



Multimodal Transport For Smart Mobility in Emerging Cities: Case of Doha

Mahnoor Hasan

Department of Architecture and Urban Planning, College of Engineering, Qatar University, Doha, Qatar
mh1204286@qu.edu.qa

Fodil Fadli

Department of Architecture and Urban Planning, College of Engineering, Qatar University, Doha, Qatar
f.fadli@qu.edu.qa

Abstract

A mobility focused smart city ensures an urban place that is shaped with latest innovations accentuating the overall well-being of its citizens. One of the significant aspects for assessing the Smart Mobility in an emerging city is the assessment of its Multimodal Transport Network. Integrating diverse transportation modes into a single route for seamless mobility is necessary to revolutionize the cities into smart cities. Qatar is currently leading the pace of smart growth by investing profoundly in smart cities infrastructure and evolving mobility technologies. This paper explores: (i) the progress of the smart mobility development and initiatives in Qatar, (ii) the Multimodal transport system in one of its smart cities, Msheireb Downtown Doha (MDD) and (iii) how the Multimodal transport system could be influenced in the light of emerging transportation technologies like Autonomous Vehicles (AVs). The study investigates in-depth the transport network of the city and makes an exploratory analysis. The qualitative approach is used in doing secondary research and performing on-site observations. On-site observations for the smart mobility assessment involved assessing indicators like walkability, cycling, inter-modality and transportation hubs and the overall public transport system in MDD. It is concluded that there is still room for improvement when it comes to developing the intermodal network for the mobility enhancement and deployment of AVs. The outcome of the study is the investigation of the smart mobility initiatives adopted in Qatar, the assessment of multimodal transport pattern of MDD, and a bus route proposal in the era of AVs.

Keywords: Smart mobility; Multimodal Transport; Emerging technologies; Qatar

1 Introduction

This section emphasizes how crucial a robust Multimodal transportation system is for the development of smart mobility in a smart city. It also highlights how the Multimodal transport system is used for assessing the smart mobility. Smart mobility lays emphasis on transportation sector and logistics, with the smart usage of technology. It places a strong emphasis on reliable travel schedules, healthy communities, and user safety. Previous scientific studies confirm that intelligent transportation system (ITS) supports smart mobility (Papa et al., 2015). Despite the absence of a universal meaning for the term “Smart City,” several researchers define it as including the following areas: smart people, smart economy, smart environment, smart governance, smart transportation, and smart lifestyle (Giffinger et al., 2007; Stratigea & Panagiotopoulou, 2014).

