

Greenways of Saudi Arabia: Activating their transportation potential

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1. Abstract

Since the early 1970s, auto-centric planning in Saudi Arabia (SA) has created car-dependent lifestyles, resulting in health and environmental problems. In the past decade, ambitious policies (e.g., The Saudi Vision 2030), regulations, awareness campaigns, city plans, and projects have sought to address this problem by transitioning to sustainable urban mobility. One form of this is active transportation (AT) via networks of greenways, which is currently being promoted in Saudi cities. However, the contemporary use of greenways for AT - for example, commuting by bike or walking - is extremely low in SA. Additionally, there is limited research on greenways in Middle Eastern countries. Thus, this paper aims to examine the factors hindering the use and development of greenways as AT corridors in SA, thereby informing efforts to unlock their AT potential.

After outlining how the forms and functions of greenways in SA evolved compared to their international counterparts, we present Jeddah city as a case study, a city with low rates of AT. Drawing on recent empirical mixed-methods research, an overview and synthesis of factors explaining the low utilisation rate of Jeddah's greenways as AT corridors is presented. Barriers to AT are categorised as site-specific (e.g., greenway design, safety, maintenance), contextual (e.g., neighbourhood walkability/accessibility, weather), behavioural and perceptual (e.g., conflicts between greenway users and perceptions). In addition to user-based evidence, we identify broader development-related challenges of building a greenway network for AT in Jeddah city, including spatial connectivity, lack of integration with the concerned authorities, limited budgets, and securing and regulating land.

Results show that multidimensional impediments to active commuting via greenways in SA are similar to those globally, for example, greenway's proximity to home addresses (Krizek and Johnson 2007; Wolch et al. 2010). However, other factors are specific to the Saudi context. These include, but are not limited to, the perception of privacy, unsuitability of formal Saudi attire for riding bicycles, and fear of public judgement. We conclude with a comprehensive model that summarises all the factors influencing greenway use for active transport in SA, which can inform future research and practice in this domain.

2. Introduction

Saudi cities are automobile-dependent due to several factors (Aldalbahi and Walker 2016; Aljoufie, 2014a, 2014b; Al-Mosaind 2018). In 2017, 100% of 3.3M surveyed Saudi households own one or more cars: 65% of them own a car, 23.3% own two cars, 7.85% own three cars, and the remaining 3.85% have 4 to 8 cars per household (The General Authority for Statistics 2017). The development of the automobile-dependent cities in Saudi Arabia (SA) gradually began in the 1950s (Aldalbahi and Walker, 2016), leapfrogging the "transit city" (Newman and Kenworthy, 1999). In the early 1970s, auto-centric environments were institutionalised via comprehensive city plans to control and direct rapid urbanisation and population growth (Abdulmughni et al. 2021; Alhajaj 2014; Mandeli 2011). Newly introduced urban forms such as large multi-lane highways led to the demise of elements that had traditionally shaped Arabic Islamic cities, such as hierarchies of open spaces

and courtyards that transitioned from public to private and vice versa (Al-Shahrani 1992; Fatani et al. 2017; Kamal 2014). Traditional spatial patterns were replaced with standardised forms of public open spaces that many regarded as fragmented and inconsiderate of socio-cultural aspects such as privacy (Addas and Maghrabi 2020; Alhajaj 2014; Hammadi 1993). Therefore, auto-centric environments fostered auto-dependent lifestyles in SA.

Consequently, the use of active transportation (AT) – i.e., commuting by bike or walking - is extremely rare in SA. For instance, the use of public and AT in Jeddah city accounts for just 4% of all trips (AECOM 2012 as cited by Aljoufie 2014b). Such conditions are impacting AT safety (i.e., accidents) (Aljoufie 2017), comfort (i.e., air and noise pollution) (Nazelle et al. 2011; WHO 2021), accessibility to daily destinations (e.g., travel distance) (Aljoufie 2014a; 2014b; Youssef et al. 2021), and residents' physical activity (PA) (Al-Hazzaa 2018; Kung et al. 2014 as cited by Almahmood et al. 2017; The General Authority for Statistics 2019).

