concerning the street and neighbours might intensify or mitigate the potential effects of building types on urban vitality or have their own effects. They must also be considered in empirical analysis.

The following *hypothetical lines of causality* link features that constitute the continuous type (*a*) to higher levels of urban vitality:

◆ The continuous type offers higher façade continuity, which in turn allows for:

◆ a higher *ground coverage* (or building coverage ratio) associated with compact urban blocks;

◆ generalized *proximity between buildings* (residences, retail activities, and so on), optimizing distances to be travelled and rendering neighbourhoods walkable (see Ewing and Cervero, 2010);

◆ high performance in absorbing *built form density* with low height, which correlates positively with demographic density (see Martin and March, 1972) and microeconomic density and diversity;

◆ increases in the number of *potential destinations* and reasons to go outside, including shops and other indoor activities, attractive features of street life;

◆ a higher *linear density of windows and doors* per metre in urban block façades;

◆ due to its spatial characteristics, empirically, the continuous type is frequently associated with *proximity to the street*, which renders more direct connections and less friction to go in and out of buildings;

◆ higher *visual permeability* to the streets facilitates the interaction between inside and outside, supporting co-presence and random interactions in public spaces, including conversations, calls for action, etc;

◆ the conjunction of these features increases the chances that the ground floor of a given building will be used for *commercial purposes* whenever its particular location meets other necessary conditions, with spillover, mutual effects in connection with pedestrian behaviour, and co-presence in the streets.

The implications would be such that keeping systemic properties like accessibility and density relatively constant, as we will attempt to do methodologically below, the *continuous type* (*a*) would better support social and microeconomic life at the local scale by relating more directly to public spaces and allowing an intense relationship between activities and pedestrians. On the other hand, the *detached type* (*b*) would have opposite effects, as a function of how wide its distances are from the street and side buildings, with potential large-scale effects on urban performance, such as increased vehicular dependence. Thus, the more dominant (*b*) is in an urban area, the more rarefied the presence of pedestrians and microeconomic activity would be. We shall also look into the *urban vitality performance of the individual architectural features* and verify whether they have their own effects on pedestrian presence, perhaps more pronounced than the type itself as a construct. Finally, we shall assess *whether building types are statistically associated with specific features*, testing the hypothetical construction of the types proposed (figure 2).

Our problem definition involves two *dependent variables* representing urban vitality: (*i*) intensity of pedestrian movement and (*ii*) presence of stationary groups and individuals in streets; and a *mediating variable*: (*iii*) the presence of commercial activities and services, measured as distributions and diversity levels as proxies of microeconomic exchanges. Since Jacobs (1961), mixed uses are seen as an independent variable in urban vitality. In contrast, we sustain a rather *dual* condition for microeconomic activity as an independent and dependent variable. We hypothesize that, beyond its role in attracting pedestrians and igniting street life, which building types are supposed to do, *retail and service activities also depend on buildings to materialize*. In other words, buildings can either express and support street-level commercial networks and activities (namely, through the continuous type) or restrict them (through the detached type) (figure 2).

Method and Empirical Application

We will seek evidence of these relationships in an empirical study, statistically compar-

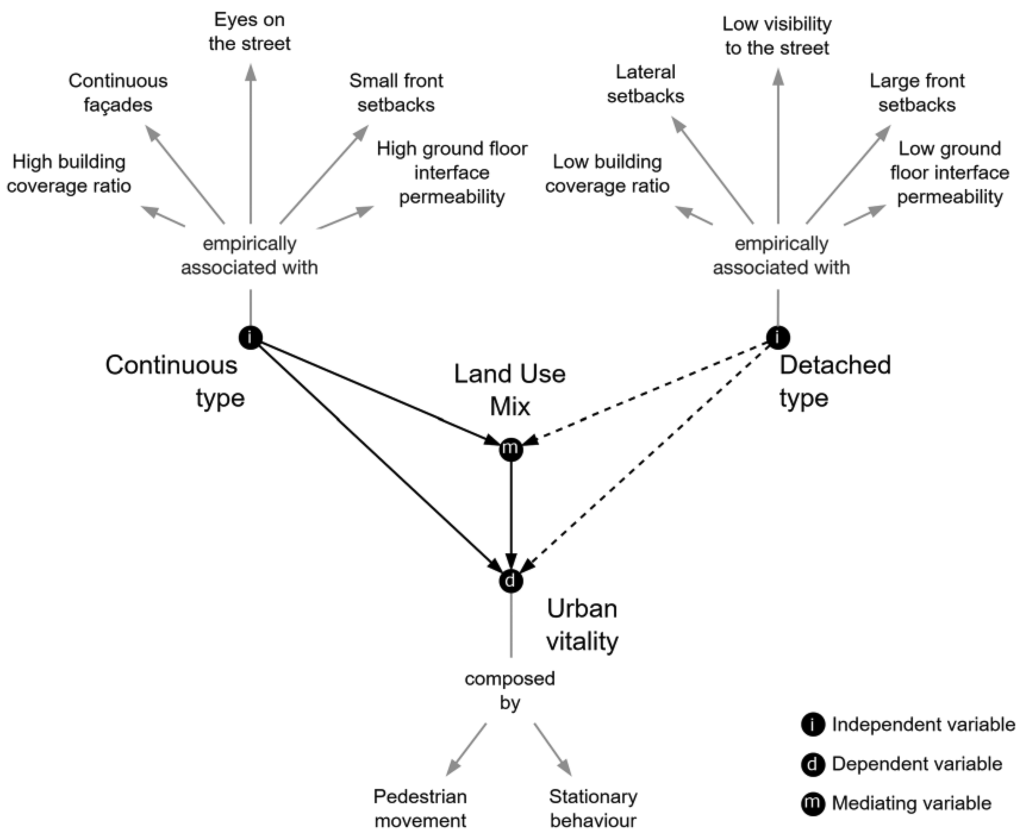

Figure 2. The research problem and its ontology. The empirical association of building types with specific architectural features is hypothesized at the top. Lines indicate hypothetical causal positive relationships between building type, associated features, and urban vitality, while dashed lines represent negative relationships.

Table 1. Spatial and social attributes collected.