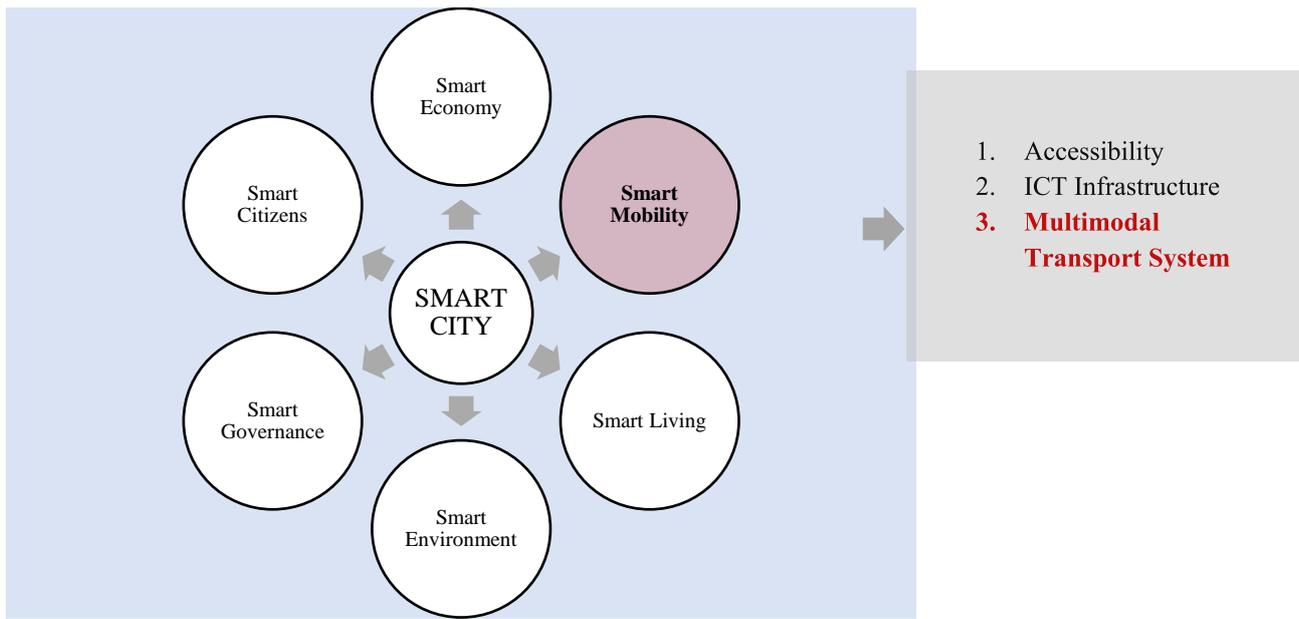


Fig. 1: Relationship between Smart city, Smart Mobility and Multimodal Transport System

Various researchers have made numerous efforts to define ‘smart city’ by combining diverse terms, representing the absence of a common definition (Chong et al., 2018; Schaffers et al., 2012; Zhuhadar et al., 2017). Smart Mobility, as one of the components of a smart city, is a crucial subject, impacting many facets of its residents’ quality of life. According to Staffans & Horelli (2014), Smart Mobility refers to innovative and sustainable ICT-aided logistics, transport and communication systems with international and local accessibility. Multimodal transport often implies that one mode of transportation is employed as the primary way of travel while the other modes are used as egress or access routes (s). Interconnectivity, which allows for multimodal or inter-modal transit linking all of a city’s resources, including its people, information, and commerce, is the crucial element of smart mobility or the transportation network of a city. Interconnections are the networks that link various transport network infrastructures (de Stasio et al., 2011).

Therefore, smart mobility is the way of connecting the Multimodal transport system used by commuters for day-to-day activities with the innovative use of technologies.

2 Multimodal Transport System as an Assessment Factor for Smart Mobility

Based on frameworks used in the past by various researchers for the assessment of smart mobility in a city, Table 1 has been created that summarizes the most important indicators used in the most recent researches for assessing smart mobility in a city. Most of the researchers agree that the deployment of multimodal transport system is considered as one of the most important assessment factors for smart mobility.

Table 1: List of most important Indicators for assessment of Smart Mobility conducted in the most recent researches

No.	Source and Year	Most Important Indicators	Cities Evaluated
1.	Biyik et al. (2021)	(i) Organizations (ii) Technology (iii) People	European Cities
2.	Munhoz et al. (2020)	(i) Accessibility (ii) Walkability (iii) Public policies	Brazilian cities

		(iv) Environmentally friendly policies (v) Urban mobility plans (vi) Maintenance (vii) Safety	
3.	Orlowski & Romanowska (2019)	(i) Technical infrastructure (ii) Information infrastructure (iii) Mobility methods (iv) Legislation	Poland
4.	Battarra et al. (2018)	(i) Accessibility (ii) Sustainability (ii) ICT	Italian Metropolitan cities
5.	Arce-Ruiz, Baucells, & Moreno Alonso (2016)	(i) Sustainable Urban Mobility Plans (SMUP) (ii) Payment integrated in Multimodal Transport system (iii) The use of ICT in traffic management (iv) Deployment of Multimodal Transport system	62 Spanish Cities

3 Methodology

Inductive approach is used as a research strategy in this research. It starts with observations and concludes that the intermodal network can be further enhanced in MDD for the deployment of AVs. Msheireb Downtown Doha (MDD) is used as the case study as the research strategy for investigating the real-life context of the transportation network. The study investigated in-depth the transport network of the city and makes an exploratory analysis. The qualitative approach was involved in doing secondary research and performing on-site observations. Analysis of the existing data was done through the theoretical and contextual background of smart mobility. On-site observations for the smart mobility assessment involved assessing indicators like walkability, cycling, inter-modality and transportation hubs and the overall public transport system in MDD. Site visits were made that investigated the site's settings. The observation approach was utilized to assess the urban design of the development. Plans were collected and maps were drawn based on relevant urban planning related indicators chosen from the most recent frameworks for smart mobility assessment.

