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Malioboro at night: Capturing human movement in an urban environment through a cinematic lens

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Abstract. The idea of spatial experience in urban environments can be related to studying human and object movement. The urban night scene experience remains underexplored in terms of how human movement and visual attention influence spatial perception. This study will use the Malioboro area as a research location, which has a distinctive pedestrian character. Although previous research at this location has addressed pedestrian patterns, few have focused on how different temporal aspects may influence spatial narratives, especially at night. Using a cinematic lens, this study explores the system of human movement and stopping points in urban environments. Two research methods were used in this study. Quantitative data is used to explore perceptions as people move through a series of cultural corridors. GIS-based kernel density is applied to determine the density of stop points. This study emphasises the relations between urban space and human movement, which can inform design strategies focused on environmental qualities. The findings demonstrate that visual attention and spatial narratives play crucial roles in guiding movement, forming memories, and enhancing engagement with the environment. This paper enhances people's understanding of urban environments by considering human movement as an integral aspect of cinematic discourse.

1 Introduction

Human movement leading to spatial experiences in the urban environment is relevant to sustainability [1]. In environmental science, walkability and sensory comfort are closely linked to public health and ecological resilience, in line with Sustainable Development Goal (SDG) 11 on sustainable cities and communities. Nighttime conditions demonstrate how lighting design, microclimate, soundscape, and materiality interact to influence behaviour and perception. Urban lighting affects not only visibility and safety but also energy consumption, light pollution, circadian rhythms, and ecological processes that impact the integrity of the urban nightscape. However, the environmental implications of visual attention and pedestrian movement at night remain largely unexplored.

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The city is considered a *cinematic apparatus* that contains the critical interplay between material and immaterial spaces. Several studies have been conducted discussing human movement in urban environments to identify various attributes of objects that drive a person's movement when experiencing the city at night [2]. In addition, a study in Rome indicated that luminance is a relevant metric for walking at night, influencing, in particular, pedestrians' comfort, visibility, and perceived lighting intensity and uniformity [3]. Also, experiments with light activate the human sensorium while contributing to urbanism. These arguments suggest that luminance influences human movement in night scenes, affecting comfort and visibility. Additionally, experiments with light engage human senses and contribute to the city's regeneration through everyday life interactions.

The attention of a person's eyes when 'capturing' the objects around their environment can be associated with the optical content. Moreover, Human attention inside the building may relate to the movement mechanism [4], considering the operational aspects. Attention presupposes a transformation of the mental field, a new way for consciousness to be present in its objects. The discussion of a person's movement in the outdoor environment at night does not yet pay attention to the subject-object relations, especially in the cultural corridor space, such as the Malioboro area. The cultural corridor in this study may have unique characteristics and attributes, and proposes a novel study on body and eye movements in urban environments.

This study aims to examine the area along Malioboro, a vibrant pedestrian corridor that remains active at night. Situated along the philosophical axis of Yogyakarta City, this corridor is one of the most popular destinations for tourists. Recently, however, the character of the corridor has changed, marked by the disappearance of the traders who once occupied the space. The elements present along the corridor can either enhance or diminish the quality of the urban environment, particularly in relation to place attachment. Given the recent developments, a pertinent question arises: what factors encourage human movement in the Malioboro area, especially at night?

This paper aims to explore visual pathways within an urban environment through the lens of human movement. By analysing the interplay between the human movement system and urban elements, we can enhance cinematic readability. The stopping points along these pathways will contribute to a narrative that illustrates an urban cinematic experience based on movement. So far, physical routes have been understood as a person's circulation space moving in urban space. Physical routes are usually in the form of roads, main roads, or narrow alleys. One form of physical route is an alley that functions to connect one place to another and has a social function in Indonesia [5]. The existence of a shortcut as an urban environment system to support physical and mental health [6]. The route used to determine a person's trips in an urban environment can provide an inclusive engagement. In addition, stopping points are essential in an approach to the urban environment that emphasises visuals and cinematics.

2 Methods

This paper uses an explorative method that involves observers when experiencing the city. Exploratory scenarios are practical for analysing uncertainty within a planning process [7]. Data collection was conducted quantitatively using Google Forms. Observers were selected as walking script actors through purposive sampling techniques. This approach aimed to showcase various visual routes and highlight the best cinematic spots identified by the observers while walking along the Malioboro area.

