

Influences on greenways usage for active transportation

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Abstract: Since the inception of the greenways' concept, transportation has been one of their inherent qualities. Nevertheless, journal articles from the past three decades reported negligible active transportation (AT) impact of many greenway investments worldwide. Simultaneously, an international empirical evidence base of greenways usage for AT has not yet been established. Therefore, this research aimed to identify and analyze the influences on greenways usage for AT via a systematic review of published peer-reviewed journal articles from 1991 until 2021. The review used protocols of the PRISMA Statement in reporting and meta-analysis. Via two levels of screening criteria, results identified 162 articles that focused on greenway users and 27 (out of 162) articles that had AT as a main part of their study. The review specified patterns in the characteristics, perceptions, and travel behaviors of active commuters via greenways, which differed from other user types. Differences in use were also affected by weather and temporal factors, greenways' location and characteristics, and contextual factors. Discussion of findings identified four study types of greenway usage, highlighted methodological concerns of systematic reviews in this field, characterized transportation-led greenways, proposed a conceptual framework that illustrates where and when greenways would be considered routes for daily commutes, and suggested future work directions. These results improve the understanding of greenways' usage, thereby informing their planning, design, and management to maximize their potential.

Citation: Zawawi, A.; Porter, N.; Ives, C. Influences on greenways usage for active transportation. *Sustainability*, **2023**, *15*, x. <https://doi.org/10.3390/xxxxx>

Academic Editor: Firstname Last-name

Received: date

Accepted: date

Published: date

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Keywords: Greenways; Active Transportation; Systematic Review; Travel Behavior; Linear Parks; Sustainable Urban Mobility; Physical Activity.

1. Introduction

This article revises and significantly extends the work published in the proceedings of the 1st Conference on Future Challenges in Sustainable Urban Planning & Territorial Management [1]. Active transportation (AT) is a form of physical activity [2] that primarily refers to walking and bicycling for commuting purposes (e.g., transporting goods or traveling to destinations) [3]. Greenways are key components of AT and green infrastructure [4]; thus, their multifunctionality contributes to many sustainability and quality-of-life agendas [5–11] (see Figure 1). For example, between 2008 and 2014, property values of 1,800 parcels within 152 m of a 13 km cultural trail in Indianapolis, Indiana, increased by 148%, translating to 1.013 billion USD [12]. These financial returns are substantial, considering the \$63 million total cost. This cultural trail is an example documented by the Indiana University Public Policy Institute, linking investments in AT infrastructure to the quality of living enhancements and economic prosperity. Other studies worldwide also calculated the cost-benefit analysis of greenways [13–16]. Therefore, planning to increase the rate of AT (e.g., via greenways) extends beyond mobility since it contributes to the health, wealth, and sustainability of cities.

While acknowledging the ecological, cultural, and recreational values of greenways, their transportation value is the focus of this research. Many scholars have asserted the

transportation function of greenways in their definitions (see Table 1). Maximizing the numerous economic, public health, social, and environmental benefits of greenways is contingent upon increasing their usage [17]. In other words, high and multifunctional greenway usage contributes to realizing sustainable communities. The same principle can also be applied regarding the transportation usage of greenways. The more people rely on those mediums (i.e., greenways) to reach their daily destinations, the fewer cars on the streets, thus, healthier and more sustainable communities.

