PLEA 2017 EDINBURGH
Design to Thrive

A Design Framework for Sustainable Mobility Hub Networks in Mid-sized Cities

Christian Martinez and Tarek Rakha

School of Architecture, Syracuse University, Syracuse NY, USA

Abstract: Contemporary society is dependent on mobility and transportation in urban and regional settings for work, services and leisure activities. Recent changes of perception have shifted the outlook of car-centric plans toward more sustainable and shared modes which are regarded as more efficient for air quality, health, and other environmental factors. When considering mid-sized cities we see that their performance issues may be partly due to population density declination, climate, available infrastructure, etc. This paper develops a framework for the design of a mobility hub network in mid-sized cities that challenges the established method of infrastructure planning. Through the analysis of three urban conditions (urban sprawl, downtown core, and institution node) this paper presents a method for an integrated urban architectural system that fosters sustainable urban mobility. These include design guidelines for mobility hubs, development of scenarios for arranging integration of programming and infrastructure, and strategies for mobility network optimization. The research method combined qualitative analysis for existing conditions, categorization of infrastructure and services available and finally mapping and projections for future scenario development of sustainable urban transportation. The investigation is concluded with a representation of design strategies for a site in Syracuse, NY USA as a test bed for the study.

Keywords: Mobility hub, Network, Mid-sized City, Sustainability, Transportation

Introduction

The dependence on single-occupancy vehicles in cities for mobility is the lead contributor to the 26-39 percent in transportation energy consumption nationwide (NY Power Authority, 2015). In recent years, American cities have been working toward reducing transportation energy consumption through planning efforts that emphasize human-powered mobility and public transportation modes (Litman, 2015). The consideration and development of mobility hubs in these efforts have been underlined as a key component to transportation planning and as positive contributors to the successful management of movement in a city using multiple-modes of travel (Metrolinx, 2008).

The Mid-sized City

In the context of this study, we characterize the mid-sized city as one with a city population under 500,000.

A mobility hub network for a mid-sized city under these assumptions will be understood to be different from that of a larger city. Mobility hub operations in larger cities tend to focus on the opportunities for overlap of various robust transit modes and networks as well as the use and activities set within the hub itself. This is possible because of opportunities derived from conditions of congestion, which mid-sized cities lack as a resource (Chakrabarti, 2013). The developed framework in this paper differs in application

due to conditions of smaller density, available infrastructure and distances between destinations. The analysis aims to expose a phenomenon of activity hubs and opportune moments of transit mode transfers. The mobility hub for a mid-sized city is thus a destination-based model that capitalizes on an available infrastructure with much reliance on the private sector and community based efforts to generate links to zone of high activity.

Framework

This paper presents a framework to generate a mobility hub network in mid-sized cities. The method is developed for urban and architectural design, where the outputs are guidelines for the design of a mobility hub and design of its urban network. The paper includes: a methodology that details analysis procedures for precedents and city characteristics, followed by the results of research focused on implementation at three urban conditions that differ in scale (urban sprawl, downtown core, and institution node), and concludes by presenting a framework that suggests future implementation in other mid-sized cities. The city of Syracuse, NY USA was analysed and tested through the presented framework for a mobility hub network, focused on sustainable transportation.

Methods

Figure 1 demonstrates the developed framework. A targeted collection of information pertaining to characteristics of the city specific to urban mobility and destination institutions and activities is analysed to determine travel behaviour and patterns in the city, key areas to capitalize on existing infrastructure and what types of mobility hubs could be implemented. A set of mobility hub design guidelines is also generated for application at the hub locations.

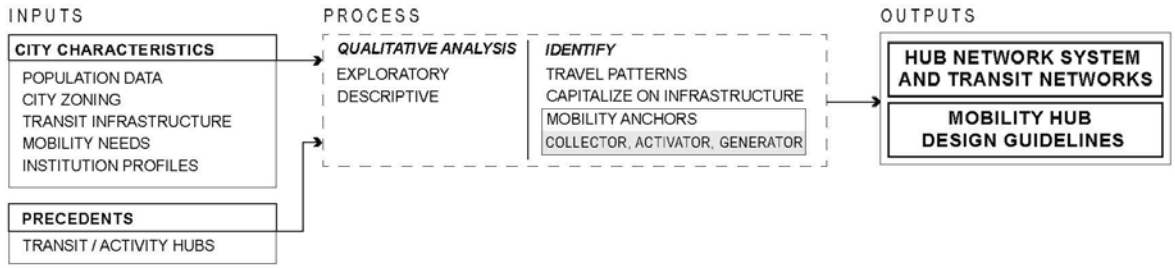

Figure 1. Presented framework.

