

Spatial Characteristics for Walkability: Analysis of Urban Design Characteristics and Street Networks around Elementary Schools

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Abstract—Walkability is an important concept in planning. The term is built around the concept of providing healthy communities, reducing dependency on automobiles and improving health consciousness in both adults and children. Based on factors including connectivity, densities, amenities, and socio-economics, this research focuses on elementary school sites through the influence of urban design characteristics and street networks within Nagpur city. Analyzing the selected school sites and deciphering what are the specific barriers and facilitators that surround them, helps produce design standards and methods that can help implement pedestrianism for every type of city infrastructure and planned development. Using geospatial data and actual surveyed data helps locate sites with high rates for walkability. After exploring the elements within both sets of data, developing a list of important urban design characteristics is meant to only provide successful means and methods of pedestrianism. Additional qualities such as distance, safety, and socio-economics also play a role in the rates of walkability of elementary schoolchildren. Combining all the variables provides a mix of aesthetic and descriptive data used towards determining the successful models.

The urban design characteristics listed as facilitators take place within all types of developments, but the number of barriers is what determines the hindrance of walkability. Dependent upon the context surrounding the school, high rates of walkability is capable based on high residential density, low number of intersections and updated pedestrian infrastructure for children to utilize. Street grids and land use variety can provide towards walkability as well. There is also dependency on the timeframe a school was built and how it connects within the context of the surrounding environment. Socio-economics and school planning plays a larger role in determining walkability within each site analysis. Overall, these findings can suggest the important configurations of a community, emphasizing all aspects within a safe and sustainable environment.

Keywords: Walkability, Urban Design Characteristics, Street Networks healthy communities.

1. INTRODUCTION

The growing importance of human health as well as environmental and economic sustainability has motivated many people to find alternative means of transportation besides the automobile and the growing popularity of

providing pedestrian routes has multiple cost-free benefits. The planning of street networks and connectivity throughout a city helps define how a city continues to expand and grow. Maneuvering streets and alleyways to become more accessible and pedestrian friendly can be a challenge if not established from the infancy of the development, but it can be done as long as multiple of the important elements within the city's infrastructure cohort the idea. ¹Most stabilized cities, especially the ones established pre-1800, have more successful methods of circulation through many different nodes and paths that allow all its residents the ability to travel from one point to another without barriers. With remarkable consistency, cities grew no larger than someone on foot could cross in an hour.

Presently cities are coping with population and residential growth challenges, the push for environmental regulations and conservation as well as economic instabilities. Most of those factors have taken precedence in many development patterns and unfortunately, in order to revitalize and maintain downtowns and city centers, necessary monetary and resident backing needs to be available. In determining how viable a city can potentially become, people rely on factors including accessibility, building densities, options in transportation, land use categorization, amenities and safety. How cities allow these different factors to reciprocate and organize can transform and help implement a strong sense of pedestrianism within an urban center or city core. There are many positives and negatives people can list, but the idea is that if a development is pedestrian friendly and safe enough for a younger child, then adults might be more inclined to walk with their children, as well as to and from their own work and residential establishment. Physical activity and accessibility to a city doesn't just provide improved health benefits, but it also provides its residents with a sense of place and responsibility to its surroundings.

¹ Soderstrom, M. (2008). The walkable city: From Haussmann's boulevards to Jane Jacobs' streets and beyond. Montreal: Véhicule Press.

2. HEALTH IN THE BUILT ENVIRONMENT

The positive health benefits of walking or any sort of physical activity have been well established for a long period of time. The concepts of providing outdoor activities and the means of easily walking or biking to multiple locations within a minimal distance from each other can provide people subconsciously with alternative ways of getting the physical activity needed to maintain a healthy lifestyle.² Most recently the concept of cities and developments providing externalities that promote physical activity has started to become popular. Urban environments are far from homogeneous, and neighborhood-level measures of the built environment have been associated with levels of walking. The built environment design provides cues and opportunities for physical activity, and perceptions of the neighborhood environment play a large role in shaping physical activity behaviors.³ Some research has shown positive associations of moderate physical activity levels with both objective and perceived accessibility of destinations such as shops, stores, and interesting places within walking distance. In addition, perceptions of certain neighborhood features (e.g., well-lit streets, biking or walking trails, pedestrian safety, traffic volume and speed, disorder, and crime) are associated with physical activity. Factors in the built environment such as street connectivity and residential density are two main physical attributes of a community that have an impact on physical activity. However, walking in most areas has become a lost mode of transportation. In early versions of traffic modeling software, pedestrians were not included as a default, and even today, modeling software tends to treat them not as actual actors, but as a mere “statistical distribution,” or as implicit “vehicular delay”.