The past two decades witnessed ambitious policies (e.g., The Saudi Vision 2030, Quality of life program 2020, and the Saudi Green Initiative), regulations, awareness campaigns, city plans, and projects that seek to address the problems of automobile dependence. Among those solutions is the transition to sustainable urban mobility, including AT via greenways networks in Saudi cities. A prominent example of such efforts is the Riyadh Sports Boulevard, where public open space connectivity to work/education/pleasure destinations is one of its key characteristics that support the realisation of walking and cycling as a mode of transport in current Saudi cities (Riyadh Sports Boulevard 2019). However, rates of AT remain low in SA. Therefore, this paper aims to unlock the AT potential of greenways in SA by examining the factors hindering their use and development as AT corridors, using Jeddah, a city of 4.6 million people located west of SA, as a case study.

3. Background and literature review

Both original and contemporary definitions characterise greenways as a network of multifunctional routes established along natural and urban corridors that contribute to various sustainable development objectives (EGWA 2000; Horte and Eisenman 2020; Little 1990; Searns 1995; Turner 2006). Greenway types in SA encompass main market streets of historic areas, historic/religious routes (e.g., Road to Thaniyat Al-Wada), transitional public open spaces, waterfronts, wadis (wet/dry creekbeds), large median islands, natural trails, and urban drainage channels (Addas and Alserayhi 2020a; Alhajaj 2014; Al-Shahrani 1992; Kamal 2014; Ministry of Hajj and Umrah 2019; MoMRA 2005; Shoaib 2020). Many of them are locally referred to as linear parks (LPs) (Jeddah Municipality et al. 2008; MoMRA 2014; 2019), though international consultants (including this paper) use the term greenway interchangeably in city comprehensive plans and manuals (Jeddah Municipality et al. 2008; “Jeddah Structure Plan” 2015). Nonetheless, Kullmann (2013) differentiated LPs as places designed to be experienced at a slower pace compared to greenways since they combine both destination and route characteristics. Walkways are another form of linear open spaces in SA, but the term is ambiguously used, and in many instances, they are not a greenway type. In addition, the contemporary greenways of SA differ from other countries in many respects. A notable difference is the absence of rail-trails and converted freeways to greenways in SA. However, The Line City's greenway in Neom, SA is a unique type that aims to connect several urban hubs, a concept like rail-trails found in the American and the European contexts (Neom 2021). In brief, Saudi greenways share many of the forms, functions, and scales found internationally, while culture, history, variable terminology, and natural settings are unique defining characteristics.

Several scholars stress the importance of research and developments that enables AT in SA (Addas and Alserayhi 2020b; Aljoufie 2017; Al-Mosaind 2018). One of Al-Mosaind (2018) conclusions critiqued how recent projects that retrofit existing streets in Riyadh to include a walkway lack a transportation dimension. Simultaneously, research has evidenced that the encouragement of PA is better via the provision of a large park in a neighbourhood instead of small, fragmented ones (Sugiyama et al. 2010 as cited by WHO 2016). This suggests that the current standardised public open space provision strategy (MoMRA 2005) is ineffective in achieving one of the QoL program 2020's central goals, which is to encourage active lifestyles where AT would be a major contributor. Recent city comprehensive plans (e.g. "Jeddah Structure Plan" 2015) and projects (e.g., Riyadh Sports Boulevard 2019) show that road contraction schemes – humanising auto-centric channel-ways via the incorporation of greenways (Cervero et al. 2017) are a clear development direction in SA. That said, research about greenways in the Middle East, particularly SA is limited (Zawawi et al. 2020; 2022), and none examined the factors influencing their use as AT corridors. In conclusion, more research and development are needed to activate the transportation potential of the growing number of greenways in Saudi cities.

4. Methods and Data

This article presents an overview and synthesis of a large programme of work undertaken between 2019 and 2021 that investigates greenways and AT in Jeddah, SA. By adopting a synoptic approach, cross-cutting themes and the most salient issues to urban planning and design can be highlighted. This necessarily limits the amount of methodological detail that can be covered here. Consequently, this article presents a methodological overview of the project, with specific information on research design, data characteristics, analytical justification, and statistical tests provided in Zawawi (*in prep.*) via the lead author. Knowledge generation in landscape architecture research often includes studies of the sites' physical characteristics and layout (referred to as structure), studies of perceptions (referred to as image), and studies of the indicators and variables that influence use experiences (referred to as action) (Brink et al. 2016). This research used mixed methods as a research strategy, following a convergent design (Quant + Qual) in its first phase and an explanatory sequential design (Quant + Qual → Qual) in its second (Creswell and Clark 2018).