Urban Vitality Features	*Variables* (averages in street segments)
Pedestrian activity	Pedestrian movement (number of pedestrians per minute) Stationary behaviour (number of pedestrians per street segment)
Microeconomic Features	*Variables* (distributions and averages in street segments)
Activity (land uses)	Number of economic activities in each of the following categories: residential, retail, service, , institutional (street-level and upper-floor activities)
	Microeconomic diversity index (street-level activities)
	based on Shannon's entropy measure and land use categories defined above.
Spatial Features	*Variables* (proportions and averages in street segments)
Building type	Continuous type (*a*)
	Detached type (*b*)
Façade permeability	Door density (number of doors per metre: street-level)
	Window densities (number of windows per metre: street-level, upper floors, total)
Building and plot	Lateral setback
	Frontal setback
	Façade width
	Plot width
	Continuity index (façade-width to plot-frontage ratio)
Interface building-street	Railing
	Front wall
	Open plot
	Garages density (number of ground-floor, front-facing garages per metre)
Building height	Number of floors per building
Densities	Built form density (Floor Area Ratio [FAR])
	Population density (census tract, persons per hectare)
	Microeconomic density (number of economic units per metre)
Area	Plot area
	Building area (sum of the areas of all building floors)
	Ground-floor area
	Building Coverage Ratio (BCR)
Land parcels	Plot density (number of plots per metre)
Accessibility	Betweenness centrality (varying radii)
(street network measures)	Closeness centrality (varying radii)

ing the distributions of different arrangements of building types and architectural characteristics and the presence of social activity in these areas. But if our goal is to clarify the urban impacts of buildings, first, we need a way to recognize its effects concerning those of other systemic components of urban form and function. We will break down these components into about twenty spatial variables and ten socioeconomic variables (table 1).

Controlling for Street Network Effects

In a long tradition in spatial economics and urban studies, *accessibility* is seen as one of the most influential among the systemic properties of cities, shaping urban form and function – from density to land use distributions (see also Alonso, 1964). From Hansen (1959) to Hillier *et al*. (1993), different theories imply that accessibility drives the distributions of density and activities. Other features of urban structure that potentially influence public space use are *population* and *built form densities*. However, these factors have mutual connections: accessibility triggers densification, and densification might lead to improvements in accessibility. These systemic forces seem to converge to a significant degree, shaping urban growth and patterns through architectural production – even though they may do so non-linearly in time (see Krafta *et al*., 2011). Nevertheless, other things being equal, more accessible and denser areas and streets tend to have more street-level activities and pedestrian movement.

If this assertion is correct, we need to define a method to recognize the effects of buildings on the vitality of public spaces to distinguish them from those of the urban structure. A way to do that would be by controlling the systemic effects of accessibility. Among methodological possibilities, we opted for a simple form: to *analyse urban areas with similar levels of accessibility* while statistically controlling for subtle variations in accessibility and density. Essentially, we will compare variations in the distribution of building types and their features with variations in variables of urban vitality in streets that fall into specific accessibility levels within randomly selected areas. This idea is further supported by a statistical relationship between accessibility and movement that is empirically widely found (e.g., Hillier *et al*., 1993; Penn *et al*., 1998): when accessibility provided by the street network increases, critical factors of vitality such as pedestrian movement and co-presence tend to increase (figure 3). However, we can see variations in this relationship: the gradual increase in accessibility levels is not perfectly replicated in an increase in pedestrian movement. Two streets with the same accessibility level often have different pedestrian volumes. Thus, not all variation in movement and co-presence is explained by accessibility. We can see this clearly by selecting a very narrow range of accessibility variation and seeing that it corresponds to a not-so-narrow range of movement intensities.

Here is the crux of the problem we want to capture. We propose that buildings' role and architectural features lie precisely in more than proportional differences between accessibility and pedestrian movement levels. *The effects of architecture would help explain these differences.* Our approach can verify whether this is the case. It implies that, if we analyse a set of streets within the same accessibility level in a city, the differences in the pedestrian movement found in these streets would be approximately free from the effects of accessibility – limited, of course, by the effectiveness of the method used to assess accessibility. Thus, *by minimizing variations in accessibility* as an effect of the street network configuration in the areas under study, we were able to *compare variations in urban vitality variables* like pedestrian movement and microeconomic diversity *with variations in architectural features* – and examine whether statistically significant relationships emerge between them. To the

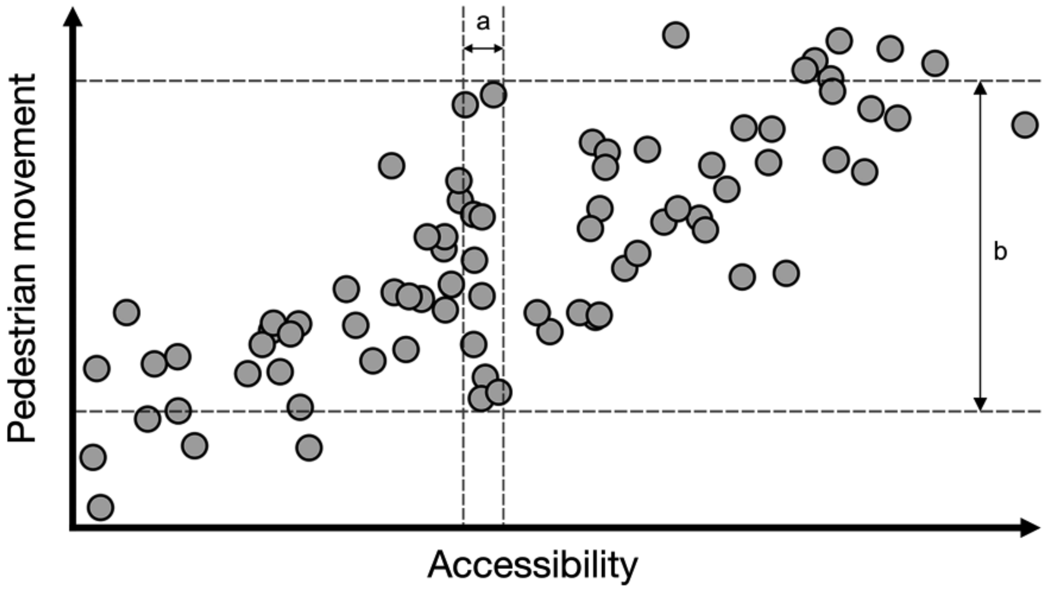

Figure 3. The relationship between accessibility and pedestrian movement: empirical findings since Hillier *et al*. (1993) have shown that when accessibility increases, pedestrian movement, and co-presence tend to increase. However, a typical distribution illustrated above also indicates that streets (points on the graph) within the same accessibility level (*a*) can have substantial differences in pedestrian movement (*b*). Therefore, vitality cannot be explained only by accessibility. We hypothesize that other things being equal, the distribution of buildings and their types can help to explain the variation. (*Source*: Adapted from Saboya *et al*., 2015)

best of our knowledge, this procedure to disentangle and identify the potential effects of buildings and their features on urban vitality is not explored in previous approaches.

