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Socio-demographic factors and children's independent mobility: A comparative analysis of discretionary and non-discretionary trips

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Abstract. Children's independent mobility (CIM) has declined in recent decades, affecting not only non-discretionary trips but also discretionary trips undertaken for leisure purposes. This trend may have implications for children's development and environmental sustainability. At the same time, neighbourhood resilience can be enhanced through the provision of neighbourhood-scale facilities that support children's daily mobility and independent travel. This study aims to compare children's independent mobility in discretionary and non-discretionary trips based on socio-demographic characteristics. The study was conducted in Perumnas Krapyak, Semarang City, Indonesia, and focused on children aged 7–12 years. The research area was delineated using GIS-based analysis according to children's walking-distance capabilities. Data were collected through questionnaires administered to 30 children equally distributed by age and gender and analysed descriptively. The results show that children's independent mobility was higher in discretionary trips (70%; CIM Level 3) than in non-discretionary trips (51.11%; CIM Level 2). Higher levels of independent mobility were associated with older age, male gender, peer presence, bicycle ownership, and familiarity with neighbours. These findings suggest that neighbourhood characteristics and socio-demographic factors play an important role in supporting children's independent mobility and contribute to the development of more child-friendly and resilient neighbourhoods.

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1. Introduction

Urban resilience cannot be separated from neighbourhood resilience. Neighbourhoods play a significant role in facilitating the provision of daily-scale facilities and accessibility that allow residents to walk, ride, and participate in other physical activities [1]. It enhances not only the neighbourhood's vitality but also the psychological resilience of residents, including children. The availability and accessibility of facilities as a form of neighbourhood resilience will offer opportunities for children's independent mobility.

Children's independent mobility (CIM) refers to their capacity and parents' permission to take them on discretionary and non-discretionary trips without adult assistance. Whether using active modes of transportation (walking, cycling, skateboarding, scooters, rollerblades, or other non-motorised mode) or mass public transportation modes (bus, local transport, or other motorised mode), this mobility usually has certain spatial and territorial boundaries and travel times [2–15].

CIMs provide numerous advantages for both the individual child and the wider community. CIMs is a collective process that connects the physical and social environments of peers, adults, and others in a community [16]. Individually, walking and cycling can improve health, physical exercise, and academic concentration [17]. The more mobility permits (CIM licences) a child possesses, the more likely it is that they will be able to recognise affordability in their neighbourhood [18,19]. Children's everyday experiences in their neighbourhood without adult supervision have an advantageous effect on their cognitive, physical, and social development, as well as helping them create a sense of place, build personal identity, and socialise in society [20]. CIMs have the potential to enhance children's development and physical activity levels, as well as their rights, by allowing access to public spaces for play, recreation, and socialisation [7]. At the neighbourhood level, children's independent mobility by walking and cycling (non-motorised) may decrease congestion, reduce exhaust emissions, and encourage community inclusion [17].

However, there has been a global reduction in CIM in recent decades [2,13]. High rates of urbanisation tend to reduce children's mobility permits. Furthermore, there is a tendency for parents to restrict their children's mobility permits for road safety reasons and concerns about harm inflicted by other people [18,19]. In Finland, children's independent mobility has declined significantly during the last 20 years. Private vehicles have replaced many active independent trips by primary school children, increasing the proportion of children being driven to school with their parents [7]. Mobility time in New Zealand has decreased from 130 minutes to 72 minutes per week over the last 20 years, while car use for school travel has risen from 31% to 58% [11]. This is also consistent with the findings of research by Putri et al. and Rini et al., who found that the usage of motorised transportation modes (particularly

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motorcycles) by parents dominates preferences in accessing primary schools in Surakarta, Indonesia [21–23].

Understanding children's independent mobility is directly tied to the purpose of child mobility [6–8]. In terms of activity location, children's trips are divided into two types: non-discretionary trips and discretionary trips [9]. Non-discretionary trips include school, courses, and extracurricular activities. Discretionary trips, on the other hand, have destinations such as parks, stores, places of worship, friends' or relatives' houses, libraries, cafes, sports communities, hobby communities, shopping places, as well as other leisure places [2,9–11].

CIM can be applied to both non-discretionary and discretionary trip destinations that children independently undertake. According to research [9,24], the proportion of children that did CIM for discretionary trip destinations (parks and stores) was higher than for non-discretionary trip destinations (school and extracurricular). Nevertheless, the CIM for non-discretionary extracurricular trips was higher than that of schools (for formal education). It also indicates that, in comparison to other trip destinations, school (for formal education) has the lowest proportion of independent mobility.

The proportion of children performing discretionary and non-discretionary CIM is closely related to children's socio-demographic characteristics, such as gender, age, the presence of sibling under the age of 18, the presence of peers on the same trip, ownership of a bicycle, ownership of a family car or motorcycle, and known people in the neighbourhood [3,11,15,23–25]. According to research [21,24], children's independence increases with age. In addition to age, children's gender also affects their independent mobility. Because girls acquire fewer mobility permits than boys, boys have a higher proportion of CIM [2,20,23,24]. CIM increases when children travel with peers, own a bicycle, have sibling under the age of 18, and know adult in the neighbourhood [23,24].