4 Smart Mobility Initiatives Adopted in Qatar

Numerous mobility-related projects are being implemented in Qatar with the goal of influencing how people travel about the city. For instance, the Ministry of Information and Communications Technology is focusing on projects that assist sponsors in adopting smart technology and support the activities of various sectors (Sustainable Smart Cities: Improving Quality of Life, 2014). Qatar is a unique case study since it has undergone rapid urbanisation and through numerous stages of growth. It has noticed significant changes in its urban fabric recently, especially with respect to Msheireb Downtown Doha (MDD). Countless strategies have been commenced with the introduction of Qatar National Vision 2030, promoting it as an emerging regional and international service hub. The core of the country's National Vision 2030 is to have a technology-driven, diversified economy. Through it, the country intends to offer cutting-edge services to all stakeholders. Qatar has been striving to achieve the vision of smart cities, and its initiatives have propelled it to the position of a digital pioneer. Smart city designers set new standards for urban development, which will have an impact on forthcoming smart cities in the nation and beyond. MDD is the first downtown regeneration project of its kind in the world that makes use of connection and smart technology to improve the city's economics, way of life, and environment (Rider, 2021). With a comprehensive approach to creating settings where its residents, companies, and visitors can thrive, Qatar has demonstrated its dedication

to setting the standard for defining the future city. Qatar is dedicated towards making comprehensive public-private cooperation, investment in innovation centres, where co-creation will support the regional economy and future global initiatives as part of an integrated smart technology ecosystem (Rider, 2021).

As Msheireb Downtown Doha (MDD) is completed, Qatar is bringing its vision of smart cities to fruition. MDD is also the first to incorporate important dimensions of a smart city, including smart city technology, smart economy, smart environment, and interconnection.

By 2030, Qatar aims to be a developed society capable of maintaining its growth and providing a high standard of living to all of its residents. The National Vision of Qatar outlines the nation's long-term objectives and provides a framework for formulating implementation plans (Qatar National Vision 2030 booklet).

The Ministry of Transport and Communications (MOTC) is developing a smart transportation system as part of the Tasmu Smart Qatar Program. Using cutting-edge digital technology, Tasmu Smart Qatar seeks to transform Qatar into a world-class smart city in order to elevate living standards and increase the country's competitiveness on a global scale. The programme has a number of goals that range from sustainability to societal advantages. The program's main goal is to use technology and resources as effectively as possible for the benefit of society, the economy, and the environment. Their approach is both environment friendly and focused on providing a good service to the general people, and make use of electric buses, smart bus hubs, WiFi-enabled street lighting, and water taxis. The transportation industry seeks to promote mobility by providing a secure and safe transportation network. Through the integration of several transportation options, seamless mobility is intended to be created throughout Qatar's streets for a customised travel experience (Tasmu Smart Qatar).

5 Multimodal Transport System in Msheireb Downtown Doha (Mdd)

Utilizing two or more modes of transportation in one journey is known as multimodal transportation. The interconnection of various types of transportation is essential for transportation efficiency. It combines the benefits and makes up for the drawbacks of various modes of transportation. Increasing the usage of public transit while reducing reliance on cars as the primary form of transportation is one of the fundamental goals of multimodal transportation. Inter-modality in MDD, is reinforced very well by suitable infrastructure like designated bicycle pathways alongside streets, tram routes and pedestrian walkways.