Despite its simplicity, this logic brings methodological implications. Of course, as a systemic spatial property, accessibility is pervasive. Different accessibility scales may be active simultaneously in the same place, potentially combined with other urban patterns and immersed in contingencies. Controlling the influence of accessibility on urban vitality is a difficult task. *Street network measures* seem suitable tools for this purpose, as they have been successful in providing detailed descriptions of spatial differentiation in cities in a variety of urban contexts. However, the description of accessibility brings further questions, such as (*i*) which measure should be used to represent accessibility? (*ii*) which definition of distance and shortest paths (metric, geometric or topological)? (*iii*) which radius of accessibility (from the most global radii of the city to the most local)? and (*iv*) which spatial unit should be used to represent streets (axial lines or segments)? In this work, we explore different accessibility measures. Since Freeman's (1978) systematization, *betweenness centrality* (BC) is calculated as the number of times a node falls in the shortest paths between all the other nodes in a system. In turn, *closeness centrality* (CC) is the average distance (represented by the number of edges or weighted edges) from one node to all other nodes in a system. In street networks, BC highlights a set of main paths, i.e. the 'skeleton' of an urban structure, with values much higher than the average values distributed among most streets, corresponding to the idea of 'being central as being between or the intermediary of others'. In turn, CC is geared to grasp streets displaying similar levels of centrality and close to each other, following the idea of 'being central as being near others' (see Porta *et al*., 2006, p. 709; cf. Freeman, 1978). This property is suitable for identifying centrality distributions in neighbouring nodes or streets, fitting our sampling method of areas with different accessibility levels in Rio de Janeiro and allowing us to optimize procedures for collecting pedestrian data.

We adopted a measure of closeness centrality known in space syntax theory as 'global integration' (Hillier, 2007),[1] a normalized measure of topological distance from any street segment or line to all others (radius *n*, meaning the *n* number of street segments or axial lines contained in the system, or CCRN) as changes of direction within a street network or all others within a specified local radius (e.g. radius 3, meaning all lines within three topological steps from every street segment or line in the system, or CCR3) (for definitions, see Hillier, 2007). To render explicit the place of these measures in the tradition of social network analysis, we prefer to keep the original terms related to centrality. We selected a combination of topological distance, global radius, and axial lines representing streets. We used closeness centrality radius-radius (CCRR) to identify the accessibility levels. This radius includes all lines within the mean depth of the most globally integrated segment in the system to avoid edge effects (*ibid*.). In Rio's case, the mean depth of the most integrated axial line was thirty steps. We kept attentive to the role of other accessibility measures and scales as independent variables in this investigation of the impacts of buildings on urban vitality – namely, betweenness centrality at different radii, by statistically monitoring and correlating them with dependent and mediating variables.

Sampling Strategy and Empirical Case

Rio sprawls over its hilly topography discontinuously, a polycentric system with higher density clusters connected by a fragmented street network and a residential fabric in which multi-storey buildings play an essential role. In Rio, they account for 37.62 per cent of home types (54 per cent for houses and 6.78 per cent for residences in gated communities). As mentioned, our experimental design was centred on the problem of identifying the potential effects of architectural types and features, controlling for the well-known effects of accessibility on urban vitality variables like pedestrian movement. Our solution was to proceed with empirical analyses within sets of streets of roughly the same accessibility levels. The sampling procedure started by dividing Rio's topological accessibility into twenty bands, arbitrarily based on a trade-off between sufficiently thin bands to maximize proximity in accessibility values between street segments in each band and keeping bands large enough to contain a sufficient number of street segments for random sampling in different areas across the city. We then selected three levels: low, medium, and high accessibility. The option for such contrasting levels is to test whether buildings would have potential vitality effects under different systemic urban conditions. For instance, areas with high accessibility could find enough systemic conditions to trigger pedestrian movement and land use diversity even if local built form conditions were unsuitable for urban vitality, according to our hypothesis. Using CCRR, we identified the twenty levels through quantiles in the distribution of accessibility values across street segments in Rio. Due to its topographical context and sprawling urbanization, Rio has a long tail of low accessibility streets in spatially segregated areas. As the accessibility distribution is left-skewed, mean and other value ranges were selected accordingly – namely, levels 7 (low), 11 (medium) and 17 (high accessibility) (figure 4*a*).

In addition, we monitored population densities in all census tracts in areas within these ranges as a second criterion to structure our sample and look into the variations of architectural types and features under different urban conditions. This approach allowed us to examine how much the general density of an area can interfere with the potential of building types to stimulate urban vitality. We also analysed population densities in Rio in three levels: low, medium, and high. We