As mentioned in the previous paragraph, various studies have been conducted to compare the proportion of children's independent mobility on discretionary and non-discretionary trips in terms of children's socio-demographic characteristics. However, these studies were conducted in Bangladesh [9,23], a country with an influential Arabic culture that has a distinct socio-cultural character from Indonesia. There are numerous studies on the impact of socio-demographics on children's independent mobility [3,11,15,20]. However, they do not specifically discuss the relationship between the proportion of discretionary and non-discretionary trip destinations. Therefore, there is a research gap to identify the comparison between the proportion of children's independent mobility with discretionary and non-discretionary trip destinations in terms of socio-demographic characteristics located in Indonesia.

Depending on prior studies, it is recognised that there is an opportunity to identify the character of children's independent mobility in terms of their socio-demographic characteristics depending on the destination of their trips. This may be used as a framework

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for interventions intended to increase children's independent mobility. Children are the main focus of the issue of decreased children's independent mobility. Therefore, interventions are uncertain to be effective and efficient unless the characteristics of children's trip destinations and socio-demographic characteristics are identified. As a result, this study aims to compare children's independent mobility levels based on discretionary and non-discretionary trips in terms of their socio-demographic characteristics.

2. Methods

2.1. Data

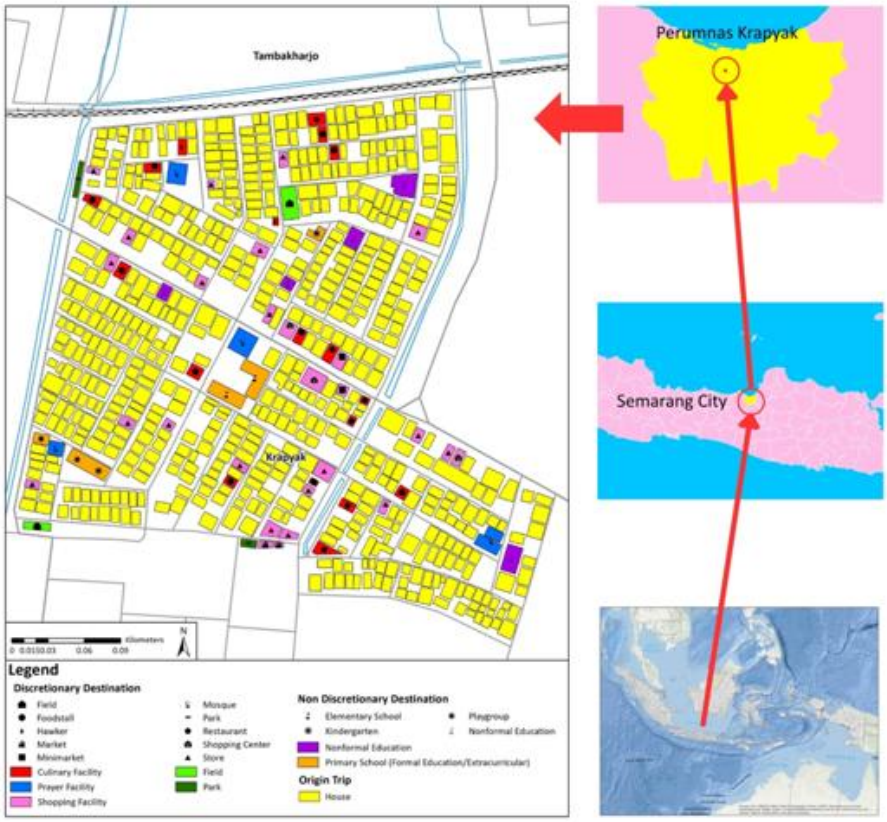

Figure 1. Distribution of neighbourhood facilities as destinations of children's discretionary and non-discretionary trips in Perumnas Krapyak, Semarang City, Indonesia.

Perumnas Krapyak, a planned housing estate in Krapyak Urban Village, West Semarang Subdistrict, Semarang City, Indonesia, is the location of the research. Considering Perum Perumnas was created by Perum Perumnas, a state-owned firm (BUMN) whose development focuses on facilitating the residential requirements of citizens in the middle to lower economic groups, the residents of Perumnas Krapyak tend to be of a homogenous economic group. Nevertheless, as planned housing, Perumnas Krapyak is provided with neighbourhood

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facilities that support the discretionary and non-discretionary destinations of children's trips (Figure 1).