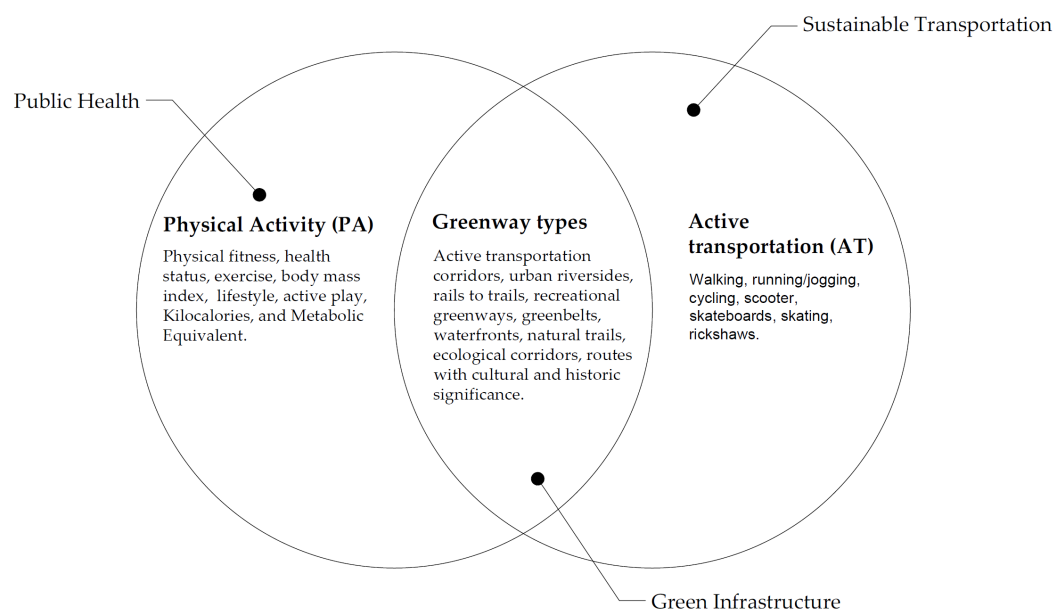


Figure 1. Relationship between greenway types, physical activity, and active transportation.

Table 1. Original and contemporary definitions of greenways. The underlined text shows where the transportation function of greenways was emphasized.

References	Definitions
(Little, 1990)	[18] "... It is any natural or landscaped <u>course for pedestrian or bicycle passage</u> . An open space connector, cultural features, or historic sites with each other and with populated areas. Locally, certain strip or linear parks designated as parkway or greenbelt."
(European Greenways Association, 2000)	[6] "Greenways are <u>communication routes reserved exclusively for non-motorized journeys</u> , developed in an integrated manner which enhances both the environment and quality of life of the surrounding area."
(Searns, 1995)	[19] "...The word 'way' implies movement, getting from here to there, from point to point. This is the important distinguishing feature of greenways—they are <u>routes of movement-for people</u> , for animals, for seeds, and, often, for water."
(Shafer et al. 2000)	[11] "Urban greenway trails ... provide places for daily recreation and <u>alternative transportation options</u> while encouraging positive face to face interaction with other people."
(Horte and Eisenman, 2020)	[20] "Urban greenways are linear public parks and places that <u>facilitate active travel</u> and recreation in urban areas."
(Turner, 2006)	[21] "...my 1996 definition ('a route which is good from an environmental point of view') ... retains my support, for the following reasons: ... making a <u>contribution to sustainable transport objectives</u> and other public goods."
(Senes et al., 2017)	[22] "We know that greenways are multi-user (cyclists, pedestrians, skaters, horseback riders, etc.) and multi-purpose (<u>commuting</u> , leisure and recreation, tourism, physical activity, etc.) trails and they are likely to be influenced by different factors."
(Lindsey et al., 2008)	[23] "Greenways are linear open spaces or parks ... that shape urban form and <u>connect people with places</u> . Urban greenways are often designed to include multi-use trails that provide opportunities for ... <u>transportation</u> ."

Many scholars argue that the ‘by-product’ of movement (the series of spaces that an individual traverses to access a location), regardless of whether initially or frequently, is more important than both the origin or destination of a travel journey to encourage pedestrian movement and support land uses [24]. Therefore, as more people commute via greenways (changing the pattern of movement over time), the more likely it will influence the pattern of land uses, increasing greenways’ accessibility in the process. Hence, well-planned and designed greenways can be seen as a gateway to influencing the land-use patterns that support automobile-dependent lifestyles. In conclusion, planning to increase commuters via greenways encompass influencing people’s travel behaviors and enhancing the places they traverse.