Considering object placement and lighting to trigger observer movement can enrich kinetic-based urban design methods. This study's findings are expected to be used in designing urban spaces that consider the attention of the observer's eyes when capturing objects visually. This study focuses on night scenes, assuming that capturing objects with specific lighting effects can influence human attention to continue moving.

1.1 Sampling and Materials

The sample used in this study is purposive sampling. The first step in purposive sampling is determining appropriate sampling criteria that align with the research objectives [8]. The study aims to see the distribution of essential points in both segments and the most significant attention in 'gazing' at the city at night. The author selects respondents with tourism criteria who are domiciled outside Yogyakarta. This was chosen considering that the target audience is a 'spectator' who does not pass through the location in their daily lives and does not have a purpose for a trip.

The age of respondents is determined to be around 19-40 years, considering the best eye conditions are in that age range [9]. The following questions are asked, starting with choosing the best spot for taking pictures to create a point on the kernel density, and continuing with questions derived from the selected spatial experience theory. If the sample meets the specified criteria, an experiment is carried out with the respondents' consent by filling out the questionnaire form according to the research objectives.

The location used for observation starts from segment I, with the starting point of *Tugu* Pal Putih landmark to *Tugu* Station; segment II starts from *Tugu* Station to Plaza Malioboro Mall; segment III starts from Plaza Malioboro Mall to the Nol Kilometres Point. The research locations can be seen in Figure 1 below:

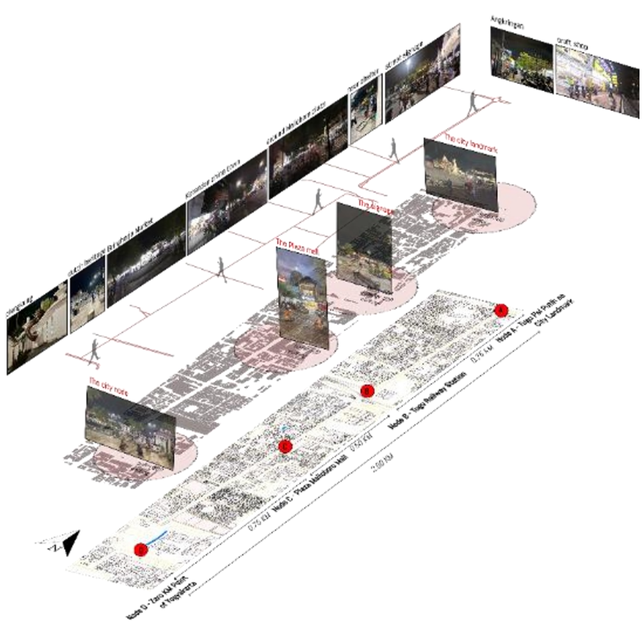

Fig. 1. Research location

The material in this study includes the research location and experimental procedures to determine the basic understanding of environmental quality based on tourist preferences. The selection of the location considers the role of the imaginary axis of Yogyakarta as a favourite tourist destination. The imaginary axis of Yogyakarta is critical to study in the visual realm, considering that this axis has been designated as a cultural heritage by UNESCO in 2023 [10], and the axis manifests as a road system. Segment division based on stopping points frequently mentioned by tourists [11]. Furthermore, segment division is also based on comfortable walking distances in a tropical city, around 500 - 800 meters or a 5–10 minute walk.

1.2 Research Design

This article examines the night environment with a focus on the lighting elements involved in capturing objects in urban settings. The research is divided into two key steps to address the objectives: (1) to observe human attention in relation to spatial experience theories; and (2) to identify distribution nodes that motivate movement at night. The research design is illustrated in Figure 2 below:

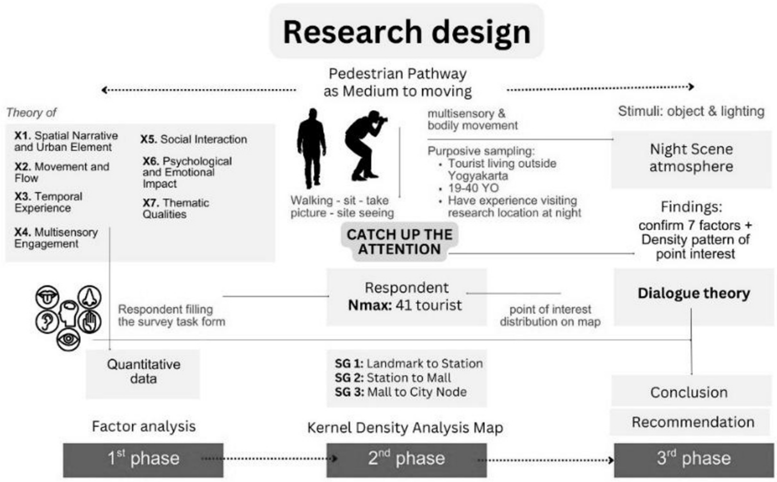

Fig.2. Research Design

The questionnaire given to selected respondents was made with the purpose of the study, which is to determine the spatial experience when walking through the night scenes. The questions that will be given are as follows:

Table 1. List of Questionnaire

Variable	Question	Parameter
X1. Spatial narrative and urban elements	X1.1. *This pedestrian has its characteristics and depicts the spirit of Yogyakarta* X1.2. *The elements that fill the space (buildings, roads, seating points, parks) feel like they synergize well with the theme*	Likert 1-5
X2. Movement and flow	X2.1. *I felt like I was walking through a pedestrian designed to direct the movement of my body and eyes* X2.2. *As I move through the night, I experience visual transitions, like moving through different scenes*	Likert 1-5
X3. Temporal experience	X3.1. *The pedestrian I walk through changes its atmosphere over time (evening to night) and offers different experiences at different times* X3.2. *I feel the change of time in this pedestrian area through the changes in lighting*	Likert 1-5
X4. Multisensory engagement and urban soundscape	X4.1. *In the night time, I involve many senses (sight, hearing, touch, smell) to capture objects around the pedestrian space* X4.2. *In the night time, the sounds around me (e.g., nature, traffic, people) contribute to my overall experience*	Likert 1-5
X5. Social interaction	X5.1. *I see the city space as a public stage at night, where people interact socially*	Likert 1-5
X6. Psychological and emotional impact	X6.1. *This space evokes strong emotions, such as being amazed, surprised, impressed, and curious.* X6.2. *I feel mentally stimulated and engaged in deep contemplation as I walk through this space at night*	Likert 1-5
X7. Thematic qualities	X7.1. *This pedestrian space feels memorable, stored in memories, and I can tell to anyone about it in detail.*	Likert 1-5

After tourists answer the questionnaire related to the driving factors of walking movement, kernel density mapping is then carried out to map favourite nodes. These nodes will later form a colour gradation that reflects the quality of the environment according to tourist preferences. The best environmental quality in this corridor can later become a potential benchmark in creating place attachment.

2 Results and Discussion

The desire to see the environment preceded the means of satisfying it. The level of satisfaction experienced by someone when walking in an urban environment is closely related to the multisensory function of the walker's movements. This study's results began with factor analysis and continued with kernel density analysis to see the cinematic nodes in their series of trips. From the 43 tourist profiles collected, only 41 met the criteria according to the study objectives. The criteria are tourism domiciled outside Yogyakarta, aged 19-40 years, and have visited one or all three segments of the research location at night. The results of the reduction factor analysis can be seen in Table 2 below:

Table 2. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.755**
Bartlett's Test of Sphericity	Approx. Chi-Square	248.557
	df	66
	Sig.	.000

The Kaiser-Mayer-Olkin Measure of Sampling Adequacy (KMO) output table and Bartlett's test show the feasibility of the variables used in the research model. Based on the output in the table above, the KMO MSA value is 0.755 > 0.50 and the Bartlett's Test of Sphericity (Sig.) value is 0.000 < 0.05, so the factor analysis can be continued because it has met the first requirement. The Anti-Image Matrices results show which variables are suitable for use in the following analysis process (see Table 3):