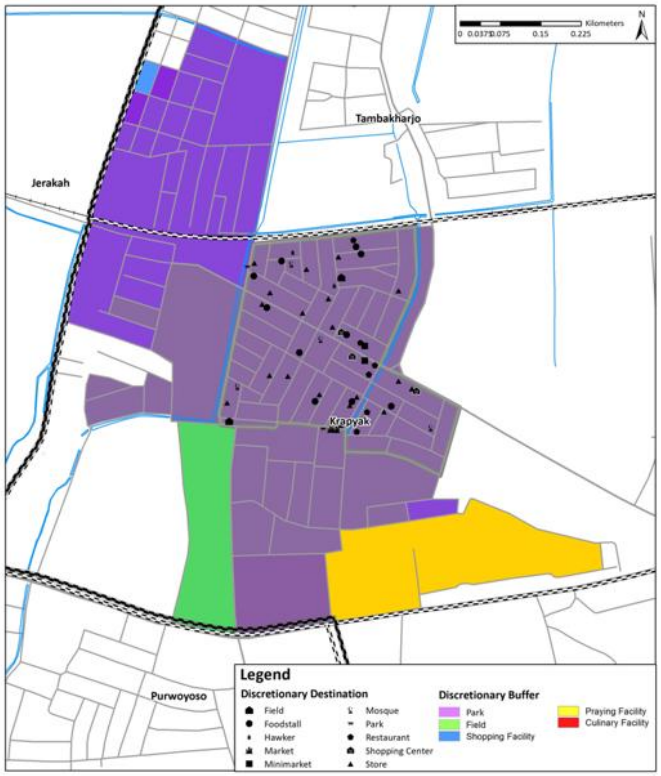

Figure 2. The coverage of neighbourhood facility as a destination for children's discretionary trips (within 400-meter walking distance) in Perumnas Krapyak.

The provision of neighbourhood facilities as a form of neighbourhood resilience will offer opportunities for children's independent mobility. In addition to being equipped with neighbourhood-scale facilities that serve as destinations for children's mobilities, the entire Perumnas Krapyak is also included in the pedestrian distance coverage area determined by a radius of 400 meters from each facility (Figures 2 and 3). The coverage area was determined by geospatial-based analysis (GIS). Accordingly, all children residing in Perumnas Krapyak can execute independent mobility on foot to all various types of trip destinations, both discretionary and non-discretionary).

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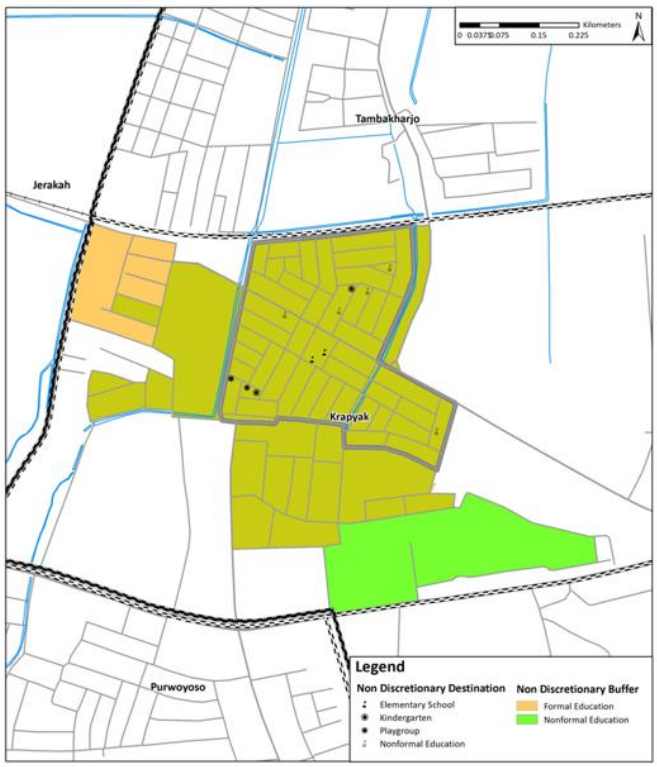

Figure 3. The coverage of neighbourhood facility as a destination for children's non-discretionary trips (within 400-meter walking distance) in Perumnas Krapyak.

2.2. Methods

This research aims to compare children's independent mobility levels within discretionary and non-discretionary trips in terms of socio-demographic characteristics. The aim will be achieved by pursuing two research objectives. A flowchart of the analytical process is shown in Figure 4.

2.2.1. Identify the characteristics of children's independent mobility based on discretionary and non-discretionary trips. The data used for this analysis was compiled from questionnaire data on children's independent mobility on each type of trip, both discretionary and non-discretionary. Discretionary trips include CIMs to a house of friend/relative (family), a park, a sports field, store/minimarket/market/shopping centre (a shopping facility), mosque/church (a praying facility), food stall/café/food hawker/restaurant (a culinary facility), and another playing area. Primary school (for formal education), primary school (for extracurricular activity), and course (for non-formal education) are examples of non-discretionary trip destinations. Gender, age, presence of sibling under 18 years old, presence of peers with the same trip, ownership of a bicycle, and known persons in the neighbourhood are the socio-demographic characteristics of children that differentiate each type of trip [3,11,15,23].

