

Original Article

# Spatial Model Based on Human Behavior through Google Maps Tracking, Case Study: The Periphery of Kupang City, East Nusa Tenggara, Indonesia

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**Abstract** – The current information technology development has resulted in innovations in human life, encompassing urban spatial planning and the architectural field. User behavior empirical recording in urban areas has recently moved to digital recording, which is understood to provide accurate, continuous, and real-time observation. This research improves a system of integration between the platform of spatial visualization, understood as Google Maps API, and Takunai, a software-based Android application for recording spatio-temporal behavior of users. The objective of the study is to improve and develop a user behavior analytical model based on digital in space, especially in behavioral observation of the post-occupancy context. This research provides a digital data collection combination known as inductive in nature, interactive visualization of Google Maps with the Takunai system, enabling the mapping and recording of users' real-time spatial distribution behavior and movement patterns. The results conclude that Takunai-Google Maps integration can provide digital spatial behavior, shifting from traditional data-driven manual observation. This approach reinforces the continuity between conventional theories of spatial behavior and contemporary spatial analytic technologies.

**Keywords** – Digital Architecture, GIS, Google Maps Api, Spatial Behavior Analysis, Takunai.

## 1. Introduction

The dynamics of a city's development in improving the quality of its physical and social environments can be observed through the ways in which residents utilize urban space. The urban spatial utilization quality has a direct effect on life quality and mental well-being of users; differently, urban spaces that are well-designed may regulate and shape the city's human behavior [1-3]. Accordingly, human spatial behavior is a crucial variable in assessing the urban planning and design interventions.

Nevertheless, a vivid research gap emerges in the examination of empirical studies assessing the relationship between urban spaces and their users' actual movement patterns. While architectural and urban design practices commonly rely on assumed or idealized user behaviors derived from typologies, symbolic interpretations, experiential knowledge, or theories of urban morphology [5-8], these assumptions are rarely validated using objective, real-time behavioral data. Contemporary studies indicate that public behavior often diverges from design expectations due to evolving lifestyles, informal spatial adaptations, and changes in urban physical configurations [4]. It produces a

crucial problem: in what way do urban spaces behave as expected when combined with the patterns of real human behavior?

Previous research on spatial behavior was dependent on methods of manual observation, encompassing interviews, visual surveys, direct field observations, and behavioral mapping. Seminal works proposed by Jan Gehl [13] and William H. Whyte [12], while qualitative insight-rich, are confronted by limited temporal continuity, scalability difficulties, and observer subjectivity. Although Geographic Information Systems (GIS) have been increasingly adopted in urban studies [9-11], most existing GIS-based analyses focus on static spatial attributes, accessibility, or land-use patterns rather than continuous, real-time human movement behavior. Moreover, few studies explicitly compare observed movement trajectories with the original spatial intentions of architects and urban planners.

Addressing this gap, the present study aims to evaluate the degree of congruence between actual user movement patterns in urban spaces and the original spatial designs envisioned by architects and urban planners. The primary



research problem is designed regarding the lack of data-driven, repeatable, and objective methods in evaluating whether the elements of urban design, like public facilities, circulation nodes, and paths, work accordingly with the behaviors of real users. By this comparison, the research strives to evaluate the urban facilities' adequacy and offer evidence-based feedback in enhancing the quality of urban design.

Current digital technology advancements offer the latest possibilities in examining spatial behavior in a more continuous manner, in real-time, and objectively. The urban design examination and digital human-movement integration indicate the methodological change from planning based on the assumption to human-centered, evidence-based design. Tracking systems use GIS-based location, a technological development manifestation, allowing data of human movement to be archived without needing the field's physical observation.

In this research, the tracking of GIS-based location is conducted through the Takunai application development, combined with the application of Google Maps. Different from navigation-oriented tracking devices or conventional GIS platforms, Takunai is designed particularly as an evaluation system for interpreting, visualizing, and capturing patterns of users' movement in the spatial design of predefined relations. Thus, this study's novelty is not merely the data source used by applying Google Maps, but also the methodological combination of architectural design assessment, behavioral analysis, and real-time tracking in the framework of a single analysis. The method makes direct actual human trajectories and planned spatial configurations comparison, an evaluation dimension that has been underexamined in previous urban research of spatial behavior.