Table 3. Anti-Image Matrices

		X1.1	X1.2	X2.1	X2.2	X3.1	X3.2	X4.1	X4.2	X5.1	X6.1	X6.2	X7.1
Anti-image Correlation	X1.1	**.795**[a]	-.318	.230	-.164	-.264	.074	-.338	.155	-.061	-.160	.094	.050
	X1.2	-.318	**.716**[a]	-.198	-.224	.317	-.081	.051	-.310	-.370	.346	-.121	-.107
	X2.1	.230	-.198	**.700**[a]	-.280	.156	.077	-.366	-.339	-.067	.174	.184	-.349
	X2.2	-.164	-.224	-.280	**.841**[a]	-.433	-.062	-.042	.238	.025	-.110	-.166	.067
	X3.1	-.264	.317	.156	-.433	**.695**[a]	-.431	.057	-.316	-.073	.049	.022	.048
	X3.2	.074	-.081	.077	-.062	-.431	**.773**[a]	-.230	-.343	.035	.282	-.162	-.172
	X4.1	-.338	.051	-.366	-.042	.057	-.230	**.844**[a]	.198	.011	-.104	-.091	-.091
	X4.2	.155	-.310	-.339	.238	-.316	-.343	.198	**.571**[a]	.052	-.561	.191	.268
	X5.1	-.061	-.370	-.067	.025	-.073	.035	.011	.052	**.875**[a]	-.248	-.298	.045
	X6.1	-.160	.346	.174	-.110	.049	.282	-.104	-.561	-.248	**.649**[a]	-.292	-.581
	X6.2	.094	-.121	.184	-.166	.022	-.162	-.091	.191	-.298	-.292	**.847**[a]	-.035
	X7.1	.050	-.107	-.349	.067	.048	-.172	-.091	.268	.045	-.581	-.035	**.764**[a]

a. Measures of Sampling Adequacy (MSA)

Table 3 above confirms that the MSA value of each variable has met the requirements, where the MSA value is > 0.50. From the output of the Anti-Image Matrices, it can be seen that the highest variable as an experience shaper is social interaction, with a value of 0.875. Social interaction is an attribute that drives spatial experience, which becomes a novel discourse about how the interaction influences human attention to visit. Furthermore, in this variable, the spectator sees the city as a stage of relations between subjects. Furthermore, to see the components formed from the correlation between variables, it can be seen in the following table:

Table 4. Rotated Component Matrix[a]

	Component			
	1	2	3	4
X1.1	.170	**.804**	.168	.074
X1.2	.085	.454	.107	**.697**
X2.1	.226	.027	.163	**.875**
X2.2	.183	**.679**	.388	.272
X3.1	.065	.418	**.818**	-.130
X3.2	.052	.322	**.776**	.198
X4.1	.339	**.533**	.085	.443
X4.2	.303	-.192	**.773**	.324
X5.1	**.552**	.466	.095	.294
X6.1	**.903**	.104	.234	.068
X6.2	**.650**	.518	.068	-.002
X7.1	**.759**	.117	.045	.394

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 7 iterations.

After identifying the factors that contribute to the spatial experience, we engage in a theoretical dialogue to interpret each one. As shown in Table 4 above, social interaction, psychological and emotional dimensions, and thematic quality are influential in shaping the spatial experience of pedestrians. Factor 1 reframes significant cinematic nodes, such as the movement scenarios of individuals, as a fluid backdrop, emphasising that the interactions of 'moving subjects' can be more essential than fixed elements, like iconic buildings. Moreover, this factor goes beyond merely positing that urban form functions as a cinematic apparatus; it suggests that urban environments characterised by specific themes significantly influence social interactions and emotional engagement.

Factor 2 highlights the relationships of narrative continuity, which arise from the kinesthetic flow associated with multisensory involvement. A notable finding in this factor is that while vision is the primary sense, olfactory and auditory stimuli also play a vital role in establishing cinematic conditions. This factor transcends the old "mental mapping" theory, offering opportunities to incorporate multisensory navigation as a connection to cinematic montage theory.

Table 5. Factors and components

Factor	Components
F1	Social interaction, psychological, emotional, and thematic qualities
F2	Spatial narrative, walking flow, and multisensory engagement
F3	Temporal experience, presence of lighting, and urban soundscape
F4	Urban elements and human movement

Factor 3 highlights how time, light, and sound ambience transform space perception across the day-to-night scene. In this study, the street lights act as a cinematic background, which is in line with the findings by Frutos et al [12]. In these findings, we focus on traditional modes of movement (e.g., *Delman, Becak*) as preferred backgrounds for photography. This highlights that a 'moving object' can be more captivating than a stationary one, such as an architectural landmark. This perspective contrasts with classical urban theory, which emphasises the importance of 'permanence.'

Factor 4 brings the study back to the 'materiality' of urban elements and their ability to encourage human movement. The city functions as a 'spatial grammar,' where recognisable and tangible urban elements shape place identity. Our findings provide empirical evidence showing how pedestrians respond to physical cues in urban environments, especially at night when parks and streets are illuminated.