Within 400 m of the metro station, public transport facilities like bus stations are accessible. The bicycle lanes and the pedestrian infrastructure are well integrated with the existing transit systems, connecting to the major metro line. There are two hubs with four and three modes of transport within the catchment area of 200m from the Metro Station. There are 4 modes of transportation namely tram, cycle, bus and metro line within the hub near to the Msheireb Metro station. The hub with three modes of transport namely; tram, bicycle, and bus lie towards the north west of Msheireb Downtown area. Inter modality is therefore considered strong because both the hubs with 3 and 4 modes of transport cover almost the entire area of MDD.

However, there is still room for improvement in the transport network of the Downtown. Inside MDD, there is no bus service available. The two bus stops existing on Al-Khail Street can be exploited to be part of a well-designed bus route. Part of the reason why there is no bus service inside MDD is that the Downtown is highly walkable and detached places have been already connected by 9 Tram stations all over the Downtown. Although the Msheireb Metro station is connected with the tram, it

necessitates commuters to walk certain number of meters to reach it. It has also been found that the cycling paths in most of the places are not ongoing and continuous. Moreover, the South-West area of the Downtown is devoid of any cycling tracks. Figure 2 demonstrates the Intermodal transportation network of Msheireb Downtown Doha (MDD).

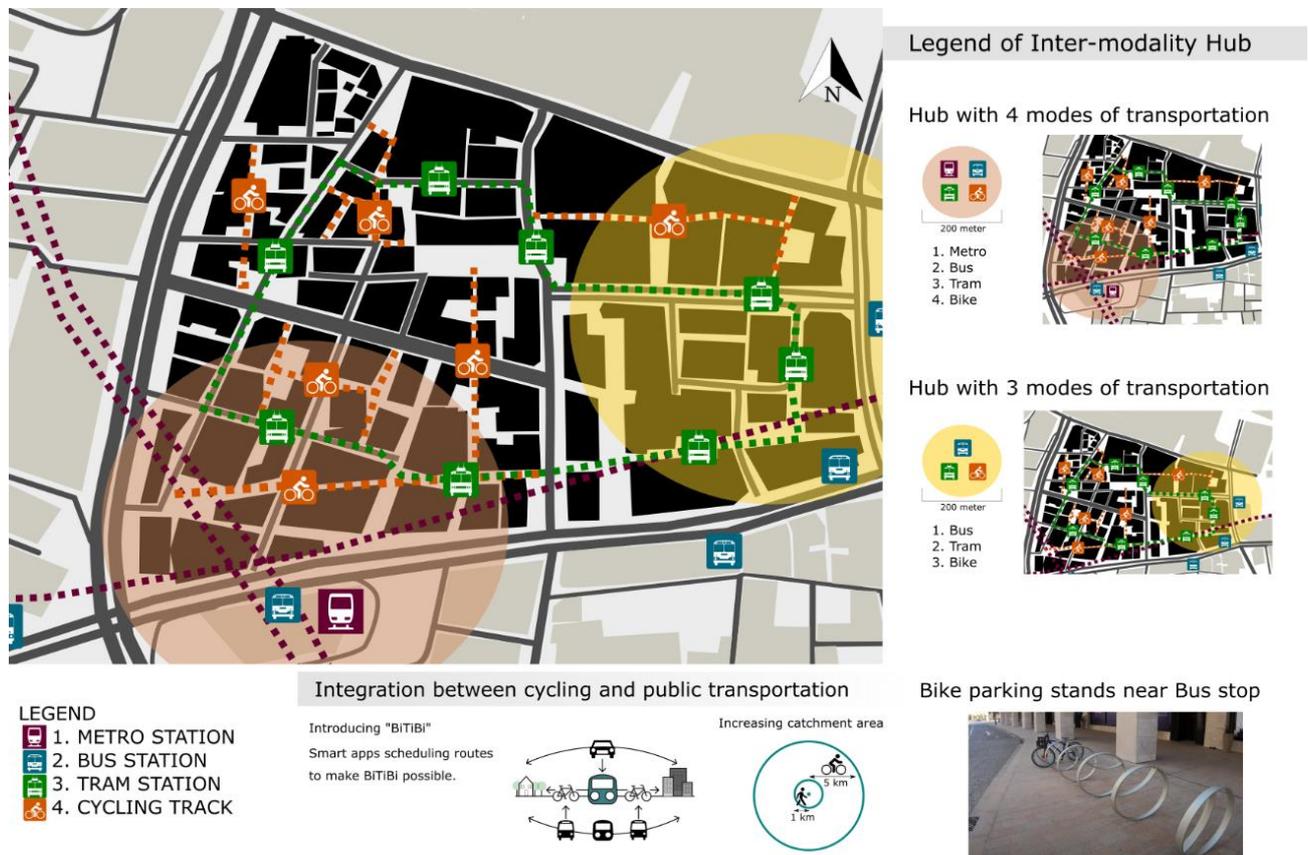


Fig. 2: Inter-modality and Transportation Hubs in Msheireb Downtown Doha