Contrasted to previous studies that depended on static GIS analysis or manual observation, this research proposes a scalable, repeatable, and dynamic method for spatial behavior evaluation. The Takunai-Google Maps integration differentiates this study from the recent devices by focusing on behavioral elements between actual use and design intention rather than merely mapping the spatial accessibility and density.

The contribution of this research is both theoretical and practical. Theoretically, this study advances architectural spatial behavior research by integrating behavioral-environmental theory with digital tracking and empirical movement data. Practically, it offers architects, urban planners, and researchers a digital evaluative tool for assessing public space performance based on actual user behavior. By bridging conventional spatial behavior theories with data-driven design practices, this research strengthens a new direction in architectural and urban studies toward digital empiricism and human-centered urban design.

## 2. Literature Review

### 2.1. Development of Theories on Behavioral Analysis in Architecture and Urban Design

It is presumed that studies on spatial behavior (behavioral-spatial studies) began to flourish in architecture as a critique of the modern master-builders [14, 15]. These architects were considered to design according to their personal preferences and to neglect the ordinary public, who were, in fact, the actual users of the buildings. Ultimately, modern designs that failed to consider user behavior proved unsuccessful. For example, this is reflected in vandalism, damaged facilities, or the wastefulness of facilities that were not used as predicted by the architect in the design process [16]. As part of this critique, several approaches began to emerge, such as environmental psychology—namely, a branch of psychology that studies and analyzes the relationship between human experience and actions with the social and physical aspects of their environments. Other examples include studies of human perception toward elements of their physical environment [17], sociological adaptations within environmental studies [18], and the space-syntax approach, which analyzes the spatial configuration of a space and its relationship with human activities and behavior [19-21].

A general feature offered by the approaches is the human behavior focus as the spatial user. Studies of spatial behavior are meaningful in architectural space, which is a physical entity that is not merely acknowledged for architecture but should be more understood as the human-environment dynamic interactions [22]. In general terms, behavior demonstrates humans in action, relating to all of their physical activities in the form of interactions with one another or with their physical environment. In architecture, behavior constitutes the users' responses and patterns of action toward the physical, social, and symbolic elements surrounding them.

According to Hershberger (1974) and Canter (1977), the relationship between behavior and space is reciprocal: the form of space influences human behavior, yet users' behavior can also shape the meaning and configuration of space [23, 24]. In the context of research in Indonesia, Setiawan (2014) emphasizes the concept of personal space as an adaptive system influenced by users' psychology and culture, thereby directly affecting the composition of the spatial program, architectural dimensions, and the arrangement of the spatial-forming planes [25].

Studies on public-space behavior later developed through the qualitative approach of behavioral mapping. For instance, the spatial contexts and human activities relationship described by Whyte (1980) and Gehl (1987) are through site sketches, diagrams, or maps. The technique of behavioral mapping allows the identification of frequencies and behavioral types, and their special physical design

relationship. Meanwhile, the actual use and urban space formal design generally occurred in other studies concerning deviations [26]. It highlights the significance of empirical behavioral studies as an understanding basis for actual spatial application dynamics.

In the urban design context, socio-spatial methods enhance the concept by perceiving the behavior of space as symbolic and the manifestation of social structures. Through this approach, behavioral studies move toward abstraction: not only observing what users do, but also why such behavior occurs and how its meaning is formed within cultural and economic contexts. Nevertheless, empirical observation of behavior remains the primary source of data, both for environmental psychology studies and for socio-spatial studies in urban design.

**2.2. Location-Tracking Technology and Spatial Analysis Based on Behavior**

Information, particularly spatial information, plays a fundamental role in urban planning and management. Most of the information used by planners is geographic, meaning that the information uses topographic maps or is connected to a geographic location through coordinate references, street addresses, or administrative boundaries. Geographic Information Systems (GIS) or Sistem Informasi Geografis (SIG) is an information system that integrates, stores, edits, analyzes, shares, and displays spatial or geographic information [27].

Over the past few decades, this system has become an increasingly common aspect of urban design and planning practice. The growing use of GIS in urban planning and design promises improvements in the quality of quantitative and qualitative data analysis, thereby enhancing the evidence base of decision-making as well as the knowledge base of the decision-making process itself.