Phase one employed a self-administered web-based questionnaire of Jeddah residents (n = 357, of which 248 were complete responses) and field observations (FOs) of 16 LPs. The questionnaire examined residents' behaviours and perceptions of Jeddah's LPs and the factors influencing their use (or non-use) of them as AT corridors. Thus, the questionnaire considered users and non-users of the nearest LP from participants' home addresses as the main design approach. Each questionnaire participant type received a shared and unique set of questions, causing variations in the number of responses. FOs had two objectives. First, describe how the planning and design of greenways (at various scales) and their surrounding neighbourhoods would influence the transportation function of greenways. Second, describe users' behaviours in Jeddah's LPs (a non-participant observer) and how they could hinder active commuters via greenways. Therefore, FOs focused on analysing the dynamic relationship between people and places (i.e., greenways).

Generated data from the questionnaire, and FOs had quantitative and qualitative elements. Qualitative data were thematically analysed using inductive and deductive approaches. As for the quantitative data, they were statistically analysed via SPSS and spatially via Quantum Geographic Information System (QGIS). The results of phase one were structured thematically and then triangulated to look for consistent or complementary results across different methodological

outputs. Phase two comprised a process of validation and expansion of phase one findings. Results from phase one that warranted further explanations were examined via semi-structured interviews with both local and international experts (n=7) and AT interest groups (n=6). Interviews' transcriptions (from a total of 10.85 hours of audio recordings) were thematically analysed as well. Inferences are a result of synthesising the findings of both phases and relating to existing literature.

5. Results: Factors hindering the use of Jeddah's greenways as AT corridors

Questionnaire findings show Jeddah's LPs are rarely used as AT corridors (2.6% of 258 responses), but instead as facilitators for physical (37.1%), leisure (20%), recreational (16.8%), and social activities (16.8%). Statistical analysis results about greenway use frequency, duration, companion preference, and behaviours confirmed such preference and perception of Jeddah's LPs. Residents were surveyed about factors that constrained their use of greenways as AT corridors. Factors found to be most important were greenway-specific factors (e.g., design), contextual factors (e.g., neighbourhood walkability), and individual and behavioural factors (e.g., perceptions).

Field observations (FOs) and mapping at three scales- city-wide, greenway (Northern Drainage Channel linear parks or NDC-LPs), and segment (site scale) – illustrate these phenomena:

City-wide scale analysis shows Jeddah's LPs are fragmented and spatially disconnected from one another, with natural landscape features, public facilities, neighbourhoods, and other daily destinations (see Figure 1). QGIS analysis revealed that only 2.1% and 13.36% of built-up areas were within a 10-minute walk & 12-minute bicycle ride, respectively, of a greenway (see Figure 1). Such findings validate the questionnaire's results that 80.9% of 298 participants do not have access to LPs within a distance of less than 1 km. Therefore, greenways' connectivity and proximity within a walkable distance are significant challenges in Jeddah.

From a greenway scale, mapping of Jeddah's NDC-LPs revealed that, on average, 34.1% of the nine LPs have areas dedicated to automobiles (i.e., car parking spaces, driveways, and narrow median islands that mainly function as traffic lanes separators). Eight high-speed traffic barriers and 15 dangerous intersections prevent the NDC from being a safe and uninterrupted AT corridor, which emphasises the need for pedestrian crossings, traffic-calming measures, and signage (See Figure 2). Lastly, an assessment of the nine LPs that make up the NDC, using systematic FOs, revealed that they lack most variables that would render them comfortable, accessible, safe, and supportive to active commuters.

Zooming in to a segment scale (site), the context insensitive design of Jeddah's LPs (1) limited its perceived value (2) contribution to both stakeholders and the environment (e.g., being an AT corridor). Apart from Al Corniche parks, many of Jeddah's LPs are unvegetated, unmaintained, and lack the facilities and amenities to support active commuters (e.g., absence of bicycle lanes and public toilets) (See Figure 2). In addition to users' behaviours, conflict among users, LP width, crowdedness, and traffic speed, these factors negatively impact users' safety and intended functions of LPs in Jeddah city. Site analysis of Al-Rehab walkway (site A) and Al-Rawdah (known as Tahlia) walkway (site B) mapped many of the impediments mentioned above.

Spatial and direct observational analysis revealed broadly four greenway types in Jeddah: (1) Over a subsurface drainage channel; (2) along an open drainage channel; (3) along Al Corniche (4) large median island. While each of these four is distinct, there is much more potential to include even more variety of greenway experiences such as natural trails.

