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Gender Differences in Perception and Measurement of Physical Space

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ABSTRACT

This study aims to measure and explain gender differences in the preference for using distance and time units when answering questions related to the measurement of physical space. The primary objective is to assess the extent to which men and women respond to distances using either distance or time units and to explore the underlying reasons for their choices based on gender. This research has significant implications for spatial planning, particularly in designing more inclusive environments that accommodate gender-based differences in spatial perception. The study employs a descriptive method, using questionnaires as the primary research instrument. The results are presented as respondent percentage distributions and analyzed through Kurt Lewin's "Frame of Reference" theory. By doing so, the study identifies gender-based preferences in the use of distance and time units. Findings indicate that men are more likely to use length-based units in their responses (64.3%) compared to women (35.7%). Conversely, a smaller proportion of men (34.2%) use time-based units, whereas women exhibit a higher preference for this approach (65.8%). Men tend to perceive length measurements such as kilometers or meters as more concrete and precise, often influenced by educational background and experiences that require accuracy in measuring distances. In contrast, women are more inclined to use time units, considering factors like traffic conditions and uncertainties in urban environments. This study contributes beyond traditional research on cognitive mapping and gender differences in spatial understanding, which have largely relied on psychological tests in controlled environments. Instead, it examines spatial perception in real-life contexts. By employing a balanced sampling methodology and updating the research perspective, this study not only reinforces previous findings but also provides new insights for more inclusive urban and transportation planning.
Keywords: Preferences, Distance, Time, Planning, Reference

ABSTRAK

Studi ini bertujuan untuk mengukur dan menjelaskan perbedaan gender dalam preferensi penggunaan satuan jarak dan waktu ketika menjawab pertanyaan terkait pengukuran ruang fisik. Tujuan utama adalah untuk menilai sejauh mana pria dan wanita merespons jarak menggunakan satuan jarak atau waktu dan untuk mengeksplorasi alasan mendasar di balik pilihan mereka berdasarkan gender. Penelitian ini memiliki implikasi signifikan untuk perencanaan spasial, terutama dalam merancang lingkungan yang lebih inklusif yang mengakomodasi perbedaan persepsi spasial berdasarkan gender. Studi ini menggunakan metode deskriptif, dengan menggunakan kuesioner sebagai instrumen penelitian utama. Hasilnya disajikan dalam bentuk distribusi persentase responden dan dianalisis melalui teori "Frame of Reference" Kurt Lewin. Dengan melakukan hal tersebut, studi ini mengidentifikasi preferensi berbasis gender dalam penggunaan satuan jarak dan waktu. Temuan menunjukkan bahwa pria lebih cenderung menggunakan satuan berbasis panjang dalam jawaban mereka (64,3%) dibandingkan wanita (35,7%). Sebaliknya, proporsi pria yang lebih kecil (34,2%) menggunakan satuan berbasis waktu, sedangkan wanita menunjukkan preferensi yang lebih tinggi untuk pendekatan ini (65,8%). Pria cenderung memandang pengukuran panjang seperti kilometer atau meter sebagai lebih konkret dan tepat, sering dipengaruhi oleh latar belakang pendidikan dan pengalaman yang memerlukan ketepatan dalam mengukur jarak. Sebaliknya, wanita lebih cenderung menggunakan satuan waktu, mempertimbangkan faktor-faktor seperti kondisi lalu lintas dan ketidakpastian di lingkungan perkotaan. Studi ini berkontribusi lebih dari sekadar penelitian tradisional tentang pemetaan kognitif dan perbedaan gender dalam pemahaman spasial, yang sebagian besar bergantung pada tes psikologis di lingkungan yang terkontrol. Sebaliknya, penelitian ini meneliti persepsi spasial dalam konteks kehidupan nyata. Dengan menggunakan metodologi sampling yang seimbang dan memperbarui perspektif

penelitian, studi ini tidak hanya memperkuat temuan sebelumnya tetapi juga memberikan wawasan baru untuk perencanaan perkotaan dan transportasi yang lebih inklusif.
Kata kunci: Preferensi, Jarak, Waktu, Perencanaan, Referensi

1. INTRODUCTION

The conceptualization of physical space is a crucial aspect of everyday life, reflected in how individuals understand, organize, and express spatial concepts through language. One factor that influences differences in spatial representation is gender. The Government Regulation of the Republic of Indonesia No. 68 of 2010 on Public Participation in Spatial Planning emphasizes the importance of community involvement in spatial planning at the national, provincial, and municipal levels, covering planning, utilization, and control stages. The public plays a role in determining land use in accordance with the rights and obligations established by regulations. The Gender-Responsive Planning and Budgeting (PPRG) approach ensures that planning and budgeting processes equitably consider the aspirations, needs, and challenges of both men and women. This approach incorporates four key aspects—access, participation, control, and benefits—to create inclusive spatial planning that responds to gender differences. However, in Indonesia, gender-based disparities in the conceptualization of physical space persist due to limitations in local data, suboptimal implementation of PPRG, and unequal access and participation of women in spatial planning.