Spatial thinking requires a support system capable of managing multilevel data, displaying relationships between objects, and performing complex analytical operations. GIS becomes an essential tool for spatial thinking because it can integrate hardware, software, and analytical procedures to manage spatially based data [28].

Furthermore, GIS functions not only for technical mapping but also as a spatial decision support system in urban planning and the design of the built environment [29, 30]. In this study context, tracking systems and GIS, like Google Maps API, offer an opportunity to acquire urban residents' actual behavioral data temporally and spatially. As the spatial thinking support system, GIS also functions as an integrating tool of hardware-software procedures encompassing management, modelling, data collection, spatially referenced data visualization, and engineering and analysis. The data is utilized in analyzing movement

trajectories of users, activity intensity, and mapping patterns of the relation between the behavior of users and urban space and architectural physical elements. Moreover, in comprehending spatial-temporal behavior, recent studies emphasize the Location-Based Services (LBS) [31]. The behavior of humans through devices of GPS can be stored objectively and automatically without depending on manual observation, resulting in more accurate quantitative data.

**2.3. The Need for System Integration: from Human Movement Data to Digital Spatial Representation**

Previous literatures illustrate that manual observation approaches like interviews, surveys, or empirical observation frequently function in mapping experience limits [32]. They are proven in terms of objectivity, continuity, and the observation scale. The digital approach allows urban and architectural researchers to incorporate actual behavioral data with spatial models comprehensively.

This research provides a thesis that Takunai, this study's developed application, and Google Maps, as the digital recording, may function as the foundation of urban space design models and new theories development, as data are easily verifiable, empirical, and real-time. The system can evaluate discrepancies between public space real use (actual use) and formal design intentions (design intent).

The spatial representation and digital behavior integration have potential in formulating a new evidence-based urban design approach. Contextually, the Google Maps-Takunai system plays a crucial role in integrating spatial-behavior observation with digital data-based contemporary spatial analytics.

Thus, this body of literature reveals an epistemological evolution in architecture: from descriptive behavioral studies toward empirical, data-driven, and technologically supported analysis, positioning human behavior as the primary indicator of the success of urban space design.

**3. Materials and Methods**

This research utilizes a grounded research method to formulate the latest theoretical framework from empirical data. This approach selection is according to the patterns of spatial behavior emergence, which are not pre-generated by existing regulatory frameworks or planning theories. This method is expected to examine the motion to which data of digital behavior gathered through the system of Takunai and Google Maps can uncover community activity dynamic patterns captured by interviews, static spatial regulations, and conventional surveys.

Different from traditional grounded study in urban research, which frequently depends on interview-based coding and qualitative observations, this research expands the grounded method through real-time digital data

integration of movement. The system functions of Takunai-Google Maps are more of a navigation tool mapping, but as an evaluating platform interpreting, visualizing, and recording movement trajectories of actual humans in the correlation of planning intentions and spatial configuration. This methodological correlation manifests the key research novelty, distinguishing it from primary survey-based or GIS-based spatial behavior research.

The grounded research method is applied to the behavior of human movement in Coastal Edge, Kupang Bay, an urban area that is coastal and has complicated socio-spatial dynamics. The coastline of Kupang Bay is a public space of the city, which has started experiencing a decline in its public understanding because of processes of privatization emerging in some segments.

In accordance with Law No. 26 of 2007 about Spatial Planning, the government should conserve the coastal areas as a protected one. Nevertheless, the Kupang Bay coastline in Kupang City's spatial plan is designed as a tourism zone and cultivation area. This inconsistency of regulation produces a critical spatial term that the objectives of formal planning diverge from standard spatial practices and national regulations.

As a result, the coastline of Kupang Bay manifests a vivid formal spatial regulations discrepancy concerning actual spatial utilization and tourism and conservation development, formed by routine community behavior, local transportation patterns, and informal economic activities. This issue results in a suitable area for examining the system's ability of Takunai-Google Maps to detect patterns of spatial behavior empirically invisible in methods of conventional observation or documents of formal planning.