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The research sample consisted of 30 children aged 7 to 12 years old (primary school age) who had lived in Perumnas Krapyak, Semarang City, Indonesia, for at least one year and were familiar enough with their residential area to perform independent mobility. The surveys were given to each age group (7-8 years old, 9-10 years old, and 11-12 years old) and gender (boys and girls). Data was collected at the end of July 2023, after the Covid 2023 epidemic was proclaimed over, so that children may engage in common activities, including both discretionary and non-discretionary trips. The data on children's independent mobility covers a period of one week. Children aged 7 to 12 years old were chosen as the research population because they have cognitive capacities and walking abilities that make it possible for independent mobility, but they remain dependent on their parents for mobility permits [3,12,16,23,26–28].

2.2.2. Analysis of children's independent mobility levels based on discretionary and non-discretionary trip purposes in terms of socio-demographic characteristics. This analysis makes use of input data produced from the outcomes of the previous stage's study. At this stage, descriptive analysis approaches will be used to compare the number of children's independent mobility based on discretionary and non-discretionary trip locations in terms of children's socio-demographic characteristics. Descriptive analysis techniques offer information on the level of assessment of the indicators of the research variables as well as the logical grounds for the respondents' assessments [29]. The assessment level will be determined using an assessment index divided into three categories: low, medium, and high. The value interval is obtained by subtracting the highest and minimum values and dividing the result by the number of classes. While the highest value is 100% and the minimum value is 0%, 0%-33.33% is in the low category (1), 33.34%-66.66% is in the medium category (2), and 66.67-100% is in the high category (3).

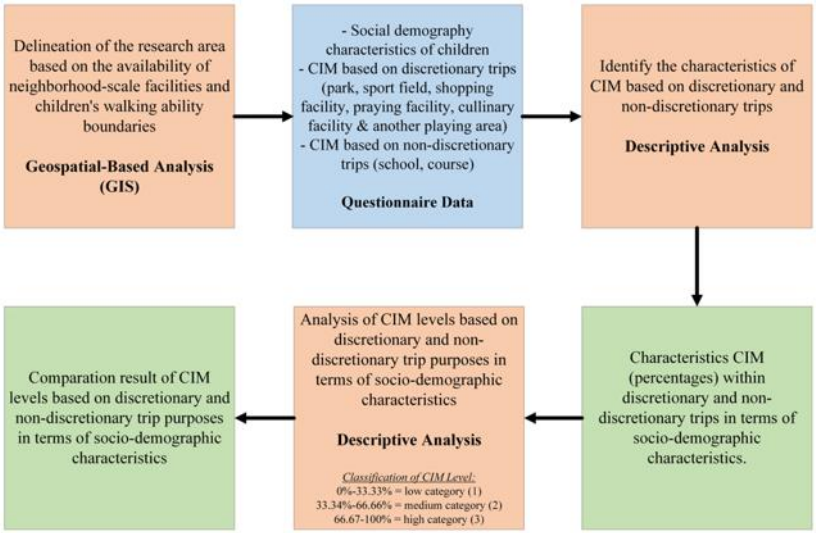

Figure 4. Flowchart of the analytical process.

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3. Result and analysis

3.1. Characteristics of children's independent mobility based on discretionary and non-discretionary trip

3.1.1. Gender and age. In all age groups, the maximum percentage of boys and girls on discretionary trips is exactly the same, namely independent mobility of children visiting friends' or relatives' houses (100%). In contrast, the lowest average proportion in boys is in the purpose of the trip to the culinary facility (33.33%), while in girls it is in praying facility (26.67%). Concerning the increase in the proportion of CIM, except taking the trip to visit a friend's/relative's house, the majority of the percentage of CIM increases at each age level, such that the older the child, the more independent mobility increases. This is consistent with research [20,23], which shows that children's independent mobility increases with age. Similarly, the average proportion of independent mobility for girls is lower than that of boys. According to the findings of [2,20,23], girls are granted fewer mobility permits than boys.

The trip destination of course (non-formal education) has the largest percentage of boys (mean 80%) and girls (mean 66.67%) across all age groups in non-discretionary trips, whereas the trip destination of school (for formal education) has the lowest percentage. Among all children's trip destinations analysed, school (for formal education) had the lowest percentage of independent mobility. This is consistent with Sharmin et al.'s research [9], which found that school is the trip destination with the lowest rate of independent mobility among children.

In terms of gender and age group, the mean independent mobility of discretionary trips (70%) is higher than non-discretionary trips (51.11%), both in boys and girls. Figure 5 shows a comparison of children's independent mobility on discretionary and non-discretionary trips by gender and age.