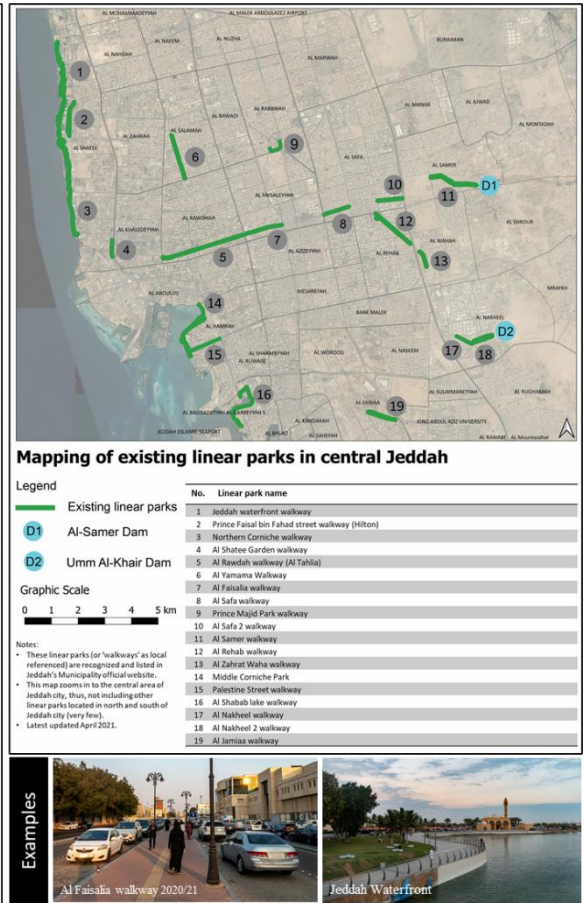
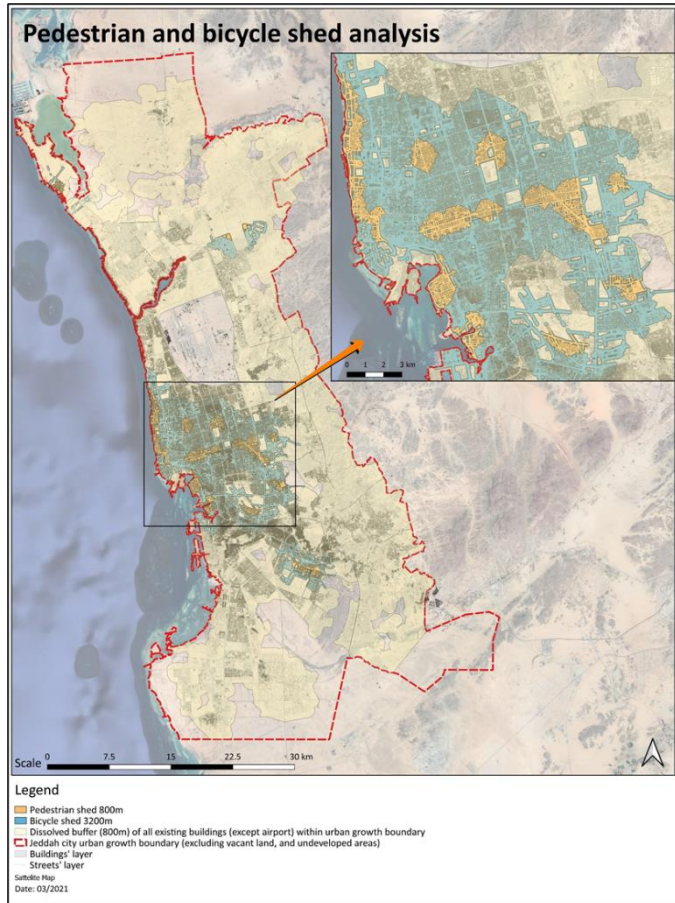


Figure 1. Proximity and connectivity analysis of Jeddah's linear parks.