Inputs

Information about the mid-sized city that detail demographics, current physical conditions and infrastructure, available transit services, mobility needs and major institutions is collected for analysis. This information aids in assessing transit modes for consideration, population and demographic travel information to accommodate and address any proposed programmatic needs for additional transit modes.

City Characteristics

Characteristics information relevant to mobility consists of a compilation of census travel data and local/municipal travel studies. Information on new mobility options and needs as determined by the city through travel action plans is to be collected to anticipate the accommodation of future infrastructure and services, especially those that influence sustainable modes of travel.

City characteristics should also include information related to major institutions and destinations/activities. This should focus on setting up profiles for institutions and areas that are accessed and support mobility patterns in the city. Based on areas and zones with

significant travel and density, these profiles can be analysed for consideration as a mobility anchor point.

Precedents

Precedent survey includes a collection of information on projects that focus on the relationship between the overlap of transit infrastructure and opportunities for support programs. These precedents provide examples of mobility hubs to catalogue design strategies for the possible configurations of transit and destination junctures (Figure 2). Precedent search is not limited to scale, as a qualitative analysis is conducted to determine application at an appropriate urban condition of the same scale.

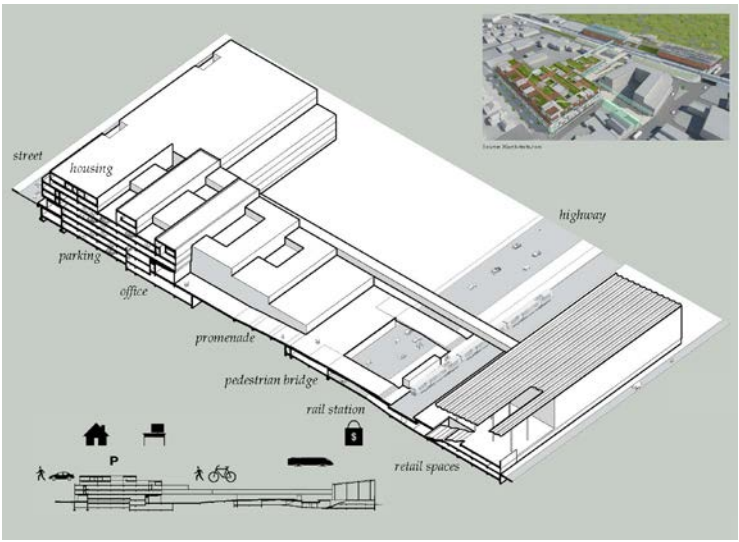

Figure 2. Parking Plus precedent by LTL Architects. Image produced by authors.

Process

Existing Conditions Opportunities

A qualitative analysis approach is used to understand travel patterns of the city from the characteristic inputs. From these patterns we can generate information that locates major travel corridors, available infrastructure, mobility services and frequented key institutions. In addition to capitalizing on overlapping infrastructures an emphasis on areas or pockets of density is a factor in determining hub locations. Infrastructure that fosters human-powered mobility (walking and biking) and public transit are primary considerations in this process. Links to car infrastructure are considered for partial trip use with a hub or nearby location offering the opportunity to drop-off or dock a vehicle and complete the trip by an alternative mode.

Anchoring programmatic needs to the existing networks and infrastructure is also considered to implement the success of new mobility modes. The proposed mobility modes will include new systems of infrastructure for additional mobility support and integration with the existing conditions. Additional travel modes create a range of travel opportunities and a flexible comprehensive network.

With the key institutions identified there are opportunities for inclusion of supplementary activity programs to further increase activity levels. These could include housing, office, grocery, retail, recreation, day-care, etc. if not already available. Supporting programs should be identified to balance the travel schedule to the area allocating more programs that offset that of the key institution. For example, in the study, the downtown

urban district and core has a business district with many of the city's major employers. This area primarily operates during weekday business hours. Additional programming may be added for activities past work hours or on weekends to generate constant flow.