This study focuses on how gender differences influence the understanding and use of distance and time units in spatial navigation. Specifically, it examines how men and women articulate physical space measurements, particularly in their use of distance and time units. Furthermore, the study explores the reasons behind these preferences based on gender, considering cognitive, perceptual, and everyday experiential factors that shape decisions regarding distance and time expression. Additionally, it investigates how gender-based differences in spatial conceptualization contribute to individuals' interactions with public spaces, especially in urban transportation and navigation systems. The study aims to provide a stronger foundation for designing more inclusive urban navigation systems and infrastructure that consider both male and female needs. By exploring how gender-based spatial preferences influence design, this research ultimately seeks to enhance accessibility and comfort for all space users. The primary focus is on understanding how men and women differ in their use of time and distance units in mapping and navigation and how these differences affect public space and transportation system design.

This study differs from previous research, which, while discussing gender differences in urban mobility, did not focus on cognitive aspects or spatial perception in measuring space. Previous studies have primarily emphasized physical behavior and navigation strategies used by men and women without exploring how spatial perception or spatial frames influence their understanding and organization of space (Rosenberg, 2007). Other research has focused on the cognitive structures underlying how people use measurement units in spatial mapping but did not directly address the influence of gender or gender-based public space planning (Tversky & Hard, 2009). Additionally, some studies have examined how men and women rely on different types of navigational cues, with men tending to use directions and distances, while women more frequently rely on visual landmarks (Lawton, 2001). Further research has explored differences in spatial frames of reference (allocentric vs. egocentric), analyzing how individuals process spatial information based on an external (map-based) versus internal (self-based) perspective. However, these studies have primarily focused on how spatial frames influence spatial organization and memory rather than gender differences in spatial perception or their implications for transportation system and public space design (Nori et al., 2004). Lastly, other studies have examined how variations in spatial memory and organization (e.g., whether individuals prefer self-based or map-based orientation) influence transportation design but have not specifically focused on gender differences or how gender shapes spatial preferences (Ruotolo, 2011).

2. THEORETICAL STUDIES

Spatial concepts in cognitive linguistics refer to our understanding of space and spatial relationships that are influenced by language and cognition. This field explores how language shapes our perception and conceptualization of space, including how spatial information is encoded, processed, and communicated through linguistic expressions. Researchers in cognitive linguistics investigate how spatial language reflects and influences spatial cognition, examining how speakers use language to convey spatial information and how this affects their mental representations of space. Language plays a crucial role in how we conceptualize and interact with our spatial environment. The terminology and grammatical structures of a language can significantly shape how its speakers perceive spatial relationships and navigate the world. Some languages use absolute directions (north, south, east, west) instead of relative directions (left, right, front, back), which can affect how speakers of those languages think about and remember spatial layouts (Levinson, 2003).

In spatial cognition, there are two primary ways to measure distance: length units and time units, each offering a different perspective on understanding space and movement. Length units, such as meters, kilometers, or miles, are used to measure the physical distance between two points or objects in space. For example, "The distance from home to school is 500 meters" provides a clear indication of how far a place is. Time units measure distance based on the duration or time needed to traverse it, which is more subjective and dependent on individual experience. For example, "It takes 10 minutes to walk to the store" describes how long it takes to reach a destination. The key difference between the two lies in how we experience them: length units measure physical distance, while time units focus on the journey and the time required. Both approaches help us understand and navigate the world around us, providing different insights into position, movement, and orientation in everyday life.