3. LAND USE DEVELOPMENT IN CITY

What are the major concerns today with planning and development? First there is urban sprawl, next there is the issue of water conservation, and then later air pollution in relation to car use and lack of alternative methods of transportation. The automobile-dependency trend throughout the city has caused for many different areas of low density and sprawl to occur outside major nodes and cities, including multiple small and large school neighborhood developments. Recently it has come to the attention to the public that there is a higher need for innovative and strategic planning for our future, otherwise natural resources will continue to be threatened and the quality of life could possibly diminish. This is where we acknowledge the fact that besides all the rules and regulations that are already in place from the state, there is a need for implemented guidelines for community development

with a heavy emphasis on the physical environment, connectivity and density, including modern social and economic sensibilities. Focusing on the discussion of school siting and development, similar guidelines and regulations that provides students with the proper means to safely travel to school is important to strategic planning for the future. By combining some commercial land use within housing areas one might create a better walkable community.

4. SITING OF PUBLIC SCHOOL FACILITIES

Combat growth is a growing problem related to school siting trends in recent years. The idea of trying to reduce sprawl has actually promoted families to move to the suburbs so their children can attend newer and generally develop tense socio-economic segregations between the newer traditional neighborhood developments within these newer suburbs and the older established urban schools. Comparing the concept of economics, specifically distinguishing how much income the child’s guardian annually accumulates, as well as the likelihood as to whether or not a child ultimately walks or bikes to school provides its own challenges. There are also other incentives for school siting adjacent to or within neighborhoods.⁴ When it comes to basic infrastructure, when school development happens near already established roads, water and utilities, the cost effectiveness is much lower. Also if the development is within a generally walkable community, transportation costs are estimated to be lower as well. However these types of school locations usually pull people away from city centers and take away from promoting schools within those established areas. It is also common to have a disconnect between local and state governments with jurisdictional school districts on decisions related to siting, building, ad renovating schools. Those decisions are driven by competition with neighboring districts and demographic shifts. The focus of school siting should be based on providing a continually updated educational system with safe and infrastructural-sound school facilities. There should also be a focus in creating schools that are integrated within the community, providing healthy and safe conditions for students to get to and from their homes.

5. MEASURING WALKABILITY

Physical proximity is one of the main factors of walkability. There are two groups of measures of pedestrian travel in the context of the physical environment: general walkability and origin-destination walkability. General aspects of walkability include specific numbers of intersections and block length and size. For example, smaller block sizes or shorter block lengths indicate better connectivity or greater potential for movement

² Bejleri, I., Steiner, R. L., Fischman, A., & Schmucker, J. M. (2011). Using GIS to analyze the role of barriers and facilitators to walking in children’s travel to school. *Urban Design International*, 16(1)

³ Steuteville, R. (2000). The New Urbanism: An alternative to modern, automobile-oriented planning and development. *New Urban News*.

⁴ Ahlport, K., Linnan, L., Vaughn, A., Evenson, K.R. and Ward, D.S. (2008). Barriers to and Facilitators of Walking and Bicycling to School: Formative Results From the Non-Motorized Travel Study. *Health Educ Behav* 2008 35: 221 originally published online 19 December 2007

through space.⁵In relation to the origin-destination walkability, measurements focusing on the straight-line distance between the origin and destination along the walkable network are one concept and the measurements related to residential density is another. Concentrations of residential dwellings in proximity to desired locations provide an indication of the potential for individuals to travel between home and a destination. Calculating children walking specifically to school must not only take into account sometimes the lifestyle of the parents, but also car ownership, work timeframe, aspect of older siblings, health of the child and parent and any specific urban design detail that could derail the accessibility of a walkable route to the school location.