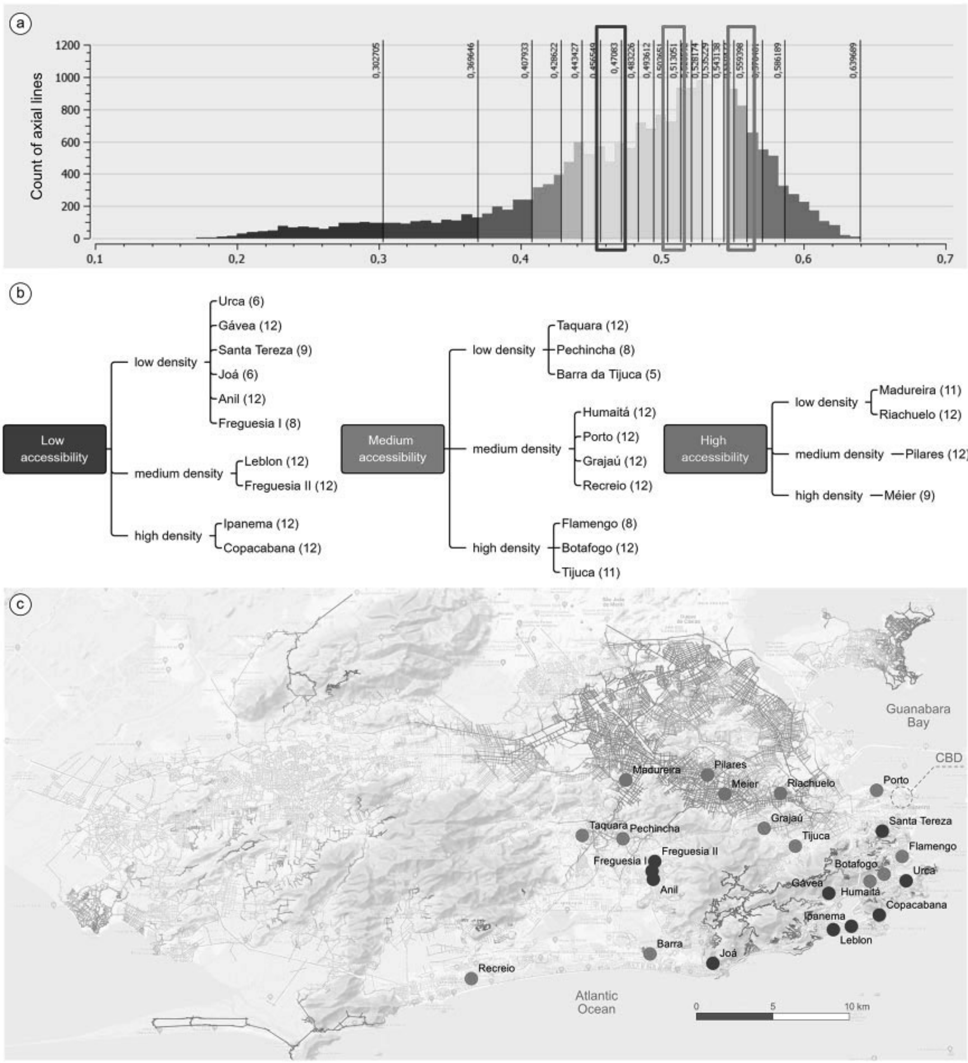

Figure 4. Sample construction. (*a*) Histogram of the distribution of streets according to closeness centrality (CCRR) values: twenty bands were generated based on quantiles. (*b*) Our method combined accessibility and density levels as criteria for randomly selecting areas to be analysed in the empirical study. (*c*) Twenty-four areas were sampled and analysed in Rio de Janeiro. Large areas to the north and west, including high accessibility streets, do not display sufficient numbers of multi-storey buildings for empirical assessment.

defined setups of different areas attempting to build *combinations* of such accessibility and density levels to have areas with distinct characteristics and guarantee the representativeness of these differences considering Rio's diverse morphology and geographic extent. Each combination needs to contain a number of street segments large enough to allow statistically significant analyses and sufficient presence of the building types of interest for the study. We defined thirty segments for each of the nine setups (three accessibility levels in each of the three density bands) (figure 4*b*). The number of street segments initially defined was 270. Our experimental design defined twenty-four areas to be covered empirically, with a maximum of twelve segments per area, given logistical constraints for pedestrian data collection *in loci*. Due to Rio's urban structure, not all combinations could meet twelve segments, particularly in the high accessibility range. Theoretically, high accessibility areas tend to be more sought after for the location of activities and architectural production. This is not necessarily the case for Rio: due to fast, large-scale urbanization to the north and west since the 1960s, areas of high accessibility often do not have high density – more easily found in areas closer to the sea, in south Rio (emblematically, in areas like Copacabana), and the CBD by the Guanabara Bay (figure 4) – which limited sampling. Twenty-four areas were randomly selected among those that met the combination criteria within the three accessibility ranges. A final map shows their location (figure 4*c*).

The twenty-four areas in Rio de Janeiro include 249 street segments and 4,174 buildings. Urban vitality was assessed through a proxy, the presence of people in public spaces of streets as moving or stationary pedestrians. Following standard procedures for pedestrian data collection in space syntax (Vaughan, 2001), trained observers counted pedestrians crossing imaginary gates in selected street segments six times during a weekday, from early morning (8 am) to evening rush-hour (6 pm), during 2.5 minutes for each time and each segment. For each gate, we calculated the average of counts. Weekdays are preferred to grasp typical everyday movement patterns, quite different from schedules, attractors, paths, and visited areas on weekends. We counted stationary pedestrians individually or in groups while observers moved along the selected street segments. In these areas, building plots were counted and measured (dimensions and area), and the type of building interface to the street was verified. The buildings, on the other hand, were surveyed with a great degree of detail, supported by digital information from Google Street View images and official municipal maps: dimensions, areas, heights, number of units (households and commercial activities), doors, windows, garages, and basic measures such as the Building Coverage Ratio (BCR, i.e. building footprint area to plot area ratio) and the Floor Area Ratio (FAR, i.e. built area to plot area ratio, or the ratio of the sum of the areas of all building floors to the sum of plot areas in street segments), and a façade continuity index was proposed. Land uses were identified, specifying activities on ground and upper floors (see table 1).

Analytical Approach

1. Test the associations between disaggregated architectural attributes and the binary typology via clustering analysis. The aim is to identify the most frequently associated features in relation to building types, and assess our binary typology as a construct in connection with our hypothesis.

2. Test bivariate associations between spatial variables and pedestrian activity variables, controlling for accessibility via Tukey comparisons (t-tests) and Pearson correlations, first considering the proportion of each of the binary types and then the disaggregated features.