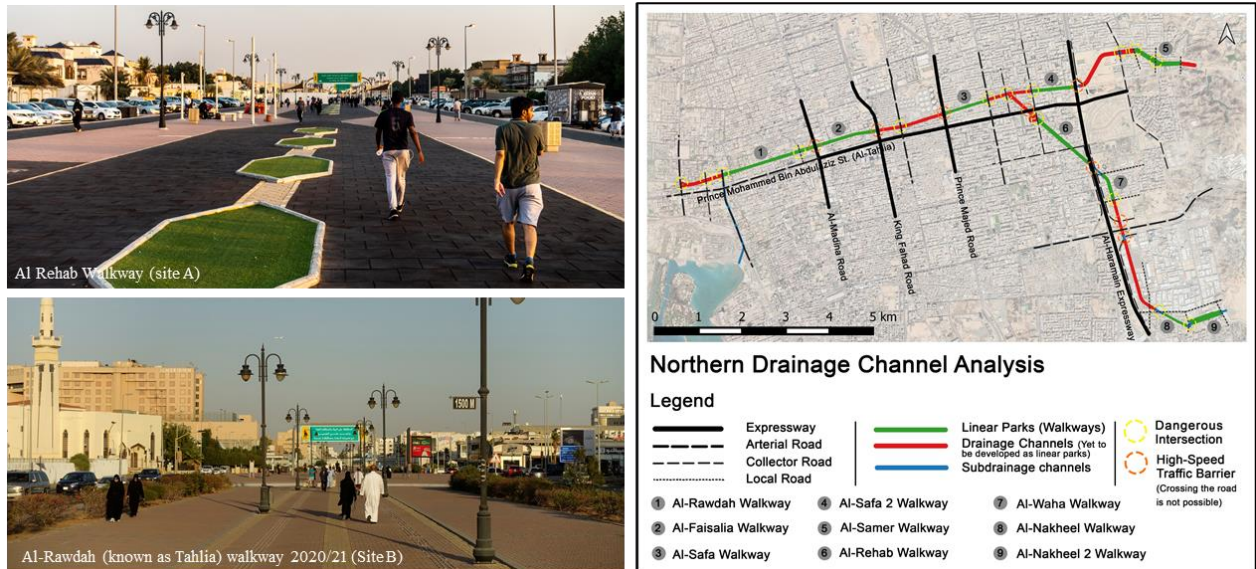


Figure 2. Analysis of the northern drainage channels linear parks (NDC-LPs).

Second are the contextual factors – characteristics of the surrounding urban environment – especially considering that greenways may not always lead to the desired destination but could be

part of the path that leads to it. In addition to the hot outdoor temperature, the other major deterrent to commuting via greenways in Jeddah is their existence in an auto-centric built environment where vehicles are given priority in urban development. The physical distance between daily destinations, street design, lack of AT infrastructure, and absence of a city mass rapid public transit system are major impediments at the city scale. At the neighbourhood scale, sites A and B assessment, via QGIS analysis and FOs, have shown that they lack many urban design qualities that make them walkable and cyclable. Specifically, QGIS assessments included pedestrian and bicycle shed analysis, land-use analysis, and block and lot size diversity. As mentioned by several interviewed experts, these deterrents are exacerbated by a lack of policies and regulations that encourage and protect active commuters in Saudi cities. In short, both physical design and policy factors were found to influence participants' travel behaviour and the transport potential of Jeddah's greenways.

Third are the individual and behavioural factors. Based on the questionnaire's findings, weather, greenway's distance from home, accessibility via AT, facilities (e.g., public toilet), and the availability of dedicated bicycle lanes are top influencers to the preference and perception of using greenways as AT corridors. In addition to the absence of bicycle-sharing services, they mentioned that these impediments also hinder cycling for transportation in Jeddah city. However, bicycle ownership, crime (e.g., theft), harassments, confidence in bicycling with traffic, reckless driving, age, health state, religious beliefs, socially constructed beliefs, and limited awareness of bicycle traffic rules were additional socio-cultural dimensions that hinder cycling for transportation in Jeddah city. The design of greenways in Jeddah city does not consider the variety in the age, skill level, and type of cyclists, contributing to many user conflicts, e.g., young cyclists vs adults walking for recreation. The interviewed experts and interest group leaders raised many of these issues. Experts also added the lack of public transportation system, the unsafe street design for active commuters, and residents' reliance on automobiles for daily commutes as major impediments.

A quarter of the questionnaire respondents had never used the perceived nearest LP from their home addresses due to the above-mentioned factors. However, lack of time (being busy) and disinterest stood out as particularly important. FO findings showed that users' behaviours and attraction to a greenway are influenced by its width, location (e.g., waterfront), maintenance, availability of playgrounds, lawn areas, and bicycle and scooter rental services. The higher foot traffic on a greenway increases the extent of commercial activities (e.g., food trucks and hawkers), crowdedness, and user conflicts, which are major comfort, health, and safety concerns.

