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Smart Steps for sustainable mobility:

Mapping the pedestrian's Traffic at the University of Moratuwa

Navigating the bustling pathways within and around the campus environment is a routine for students. The implementation of a sustainable transportation system within the campus environment is a vital aspect of the creation of a pleasant campus atmosphere [1]. Nevertheless, pedestrian walkways frequently utilized by students still missing adequate attention [2]. Present urban campus environments face challenges in managing pedestrian traffic due to spatial constraints, inadequate infrastructure, and increased vehicular flow, which directly affects safety and accessibility. In the context of the campus environment, walking is not merely a source of transportation; it is also regarded as a means of social interaction, leisure, and physical activity.

Moreover, previous studies indicate that the concept of creating walkable campus environments is beneficial not only for sustainability but also for lowering the stress levels of pedestrians [1]. Given the background, enhancing pedestrian space is a primary focus in contemporary sustainable development practices, as it significantly impacts public well-being [3]. This article aims to analyze and visualize pedestrian traffic patterns in and around the campus. It demonstrates the use of advanced technology that incorporates real-time tracking with mobile phone sensing data and machine learning techniques. This approach not only maps but also identifies congestion zones to enhance pedestrian movement, making the environment safer and more accessible while informing infrastructure planning at the University of Moratuwa.

> "In the context of sustainable development and the creation of pedestrian-friendly campus environments, optimizing walking spaces has emerged as a central focus in urban planning."

The Power of Real-Time Data:

Comprehending the complexities of personal experiences concerning "seconds" and "meters" facilitates groundbreaking research and informed strategic decisions [4]. Traditionally, understanding the determinants of pedestrian behavior relies on surveys and observational techniques. Recent research illustrates how real-time tracking data can be employed by municipalities to improve public space design and safety [4]. This experimental study illustrates these advantages by utilizing real-time GPS and walking speed data obtained from mobile phone sensors of 60 participants navigating the case study area, tracking walking speeds and locations during peak morning hours (7:30–9:30 a.m.) and evening hours (4:00–6:00 p.m.).

Machine learning makes sense of chaos.

The acquired data includes various characteristics of pedestrian walking, such as time, acceleration, speed, and coordinates, of individuals. The initial step of the procedure involves data preprocessing. Outliers in the walking data were identified as speeds of 0.00 m/s, indicating waiting, while speeds of 2.5 m/s or higher are likely inaccurate due to GPS errors. Next, k-means clustering, an unsupervised machine learning technique, is applied to the dataset to identify patterns in walking speed in and around the university. This approach facilitates the recognition of similar behaviors without predefined categories. The literature [5] indicates that k-means clustering demonstrates high accuracy rates, particularly when speed profiles serve as attributes. It can effectively manage spatial patterns in unlabeled data with minimal parameter adjustments across different locations. However, it requires a predetermined number of clusters. The data was then sorted into four-speed categories based on literature, and IQR removal methods were used to remove points that were not inside the range. Then, using the min-max scaler, data was normalized, and using the silhouette analysis, the number of clusters was identified and mapped.

In both hours, a significant number of slow-moving pedestrian clusters with a mean speed value of 0.69 ms^{-1} can be noticed mainly in front of the main university gate, along the main route of the university, Bandaranayake Mawatha, and the Molpe route. According to the field observations, these places serve as the primary entry points for vehicles at the university, and during peak times, there is a significant increase in vehicular traffic. Additionally, the dense retail infrastructure on Molpe Road contributes to a high number of slow-speed clusters in these areas. Also, in the morning, a relatively slow speed of walking is noticed in the Lagan region, due to its predominantly green environment within the university. Individuals tend to walk more slowly in green areas, as highlighted in the literature. Similarly, the Sentra Court area experiences high slow-speed foot traffic during the evening hours, specifically from 4:00 to 6:00 p.m. This is primarily because it is a waiting area for the university. However, there is no significant amount of slow-moving traffic in the vicinity of the Sentra Court during the morning compared to the evening.

In the morning, a significant number of fast walkers, with a mean walking speed of 1.41 ms^{-1}, can be observed along Mola Road and Ananadrama Road, particularly among students commuting from boarding to the university. The fast cluster analysis results demonstrate a notable concentration of rapidly moving pedestrians in front of the IT facility, with an average speed of 1.81 ms^{-1}. According to the observation, this area is primarily utilized as a transport corridor compared to the space for social interaction.