Mobility Hub Anchors

Identifying mobility hub locations in the mid-sized city relies on the ability of an area to perform as an anchor point to sustain activity. All mobility hubs in the network of a mid-sized city are mapped with the intent of them operating as a city wide system. Some criteria to consider are maintaining a quarter-mile radius of activity zone or destination area from each mobility hub and also keeping a two mile distance between hubs. This would accommodate pedestrian trips from the hub location to the destination and bike or public transit trips between hubs. Each hub location would differ in operation, size and type (Engel-Yan and Leonard, 2012). Figure 3 represents hub location types that are categorized based on existing conditions and prospects to link with destination activities. Collector hubs are larger hubs that are located in proximity to active areas with good supporting infrastructure and would be primary hubs in the network, meanwhile activator hubs make an effort either to introduce new activities or new modes of transit. Generator hubs attempt to service areas that lack infrastructure or activities for any sustainable mobility.

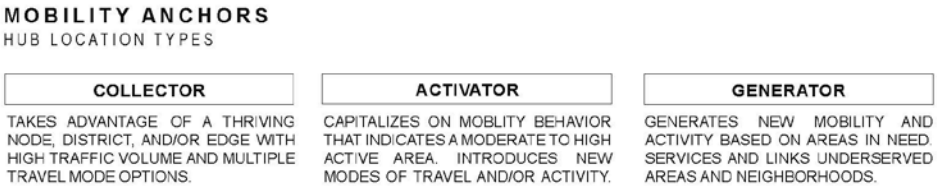

Figure 3. Mobility hub types based on activity and infrastructure parameters.

Output – Network and Hub Design Guidelines

Two outputs are determined from processes outlined above. A scheme for a network of mobility hubs is derived with mobility hub locations and impact areas. The second output is a set of guidelines for mobility hub design.

Results

The method was applied to Syracuse, NY as a test-bed for a mid-sized city. The mobility hub network for Syracuse operates as a destination-based hub system. Each mobility hub weighs equally in the system to each other despite different characteristics and locations. Programs vary based on the available infrastructure and characteristics of density and scale. From the three urban conditions derived from the analysis of Syracuse, (urban sprawl, downtown core, and institution node) each are ascribed a hub as a link in the system.

Syracuse Profile Inputs

The survey conducted on city characteristics of Syracuse resulted in finding population demographics and major transit infrastructures. Areas with higher rates of access, the major corridors and thoroughfares that connect them and the institutions at play were found for analysis (Figure 4).

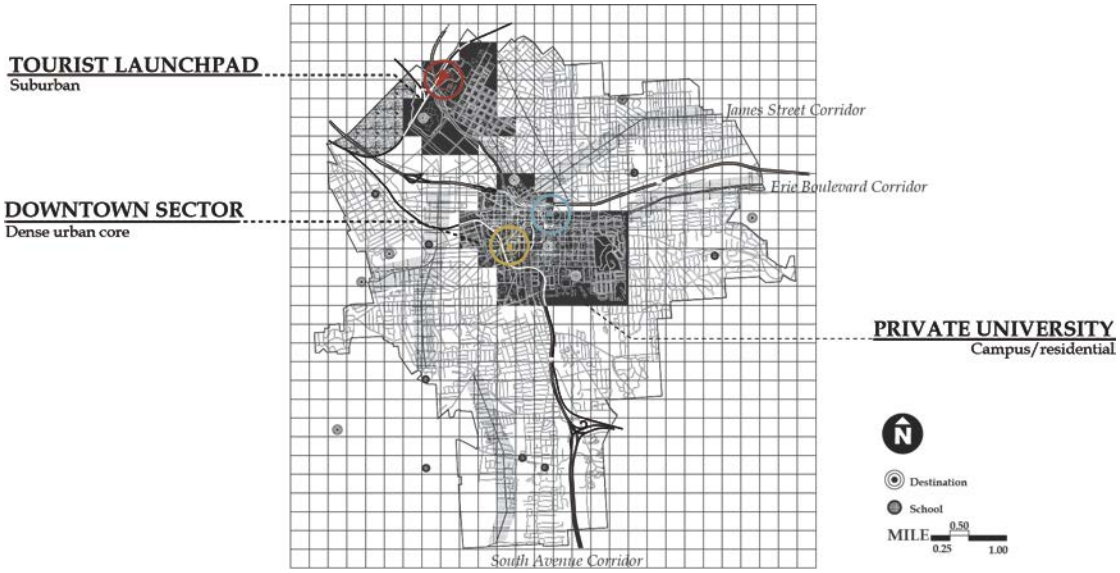

Figure 4. Syracuse general profile. Major thoroughfares and institution locations. Image produced by authors.