To enable the transportation function of greenways, many scholars introduced several approaches to integrating them with sustainable urban mobility plans (SUMP), including public transportation [4, 25–27]. These integration opportunities stem from the overlapping agendas between greenways and SUMP, such as enhancing livability and accessibility to live/work/play destinations. As Zawawi et al. (2020) discussed, overcoming automobile dependence via the adoption of SUMP provides land reclamation opportunities at multiple levels due to reduced vehicle ownership, parking needs, and road capacity [4]. These reclaimed lands in the form of, for instance, greenways would transform the mono-functional, abandoned, and underperforming city infrastructure into sustainable landscapes for nature and people [4]. Simultaneously, retrofitted streets to include greenways, known as road contraction schemes [28], contribute to (re)building a city’s green infrastructure [8, 29], serving as a foundational layer that structure and sustain urban redevelopment [30–32]. Examples of such a project type are the Comox-Helmcken Greenway in Vancouver, Canada [33–35], the neighborhood greenways of Portland, Oregon [36], and the transport greenways of Shenzhen, China [37]. In brief, as cities reclaim more of their valuable spaces that were once dedicated to the automobile infrastructure due to their increasing adoption of SUMP, greenways are posited as a vehicle for advancing sustainability and quality of life agendas.

Nonetheless, if facilitating active travel is an expected function or an intrinsic quality of greenways, why did many studies report meager commuting trips via greenways? [38–52]. Should all greenways function as active transportation corridors (ATCs) similarly? If not, what is causing the variation in using greenways as ATCs? (see the summarized answer in Subsection 4.6). What are the characteristics of transportation-led greenways or ATCs? (See the answer in Section 5). When would greenways be used for commuting purposes? (See the summarized answer in Subsection 4.6). What are the study types and data collection methods used to examine or measure the transportation usage of greenways? (See the answer in Subsections 3.2 and 3.3). Which countries contribute most to the existing literature about using greenways as ATCs? (See the summarized answer in Subsection 3.1). The answer to these questions contributes to the need for further research on the utilitarian usage of greenways [38]. Therefore, this research aimed to identify and analyze influences on using greenways as ATCs via a systematic review. Doing so enhances the understanding of active commuters’ perceptions, behaviors, and needs of greenways and how they differ from other user types. These results contribute to activating greenways’ function as facilitators of AT.

1.1 Theoretical framework

Several behavioral change theories and models, such as Schneider’s (2013) “*theory of routine mode choice decisions*,” Alfonzo’s (2005) “*Hierarchy of Walking Needs Within a Social-Ecological Framework*,” and Saelens et al. (2003) “*ecological model of neighborhood environment influence on walking and cycling*” explained that factors influencing people’s decision to walk or cycle are multidimensional [53–59]. It involves understanding complex interactions between personal (e.g., demographics and health), psychological (e.g., attitude and perceptions), behavioral (e.g., self-efficacy), situational (e.g., travel time and cost),

temporal (e.g., time of the day), sociocultural (e.g., community norms), regional (e.g., climate and topography), built environmental (e.g., safety, accessibility, and comfort), and policy factors (e.g., incentives and programs). These behavioral change theories can be understood within a larger theoretical framework of urban social-ecological-technological systems (SETS), whereby urban form and function are the product of intersecting natural, human, and technological phenomena [60]. In undertaking a review of urban mobility via greenways, it was, therefore, necessary to include literature from a wide range of disciplinary perspectives to ensure all these dimensions are included.

As such, the theoretical framework guided the systematic review to enhance the understanding of where and when greenways influence one's decision to travel actively for commuting purposes. Specifically, in addition to the systematic review results, behavioral change theories and models helped form connections between various factors and influenced the proposed conceptual framework (see Subsection 5.1). They also facilitated the identification of unexamined research areas that may inform the planning and management of greenways, including as ATCs. These contributions strengthen the foundation of knowledge about the AT function of greenways, enhance the accessibility of available evidence to decision-makers, and identify knowledge gaps in this field.

2. Method: Systematic review

To achieve the abovementioned goals, the authors conducted a systematic review using protocols of the 'Preferred Reporting Items for Systematic Review Recommendations' (PRISMA Statement) [61]. Even though using a systematic review to identify and analyze the influences on the use of greenways was a recent precedent work [62], to the best of the authors' knowledge, no review focused on their usage as ATCs.