After identifying the primary factors that influence walkers' movements in nighttime settings, we also analysed cinematic nodes as potential backgrounds for photography or video. In this case, we employed kernel density mapping analysis to locate these cinematic nodes. Kernel density can show colour gradation according to the density of the selected points [13]. The nodes mentioned by the tourists become observation points, which will then be analysed using kernel density estimation to see the point of interest (POI). The results of the kernel density analysis (KDA) can be seen in Figure 3 below:

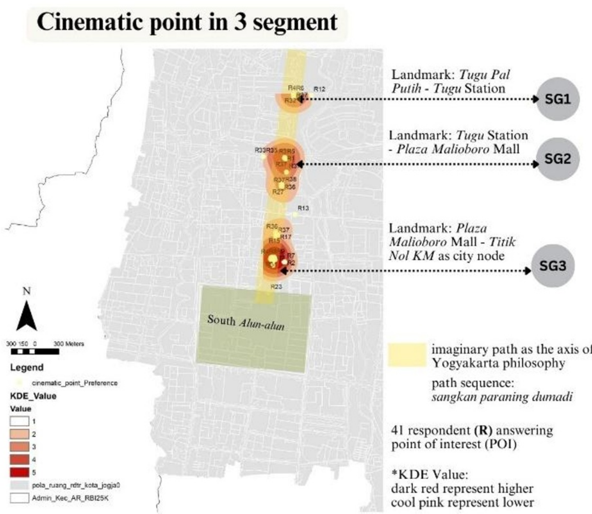

Fig. 3. The distribution map of visitors' spatial preferences as cinematic nodes at night.

The kernel density mapping indicates that darker shades represent higher density values, while lighter shades signify lower ones. The most popular location, based on tourist preferences, is the zero-kilometre point in Yogyakarta, followed closely by the sign for "Malioboro Street." In contrast, the horse-drawn carriage parking lot is favoured as a backdrop for tourists. The *delman*, or horse-drawn carriage, serves as a notable temporary feature that exceeds expectations, making the parking lot a cinematic setting preferred over more permanent elements such as buildings or street furniture. Interestingly, the Tugu Pal Putih, a city landmark, is not frequently identified as an appealing node in the night scene.

This paper demonstrates that kernel mapping can be an effective tool for exploring the density of human movement and common stopping points. This extends the kernel method, which has been more widely used to analyse crime spots, disease distribution, and public facility placement [14-15]. The findings of this paper demonstrate that the kernel mapping method effectively identifies key areas that attract pedestrians to pause and capture photographs with the urban landscape as a backdrop. This indicates that the settings at these stopping points possess significant cinematic appeal for those walking through the city.

This paper seeks to enrich the discourse surrounding the urban environment by focusing on visualisation and human movement. People's perception of environmental quality is intricately linked to urban elements that can be visually represented, remembered, and later recounted as narratives. The study integrates the principles of experiential urbanism and spatial storytelling shaped by human movement. Temporal objects such as streetlights, road signs, and horse-drawn carriages contribute to meaningful spatial experiences for pedestrians. Urban storytelling unfolds when we regard the city as a stage, where the community acts as performers, interpreting the narrative through their physical presence. Moreover, various urban elements can inspire walking, an essential component of creating walkable cities, an important aspect of sustainability that ultimately enhances community well-being.

3 Conclusions and Recommendations

This study examines the interplay between human movement and visual attention in shaping experiences within the nighttime urban environment. It highlights that visual attention extends beyond just the structural aspects of our vision; environmental factors like lighting and spatial organisation influence it. The results reveal that visual attention and spatial narratives are essential in guiding movement, shaping memories, and enhancing environment engagement.

Further, the research argues that movement in urban environments encompasses a variety of social interaction, psychological, emotional, and thematic qualities that arise from its settings. Since the study is based on a single case, it acknowledges the potential for varied outcomes in different contexts. The design of human movement systems should harmonise closely with urban features to create more engaging pedestrian spaces.

This study offers insights into human movement in urban environments, but it has limitations. It focuses on a single urban corridor and tourists aged 19 to 40, excluding insights from older people and individuals with disabilities. Reliance on perception without technology like eye tracking limits data objectivity, and concentrating solely on night scenes restricts comparative analysis. Future studies should fill these gaps by involving a wider array of participants and exploring various cultural corridors. Using advanced technologies, such as eye tracking, could provide deeper insights into visual attention and movement behaviours. Additionally, investigating different times of day could offer a fuller picture of how temporal changes influence spatial experiences, ultimately guiding urban design toward more human-centred environments.

4 Acknowledges

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