6. URBAN DESIGN CHARACTERISTICS

Defining what qualities make a city a successful pedestrian-influenced urban core, focusing on urban design characteristics, help outline this research topic. The specific list of important variables includes aspects of not only walkability, but also urban design and land use. Urban design elements include architecture, land use categorization, usage of public space, traffic solutions, quality of sidewalks, and street level activities as some of the variables that determine the type of livable community people live in. Land use mainly divides the separation between commercial, residential, and mixed use (or multi-family), amongst a few others. The main theory is that each particular aspect defined of urban design and land use can manipulate the outcome for pedestrianism to be a popular transportation option.⁶Combining these urban design and land use elements, there are design principles outlined to help plan for a unified community. Additionally, within the design principles there must be a focus on pedestrianism, open spaces, community focus, streetscapes, and maintenance to name a few.

Common barriers that may reduce walkability between home and school could include hazardous walking conditions like inadequate sidewalks, high speed and volume of traffic, fences or walls, and the absence of crossing guards to facilitate the safe crossing of the street. In contrast, facilitators that can enhance opportunities for walking could include trails and other informal pathways, rear entrances to school grounds and the employment of crossing guards at hazardous street intersections. Furthermore, by collecting the multiple parts of the data within the study and then creating an outline for an urban design analysis based on Matthew Carmona's dimensions of urban design, specific questions about the site and its surroundings are focused upon in full detail. Focusing

on the dimensions such as morphological, perceptual, social and visual, this separation is for the purpose of clarity in exposition and analysis only. Overlapping and interrelated, these dimensions are the 'everyday matter' of urban design. Creating an overall complexion for pedestrianism, considering both the technical systems and the detailed design complexities, completes an overall design aesthetic and overlay that promotes and continues to change with time.

7. STREET CONNECTIVITY

Because streets accommodate most forms of travel, their importance serves as a central focus in understanding patterns of walkability. Historically cities have developed using different patterns and trends. Conventional street designs have had adverse effects resulting in reduced connectivity, an increase in vehicle miles traveled, increased traffic conditions, and a host of other public nuisances and health-related issues. Theorists and planners such as Clarence Perry and Clarence Stein both publicized the importance of street hierarchy and pedestrian-friendly neighborhoods. Both men were some of the early promoters of a community development built around a school, which unfortunately took on many different forms by developers as subdivisions and presumably safer informal road linkages. Street connectivity can be used to create social interactions and spaces throughout different areas of a city. Segments of streets can be designed to accommodate pedestrian use and outdoor dining at midday as well as large public gatherings at other times. Along with that, sidewalks connected to these streets are social spaces.

8. DISCUSSION AND CONCLUSION

This study analytically identifies several different urban design characteristics as well as logistics of development that are important towards encouraging walkability amongst young children. When discussing the complexities of how children walk to school in relation to their built environment, there are a lot of different variables taken into account that normally might not be considered if strictly discussing adults. In this case, the main focus was centered upon visual characteristics and somewhat then deciphered generalities from socio-economic and historical details. Focusing on the network sheds, that represented data such as straight-line distance, block length or size, and connectivity within both half-mile and one-mile distances provided a good basis for the study, but the addition of the urban design analysis gave physicality to these sites and provided further explanation for the high rates of walkability. The urban design characteristics were more of a measure for daily conditions and obstacles pedestrians face. Not only does a pedestrian consider the distance and amount of time it takes to get from one point to another, they also must consider the variables that enable or hinder them from getting there along the way (placement of sidewalks, major roads/highways, placement of crossing guards or crosswalks, etc.). Configurations of blocks and street networks as well as residential density can make up some of

⁵ Gray, J. A., Zimmerman, J. L., & Rimmer, J. H. (2012). Built environment instruments for walkability, bikeability, and recreation: Disability and universal design relevant? *Disability and Health Journal*, 5(2)

⁶ Forsyth, A & Southworth, M. (2008, February 1-3). Guest Editorial: Cities Afoot- Pedestrians, Walkability and Urban Design. *Journal of Urban Design*.

the main important aspects. Also school-siting ordinances, concurrency, planning policies and anything relevant to the counties in school siting could be a determinant.

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