Exploratory Analysis

Qualitative analysis of the city characteristics was done to identify opportunities for hub locations. Three key areas were identified as potential collector hubs because of the infrastructure resources and institution profiles.

Sprawl-City Edge

As noted earlier, Syracuse has been experiencing a consistent decrease in the residential population of the city while the residential population in the neighbouring suburban towns has increased and continues to grow. With consideration of a large population of travellers to the city coming from outside the city limits by car the scope of the mobility hub is altered to address users from greater distances. The focus here is on utilizing the strong network of car infrastructure and regional transit to draw in commuters within a 10 – 20 minute commute area of the regional zone at the edge city. At the site of the Destiny Mall in Syracuse and Regional Transit Centre we find these two systems converge (Figure 5).

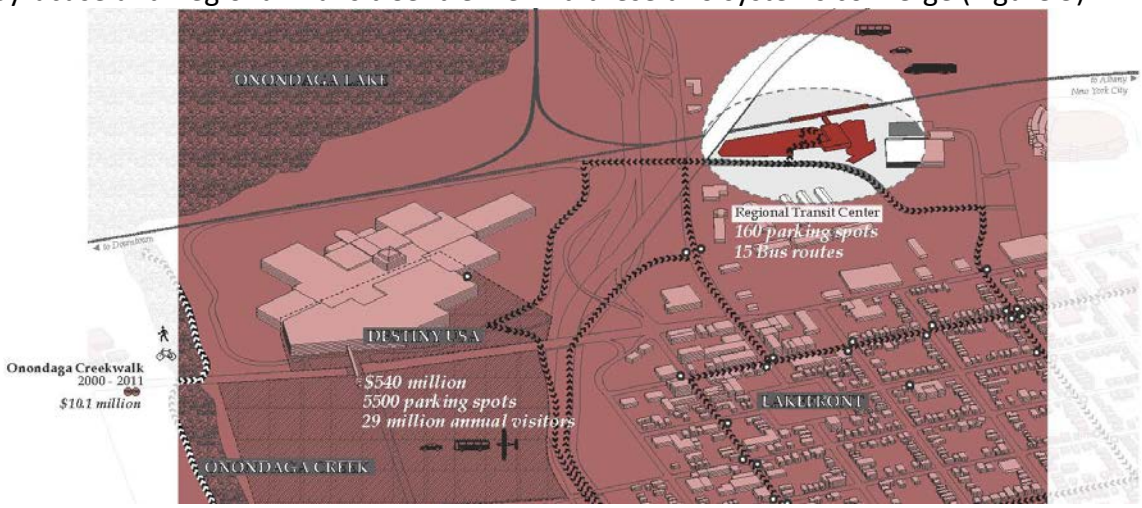

Figure 5. City Edge. Sprawl characteristics and transit catalysts. Image produced by authors.

Downtown-Urban Core

The downtown zone consists of an array of destinations and an urban density and size that can capitalize on walking and biking, the mobility hub for this location is focused on linking the current mobility systems to seamlessly integrate all modes of transportation. A priority

here is to manage parking for the business and convention districts from travellers of the region at a particular location and convert the rest of the trip to the downtown destination via human powered mobility or public transportation. One of the main issues to overcome is the convenience of the use of the automobile to and within this district.

Institution Node

From the survey we find there are two major institutions located within the same neighbourhood. These are Upstate Medical University and Syracuse University. These universities have the highest numbers of employees in the region among two institutions. In addition to the large numbers of trips made to these locations for work they offer additional destinations for education, recreation and entertainment. The existing transit infrastructure relies mostly on driving and parking. The trip is then completed by either walking or shuttle network provided by the institution. These institutions have established themselves as walkable communities within the primary zone of activities from the campus setup that promotes walking.

