

Multi-criteria sustainability-based approach to optimising a high school location

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Extended Abstract

Choosing a suitable location for a new high school is a complex urban planning challenge that directly impacts social equity, accessibility, and long-term sustainability objectives. This study addresses the limitations of traditional school siting methods, which often focus narrowly on demographic demand, land availability, and construction costs, by applying the Spatial Navigation, Analysis, & Identification of Location (SNAIL) model. This multi-criteria framework integrates geographic, environmental, and socioeconomic variables to provide a systematic and transparent assessment of potential sites. The analysis focuses on the city of Karmiel, a rapidly growing medium-sized city in northern Israel with approximately 47,000 residents and an annual growth rate of 2.3%.

The SNAIL model follows a structured seven-phase sequence: defining the search objective, identifying criteria, performing an "integrity check" to ensure sustainability dimensions (social, economic, and environmental) are represented, ranking and weighting those criteria, conducting supply and demand analysis, defining alternatives, and finally selecting the best site based on weighted scores. Through a literature review and pilot questionnaires with municipal experts, twelve final criteria were established. These included social factors like walking distance and road safety; economic factors such as school demand and slope suitability; and environmental factors including air quality and proximity to green spaces.

To determine the relative importance of these criteria, the study surveyed 24 planning experts and 50 parents. The findings revealed significant differences in priorities between the two groups. While both agreed that road safety and school demand were the most critical factors, experts placed significantly more weight on technical and environmental standards, such as slope suitability, lot size, and air quality. In contrast, parents placed a higher emphasis on

immediate daily needs, such as walking distance from home, which impacts family schedules and the feasibility of active travel.

The model was then used to evaluate six alternative candidate sites in Karmiel. Statistical analysis using ANOVA indicated that the most significant differentiators between the sites were air quality, availability of public transport, and proximity to emergency services. Site 6 emerged as the optimal location with the highest weighted rank (6.875), performing exceptionally well in the high-priority areas of road safety and school demand. Conversely, Sites 2 and 5 ranked lowest due to poor air quality scores and challenges regarding accessibility and demand.

The results support the research hypothesis that a multi-criteria approach can successfully distinguish between alternative locations based on integrated sustainability metrics. The study concludes that the SNAIL model serves as a robust decision-support tool that makes the trade-offs between accessibility, environmental health, and construction feasibility explicit. By incorporating stakeholder preferences into a transparent spatial framework, urban planners can better ensure that new schools serve as equitable community anchors that promote student well-being and reduce environmental risks.

Keywords: School location; spatial navigation, analysis & identification of location (SNAIL) model; GIS; accessibility; environmental quality; social equity.