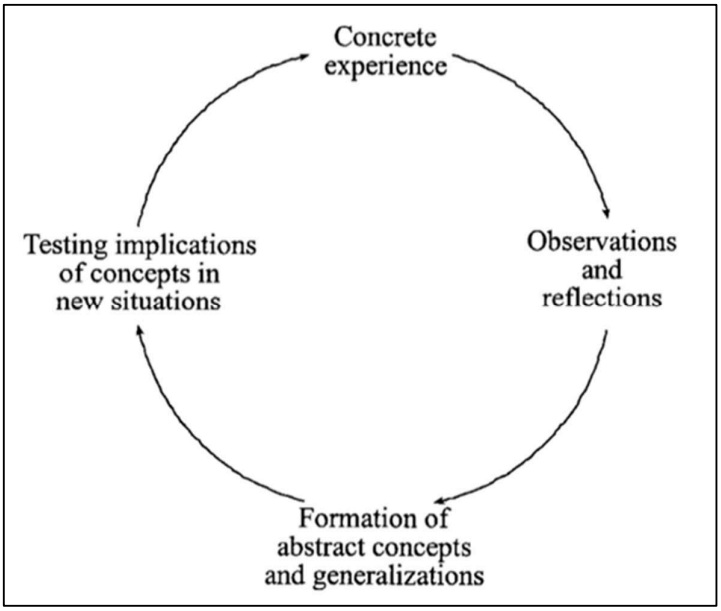

Figure 1. Frame of Reference
Source : *Miettinen, 2000*

Language use in responding to spatial questions is also influenced by embodied cognition, the theory that our thoughts are significantly shaped by our bodies and sensorimotor experiences. Women may be more inclined to use time because their physical experiences in movement and interaction with their environment are often measured in terms of time, such as travel durations or activities. From the perspective of conceptual metaphor theory, time is often metaphorically mapped onto distance in our everyday language. For example, we commonly use expressions like "a long journey" to describe a lengthy duration. This metaphor reflects how we map our experience of time onto physical space. Research indicates that the use of this

metaphor is more dominant in how women answer questions about space, suggesting that women tend to map their experience of time onto physical space (Garcia & Winata, 2023). In physical space measurement, this theory helps explain how people use different references to measure and understand distance. In this context, women tend to use time-based reference frames because they are more relevant to their everyday experiences or easier to understand in social contexts. Studies have highlighted that differences in the use of time-based reference frames between men and women may be reflected in their understanding and interpretation of spatial information.

The concept of a frame of reference in cognitive linguistics plays an important role in how individuals understand and respond to distance, whether in length or time units. This frame influences how individuals process spatial information and make decisions. Generally, there are two main types of reference frames. The first is the egocentric reference frame, which focuses on the observer's position in relation to the environment. For example, when someone says, "The distance is 10 meters in front of me," they are using a personal perspective as a reference. The second is the allocentric reference frame, which centers on an external object or environment, independent of the observer's position. For example, on a map, a building might be described as "200 meters north of the city park," which applies to anyone. Research indicates that men tend to rely more on allocentric reference frames, using map-based orientation or coordinates. In contrast, women more frequently use egocentric reference frames, relying on visual cues such as buildings or specific objects as reference points (Nori et al., 2004).

Understanding distance can also be influenced by whether someone is more accustomed to using length units like meters or kilometers or time units like minutes or hours. For example, many people find it easier to understand distance in terms of time, such as "5 minutes walking" rather than a precise number like "500 meters," because it aligns more with everyday experiences. The tendency for men and women to use different spatial reference frames is also evident. Men are more likely to rely on allocentric reference frames, focusing on external objects or the environment, while women tend to use egocentric reference frames, which center on their personal position and visual cues such as buildings (Nori et al., 2004). fMRI studies have revealed that allocentric frames are processed in the hippocampus and medial temporal lobes, while egocentric frames are processed in the caudate nucleus, retrosplenial cortex, and parietal cortex (Rinne et al., 2022). Research also indicates that older adults are more likely to switch from allocentric to egocentric frames than the other way around, reflecting the brain's flexibility in navigating space (Ladyka-Wojcik et al., 2021). Ongoing research seeks to

understand how these differences relate to gender and how the brain prioritizes reference frames in spatial orientation (Sargent et al., 2008; Szczepanski & Saalmann, 2013). This theory explains how individuals measure and understand distance in physical space, whether in terms of length or time. A frame of reference refers to how a person uses specific cues or references to organize and process information when measuring distance or making decisions. This frame influences how we think and make decisions in everyday situations. In simple terms, this theory helps us understand how we use various cues to measure distance and understand the space around us.