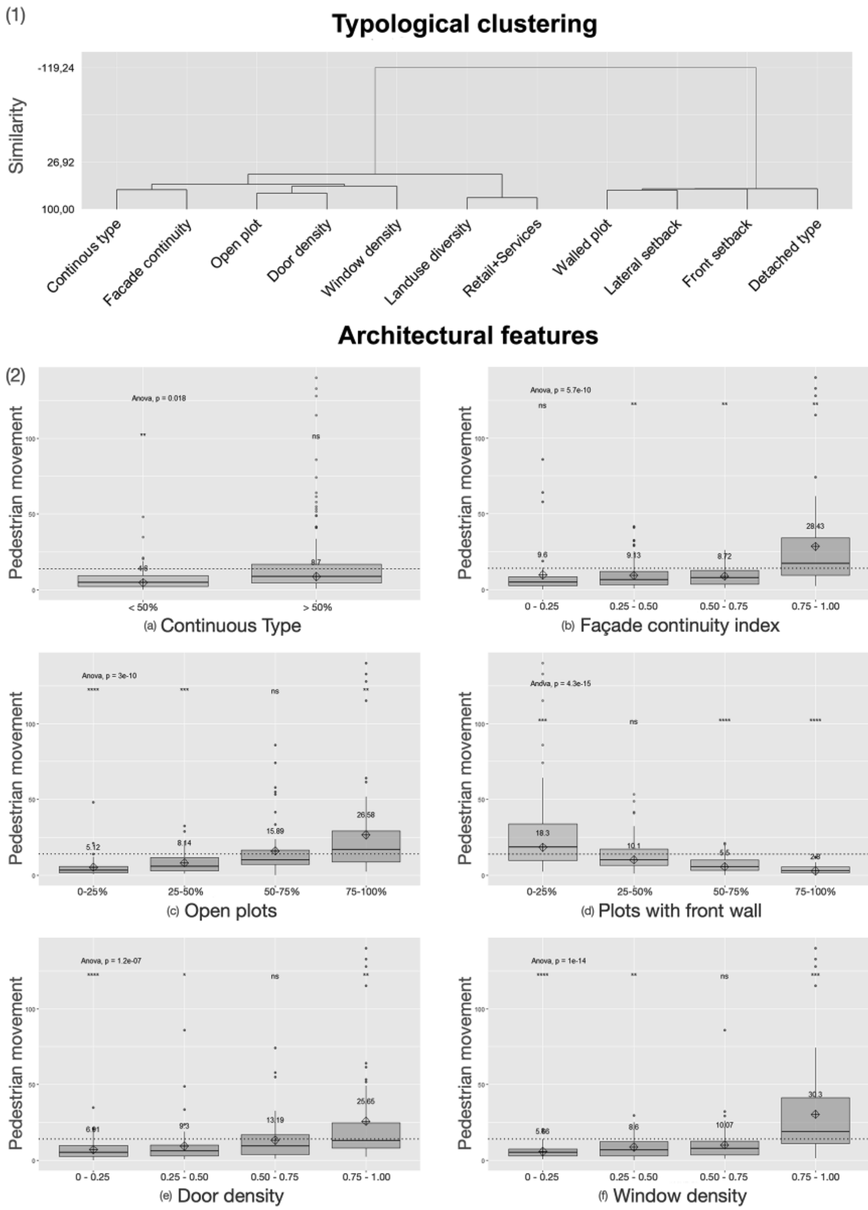

Figure 5. (1) Cluster analysis shows that key architectural features are consistently associated with two distinct building types in Rio de Janeiro. (2) Urban vitality performance of the continuous type and features: boxplots show pedestrian movement averages in Rio de Janeiro (all accessibility levels) in each class of (*a*) proportion of continuous type in street segments (< 50% and >=50%); (*b*) façade continuity index (quantiles); (*c*) open plots (percentiles); (*d*) plots with front walls (percentiles); (*e*) door density at the ground floor (quantiles); and (*f*) window density (quantiles). ***0.01, **0.05, *0.1, ns = no significance.

3. Model the multivariate association between spatial, microeconomic, and pedestrian activity variables, controlling for spatial dependence through Moran's indexes and Spatial Lag Regression.

Results and Discussion

The relationship between types and detailed architectural features, such as door density or frontal setbacks, might vary. We statistically tested whether the binary typology is empirically associated with specific architectural features and land uses to verify this. We started by conducting a cluster analysis on the database containing the attributes of buildings in Rio. Cluster analysis is a technique for grouping variables more frequently associated within a distribution so that objects in the same cluster are more likely to appear together than those grouped in other clusters (Hair *et al*., 1995). We ran the analysis with the correlation coefficient as the measure of statistical distance between objects and applied the 'complete linkage' ('furthest neighbour') method, which is based on the evaluation of the maximum distance between two objects of different groupings. This hierarchical procedure is represented in a tree diagram or dendrogram where each variable progressively connects to a group of its own. The nearest groups are agglomerated to form new groups in the next step of similarity. Figure 5 shows two main groups clearly separated, only connected to each other at a high negative level of similarity. The first one combines, at a 45 per cent similarity level, very consistent subgroups: the continuous type and façade continuity (69 per cent similar), open plot, door density, window density (64 per cent similar), and land use diversity and commercial activities at the ground floor (82 per cent). The second group comprises frontal and lateral setbacks, walls and railings, and the detached type, all grouped at an approximate 68 per cent degree of similarity. This analysis shows that the binary typology proposed (see figure 2) consistently relates to distinct ensembles of architectural features.

The Urban Vitality Performance of the Building Types and Features

To check whether the binary types and disaggregated architectural features impact pedestrian movement, we conducted a similar comparison of means through Anova and Tukey tests. Tests returned a statistically significant difference of means for all variables at a 95 per cent confidence level, indicating that the higher the proportion of open plots and continuous types, the density of doors and windows, and the façade continuity, the higher the pedestrian movement and, conversely, the higher the proportion of walled plots, the lower the pedestrian movement. To address the nuanced relationships between building features and pedestrian behaviour, let us explore some bivariate and multivariate statistical techniques.

I. *Pedestrians and Building Type*. Continuous and detached types showed diametrically opposed performances regarding pedestrian movement and stationary behaviour. On average, streets where the continuous type is predominant tend to have more than twice as many moving pedestrians as streets with a dominant detached type for all street segments analysed (figure 5*a*). In Rio's low-accessibility streets, moving pedestrian averages are around three times higher in segments with more than 50 per cent of continuous types than in those with less than 50 per cent ($p < 0.01$). This trend is weaker in high-accessibility areas, but pedestrian activity is still more prominent on streets with a predominance of continuous types (table 2).