2.1 Identification of studies

The identification of studies via databases about the usage and users of greenways from 1991 until June 2021 had two phases (see Figure 2). The search terms provided in Table 2 were used to identify the relevant articles in both phases. Moreover, studies were identified using Web of Science, Science Direct, and Scopus databases. Compared to Zawawi et al. (2022) [1], only journal articles were considered since they typically comprise full methodological details and results that permit a fair assessment of study bias, as required in the PRISMA 2020 checklist [61]. In addition, unlike the previous study [1], the presented systematic review included articles (in its first phase) that examined the economic, social, ecological, health, and economic impact of greenway usage. Such a wide scope offers the opportunity to comprehensively reflect on the greenway usage literature. The last difference between the current and the previous systematic review [1] is the inclusion of articles that primarily collected data from secondary sources. One of the lessons learned from the previous attempt is that numerous journal articles in the greenway usage literature relied on crowdsourced data, automated counters (data from secondary sources), and self-tracking applications such as Codoon, Strava, MapMyFitness, and more. Despite the advantages of primary source data, they are unfeasible in many cases in such a field. Additionally, the use of these technological advancements broadens research possibilities and could enhance scientific objectivity. Thus, the systematic review was repeated, yielding different results compared to the first attempt.

The database search in phase one had several search criteria. The term 'greenway' must be part of an article's title, abstract, or keywords. Furthermore, it must be a peer-reviewed journal article, written in English, and published between 1991 and June 2021 (added filters). These search terms resulted in 884 articles (a combined total of phase one).

Examining the reference list of recent literature reviews about greenways usage [20, 22, 62] revealed that the database search of phase one did not capture all relevant papers. These uncaptured articles mainly used trails as a synonym for greenways. Therefore, the second phase searched the Science Direct database using the term "trails or trail users"

and the same search filters used in phase one to capture other relevant articles, adding 242 articles. Therefore, identified studies from both phases totaled 1126 articles.

Despite these efforts, a comparison between the identified journal articles and recent literature reviews about greenways usage [20, 22, 62] revealed that such a measure (i.e., phase two) did not capture all relevant articles. Therefore, the snowballing process added a total of 27 articles.

Before the screening process, EndNote X9 was used to find duplicates in identified literature of both phases automatically. Such a method did not capture all duplicates. Thus, manual examination of duplicates was applied as well. As shown in Figure 2, phase one had 347 duplicates. The addition of phase two articles resulted in 57 duplicates, amounting to 405 articles in total for both phases (excluding nearly 36%). Microsoft Excel was used to organize and analyze results.