3. METHOD

The method used in this study is a quantitative descriptive approach, which aims to describe or depict a phenomenon based on numerical data that is collected and analyzed statistically. This method is employed to understand patterns, trends, or characteristics of a variable without intervening or manipulating the research subjects. The goal is to analyze the relationship between gender and how individuals respond to questions regarding distance in length units (meters/kilometers) or time units (minutes/hours). The data collected is analyzed using SPSS (Statistical Package for the Social Sciences) software to perform the appropriate statistical tests. The Chi-Square (χ^2) test is used to determine whether there is a significant relationship between gender and the choice of answer units. Bivariate analysis is applied in this study to understand how gender (male and female) influences how individuals respond to questions about distance, specifically whether they are more likely to answer in length units (meters/kilometers) or time units (minutes/hours). In this context, gender serves as the independent variable, while the choice of answer unit is the dependent variable.

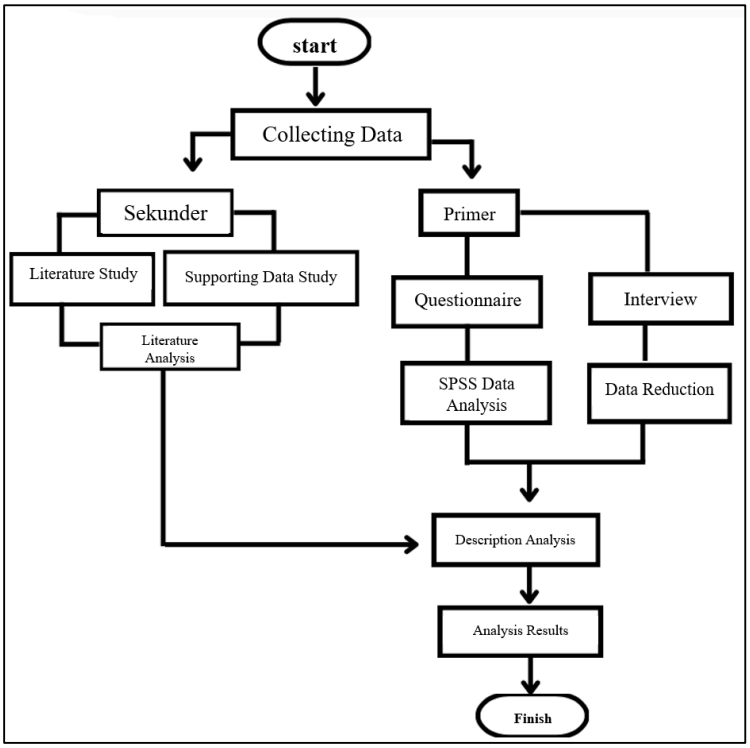

Figure 2. *Research Flow*
Source : Author, 2025

This study involves 40 male respondents and 40 female respondents aged between 18-40 years. Although limited to young and middle-aged adults, this age range is considered representative for analyzing spatial cognition differences based on gender, as individuals within this age range generally have relatively stable cognitive abilities (Niedenthal et al., 2007). To address potential age bias, an extension of the age range or secondary analysis of the impact of age on spatial cognition could be considered (Voyer et al., 2007). Additionally, to account for cultural and geographical biases, especially regarding whether urban and rural populations are adequately represented, this study focuses on an urban population in Yogyakarta. The differences are more pronounced when both groups in the sample have similar educational backgrounds and experiences, as in this study with UGM (Gadjah Mada University) students. However, this may not fully reflect the social diversity present in society (Cheryan et al., 2017). This sample provides insights into gender-based spatial cognition differences, and expanding the age range and ensuring geographical diversity will improve the validity and generalizability of the study's findings. To address these potential biases, it is important to use triangulation with observational data. Triangulation allows for the use of various data sources to verify or complement self-reports. In the context of spatial perception, direct observations and interviews regarding individuals' abilities to perform spatial tasks are conducted, followed by validity and

reliability testing to ensure the questionnaire statements can be used on a broader scale, with a pre-test conducted for 30 initial respondents. The results are as follows:

Correlations

		P1	P2	P3	P4	P5	TOTAL
P1	Pearson Correlation	1	.796**	.796**	.864**	.870**	.917**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	30	30	30	30	30	30
P2	Pearson Correlation	.796**	1	1.000**	.796**	.932**	.958**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	30	30	30	30	30	30
P3	Pearson Correlation	.796**	1.000**	1	.796**	.932**	.958**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	30	30	30	30	30	30
P4	Pearson Correlation	.864**	.796**	.796**	1	.870**	.917**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	30	30	30	30	30	30
P5	Pearson Correlation	.870**	.932**	.932**	.870**	1	.974**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	30	30	30	30	30	30
TOTAL	Pearson Correlation	.917**	.958**	.958**	.917**	.974**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 3. *Validity Test*
Source *: Author, 2025*

The results of the Product Moment pre-test for 30 respondents show a calculated r value for the "total" score of each questionnaire item (P1, P2, P3, P4, P5), with a table r value of 0.361. Since the calculated r value is greater than the table r value, it can be concluded that the data is valid.