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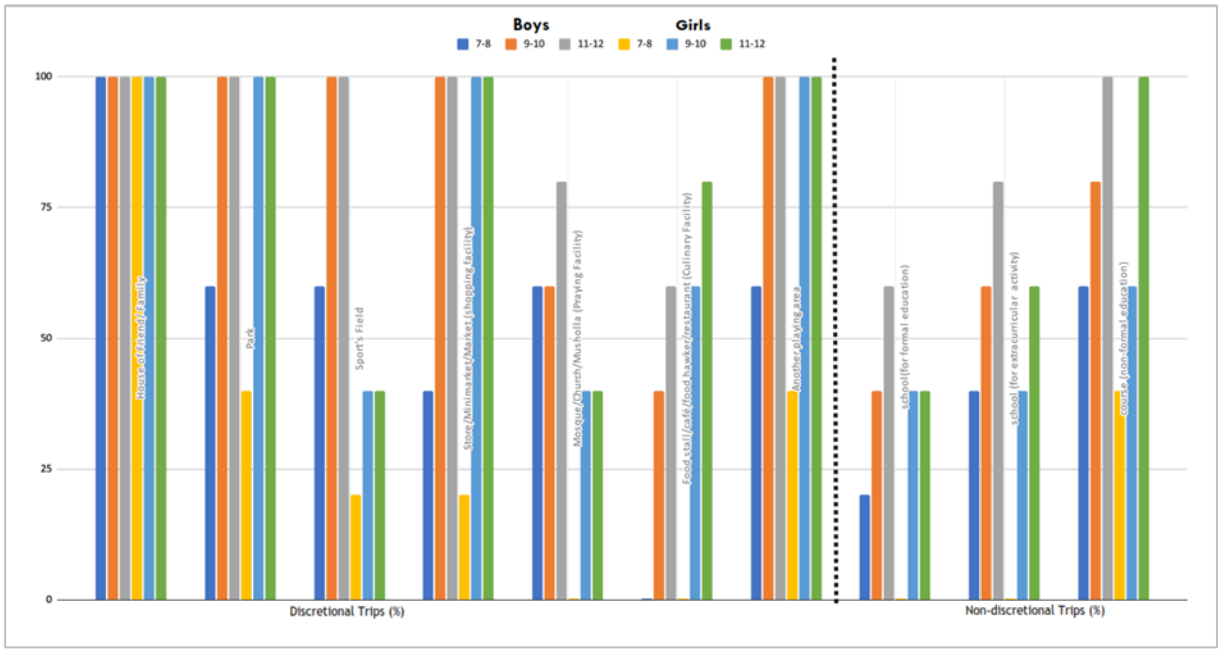

Figure 5. Comparison of children's independent mobility in discretionary and non-discretionary trips by gender and age.

3.1.2. Gender and presence of sibling under 18 years old. On discretionary trips, both boys and girls prove that the research results align with Sharmin et al.'s [23] finding, namely that the presence of sibling improves the proportion of children's independent mobility. The average distinction in the proportion of children who do independent mobility of children who have and do not have sibling under the age of 18 is known to be higher in boys (35.23%) than girls (22.86%), contrary to the findings of previous research result [23,24].

In line with discretionary trips, both boys and girls proved a high proportion of independent mobility due to the presence of sibling under 18 years old on non-discretionary trips. Similarly, the mean difference between children who performed independent mobility with and without the presence of sibling under 18 years old, was 37.78% in boys and 24.44% in girls.

According to Figure 6, the average proportion of children who do children independent mobility and have sibling under 18 years of age on discretionary trips (49.52%) is higher than the percentage of children who perform non-discretionary trips (41.11%).

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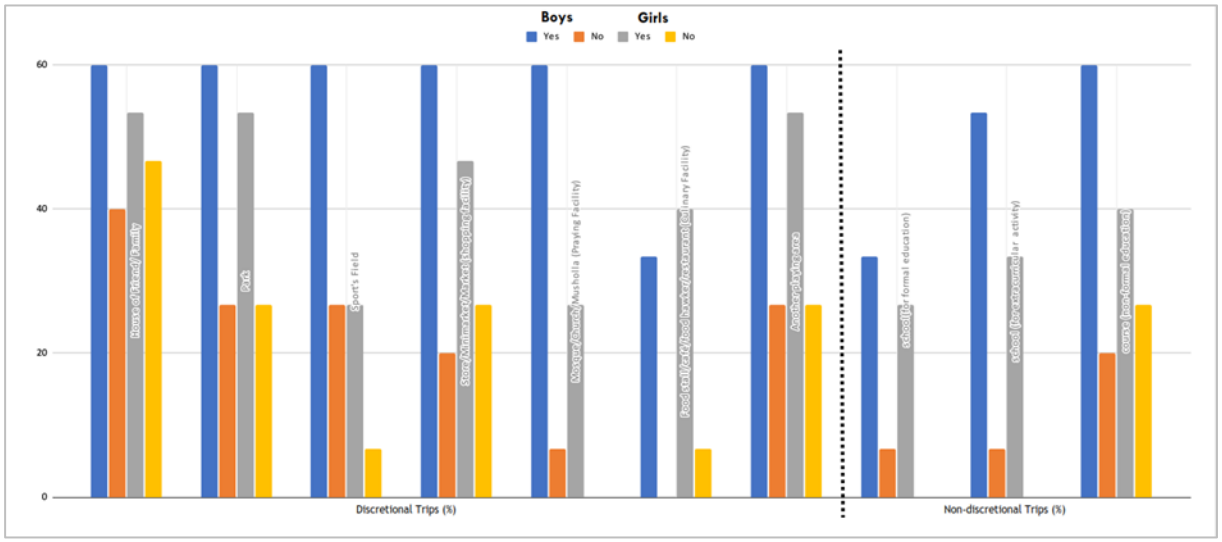

Figure 6. Comparison of children's independent mobility in discretionary and non-discretionary trips by gender and presence of sibling under 18 years old.