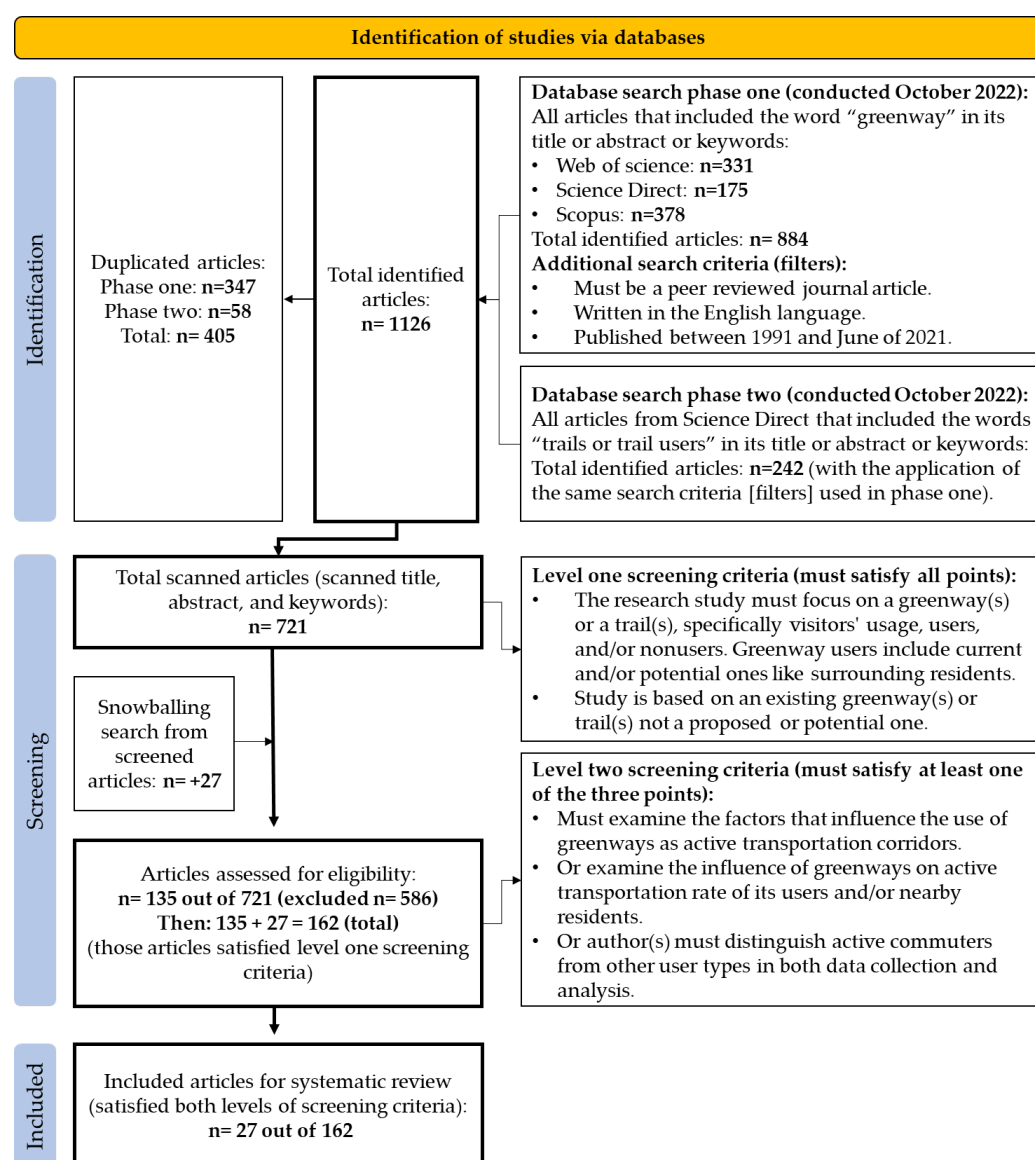


Figure 2. Systematic literature review flow diagram.

Table 2. Database search strategy.

Electronic database	Search terms (all conducted in early October 2022)	Results
Web of Science (Core collection)	Used the term "greenway" (via Clarivate) and filtered search results to only show journal articles written in English and published from 01/01/1991 until 30/06/2021.	331