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.970	5

Figure 4. Reability Test
Source : *Author, 2025*

The Cronbach's alpha value is greater than 0.00, indicating that the instrument used has good reliability. If the data has normal validity and good reliability, it means that the instrument used (in this case, the questionnaire) can be trusted to measure what it is supposed to measure and provide consistent results. In other words, the questionnaire can be processed and analyzed further, as the collected data meets the criteria for producing valid and accountable findings. The appropriate statistical test to analyze the relationship is the Chi-Square (χ^2) test, which can determine whether there is a significant difference in response patterns between men and women, with the following formula for calculation:

$$Analisis\ Hubungan = \boldsymbol{\chi^2} Hitung > \ Tabel\ \boldsymbol{\chi^2_{0.05\ (1)}} \quad \text{.....(1)}$$

$$C = \sqrt{\frac{X^2}{X^2+n}} \quad \text{.....(2)}$$

If the calculated χ^2 value is greater than the degrees of freedom (d.f) table value, it is considered that there is a relationship between gender and the response category (based on distance in length and time). If there is a relationship between gender and the way individuals answer questions about distance, further interpretation can be made by analyzing the column percentage distribution in each observation cell. The column percentage is calculated by comparing the number of respondents in each answer category (distance or time) to the total number of respondents in a specific gender category.This study uses a questionnaire as the main instrument to collect data from respondents, aiming to obtain quantitative information about their preferences or answer patterns to the questions posed. The questionnaire allows the researcher to gather data from a large number of respondents in a structured and easily analyzable manner. To strengthen the results and provide a deeper understanding of the responses provided by the respondents, interviews are used as a supporting method. Through interviews, the researcher can explore further the reasons, context, or perspectives behind the answers given by respondents in the questionnaire, providing qualitative data that enriches the analysis. This interview approach helps the researcher confirm findings from the questionnaire and offers additional insights that may not be revealed in the structured answers of the questionnaire. The Stratified Random Sampling method is used in this study, as the sample selection is based on certain characteristics, namely age, the ability to understand Indonesian, and the frequency of traveling activity. This approach allows the population to be divided into several strata or groups that are more homogeneous, such as specific age groups (e.g., 18–25

years, 26–40 years, and 41–60 years), levels of Indonesian language proficiency (fluent, moderate, not fluent), and frequency of traveling (frequent, moderate, rare).

Table 1. Sampling

Gender	Number of Respondents	Age Group	Level of Frequency	Language Proficiency
Man	40	18-40 Years old	Frequently	Native
Women	40	18-40 Years old	Frequently	Native

Source: Author, 2025

Table 1 shows the number of respondents in this study, consisting of 40 men and 40 women, aged 18–40 years. Respondents were selected based on a high frequency of traveling and fluency in the Indonesian language. The sample selection was conducted using the Stratified Random Sampling method, where the population was divided into several strata based on certain characteristics before random sampling was carried out. Data collection was performed through a questionnaire designed to measure how respondents answered questions about distance, both in length units (meter/kilometer) and time units (minutes/hours). This questionnaire was given to respondents who met the research criteria, ensuring that the data obtained could more representatively reflect patterns and trends in understanding the concept of distance. Interview analysis is the process of interpreting data obtained from interviews to explore patterns, themes, and relationships between the information provided by respondents. Data reduction is an initial stage in qualitative data analysis that involves screening, organizing, and grouping relevant data from interviews to focus on information that supports the research objectives.