II. *Pedestrians and the Façade Continuity Index*. Our hypothesis predicts a relationship between façade continuity in urban blocks and the social life of streets as public spaces

Table 2. Pearson correlations for building types and features and pedestrian behaviour variables in street segments with low accessibility (n = 104) and high accessibility (n = 45) levels.

Building Types and Features	*Moving Pedestrians*		*Stationary Behaviour*	
	Low accessibility	High accessibility	Low accessibility	High accessibility
Continuous type (proportion along segments)	0.33**	0.07	0.41**	0.21
Detached type (proportion along segments)	–0.34**	–0.04	–0.42**	–0.22
Façade Continuity Index	0.42**	0.12	0.46**	0.42*
Frontal setback	–0.42**	–0.11	–0.39**	–0.25
Open plots (proportion)	0.63**	0.41**	0.55**	0.46**
Windows (density)	0.73**	0.25	0.51**	0.18

Note: **p <0.01; *p: *<0.05.

around them. When the façade-continuity index is broken into intervals, considering all accessibility ranges in Rio, we see a trend of *increasing pedestrian presence along with increasing façade continuity*, reaching a steep curve in indexes above 95 per cent (figure 5*b*, table 2).

III. *Pedestrians and Setbacks*. Analyses of average distances between buildings in blocks (lateral setbacks in street segments) considering all accessibility ranges in Rio show that pedestrian movement decreases as distances increase, from around fourteen pedestrians per minute, where average distances are less than 2.5 m, to about three pedestrians per minute for distances between 15 and 20 m. We also observed a similar reduction in the pedestrian movement for increasing distances between buildings and the street (frontal setbacks): from 11.5 moving pedestrians per minute where average distances are less than 1 m to 2.3 pedestrians per minute for distances greater than 5 m (not shown in figure 5).

IV. *Pedestrians, Open Plots and Front Walls*. When we consider the absence of barriers between buildings and the street, we find that the higher the presence of open interfaces, free from walls and railings, the higher the number of moving pedestrians in the streets (figure 5*c*, *d*). Numbers fall systematically when front walls become dominant.

V. *Pedestrians, Doors, and Windows*. Corroborating the Jacobsian hypothesis, we found a clear pattern: considering all accessibility ranges, the increase in window density corresponds to an increase in the number of pedestrians. A similar relationship was found between pedestrians and door density (figure 5*e*, *f*).

VI. *Buildings and Street-Level Economic Activities*. We found positive correlations between the continuous type and the proportion of non-residential activities such as retail and services. These trends are more expressive in low-accessibility areas (table 3). Similar performance of continuous types was found in relation to the microeconomic diversity index (r = 0.43, p <0.01, not shown in table 3). In turn, we also found *a decline in land use diversity when there is an increasing presence of the detached type* (r = –0.46, p <0.01, not shown). Other items associated with the detached type, such as front walls and frontal setbacks, are less likely to couple with commercial activities (see table 3).

Table 3. Pearson correlations for local economic activities and architectural features in different accessibility levels in Rio (n = 104 for low accessibility areas, n = 45 for high accessibility areas).

Building Types and Features	*Commercial Activities*	
	Low accessibility areas (n = 104)	High accessibility areas (n = 45)
Continuous type (proportion)	0.42**	0.33*
Detached type (proportion)	–0.45**	-0.34*
Façade Continuity Index	0.38**	0.39*
Frontal setback	–0.29**	–0.18
Windows (density)	0.52**	-0.19
Open plots (proportion)	0.65**	0.53**

Note: p: *<0.05; **<0.01.

Controlling for Accessibility: Statistical Observations

Even though our approach was based on looking into streets with specific accessibility levels, street network effects are pervasive and multi-scalar. We monitored these potential effects through different topological measures and scales and their correlations with dependent variables. *Closeness centrality RN* showed negative correlations with pedestrian movement (r = –0.37) and stationary behaviour (r = –0.42) in low accessibility areas in Rio (p <0.01), and coefficients close to zero in high accessibility areas, with no statistical significance (table 4). In turn, CCRR at the mean depth of thirty topological steps shows negative coefficients at low and high accessibility levels, again with no statistical significance. This suggests that the effects of global accessibility were successfully controlled, and *the association of architectural variables with the dependent variables was free from the multiplying effects stemming from the street network* at these larger scales of relatedness. Accessibility at the local scale, measured as closeness centrality R3, showed stronger signs of presence as the measure correlated positively with pedestrian variables. Finally, *betweenness centrality RR* showed mixed results in correlations with pedestrian variables.

A Spatial Model to Examine Combined Effects of Accessibility, Land Use and Buildings

We examined the potential effects of each architectural factor on pedestrian behaviour and commercial activities based on bivariate correlations. However, it is necessary to assess their combined effects on pedestrian activity

Table 4. Pearson correlations between different measures of accessibility and dependent variables in Rio de Janeiro: Pearson correlations. p: *<0.05; **<0.01.

Accessibility Measures	*Moving Pedestrians*		*Stationary Behaviour*	
	Low accessibility	High accessibility	Low accessibility	High accessibility
Closeness centrality RN	–0.37**	0.05	–0.42**	–0.17
Closeness centrality RR	–0.15	-0.12	–0.15	–0.26
Closeness centrality R3	0.39**	0.39**	0.39**	0.19
Betweenness centrality RR	–0.15	0.56**	–0.03	0.22

with statistical techniques of multivariate dependence such as multiple linear regression. The goal is to ascertain which combination of the spatial variables was the ablest to explain the fluctuations in pedestrian movement. They allowed us to test whether the associations between the proportion of building types, distribution of architectural features and pedestrian behaviour remain statistically significant when other control variables like accessibility measures are held constant. We conceptualized a model, with few explanatory variables that include the different dimensions of features analysed, systematically varying the measures of the architectural form and keeping variables closeness centrality RR and R3 fixed, to control for global and local accessibility, along with land use diversity and microeconomic density. However, the initial candidate, the Ordinary Least Square (OLS) technique, does not adequately account for potential spatial autocorrelation. Pedestrian movement and stationary behaviour might display clustering effects, i.e. a similarity in intensities for close streets. Movement is likely to be more strongly correlated within adjacent streets than between distant ones (as in Tobler's first law). We evaluated this possibility through the Moran Global Index, which measures the dependence between attributes of interest and their location (Anselin, 1995), plotting the original variable against its 'lagged' version, which is the average of the values of neighbours within a radius of 363 metres threshold, the minimum distance necessary to avoid isolated points and connect all points inside an area. The resulting Moran Global index for moving pedestrians is 0.477, with $p < 0.01$, indicating a moderate degree of spatial autocorrelation in the sample as a whole.