3.1.3. Gender and presence of peers on the same trip. CIM increases when children travel with their peers, according to [23]. This is consistent with the results of the research on discretionary trips, which found a difference in the proportion of independent mobility of children with and without peers on the same trip of 67.62% in boys and 45.71% in girls. Similarly, on non-discretionary trips, 55.56% (boys) and 37.78% (girls). This indicates how the presence of peers has a significant impact on children's independent mobility.

Figure 7 shows that on discretionary trips, the average percentage of children who conducted children independent mobility and had peers with the same trip (39.52%) was higher than on non-discretionary trips (24.44%).

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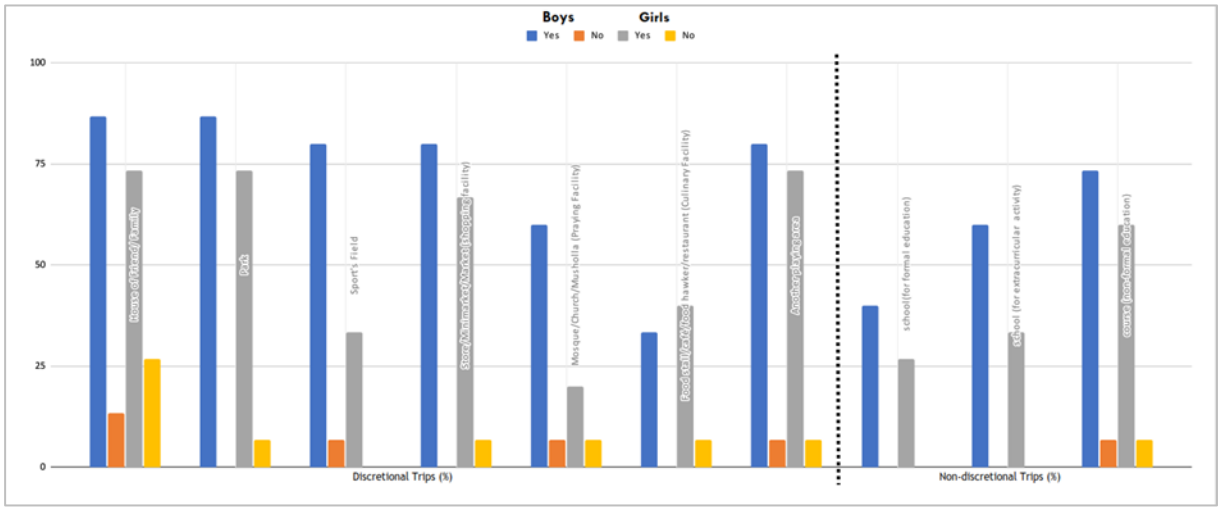

Figure 7. Comparison of children's independent mobility in discretionary and non-discretionary trips by gender and presence of peers with the same trip.

3.1.4. Gender and ownership of bicycle. According to previous research [23,24], bicycle ownership influences CIM improvement. Figure 8 illustrates that the percentage of discretionary trips is higher than the percentage of non-discretionary trips. The difference in the discretionary trip between children who performed independent mobility with and without bicycle ownership was 69.52% (boys) and 57.14% (girls). This percentage is higher than that of the non-discretionary trip, which was 60% for boys and 37.78% for girls. Nevertheless, all percentages reveal that the difference between children who possess bicycles is higher, which is in line with Sharmin et al.'s opinion [23].

Figure 8 shows that the mean proportion of children who performed independent mobility with discretionary trip destinations and possessed a bicycle was higher (67.14%) than the proportion of children who performed independent mobility with non-discretionary trip destinations (50%).

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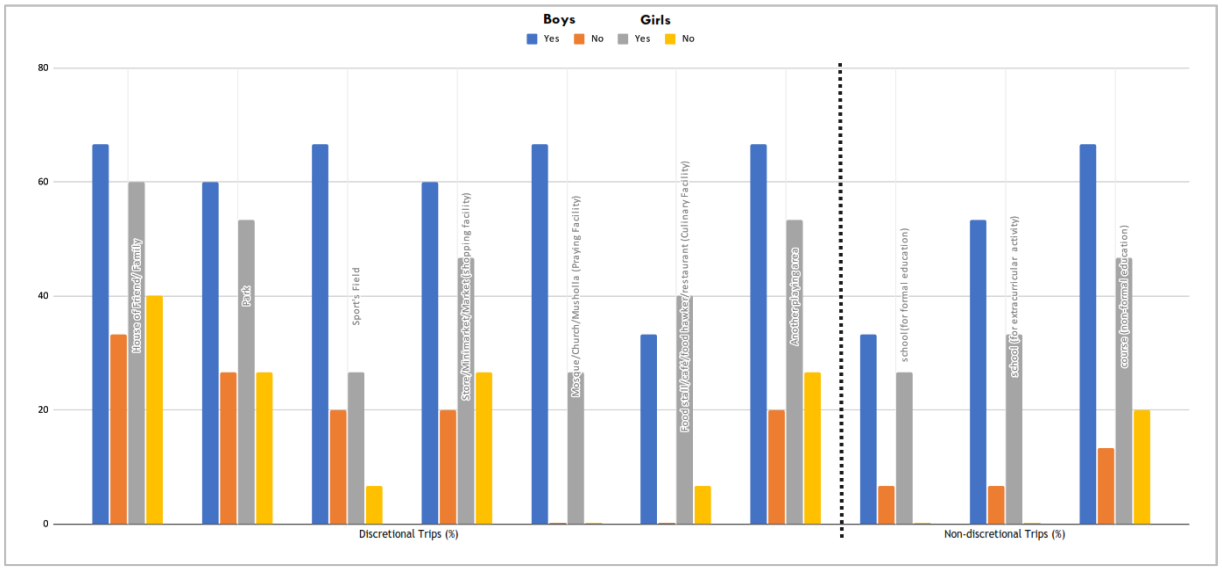