4. RESULTS AND DISCUSSION

4.1. THE RELATIONSHIP BETWEEN GENDER AND COGNITIVE RESPONSES

The analysis of the relationship between gender and response patterns in this study is a process used to examine whether there is a connection or influence between gender and the way individuals respond in a research context. In this case, the study aims to determine whether gender (male or female) is related to the type or pattern of responses provided by individuals to a specific question or statement.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.218[a]	1	.007		
Continuity Correction[b]	6.065	1	.014		
Likelihood Ratio	7.332	1	.007		
Fisher's Exact Test				.013	.007
Linear-by-Linear Association	7.128	1	.008		
N of Valid Cases	80				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 19.00.

b. Computed only for a 2x2 table

Figure 5. Relationship Test
Source *: Author, 2025*

The analysis of the relationship between two variables using the Chi-Square (χ^2) test aims to determine whether there is a significant relationship between the two variables. In this study, with a significance level of 0.05 and degrees of freedom d.f = (2-1)(2-1) = 1, the χ^2 critical value used as a threshold is 3.84. If the calculated χ^2 value is greater than 3.84, it can be concluded that there is a significant relationship between the two variables, for example, between gender (male and female) and response type (such as choosing length or time units). This indicates that the observed differences are not due to chance, but rather influenced by relevant factors. Conversely, if the calculated χ^2 value is smaller than 3.84, the relationship between the variables is not significant, and the differences can be explained by chance.

Relationship Analysis = χ^2 Calculated > χ^2 Table (0.05)
Relationship Analysis = 7.218 > 3.84

Since the calculated χ^2 value is greater than the χ^2 table value, it can be concluded that there is a significant relationship between the two variables tested, meaning that the two variables are related in a way that is not due to chance. This relationship can be further explained through the Theory of Frame of Reference. This theory posits that individuals or groups perceive and interpret the world based on their experiences, knowledge, and social context. In the context of this study, if a significant relationship is found between gender and response type, it can be understood that the way men and women respond to a question or topic is influenced by their different frames of reference.The Contingency Coefficient is a statistical measure used to assess the strength of the relationship between two nominal (or categorical) variables in a contingency table. It is used to determine the strength of the association between these variables, even when the variables do not have a clear order or scale (such as qualitative data).

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Contingency Coefficient	.288	.007
N of Valid Cases		80	

Figure 6. Significance Test
Source : *Author, 2025*

The Contingency Coefficient value of C = 0.288 indicates a weak to moderate relationship between the two variables being tested. The closer the value of C is to 1, the stronger the relationship between the variables, whereas the closer the value is to 0, the weaker the relationship. The findings of this study suggest that men are more likely to respond using distance units, while women tend to use time units more frequently. This difference is reflected in the contingency coefficient value of C = 0.288, indicating a weak to moderate relationship between gender and response choice. Men, who are more often involved in activities related to distance measurement, tend to choose distance units, while women, who are more accustomed to managing time, tend to select time units. The value of C = 0.288 suggests that while there is a relationship between the two variables, the difference is still relatively moderate, and other factors such as social context and personal experiences also play a role in influencing response choices. Social and cultural differences in gender experiences can affect how individuals respond to various situations, including the selection of units for measuring time and distance (Shapiro & Neuberg, 2007).

Although there is a clear trend between gender and the preference for units used, this relationship is not very strong and is influenced by various social and cultural factors that shape each gender's frame of reference. One of the key factors that can explain this variation is the social and cultural context that shapes the experiences of men and women. In this study, male respondents are often more engaged in activities focused on distance measurement, such as outdoor sports, transportation activities like walking or cycling, or jobs requiring spatial orientation with more active physical movement compared to women. On the other hand, women are more frequently involved in time management and efficiency, such as planning daily activities and managing schedules. Interview results also show that activities involving cognitive aspects influence how they define space, which, in turn, affects the selection of units used for measuring space.

4.2. THE RELATIONSHIP BETWEEN GENDER AND COGNITIVE RESPONSES

The distribution of gender responses in percentages, in the context of research findings, refers to the division or spread of response results based on gender (male and female), calculated as a percentage of the total sample or respondents. This is used to examine how each gender responds or reacts to a particular question or topic being studied.

Kecenderungan * Jenis_Kelamin Crosstabulation

			Jenis_Kelamin		
			Pria	Wanita	Total
Kecenderungan	Satuan Panjang	Count	27	15	42
		Expected Count	21.0	21.0	42.0
		% within Kecenderungan	64.3%	35.7%	100.0%
	Satuan Waktu	Count	13	25	38
		Expected Count	19.0	19.0	38.0
		% within Kecenderungan	34.2%	65.8%	100.0%
Total		Count	40	40	80
		Expected Count	40.0	40.0	80.0
		% within Kecenderungan	50.0%	50.0%	100.0%

Figure 7. Distribution Results
Source : *Author, 2025*

This study shows that men are more likely to use distance units in their responses, with 64.3%, compared to women at only 35.7%. Conversely, fewer men answered using time units, with 34.2%, while 65.8% of women chose time units. These results indicate that men tend to use distance units more, while women are more likely to use time units in their responses.