Syracuse Mobility Hub Network

The mobility hub network for Syracuse in the context of this study would be comprised of thirteen hubs. Each would operate across three scales based on level of activity, density and available and future infrastructure. The two-mile distances between hubs are intended to provide adequate coverage and accessibility for travel by public transit or service a fifteen minute bicycle ride (Figure 6).

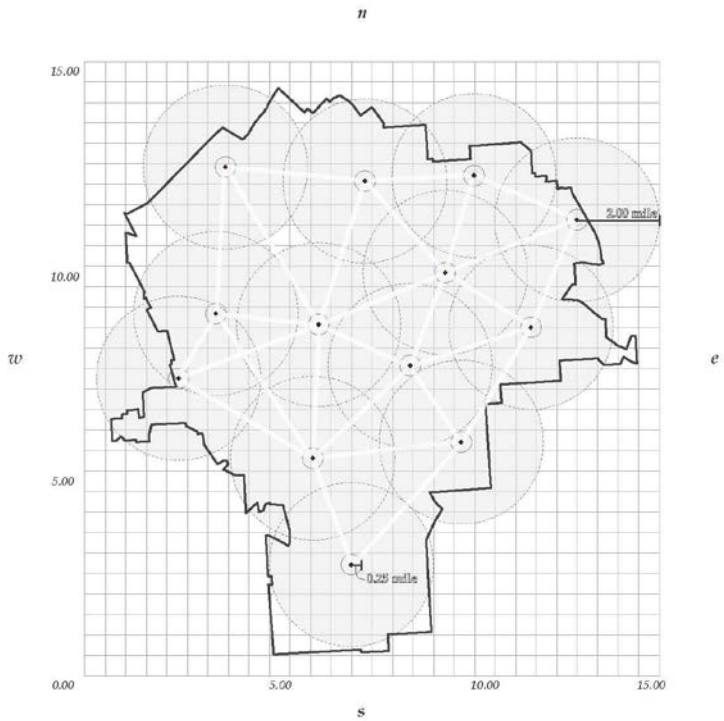

Figure 6. Syracuse mobility hub network. Image produced by authors.

Mobility Hub Design Guidelines

In addition to the hub design considerations stated in the methods, the guidelines for the design of hubs in Syracuse include some of the following strategies:

Site specific locations – Locations for infill to be considered at an opportunity where two transit mode infrastructures overlap. Placement at the edge or centre within proximity of destination is decided based on anticipated impacts.

Convergence of infrastructure – All accommodating infrastructures are to be housed within the hub. The moments of convergence can be stacked, flanked side by side, staggered or overlapped.

Integration of mixed use programming – Activity drivers to stimulate economy and attraction to the site as well as mobility services should be configured in the hub in collaboration with the design of the convergence of transit infrastructures.