The location of the chosen research is the Kupang Bay coastline, which is distinguished into two segments of analysis (Figure 1). The segmentation is formulated to enable analysis of comparative behavior according to formal spatial intervention levels. The extension of segment I is from Hotel on the Rock and Resto Handayani to Resto Suba Suka. An area developed based on environmental and building planning guidelines is represented in this segment, and thus reflects the intentions of formal design. The extension of segment II is from Teddy's Bar Beach to Ketapang Satu. Differently, this segment has a weakness of organized spatial arrangement and is not developed based on the guidelines of official planning, producing adaptive and informal spatial performances to dominate.

This research illustrates the Takunai methodological novelty as a media in assessing the correlations between actual spatial use and planned spatial form through comparing real-time data of human movement between these two parts. This differentiation separates prior GIS devices

from Takunai-Google Maps, which mainly highlights land-use classification or static spatial attributes rather than analysis of behavioral congruence.



**Fig. 1 Research location map**

Source: RTBL Strategic Area of Pasir Panjang Beach and Kelapa Lima Beach in Pasir Panjang and Kelapa Lima Sub-districts (Cluster A), Kupang City

### 3.1. Data Sources

The data were collected through the application of Takunai, which records space users' movement in the spatial coordinates form (latitude-longitude) linked to Google Maps. The records of application include: (a) Spatial coordinates or latitude-longitude for every five seconds; (b) the presence duration and time of each point; (c) the visit frequency in the same spot; and (d) the location's movement trajectory.

Data were obtained through the Takunai application, which records the movement of space users in the form of spatial coordinates (latitude-longitude) connected to Google Maps. This application records: (a) Spatial coordinates (latitude-longitude) periodically every 5 seconds; (b) The time and duration of presence at each point; (c) The frequency of visits to the exact location; and (d) The movement trajectory between locations.

Data were collected over 14 days of continuous observation. All data were synchronized with the Google Maps API to produce spatial behavior maps that represent the users' behavioral footprint within the context of urban space.

In addition to digital data, secondary supporting data were also collected for validation, including: (a) Official Spatial Plans of Kupang Bay; (b) An Inventory of Physical Elements (roads, buildings, open spaces, public facilities); (c) Field photographs and limited visual observations (spot-check) for verifying activity locations.

**3.2. Variables and Analytical Focus**

The three primary variables in this research are: First, users’ movement within space. Observations of this variable include movement patterns and direction (movement pattern); the frequency of visits and duration of presence (activity density); and the concentration of human activity in the space (behavioral density). Second, the context of the urban space. Observations of this variable include physical structures such as road networks, public open spaces, and buildings; accessibility; and spatial functions (both the designated functions according to the spatial plan and their actual use in practice). Third, digital platforms and data validity. This variable incorporates Google Maps API for spatial data visualization; Takunai implementation recording temporal and spatial data accuracy; and field observation in evaluating data reliability for validation.

**3.3. Research Method**

In accordance with the objective of the research, the methodology comprises four stages: First, visitor movement visualization and description employing the Takunai and Google Maps application. Data acquired through Takunai recordings are processed into tabulated form, producing summaries of respondents’ movements and stopping points. At this stage, the intensity level of respondents’ presence at the same point at different times becomes identifiable. Second, abstracting the trends and patterns that emerge.

Third, highlighting three main contributions of Takunai–Google Maps–based recording for urban design practice. Fourth, proposing a potential synthesis between Takunai–Google Maps and other architectural analytical methods.

**4. Result and Discussion**

**4.1. Visualization of Visitor Movement**

The data obtained in this study consist of movement data from respondents (university students) who were provided with the Takunai link. The recorded data contain sequences of movement and stopping points. These data are recorded on Google Maps both as maps and as coordinate and time data. Thus, each respondent is individually recorded according to their movements. Below is a sample of the data recorded by the Takunai application, consisting of coordinate points, time, and movement maps. Google records coordinate points only when a respondent remains at a location for a minimum of approximately 15 minutes. Therefore, respondents who pass through a point without stopping will not have their coordinates recorded. This aligns with the researcher’s intention to ensure that when a respondent comes to a point and stops, the stopping behavior is strongly related to the area or its spatial-psychological factors. Among the five respondents, the following is an example of raw data from Takunai tracking for one respondent:

**Table 1. Sample of raw data from Takunai records**

No	Location		Name
	“Lat”	Long	
1	-101,453,353	1,236,151,161	Jufryanto Mantolas
2	-101,453,148	123,615,127	Jufryanto Mantolas
3	-101,445,984	1,236,166,028	Jufryanto Mantolas
4	-101,448,678	1,236,168,142	Jufryanto Mantolas
5	-101,453,029	1,236,165,561	Jufryanto Mantolas
6	-101,441,824	1,236,229,875	Jufryanto Mantolas
7	-101,455,367	1,236,144,634	Jufryanto Mantolas
8	-101,454,666	1,236,148,547	Jufryanto Mantolas
9	-101,451,398	1,236,164,661	Jufryanto Mantolas
10	-101,452,845	1,236,164,517	Jufryanto Mantolas
11	-101,453,431	1,236,163,618	Jufryanto Mantolas
12	-101,452,884	123,615,081	Jufryanto Mantolas
13	-101,453,116	-1,236,151,056	Jufryanto Mantolas
14	-101,455,199	1,236,160,702	Jufryanto Mantolas
15	-101,454,525	1,236,161,681	Jufryanto Mantolas
16	-101,455,315	1,236,162,497	Jufryanto Mantolas
17	-101,145,095	1,236,165,983	Jufryanto Mantolas
18	-101,452,484	1,236,164,076	Jufryanto Mantolas
19	-101,450,026	1,236,164,389	Jufryanto Mantolas
20	-101,455,804	1,236,161,793	Jufryanto Mantolas
21	-101,452,658	123,614,849	Jufryanto Mantolas
22	-101,454,192	1,236,160,482	Jufryanto Mantolas

The Takunai application essentially functions similarly to the Google search engine, and it is directly linked to Google Maps. From the movement recap recorded through Takunai, movement patterns and tendencies become observable both from coordinate points and maps. The application records every stopping point where respondents perform activities, as shown in the visualization of respondents' movements below. In the figure, blue nodes represent stopping points. From this illustration, the frequency with which respondents remain at locations close to the exact coordinates can be determined.

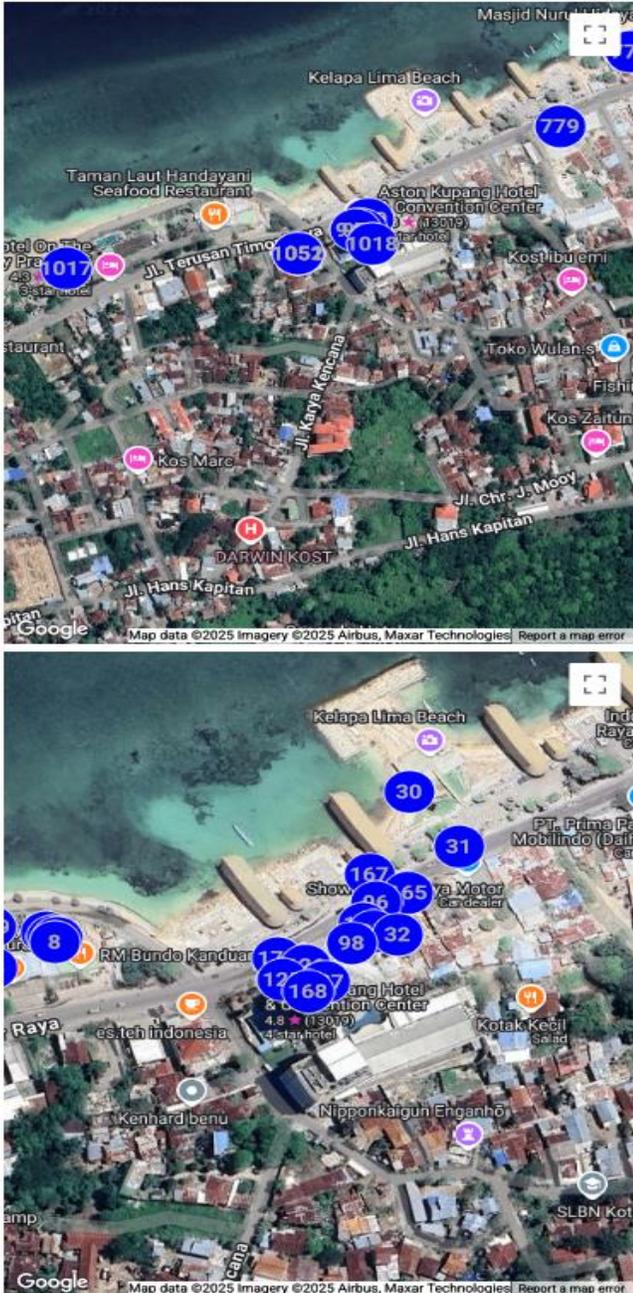


Fig. 2 Example of respondent movement visualization based on google maps-takunai recording