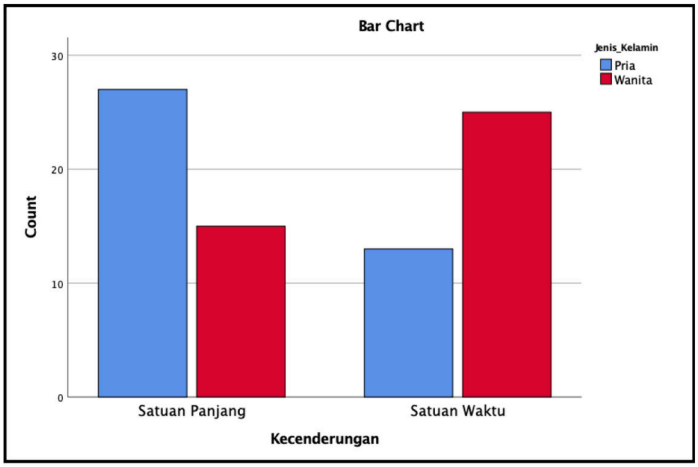

Figure 8. *Comparison Diagram*
Source : *Author, 2025*

This difference in tendencies can be understood through the theory of frame of reference, which explains how individuals perceive the world based on their experiences, knowledge, and social context. Men, who are more often involved in physical or technical activities, such as sports or construction, may be more accustomed to measuring length or distance, which shapes their frame of reference. On the other hand, women, who are often

involved in social roles related to time management and daily activities, such as scheduling or household chores, are more familiar with using time units. Social and cultural influences also play a significant role in shaping this frame of reference, where cultural norms often associate men with technical work and women with managing daily life. This preference definition is supported by the findings from the interview data presented in the table.

Table 2. Interview Reduction

Gender	Preference Control
Male	Distance units are more definite
Male	The reason I chose distance or time units above is to make it easier for someone to calculate distance or time
Male	Because I always use Gmaps when traveling, so using time units as a reference is more effective for estimating travel time according to the plan
Male	Because in kilometers, I find it easier to estimate than time
Women	As individuals living in a big city, it's difficult to provide a definite answer for the time unit to travel a certain distance due to the city's congestion.
Women	We choose time units because we don't know the distance in meters or kilometers to the location. We only usually use time as a reference when traveling to that location.
Women	Because we can't accurately measure the distance using meters or kilometers.
Women	Because it's easier to estimate in time units.

This difference in perception can be understood through the theory of frame of reference, which explains how individuals view the world based on their experiences, knowledge, and social contexts. Men tend to choose distance units because they are more accustomed to measuring travel with physical distance data, as reflected in the use of Gmaps for route planning. On the other hand, women prefer time units, especially in dense urban environments, where time is easier to predict than distance, which is affected by traffic. This understanding is important for urban planning, as it can help city designers create infrastructure that takes these preference differences into account, for example by designing a more flexible and efficient transportation system. Gender equality regulations and policies, such as Law No. 7 of 1984 on the Ratification of the Convention on the Elimination of All Forms of Discrimination Against Women, can be applied to support gender-responsive urban planning. These policies can ensure that public facilities and urban infrastructure meet the needs of both men and women equally, providing better and adequate access for both groups. The gender differences in preferences for using distance and time units can provide significant benefits in creating more inclusive and responsive urban planning. In designing urban infrastructure and policies, an understanding of these frames of reference can help create more equitable and efficient public spaces.

The findings suggest that men and women have different ways of processing spatial information, which relates to how their brains function. Previous research shows that these differences are influenced by age and gender, with men more often using allocentric strategies (relying on maps or external coordinates), while women more frequently use egocentric strategies based on their self-orientation to the environment (Ladyka-Wojcik et al., 2021). This finding is further deepened by explaining that men engage the hippocampus more for allocentric navigation, while women use the caudate nucleus more for egocentric spatial processing (Rinne et al., 2022). This shows that men and women process spatial information differently in their brains. With this understanding, we can see how these differences in spatial perspective affect how they use time and distance units in cognitive mapping, which can also be applied in the design of more inclusive transportation systems. In urban planning, the differences in how men and women respond to questions regarding distance or time units can influence the design of more gender-responsive urban infrastructure. If men tend to use distance units, and women more frequently use time units, this can affect how they perceive the distance traveled in a journey. It is crucial for urban planners to understand these differences so they can design transportation systems and public spaces that are accessible and understandable to all individuals in a way that aligns with their cognitive preferences.