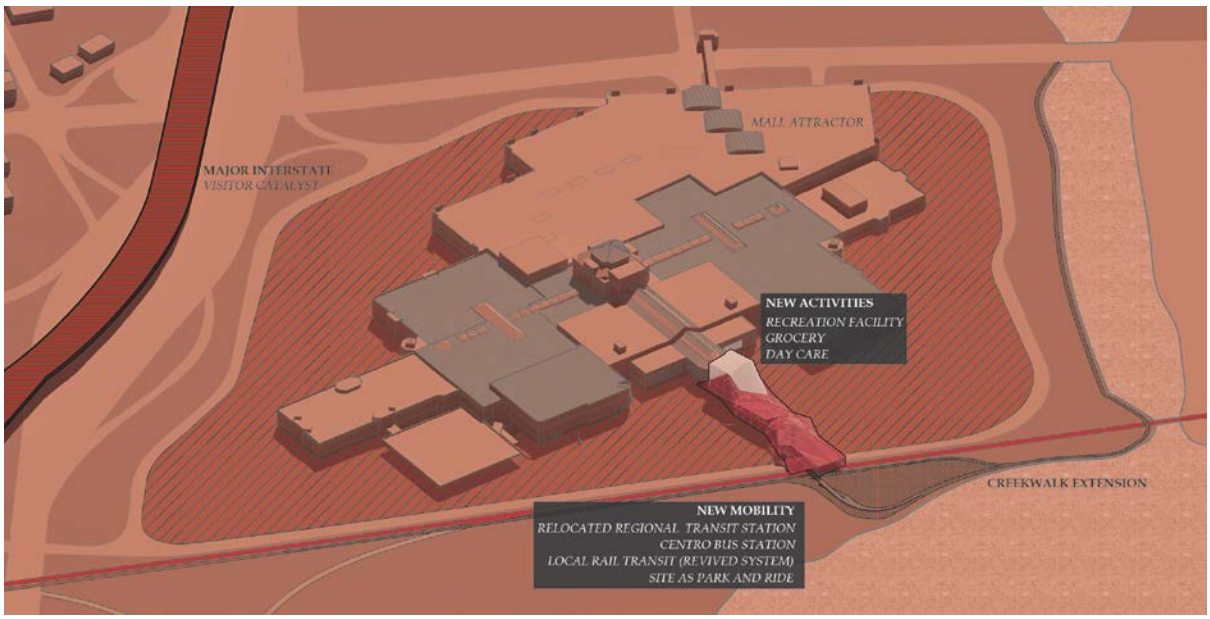

Figure 7. Sprawl-city edge transit hub. Image produced by authors.

Discussion

It is worth noting that the solution of a mobility hub network is not a one size fits all. This framework is intended for a working method in creating a network and guidelines for the design of a mobility hub. When applied to future case studies it is inevitable that design of the network and mobility hubs will be different despite following similar principles of accessibility, activity and sustainable mobility.

Supporting Institutions

In the case of mid-sized cities, a destination based model would rely on significant support from the private sector. The role that the destination plays in this model anticipates generous provisions from the affiliation with key institutions. Therefore, the institutions of a city are crucial resources for the feasibility of a hub network.

System Phasing and Prioritization

Recent literature suggests that in developing the network there is prioritization in the phasing of mobility hubs (Engel-Yan and Leonard, 2012). Planning for improving transit infrastructure is a major priority to perform as a catalyst for successful mobility and accessibility between hub destinations. Once an adequate transportation system is in place, collector hubs would be first in priority while other hubs would be phased shortly after their completion. The goal would be to make sure that there are initial drivers for established the network followed by activator and generator hubs that increase accessibility to and from areas that require more support.

Conclusion

The proposed scheme for a mobility hub network in Syracuse focuses on and anticipates new mobility for the city that is driven by travel to key destinations and sustainable travel mode choices. Based on the mobility hub design guidelines, a design approach can be followed for implementation at other suggested locations across the city. Although not a conventional element of urban design or urban planning, mobility hubs can play a vital role in motivating human-powered mobility, sharing economies and public transit in other mid-sized cities and because of the convenience of car use in these cities a network approach of mobility hubs as presented through this framework could provide an alternative. Further investigations into this matter should outline quantitative assessment and feedback mechanisms that can predict potential outcomes of the results.

Acknowledgements

This publication is based on work supported in part by the New York State Energy Research and Development Authority (NYSERDA) and New York State Department of Transportation (NYSDOT), grant no. 83182. The opinions, results, findings and/or interpretations of data contained therein are the responsibility of the authors and do not necessarily represent the opinions, interpretations, or policy of the State, NYSERDA and NYSDOT.

References

Chakrabarti, V. (2013). *A Country of Cities: A Manifesto for an Urban America*. New York: Metropolis Books.

Engel-Yan, J. and Leonard, A. (2012). Mobility Hub Guidelines: Tools for Achieving Successful Station Areas. *ITE Journal*, 82(1) pp.42-47

Litman, T. (2014). Introduction to Multi-Modal Transportation Planning: Principles and Practices. Victoria Transport Policy Institute, pp. 1-18.

Metrolinx (2008). Mobility Hubs Development of a Regional Transportation Plan for the Greater Toronto and Hamilton Area.

NY Power Authority (2015). Five Cities Energy Plans.

Syracuse Metro Transportation Council (2015). Transportation Atlas.

Zielinski, S. (2006). New Mobility: The Next Generation of Sustainable Urban Transportation. In: *12th U.S. Frontiers of Engineering Symposium*, Dearborn, Michigan, 21-23 September 2006.