The movement trajectories show a dominant east-west direction parallel to the coastline, as well as strong connections between informal parking areas, culinary nodes, and access points to the waterfront public space. High activity concentrations outside the official spatial-planning corridor indicate the likelihood of a deviation between planned spatial design and actual use. Based on these data, a preliminary interpretation is that formal designs oriented toward exclusive tourism functions do not fully reflect the behavioral realities of coastal communities, whose spatial practices are more dynamic and dependent on daily economic needs.

4.2. Mapping Movement Patterns

From the movement recap recorded through the Takunai application, movement patterns and tendencies are visible both through coordinate points and maps.

Table 2. Movement recap based on visit frequency

NO	Respondent Name	Visit intensity
1	Jufryanto Mantolas	22
2	Mario Jonathan Dawang	12
3	Lusius Tida Lo Lemaking	41
4	Natalia Cinthya Putri mau	9
5	Siprianus Lino Kali	10

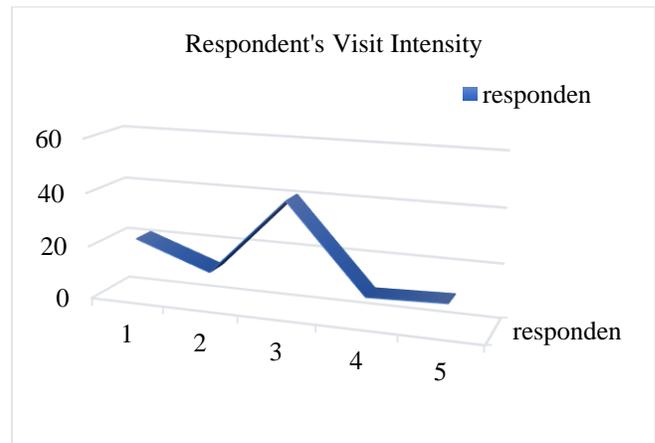


Fig. 3 Visit intensity chart

It is evident in the chart and table above that an application of Takunai is able to record frequent real-time activities of respondents on their Android devices. Respondents' most activities are also recorded neatly in the Takunai app, with movement distribution. The recording is essential in unveiling architecture, planning, and infrastructure design.

The accuracy of the research data is illustrated by recording movements of coordinate points through a satellite. It is known to be highly valid because of the real-time movements of the respondents. The completeness of collected data reflects respondents' natural activities, which

means activities in the coordinate points were not conducted by all respondents; outside the targeted coordinates, activities were engaged in by some. Collected from recorded time logs and coordinate points, movement patterns, and time duration of the respondents illustrate the consistency of the data. Thus, it is highly unlikely to duplicate the data due to personal recording.

This research illustrates urban design practice in three main contributions due to the recordings:

1. Revealing spontaneous behavioral patterns of users interacting with physical urban elements: The Takunai–Google Maps system identified activities not documented by conventional surveys, such as informal paths linking tourist areas and fishermen’s settlements. These patterns demonstrate the current urban behavior generating the latest spatial structures.
2. Decreasing the design actual use and intentions gap: based on the empirical evidence through digital behavior data, planners and architects can formulate proposals, reducing the real-world use and idealized design gap.
3. Formulating adaptive public space design guidelines: more responsive public space design can be acquired through actual behavioral data, encompassing reorganizing seating areas, kiosk layouts, and pedestrian access based on real-time movements.

**4.3. Takunai-Google Maps and Other Behavioral Analysis Methods: Potential Synthesis**

Determining qualitative and quantitative methods becomes the most applied science challenge that most researchers have experienced concerning urban design and

architecture. In terms of statistical results, the quantitative method is considered objective and testable with more robust generalizability, yet it is frequently restricted in uncovering meaning. Meanwhile, concerning meaning and interpretation, qualitative methods are more appropriate to case-by-case analysis, yet are vulnerable to producing biased results.