An incentive to support the bike-train-bike modal over vehicles and car-train hybrids is the BiTiBi (bike-train-bike) idea utilised in the European setting. The most significant guidelines in the BiTiBi approach are the establishment of adequate bike parking at metro stations and offer bikes, particularly for the last mile. In the case of MDD, this concept has been used with the provision of bike stands close to the metro station. This concept can be implemented at other metro stations in Qatar to ensure BiTiBi is applied.

6 Multimodal Network in the Light of Emerging Technologies like Autonomous Vehicles

According to (Bezai, Medjdoub, Al-Habaibeh, Chalal & Fadli (2021), infrastructure has a significant impact on the successful deployment of developing technologies like Autonomous Vehicles. Travelers must be able to reach a variety of transportation hubs, such as bus stops, railway stations, etc., in order to switch between AVs. Since AVs are expected to be the final mode of transportation utilised to get to the desired location in an urban setting, the mobility hubs must guarantee that there is an easy interchange of transportation modes. The mobility centres also need to have areas for bike stations and spacious walkways for both bikers and pedestrians. Re-designing the transit bus network is crucial for the effective implementation of AV technology. A traveller who plans his route from two points outside the city's downtown is compelled to take two buses—one to get him from his starting point to the downtown core and another from the downtown core to his destination—due to

the bus network configuration, which radiates from the central core into many metro areas.