For local analysis, we used the LISA (Local Index of Spatial Autocorrelation), which shows the location and intensity of clustering. We identified clusters in our sample, namely high pedestrian movement in neighbouring streets, mostly in south Rio, and low movement in neighbouring streets in west Rio ($p < 0.01$). Significant clusters appear in all accessibility levels, without dominance in any specific level. These results indicate clustering in our data, so we ran a pilot OLS regression to perform spatial dependence diagnostics. The global Moran index calculated for the regression errors (differences between observed and modelled values) was 5.254 and $p < 0.000$, advising us against the OLS approach. Following Anselin *et al*. (1996), we assessed the Lagrange Multiplier test statistics and concluded that a spatial lag model would be the best to deal with our data. Finally, we ran the final models with a spatial lag specification, including our control variables and varying systematically the architectural features. The five best model fits obtained are listed in table 5.

Table 5. Spatial lag model: fit statistics and coefficients of spatial variables impact on pedestrian movement including the spatially lagged dependent variable (W–log–ped).

SPATIAL LAG MODEL – MAXIMUM LIKELIHOOD ESTIMATION				
Spatial Weight 363.000				
Dependent Variable	Pedestrian movement (log)			
Number of Observations	249			
M1 – LATERAL SETBACK	***SL***	*OLS*		
R-squared	***0.660***	*0.581*		
Log likelihood	***–41.370***	*-63.329*		
AIC	***96.740***	*138.659*		
Schwarz criterion	***121.364***	*159.764*		
Variable	**Coefficient**	**Std. Error**	**z-value**	**Probability**
W_log_ped	0.413	0.057	7.213	0.000
Intercept	0.297	0.229	1.302	0.193
Closeness centrality_RR	–0.851	0.501	–1.700	0.089

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Closeness centrality_R3	0.148	0.045	3.286	0.001
Landuse diversity ground floor	0.504	0.068	7.369	0.000
Microeconomic density	0.118	0.019	6.105	0.000
Lateral setback	0.000	0.000	–1.082	0.279
M2 – CONTINUOUS TYPE	***SL***	*OLS*		
R-squared	***0.660***	*0.574*		
Log likelihood	***–41.880***	*–65.377*		
AIC	***97.761***	*142.755*		
Schwarz criterion	***122.383***	*163.860*		
Variable	**Coefficient**	**Std. Error**	**z-value**	**Probability**
W_log_ped	0.429	0.057	7.541	0.000
Intercept	0.245	0.225	1.088	0.276
Closeness centrality_RR	–0.803	0.500	–1.607	0.108
Closeness centrality_R3	0.152	0.045	3.365	0.001
Landuse diversity ground floor	0.502	0.069	7.266	0.000
Microeconomic density	0.118	0.019	6.157	0.000
Continuous type	–0.014	0.077	–0.182	0.856
M3 – FACADE CONTINUITY	***SL***	*OLS*		
R-squared	***0.661***	*0.590*		
Log likelihood	***–40.805***	*–60.776*		
AIC	***95.610***	*133.552*		
Schwarz criterion	***120.233***	*154.657*		
Variable	**Coefficient**	**Std. Error**	**z-value**	**Probability**
W_log_ped	0.402	0.058	6.877	0.000
Intercept	0.106	0.240	0.442	0.659
Closeness centrality_RR	–0.854	0.499	–1.709	0.087
Closeness centrality_R3	0.156	0.045	3.463	0.001
Landuse diversity ground floor	0.504	0.069	7.349	0.000
Microeconomic density	0.116	0.020	5.923	0.000
Continuity index	0.206	0.136	1.516	0.130
M4 – OPEN PLOT	***SL***	*OLS*		
R-squared	*0.670*	*0.611*		
Log likelihood	*–36.739*	*–53.965*		
AIC	*87.479*	*119.931*		
Schwarz criterion	*112.102*	*141.036*		
Variable	**Coefficient**	**Std. Error**	**z-value**	**Probability**
W_log_ped	0.370	0.060	6.171	0.000
Intercept	0.138	0.221	0.625	0.532
Closeness centrality_RR	–0.576	0.496	–1.162	0.245
Closeness centrality_R3	0.154	0.044	3.464	0.001
Landuse diversity ground floor	0.446	0.070	6.345	0.000
Microeconomic density	0.114	0.019	6.035	0.000
Open plot	0.222	0.070	3.179	0.001
M5 – DOOR DENSITY	***SL***	*OLS*		
R-squared	***0.671***	*0.600*		
Log likelihood	***–36.922***	*–57.644*		
AIC	***87.844***	*127.290*		
Schwarz criterion	***112.467***	*148.394*		
Variable	**Coefficient**	**Std. Error**	**z-value**	**Probability**
W_log_ped	0.394	0.057	6.876	0.000
Intercept	0.286	0.220	1.298	0.194
Closeness centrality_RR	–1.059	0.499	–2.121	0.034
Closeness centrality_R3	0.158	0.044	3.571	0.000
Landuse diversity ground floor	0.458	0.070	6.579	0.000
Microeconomic density	0.112	0.019	5.964	0.000
Door density	0.628	0.199	3.153	0.002

In all models, coefficient signs are intuitive, indicating a positive effect of closeness centrality R3, land use diversity, microeconomic density, and selected architectural features on pedestrian movement, while closeness centrality RR, controlled through our sampling strategy, has a negative effect.

Conclusion: The Unintended Consequences of Architectural Choices

A binary building typology is a minimal way of describing differences in built form, based on a univocal spatial attribute of buildings: the property of being or not continuous to at least one of its neighbours. Through this most basic relational feature, built form complexes can be sufficiently described, and the resulting types can be used to assess the relation of buildings to urban vitality factors such as pedestrian presence in the streets. In this paper, we argue that:

◆ Such an approach allows for precise measurement of variations within sequences of buildings and their potential effect on urban vitality at the scale of the street segment.

