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Location Selection for Integrated Mobility Services: A Study on Mobility Hub Placement for UAM and Surface Mobility Services

Joonho Park[a*], Eugene Lee[a], Haneul Park[a], Jinhee Kim[b], Jaehyun (Jason) So[a]

[a]*Ajou University, Republic of Korea*
[b]*Yonsei University, Republic of Korea*

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This work addresses the following topic(s) from the Call for Contributions:
(Please check at least one box)

☐ Placemaking to integrate urban spaces and mobility
☒ Promoting sustainable mobility choices in metropolitan regions
☐ Governing responsible mobility innovations
☐ Shaping the transition towards mobility justice
☐ System analysis, design, and evaluation
☐ other: ________________________

Extended Abstract

Problem statement

Based on the increasing needs of people—such as the instinctive desire to move, the need for seamless mobility from the beginning to the end of a journey, and a clean, sustainable urban environment—mobility services are driving a paradigm shift to emerging smart mobility solutions from conventional public transportation modes. Emerging smart mobility solutions, including urban air mobility (UAM), personal mobility (PM), car- and ride-sharing services, autonomous vehicle (AV) transit (e.g. AV shuttles and buses), and demand-responsive transit (DRT), are gaining prominence because of their many advantages including the reduced number of moving units, demand-responsive operation, anytime/anywhere availability of zero-emission vehicles (electric, plug-in electric, and hydrogen), and sustainable urban transport operation and development. However, the emergence of smart mobility has raised concerns regarding the sustainability of urban mobility systems if these new mobility solutions are envisioned to operate alongside existing public transportation (such as buses and metros) in the future. As new mobility solutions and existing public transportation systems are integrated, their complexity—in terms of accessibility and transferability between them—will increase. The need for a new type of mobility transfer facility that can connect both existing public transportation services and emerging smart mobility services has already been raised. Although public transportation transfer centers have previously been responsible for connecting public transportation (such as buses and subways) new UAM requirements in low-altitude airspace and multiple underground metro lines have highlighted the need for a new type of mobility transfer facility. More importantly, from an effective mobility perspective, new questions have arisen about where to locate connections for each mode of transportation with other mobility services. The process of connecting various transportation modes and services assumes a high demand for mobility services in an area, which implies that the area is already developed. Consequently, constructing a new hub facility can be challenging, especially if the facility needs to support mobility operations underground, at ground level, and in low-altitude airspace, which requires securing physical airspace for UAM takeoff and landing requirements.

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[*] *Corresponding author. Tel.: +xx-xxx-xxxxx; fax: +xx-xxx-xxxxx.*
E-mail address: nameexample@example.edu

Research objectives

This study aimed to develop a methodology for selecting the location of a mobility hub connecting various smart mobility services, with the goal of ensuring the effective operation of emerging smart mobility services and ultimately achieving sustainable urban mobility in the future. Accordingly, this study devised a two-step approach comprised of a vertiport obstacle analysis and an analytic hierarchy process (AHP)-based analysis. The initial implementation of the vertiport obstacle analysis was performed because international regulations strictly limit takeoff and landing trajectories for safety reasons. Although it is unlikely that all mobility transfer facilities in urban areas will be utilized as UAM vertiports, this study will answer the practical question of where to locate mobility hubs that include UAM vertiport functions. To validate the proposed methodology, a case study was conducted in the capital metropolitan area in Korea (including Seoul, Incheon, and cities in the Gyeonggi province). It should be noted that the scope of smart mobility services included public transportation (metros and buses), PM, car sharing, and DRT that mostly operate under ground and at ground level, whereas DRT and UAM would likely operate in low-altitude airspace, as currently deployed in Korea. Moreover, train stations, express bus terminals, public parking buildings, and public garages were used as candidate locations for mobility hubs, following the Seoul Metropolitan Government's mobility hub facility plan. Finally, this paper describes the established methodology for selecting the location of a mobility hub and presents the final selection results obtained using the proposed method.

Methodological approach

This study used a two-step location selection approach. First, to filter out the locations that could not support UAM, a vertiport obstacle analysis was conducted serving as an initial preprocessing procedure. This analysis identified obstacles that could impact UAM takeoffs and landings. Second, the potential locations were assessed based on the scores of all criteria including environmental condition factors, traffic condition factors, and potential traffic demands. To establish an evaluation system to determine the appropriate location of mobility hubs based on the candidate group, multicriteria decision-making (MCDM) literature for transportation facility location selection was reviewed. The top three and bottom twelve hierarchical evaluation structures were designed by selecting assessment aspects that were usually addressed when evaluating the location of transportation transfer facilities and additional factors that needed to be considered when managing UAM, and multi-mobility services.

(Expected) results

For the case study, a total of 264 facilities located in Seoul (Gyeonggi province) and Incheon—comprising public parking buildings, public transportation garage facilities, express bus terminals, and train stations—were evaluated. Of the 264 candidates, 177 were found to meet the airspace requirements for UAM takeoff and landing. The AHP was then conducted to examine the criteria for selecting mobility hub locations in terms of their importance and weights. The analysis showed that environmental conditions were the most important factor to consider, owing to the emergence of smart mobility modes and services with different operational characteristics, which required the surrounding conditions to be considered—such as the "Risk of Flight" and "Noise and Privacy" concerns. The sub-criteria, "Risk of Flight," "Opportunity of Transfer," "Floating Population," and "Demand of Public Transit" were ranked in descending order of importance, with survey respondents considering safety to be the top priority. Moreover, mobility hubs should be located where various mobility modes and services can be connected, in areas of population growth where existing public transportation can be replaced; people want a mobility hub to be located in a safe and convenient place, and this is the key to maintaining a sustainable urban system—that is, by increasing the utility of the mobility hubs.