Figure 8. Comparison of children's independent mobility in discretionary and non-discretionary trips by gender and ownership of bicycle.

3.1.5. Gender and known adult in the neighbourhood. The research on discretionary trips discovered that 42.85% of boys and 24.76% of girls who do independent mobility knew someone in their community. Similarly, on non-discretionary trips, 42.22% of boys and 28.89% of girls go independently and know the adult around them. Even though the gap is smaller among girls, the proportion of children who know people in their community is still higher than the proportion of children who do not know adult in their neighbourhood. This is by the findings of the research [23,24], which concluded that CIM increases in children who know adult in their neighbourhood.

Figure 9 illustrates that the mean proportion of children who did independent mobility with a discretionary trip destination and a known adult in the neighbourhood was higher (51.9%) than the proportion of children who conducted non-discretionary trip destination (43.33%).

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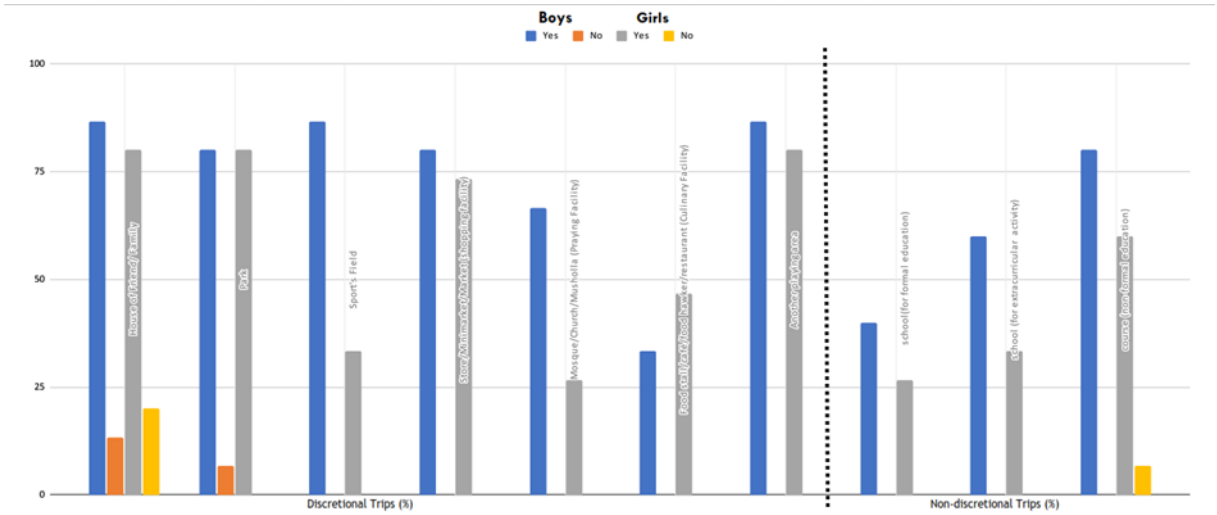

Figure 9. Comparison of children's independent mobility in discretionary and non-discretionary trips by gender and known adult in the neighbourhood.

3.2. Children's independent mobility levels based on discretionary and non-discretionary trip purposes in terms of socio-demographic characteristics

In terms of gender and age, the mean level of CIM on discretionary trips was higher than on non-discretionary trips. While boys surpass girls on average, the level of CIM on discretionary trips only differs between the ages of 7-8 years old. The eldest age group (11-12 years old) had the highest level of CIM. Nevertheless, changes have been noticed in the 9-10 years old group, both boys and girls, on discretionary trips. The equivalent was true for non-discretionary trips for girls.

Table 1. Comparison of children's independent mobility levels based on discretionary and non-discretionary trips in terms of gender and age of children.