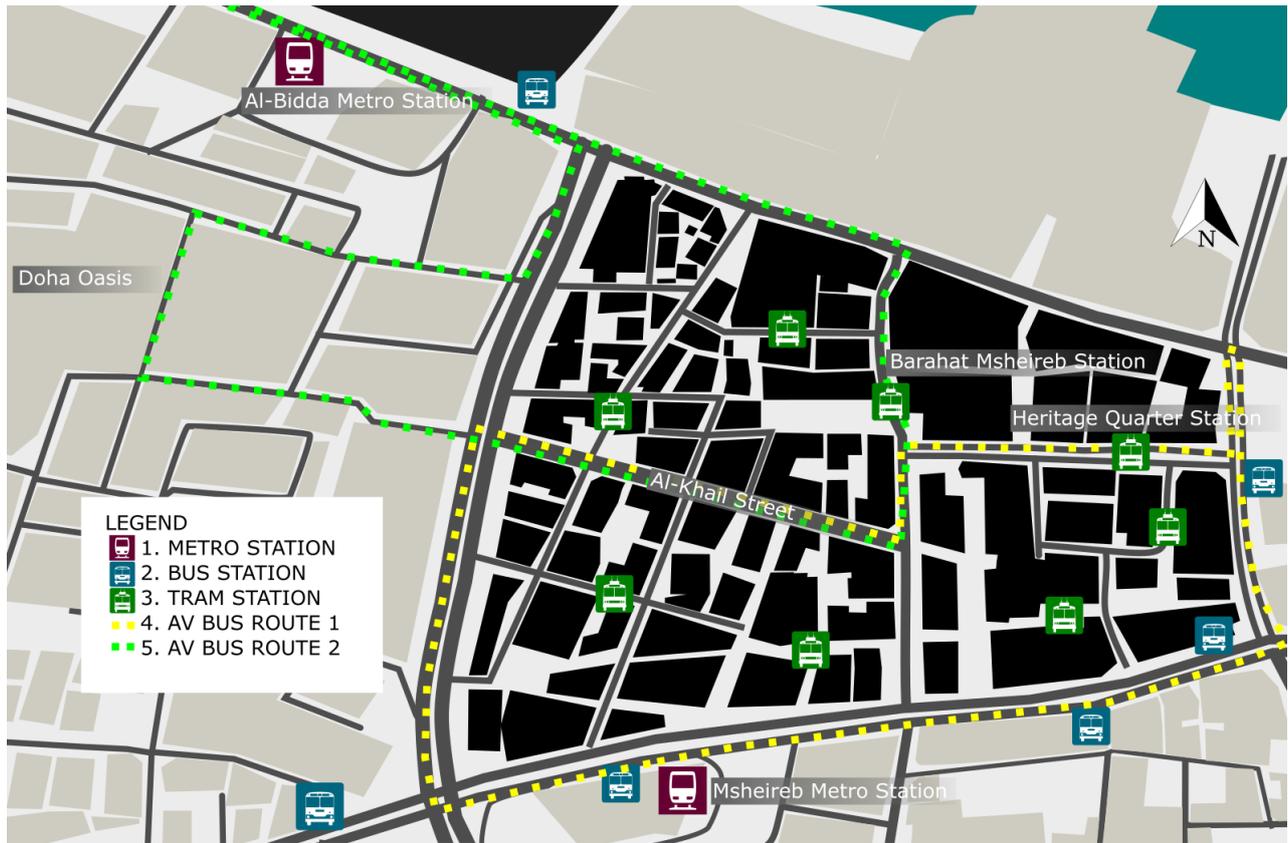


Fig. 3: AV bus route proposal

For the effective implementation of AVs on the streets of MDD, the following proposals are made with regard to the transport network. In close proximity to the MDD, are two Metro stations: (a) Msheireb Metro Station, which connects the red, green, and gold lines; (b) Al-Bidda Metro Station, which serves the red and green lines and which can be connected to the Tram stations by autonomous minibuses. Two routes could be created: one linking the Msheireb Metro Station with the Heritage Quarter Tram Station (for tourists visiting the Heritage Quarter) and Al Khail Street, a three-lane commercial street; the other linking the Al-Bidda Metro Station with the Barahat Msheireb Station and the Doha Oasis, a popular theme park for tourists (Figure 3). Both Metro stations already have bus stops that may be utilised by autonomous minibuses as well as regular buses. The minibus stop may be close to the Tram stations. It is possible to restructure both bus stops to make them more effective and smarter. Finally, instead of merely being located on the external main road, internal streets can also be used as locations for mini bus stops.

7 Conclusion

This paper investigated the smart mobility initiatives taking place in Qatar and the Multimodal transportation system in one of Qatar's smart cities, Msheireb Downtown Doha (MDD). It provided an insight into how the growth of smart mobility in Qatar, in light of cutting-edge transportation technology like autonomous cars, may affect the Multimodal transport system. There are several ways that this study might be developed in accordance with the idea of smart mobility. It gave an insight into how the multi-modal transport system could be influenced by the development of smart mobility in Qatar in the light of emerging transportation technologies like Autonomous vehicles. This study

can be advanced further in many ways in line with the smart mobility concept. Apart from assessing the Multimodal transport network, additional mobility indicators can be added for assessing the smart mobility from urban planning perspective allowing cities to adapt them in the most sustainable way. Using this paper as the base information, diverse ways can be recognised to integrate the globally available smart transportation technologies in the existing urban fabric of Qatar.

Acknowledgements

This paper was made possible by an Award [GSRA6-2-0514-19027] from Qatar National Research Fund (a member of Qatar Foundation). The contents herein are solely the responsibility of the author.