The way Jeddah's greenways are developed and maintained was found to influence their use. The interviewed experts identified the development challenges of Jeddah's LPs, such as water scarcity, limited budgets, lack of integration between concerned authorities, governance, maintenance, non-compliance with building codes, and restrictions of government contracts. Many of these challenges are shared with the reported development of public open spaces (Alhajaj 2014; Almahmood et al. 2018; Hammadi 1993; Maghrabi 2019; Mandeli 2011). However, unique greenway development challenges in Jeddah city are as follows: securing and regulating land for greenways; spatial connectivity; accessibility via AT; and inclusive design to avoid use and user conflicts (e.g., disrupting visitors seeking social activities). There is also a need to overcome the lack of road traffic signs, signals, and road markings for active commuters and the non-compliance with national road design standards. Lastly, since the experiences of harassment and theft vary by location in Jeddah city, it can hinder the effectiveness of any proposed greenway network in the future (e.g., cycling to/through a low-income neighbourhood or an area with a high crime rate).

Based on all the above empirical results, the following comprehensive model (see Figure 3) summarises all the factors influencing people’s decision to walk or cycle for transportation via greenways in Jeddah. This model is built around a hypothetical trip that has a defined origin and destination. This model includes factors already identified in existing greenway literature (Zawawi 2022) alongside various factors foregrounded by this case study; physical context, urban laws and development, socio-demographic and individual variables, and weather and temporal variables.