The theory of frame of reference in spatial cognition explains that individuals build their understanding of space based on their experiences and social contexts. Men and women have different experiences in spatial orientation and understanding of distance or time. This understanding is essential in the development of navigation tools and route planning that focus on differences in thinking and spatial orientation. Gender differences in spatial navigation preferences affect urban experiences and transportation planning, particularly regarding the understanding of distance and time. Men tend to use distance units, while women more frequently choose time units or landmarks. These findings align with previous studies, such as Montello (1993) and Shapiro & Neuberg (2007), which show that men rely more on direction and distance, while women focus on objects or locations. However, this study shows a more moderate relationship between gender and navigation preferences ($C = 0.288$), unlike studies that found a stronger relationship (Huffman & Rehling, 1995). This difference is influenced by social, cultural, and external factors such as educational background. In transportation planning, it is important to consider these preference differences. Women tend to choose transportation modes that offer safety and comfort, while men prefer efficient and fast modes (Cohen & Heath, 2011). Several studies supporting the importance of considering gender differences in

transportation system design also indicate that other factors, such as age and technology experience, also influence this (Bennett & Leonard, 2015). This study acknowledges the cultural influence but does not provide an in-depth discussion on how social expectations influence how men and women navigate space. Research in anthropology and sociolinguistics has shown that the structure of language has a significant impact on spatial cognition (Majid et al., 2004). Therefore, while gender influences navigation preferences, broader social and cultural factors play a significant role in shaping perceptions and navigation behavior, and should be considered in inclusive urban planning.

The impact of gender perception differences on spatial measurement in urban space and transportation planning is evident in how individuals understand, plan, and interact with transportation systems and urban infrastructure. Men, who rely more on distance units for navigation, tend to be more comfortable with transportation systems based on distance data, such as digital map applications that display travel distances in kilometers. Conversely, women, who prioritize time units, tend to rely more on travel duration estimates and landmark-based directions, which are better suited to dynamic and dense urban environments. This difference can affect the effectiveness of transportation information communication, navigation system design, and public transportation schedules to align better with user preferences. If transportation systems and urban design only accommodate one perspective, such as displaying travel information solely in terms of distance without time estimates, then the group that prioritizes time units, particularly women, may face barriers in planning their journeys.

5. CONCLUSION

The implications of this study's findings suggest several key considerations for urban planning and transportation design. First, understanding the gender-based differences in spatial cognition, specifically the preference for distance versus time units, can guide more inclusive urban infrastructure development. Planners can design transportation systems, pedestrian pathways, and public spaces that address these differences, ensuring that both men and women can navigate the urban environment efficiently and comfortably. Moreover, this research emphasizes the importance of integrating gender-responsive approaches into urban planning policies, such as incorporating both time and distance measurements in public signage and transportation systems. This approach can improve accessibility for all, reducing gender-based disparities in mobility and public space use.This study enriches the theory and practice of spatial planning by integrating an understanding of gender-based spatial cognition differences into

more inclusive urban planning and transportation systems. The findings regarding men's preference for distance units and women's preference for time units not only affirm previous research but also expand the concept of spatial navigation by highlighting how social factors and daily experiences shape the way individuals perceive space. From a theoretical perspective, this study contributes by bridging spatial cognition theory and gender-based urban planning, demonstrating that social experience plays a key role in shaping an individual's frame of reference when navigating space.

This study has several limitations that should be considered. First, the research was conducted in Yogyakarta, meaning the results may not fully reflect spatial preferences based on gender in regions with different social and cultural characteristics. Second, the study did not explore other factors that could influence preferences for distance and time units, such as education level, technology experience, or individual cognitive strategies. The contingency coefficient (C = 0.288) indicates a weak to moderate relationship between gender and unit preference, suggesting that other factors may also contribute. Additionally, the study primarily relied on a quantitative approach, which did not delve into the reasons behind spatial navigation preferences through qualitative insights. Furthermore, the analysis did not directly examine how urban infrastructure design and the physical environment play a role in shaping how individuals understand and navigate space. Therefore, further research using a multidisciplinary approach (including anthropology, cognitive psychology, and urban design) is needed for a more comprehensive understanding of gender-inclusive urban planning.

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