This study’s findings reveal that Takunai-Google Maps produced robust potential incorporated with earlier developed architectural analytical methods like qualitative-interpretive and morphological-predictive. This crucial synthesis plays an essential role in combining spatial meaning (qualitative interpretation) and empirical data (quantitative evidence) in a comprehensive research framework.

**4.3.1. The Existing Methods Integration for Predicting Human Movement**

Bill Hillier and Julienne Hanson (1984) formulated an approach of spatial analysis known as space syntax. In this approach, the structure of space relations is examined through geometric representations and network graphs. Its role is to foresee human movement spatial configuration based by employing parameters like integration, choice, and connectivity.

However, behavior is evaluated by Space Syntax not through real-time human movement but space geometry. Meanwhile, empirical, real-time, and real-world data are recorded by Takunai-Google Maps through trajectories and densities of human activity movement. Integrating the two methods produces dual-perspective analysis.

Aspect	Space Syntax	Takunai–Google Maps	Example of Synthesis
Type of data	Predictive movement based on the configuration of space	User behaviors’ actual movement	Synthetic predictions: empirical validation
Approach	Model → behavior (deductive)	Data → pattern (inductive)	Feedback loop of model behavior
Output	Syntactic integration value maps	Behavioral density maps	Actual user behavior and spatial configuration correlation

This method can produce a behavioral validation conceptual framework where Space Syntax analysis outcomes are evaluated and verified by Takunai. In other words, the evaluation of urban design and architectural design proposals can be conducted through both empirical confirmation and geometrical-morphological reasoning. This integrated strategy is effective in producing accurate models of human movement in the field of architectural and urban space analysis.

**4.3.2. Qualitative Approach Integration for Interpreting Meaning**

This study’s motivation was to comprehend public-space behavior as a reflection of relational dynamics between urban

space and humans. Rather than recording human behavior, qualitative approaches like spatial ethnography and phenomenology are crucial in interpreting the meaning of human actions. Spatial ethnography, introduced in Gehl’s (1987) and Whyte’s (1980) work, is concerned with humans’ behaviors, habitual practices, and interactions that provide public spaces’ identity. Meanwhile, phenomenology, proposed by experts like Seamon, defines place or space as humans’ integrated experiences and meanings.

These methods are completed by the Takunai-Google Maps system through objective and measurable empirical data layer by identifying the real-time activity frequency concentrations, trajectories, and visits. The data recorded by

the system was then interpreted by spatial ethnography to discover the emotional experiences, social intentions, or contexts. Hence, through this integration, two-tiered analytical frameworks can be established:

*Empirical Layer (Behavioral Level)*

Takunai-Google Maps identifies the behavioral attraction locations, activities, and movement patterns. For example, a place with a high frequency of visits is considered a social interaction center or a behavioral attractor.

*Interpretive Layer (Experiential Level)*

Elaborated through ethnographic interviews or qualitative observation to discover motivations, values, or perceptions behind the actions of users.

In comprehending more holistic public-space behavior, the integration of experiential meaning and behavioral traces generates a synthetic approach. Hence, user behavior is understood not only as spatial movement but also as an expression of the relational bond between people and their environment (human–place interaction).

In this context, public space functions as a meaning system frequently reflected by human action, while the

Takunai system functions as a visual tool of the empirical negotiation. This approach evidences the movement of traditional behavioral study to interpretive behavioral analysis, where it is possible to interpret and trace public-space behavior. It connects experiential spatial knowledge with digital data, reflecting architecture as a study of interdisciplinary integrating technology, behavior, and meaning into a coherent scientific framework.

**5. Conclusion**

The conclusions are determined based on the study analysis. First, accurate, real-time, and objective human behavior quantitative data are produced by the Takunai-Google Maps API. Second, this research demonstrates conceptual and technical spatial behavior understanding regarding the digital era, as well as providing empirical data on spatial planning discrepancies and actual practices. Third, this research encountered challenges in performing the approach, including the protection needs of strong privacy, reliance on users, and extensive limitations in identifying meaning and perception. Thus, it is recommended to develop a comprehensive methodology combining quantitative digital recording and an interpretive method that concerns social context and meaning.

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