Socio-demographic of Children		Discretionary Trips		Non-Discretionary Trips	
Gender	**Age**	**Average (%)**	**Level of CIM***	**Average (%)**	**Level of CIM***
Boys	7-8	54.29	2	40	2
	9-10	85.71	3	60	2
	11-12	91.43	3	80	3
Girls	7-8	54.29	2	40	2
	9-10	85.71	3	60	2
	11-12	91.43	3	80	3

*1: low, 2: medium, 3: high

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The findings of this study coincide with those of [20,23], who suggest age and gender determine children's independent mobility. While girls acquire fewer mobility permits than boys, boys have a higher proportion of CIM [2,20,23].

Nevertheless, there is a distinctive pattern of increasing CIM in boys when they go on non-discretionary trips. Although the average percentage of CIM increases by child age, the increase in level appears solely in the 11-12 years old group, precisely from a medium CIM level to a high CIM level. Table 1 presents a detailed comparison of children's independent mobility levels depending on discretionary and non-discretionary trip destinations, alongside children's socio-demographics (gender and age).

The mean percentage of children engaging in independent mobility for discretionary trips is 70%, with a notable difference between genders: boys average 77.14%, while girls average 62.86%. Meanwhile, the mean percentage of children utilizing independent mobility for non-discretionary trips stands at 51.11%, with boys at 60% and girls at 42.22%. These data suggest that the prevalence of children's independent mobility (CIM) is higher for discretionary trip, categorized as 'high' (3), compared to non-discretionary trip, which falls into the 'medium' (2) category.

Table 2. Comparison of children's independent mobility levels based on discretionary and non-discretionary trips in terms of socio-demographic characteristics.

Socio-demographic of Children		Discretionary Trips		Non-Discretionary Trips	
		Average (%)	Level of CIM*	Average (%)	Level of CIM*
Boys	Presence of sibling age under 18 years old	56.19	2	48.89	2
	Presence of peers with the same trip	72.38	3	57.78	2
	Ownership of bicycle	74.29	3	60	2
	Presence of known adult in neighbourhood	60	2	51.11	2
Girls	Presence of sibling age under 18 years old	42.86	2	33.33	2
	Presence of peers with the same trip	54.29	2	40	2
	Ownership of bicycle	60	2	40	2
	Presence of known adult in neighbourhood	43.81	2	35.56	2

*1: low, 2: medium, 3: high

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The character of children's independent mobility based on discretionary and non-discretionary trips is known to be considerably higher than non-discretionary trips in terms of children's socio-demographic characteristics other than age. When it comes to CIM level, almost all of them are classed as medium, with the exception of females aged 7-8 years, who are rated as low, and both the presence of peers on the same trip and ownership of a bicycle on discretionary trips, which are considered as high. Moreover, across all socio-demographic categories of children, boys had higher CIM than girls, both on discretionary and non-discretionary trips (Table 1).

The influence of socio-demographics on children's independent mobility on discretionary and non-discretionary trips is ranked in Table 2. Although generally at comparable CIM levels, both medium (2), the mean percentage of socio-demographic characteristics influencing children's independent mobility is higher for discretionary trips (57.98%) than for non-discretionary trips (45.83%). However, in both types of trip destinations, the ranking order is nearly identical for both boys and girls, specifically ownership of a bicycle, presence of peers on the same trip, presence of known adult in the neighbourhood, and presence of a sibling under the age of 18 years. Non-discretionary trips for girls reveal barely any slight variation, with a similar percentage of bicycle ownership and the presence of peers on the same trip.

In general, the study's results align with those of [3,11,15,23,24]. The presence of friends who go together, ownership of a bicycle, the presence of sibling under 18 years, and knowing adult in the neighbourhood all encourage an increase in CIM.

4. Conclusions

The average percentage and level of CIM reflect the results of the research comparing children's independent mobility between discretionary and non-discretionary trips in terms of socio-demographic characteristics in Perumnas Krapyak, Semarang City, Indonesia. Neighbourhood resilience by providing daily scale facilities as children's trip destinations within Perumnas Krapyak, further supports children's independent mobility in each type of trip destination, despite having various percentages and levels of CIM.

Discretionary trips have a higher CIM proportion and level than non-discretionary trips. Based on age and gender, the average proportion of discretionary trips was 70% (high), while non-discretionary trips averaged 51.11% (medium). This aligns with the average proportion of CIM, which is influenced by socio-demographic characteristics. Although both are medium-level, discretionary trips averaged 57.98%, compared to 51.11% for non-discretionary trips.

The male gender (boys) and children of older ages have a higher percentage and level of CIM. Other socio-demographic characteristics determine the percentage of CIM in both types of trips and gender variations, with the highest rank order of contributing to bicycle ownership, presence of peers with the same trip, presence of known adult in the neighbourhood, and presence of sibling age under 18 years old. However, when it pertains to the CIM level, almost all of them are classified as medium, with the exception of girls aged 7-8 years, who can be

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classified as low, and both the presence of peers on the same trip and ownership of a bicycle on discretionary trips, which can be classified as high. When referring to the same results based on the average percentage and level of CIM, the characteristics of age, gender, presence of peers with the same trip, and ownership of bicycle can be prioritised to assist with the phenomenon of children independent mobility, particularly to improve CIM of mandatory and daily scale frequency trips.

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