The proposed system enables the identification of congestion zones and optimizes routes for automobiles and pedestrians. Moreover, recognizing these patterns facilitates the development of pedestrian-friendly infrastructure and the optimization of urban layouts of specific locations. Due to the limitations of sample size duration, future research may extend the duration for analyzing temporal changes, utilize diverse stratified groups, and investigate spatial aspects of hotspots.

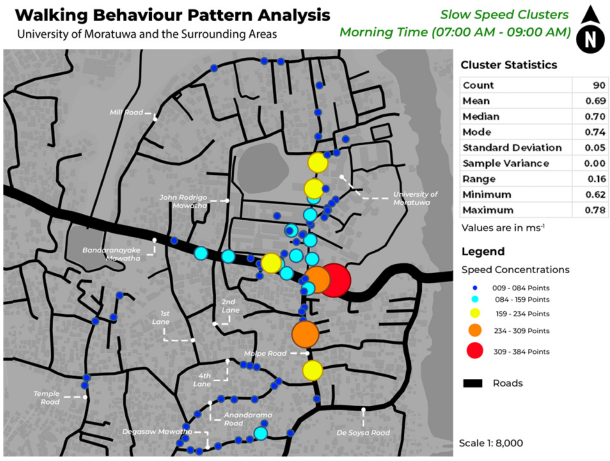

Figure 1: Pedestrian concentration in slow walking speeds during morning hours

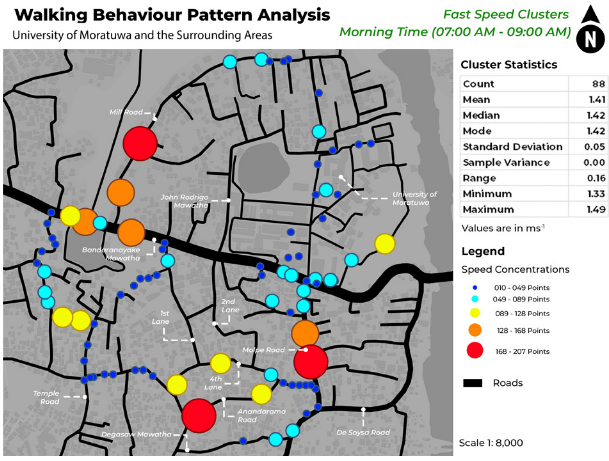

Figure 2: Pedestrian concentration in fast walking speeds during morning hours

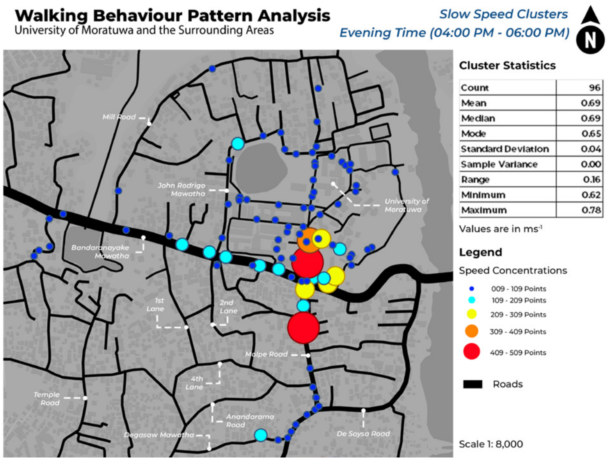

Figure 3: Pedestrian concentration in slow walking speeds during Evening hours

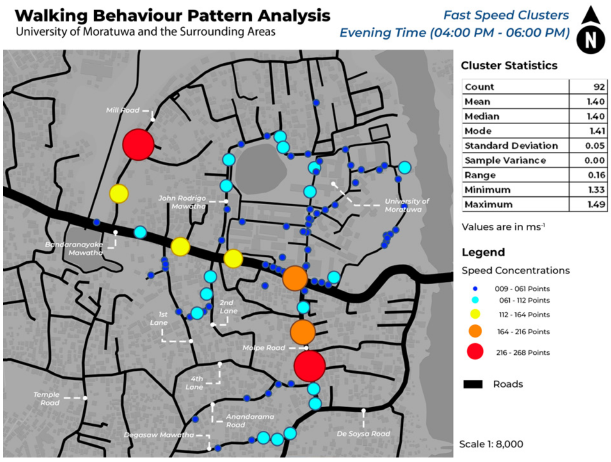

Figure 4: Pedestrian concentration in slow walking speeds during Evening hours

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