◆ A step further, our empirical analyses show that the proposed binary typology is coherently composed of specific architectural features. Our method contributes by identifying buildings as discrete spatial entities associated with detailed architectural attributes like door and window densities, setback sizes, and interface building-street.

◆ They also showed that these features have effects of their own, sometimes more pronounced than the type as a construct.

◆ Altogether, our findings corroborate the hypothesis that urban vitality relates intimately to architectural form.

That the built environment matters in collective life has been consistently demonstrated empirically by different approaches – from spatial economics to space syntax. Our results, centred on building types and characteristics, also converge with findings obtained by built form typologies based on combinations of architectural densities able to grasp differences and patterns of the urban fabric in European contexts (e.g., Berghauser-Pont *et al.*, 2019; cf. Oliveira *et al.*, 2020; Scepanovic *et al.*, 2021). What our research aims to add to this growing body of work is recognition that building types and their associated features are a crucial part of that relationship and are deeply related to the use of the urban space.

In addition, even if previous works include accessibility analyses, they hardly explored *accessibility levels as a sampling strategy* designed to control for the effect of accessibility on dependent urban vitality variables. By minimizing variations in accessibility as an effect of the street network configuration in the areas under study, we could compare variations in the distribution of proportions of building types and architectural features with variations in urban vitality variables, like pedestrian movement and microeconomic diversity – and find statistically significant relationships between them. In short, the methodological procedure to control accessibility to identify more clearly the potential effects of architectural features on urban vitality was not explored before. Accordingly, in the search for architectural features that seem most able to 'create life' – to borrow Hillier *et al.*'s (1987) words in their critique of architectural determinism – the patterns of association found to suggest that, other things being equal:

◆ *Continuous* and *detached architectural types* showed diametrically opposed performances regarding pedestrian movement and stationary behaviour as proxies for urban vitality.

◆ The greater the architectural features associated with the *continuous type* (e.g. more continuous façades along the urban block, higher densities of doors and windows, closeness to the street, and open plot interfaces), the higher the conditions for urban vitality to emerge.

◆ In turn, *decreases in microeconomic activities and land use diversity* appear consistently associated with the *detached type*, statistically associated with discontinuous façades, fewer doors and windows per metre, larger distances to the street, and railings or walls separating the plot from the sidewalk.

The relationship between building types and pedestrian behaviour is especially compelling in *low and medium accessibility urban areas*. Notably, such areas constitute most parts of cities – and those are the areas where the powerful systemic forces of accessibility are less felt and where buildings matter the most. In turn, coefficients of relations between architectural features and urban vitality variables in high accessibility areas also follow this trend – but only façade continuity and the proportion of open plots showed statistically significant correlations.

The pattern of *association of building types to microeconomic activities* is very similar. The same typological features correlate consistently with the land use mix in low accessibility areas, while in high accessibility, we have the proportion of continuous types, the proportion of detached types, and the façade continuity added to the roll of statistically significant associations, all with the expected signs. We have, therefore, a compound effect: detached types are directly detrimental to moving and stationary pedestrians because of the reasons described above and supported by the evidence gathered in this study. However, they also *negatively impact urban vitality indirectly through their inadequacy to accommodate non-residential activities such as retail and services*, which are also usually factors of attraction to pedestrians (Hillier *et al*., 1993). To make matters worse, lower pedestrian presence is a factor that may contribute to decreasing the economic viability of retail and services in a vicious feedback loop for urban vitality (figure 6).

Then we have the question of *density* and its relation to building types. The introduction of detached types on previously empty areas will clearly increase the density and possibly the offer of activities. But that does not in itself establish a suitable urban life, especially compared with other architectural scenarios, as this study shows. As Jacobs (1961) observed, density is a critical factor for pedestrian movement and commercial presence, and diversity – but in similar density and accessibility conditions, the building type makes a difference. This result converges with Gordon and Ikeda's (2011) findings on low-rise buildings with

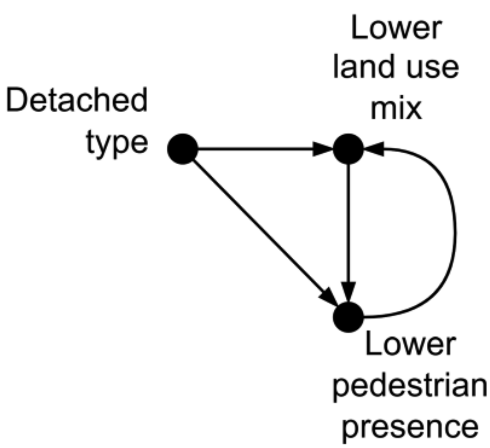

Figure 6. The detached type and associated architectural features are statistically related to lower diversity in land use mixes and lower presence of pedestrians in streets in Rio; in turn, compound and feedback loops seem active between lower land use diversity and pedestrian presence.

high ground coverage associated with the promotion of random interactions in the economy, dubbed 'Jacobs densities'. Unlike the detached type (r = –0.44), the continuous type has positive correlations (r = 0.43) with built density, in line with Martin and March's (1972) geometrical demonstration of the superior capacity of compact city blocks compared with blocks of volumes that are detached to absorb density with less height. Along with the multiplying effects of street channels, continuous buildings provide better conditions for the local materialization of activities and contact in public spaces, particularly in areas of lower accessibility.

This is where detached buildings display negative effects, with possible systemic implications on broader scales. Importantly, empirical research carried out with the same method in two other state capitals in Brazil, Florianópolis and Porto Alegre, shows considerable convergence with our findings (see Saboya *et al*., 2015; Netto *et al*., 2019). That said, we still need to consider the role of context and local behaviour when attempting to identify coincidences and causalities actively in play. Importantly, our findings suggest the need for rethinking urban regulations and recognizing the potential negative effects of trending architectural patterns in Brazil and elsewhere. These effects will not go away if we ignore their existence.

NOTES

1. As Porta *et al*. (2006, p. 710) point out, the measure of integration in the Space Syntax tradition 'turns out to be nothing other than a normalized closeness centrality'.

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