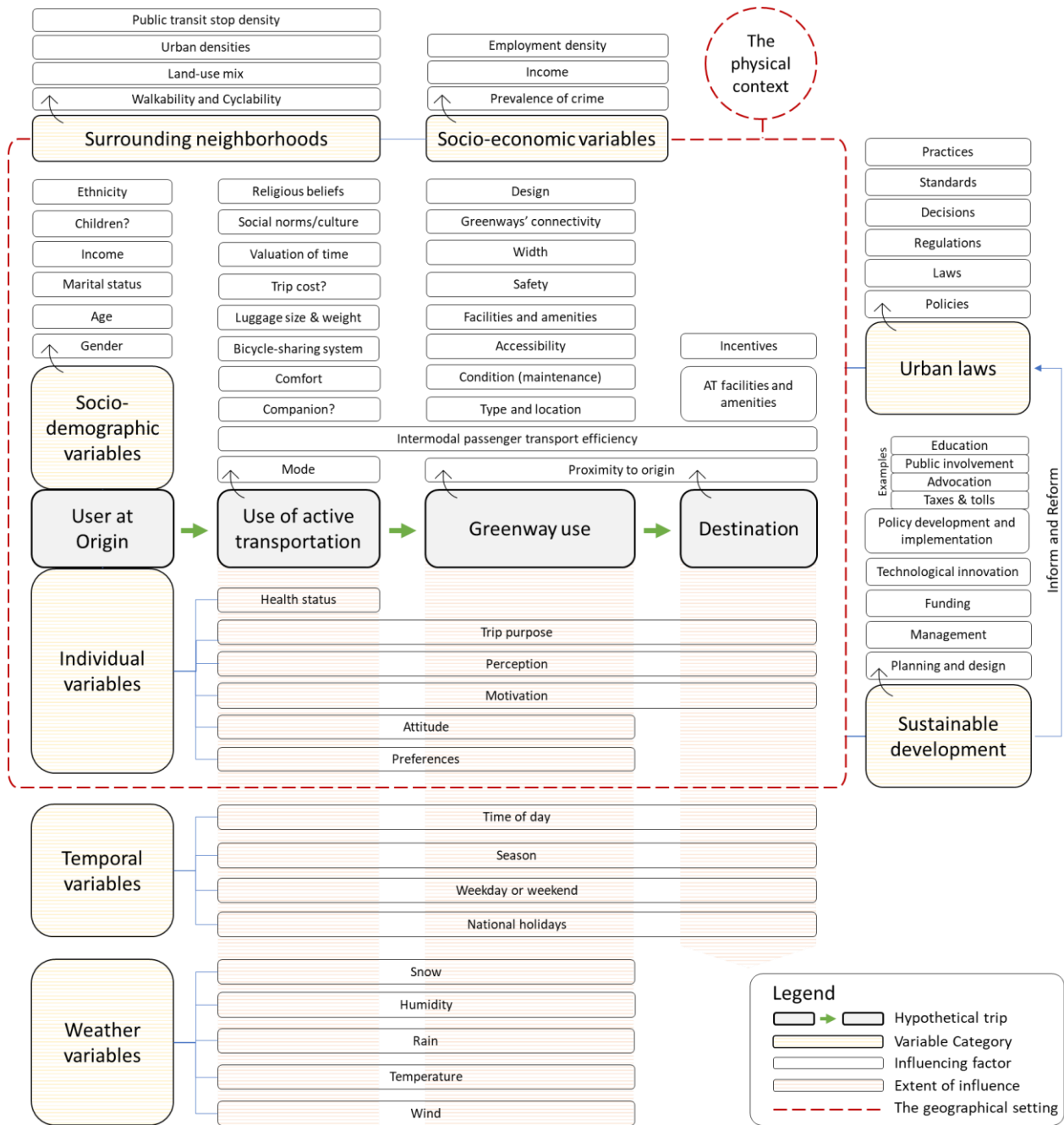


Figure 3. A comprehensive model of the factors influencing the use of greenways as active transportation corridors.

6. Discussion and conclusion: Activating the transportation function of Jeddah's greenways

Increasing the use of greenways for AT in SA is a significant planning, design and public policy challenge. This study illustrates a range of planning and design improvements that are required to improve greenway connectivity, quality and safety. Physical infrastructure change may not lead to behaviour change; however, given existing social-cultural factors and perceptions, and hence public policy initiatives are needed. The first challenge is converting non-users to users of greenways for AT, especially since the predominant physical inactivity in Saudi Arabia (80%) is due primarily to Saudi residents' lack of desire and time (The General Authority for Statistics 2019). Increasing arrivals to greenways via AT is advantageous since it has been evidenced to increase the likelihood of its use for transportation (Chen et al. 2019; Chi and Lin 2019; Wolff-Hughes et al. 2014). Incentive programs are needed to motivate all ages and abilities to lead an active lifestyle (e.g., education and installing end-of-trip bicycle facilities). Next, since almost a quarter of Saudi residents are obese (Althumiri et al. 2021), the lack of physical fitness can be a barrier to active commuting for many people (Wolch et al. 2010). Improving law enforcement to prevent misconduct may address safety. Finally, maximising greenways potential in SA must also redefine its definition, typology, and values by learning from global experiences and best practices while setting minimum requirements regarding the quality, project program, and range of services and facilities of each greenway type.

Activating the transportation function of greenways in an automobile-dependent city like Jeddah requires multidimensional changes, leading to sustainable urban transformation. First, change must follow a systems-thinking approach (Abson et al. 2017). In other words, the greenway use and development challenges mentioned earlier must be addressed comprehensively, collaboratively with stakeholders, and simultaneously rather than discrete tasks. Thus, it is vital to understand the dynamic interrelationships of the different elements that shaped those challenges and the extent of their impact. Second, change must consider how knowledge is produced, shared, and used for building a greenway network for AT, which substantiates the role of research and development. Inclusion of residents' perspectives in addition to expert voices is critical here. Third, change must start small by phasing in change gradually. It is a vital experimentation strategy to build a greenway constituency, minimise both challenges and risks, and evaluate implemented measures (Flink and Searns 1993). Fourth, change must consider equity, diversity, and inclusion as a primary lens in its decisions to avoid gentrification and social segregation (Bopp et al. 2018). Fifth, change must be accompanied by a reformation of urban laws for creating walkable environments that enable AT via greenways (UN-Habitat 2016). Sixth, change must increase the capacity of institutional actors involved in planning for AT. Lastly, change must be a measured long-term commitment.

In conclusion, the success of activating the transportation function of greenways is not exclusively dependent on building AT infrastructure and physical networks; other social, cultural, legal, and contextual factors are also key. First is greenways' support and integration with planning initiatives (e.g., sustainable urban mobility, green infrastructure, and tourism plans). Second, greenways must gain public support from, e.g., helping businesses thrive, enabling active lifestyles, and furthering the cause of institutions and organisations involved in sustainable development. The third is greenways' ability to perform other functions (e.g., environmental protection) without conflicts. Fourth is greenways' attraction to people of all ages and abilities to actively commute to daily destinations. Considering all the attributes translates to more funds towards its development and maintenance, a vital component to greenways' realisation and sustainability.

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