References

- Arce-Ruiz, R., Baucells, N. & Moreno Alonso, C. (2016). *Smart Mobility in Smart Cities*.
- Battarra, et al. (2018). Smart Mobility in Italian Metropolitan Cities: A comparative analysis through Indicators and actions. *Sustainable Cities and Society*, 41. doi: 10.1016/j.scs.2018.06.006.
- Benevolo, C., Dameri, R. & D'Auria, B. (2016). Smart Mobility in Smart City. Action taxonomy, ICT intensity and public benefits. In (Vol. 11, pp. 13-28).
- Bezai, et al. (2021). Future cities and autonomous vehicles: analysis of the barriers to full adoption. *Energy and Built Environment*, 2(1), 65-81. doi:https://doi.org/10.1016/j.enbenv.2020.05.002.
- Bıyık, et al. (2021). Smart Mobility Adoption: A Review of the Literature. *Journal of Open Innovation: Technology, Market, and Complexity*, 7, 146. doi:10.3390/joitmc7020146.
- Chong, et al. (2018). Dynamic capabilities of a smart city: An innovative approach to discovering urban problems and solutions. *Government Information Quarterly*, 35. doi:10.1016/j.giq.2018.07.005.
- de Stasio, C., Fiorello, D. & Maffii, S. (2011). Public transport accessibility through co-modality: Are interconnectivity indicators good enough? *Research in Transportation Business & Management*, 2, 48-56. doi:https://doi.org/10.1016/j.rtbm.2011.07.003.
- Giffinger, et al. (2007). Smart cities - Ranking of European medium-sized cities.
- Munhoz, et al. (2020). Smart Mobility: The Main Drivers for Increasing the Intelligence of Urban Mobility. *Sustainability*, 12, 10675. doi:10.3390/su122410675.
- Orlowski, A. & Romanowska, P. (2019). Smart Cities Concept: Smart Mobility Indicator. *Cybernetics and Systems*. doi:10.1080/01969722.2019.1565120.
- Papa, E. & Lauwers, D. (2015). Smart mobility: Opportunity or threat to innovate places and cities? , 543-550.
- Qatar National Vision 2030. (n.d.). Retrieved December 06, 2021, from <https://hukoomi.gov.qa/en/about-qatar/qatar-national-vision-2030#tab-3>.
- Rider, B. (2021, February 18). Qatar's Smart Cities of the Future [Web log post]. Retrieved from <https://www.linkedin.com/pulse/qatars-smart-cities-future-beverly-rider>.
- Schaffers, H., Ratti, C. & Komninos, N. (2012). Special Issue on Smart Applications for Smart Cities - New Approaches to Innovation: Guest Editors' Introduction. *Journal of Theoretical and Applied Electronic Commerce Research*, 7, II-V. doi:10.4067/S0718-18762012000300005.
- Staffans, A. & Horelli, L. (2014). Expanded Urban Planning as a Vehicle for Understanding and Shaping Smart, Liveable Cities. *The Journal of Community Informatics*. 10. 10.15353/joci.v10i3.3439.
- Stratigea, A. & Panagiotopoulou, M. (2014). *Smart' Cities as a New Paradigm for Serving Urban Sustainability Objectives – A View in the Mediterranean Experience*.

Sustainable smart cities: Improving quality of life. (2014). Retrieved October 6, 2022, from https://motc.gov.qa/sites/default/files/sustainable_smart_cities_-_improving_quality_of_life.pdf.

Tasmu Smart Qatar, Retrieved from <http://smart.gov.qa/en>.

Zhuhadar, et al. (2017). The next wave of innovation—Review of smart cities intelligent operation systems. *Computers in Human Behavior*, 66, 273-281. doi:10.1016/j.chb.2016.09.030.

Cite as: Hasan M., Fadli F., “Multimodal Transport For Smart Mobility in Emerging Cities: Case of Doha ”, *The 2nd International Conference on Civil Infrastructure and Construction (CIC 2023)*, Doha, Qatar, 5-8 February 2023, DOI: <https://doi.org/10.29117/cic.2023.0120>