Science Direct	Phase one: used the term “greenway” to identify articles with such a term in their title, abstract, or keywords. Search results were filtered to only show research articles written in English, published from 1991 until 2021.	175
	Phase two: used the term “trails or trail users” to identify articles with such a term in their title, abstract, or keywords. Search results were filtered exactly like in phase one.	242
Scopus	Used the term “greenway” in the search field, then limited the search results using the following Boolean term: TITLE-ABS-KEY (greenway) AND PUBYEAR > 1990 AND PUBYEAR < 2022 AND (LIMIT-TO (PUBSTAGE , “final”)) AND (LIMIT-TO (DOC-TYPE , “ar”)) AND (LIMIT-TO (LANGUAGE , “English”)) AND (LIMIT-TO (SRC-TYPE , “j”))	213
Total (includes duplicate articles from multiple databases)		1126
Snowballing of screened journal articles added 27 articles that satisfied the first screening criteria.		175
		176
2.2 Screening		177
Screening aimed to identify studies that had AT usage of greenways as a part of their data collection and analysis (see Figure 2). Therefore, two levels of screening criteria were used for articles that satisfied the search terms mentioned in Subsection 2.1. The first screening criteria level included articles that focused on usage and users of greenways. Additionally, the study must be based on an existing greenway, not a proposed or a potential one. Thus, studies that incorporated stakeholders’ preferences on a potential greenway development or plan were not included since it is outside the scope of this systematic review. The same applies to studies that aimed to analyze factors influencing AT usage because they are, in many cases, unfocused on greenways. To clarify, Li and Fan (2020) and Krizek et al. (2007) are two studies that examined the influences on cyclists’ travel route choices [63, 64]. Only the latter was included since it focused on the effect of an urban trail system on cyclists’ travel route choice. Thus, the latter study can be viewed as a subcategory of studies like Li and Fan (2020) that aimed to examine influences on bicycle usage. With that in mind, the authors successfully retrieved all articles sought for screening via the University of Nottingham’s institutional access and library. The extensive first-level screening included 135 out of 721 articles (586 were excluded). With the addition of articles identified via the snowballing method (n=27), the total became 162 articles. These 162 articles were classified based on greenway type, country, and region/city. Such an effort contributes to clarifying the state of existing literature about the usage and users of greenways internationally and improving access to available evidence to decision-makers and future research. The greenway typology used to differentiate between these articles was influenced by Horte and Eisenman (2020) [20]. They provided a detailed description of five urban greenway types. However, what is not part of their typology is a multi-setting greenway resulting from its scale, connecting rural to/from the urban context. Like those studied by [43, 65], greenways of such type are difficult to classify solely based on their landscape context. In other instances, many scholars examined several greenway types in a study. Thus, the multitype greenway(s) was added as a category, amounting to five greenway types used for this study. They are waterways, rail-to-trails, natural trails, active travel corridors (including freeway-to-greenway type), and multitype greenways. In short, as a result of the first screening criteria, all 162 articles were analyzed and categorized based on greenway type, country, and city. The second screening criteria applied to the 162 articles to ensure that an included one must satisfy at least one of three conditions. As shown in Figure 2, an included article must examine the factors that influence the use of greenways as ATCs; or examine the influence of greenways on AT rate of their users or nearby residents; or the collected data must distinguish commuters from other user types in both data collection and analysis. Thus, the second screening level required reading the aim(s), method(s), and result(s) of the 162 papers. Only 27 out of 162 articles satisfied the second screening criteria and were included for a detailed analysis to identify the influences on greenways usage as ATCs.		178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216

2.3 Analysis and synthesis of the included articles

To achieve the abovementioned goal, a review of the 27 articles identified greenway use forms and the factors influencing their usage. Forms of greenway usage were either reported by users (e.g., use purpose, frequency, and duration via a questionnaire) or calculated using measurement tools (e.g., pedestrian and cyclists' volumes using automated counters). Influencing factors were divided into socioeconomic and demographic influences; weather and temporal influences; environmental and accessibility influences; influences of greenway characteristics; and travel behavior and individual influences. Each variable category had multiple factors influencing the transportation function of greenways. The arrival of such an analysis framework resulted from synthesizing the identified greenway use forms and the factors influencing their usage as ATCs across the 27 articles.

The outcomes of the analysis process specified dependent variables (types or qualities of use) and independent ones (factors affecting their use) and their relationship for each of the 27 articles. However, the nature of influence, precisely the direction of correlation or affect size, was not specified in tables and diagrams (only text). Furthermore, presented results in Tables and diagrams indicated what was found to be an 'influencing' variable because an independent variable (e.g., age) can be a factor that increases or decreases the likelihood of greenway usage. Thus, it depends on the study type (e.g., comparison between two greenways), variable measurement, statistical models, and covariates. For example, age groups are not similarly affected by the factors (e.g., motivation) influencing their greenway use [38, 66]. Additionally, results varied according to differences in greenway types, locations, study objectives, time of year, and analytical methods, making it difficult to identify generalizable patterns. Therefore, to enhance the communication of results, tables, and diagrams presented in this article do not specify the nature of influence between the dependent and independent variables for the included 27 articles.

2.4 Risk of bias assessment

As shown in Table 4, all the included 27 articles utilized surveys (questionnaires and/or AT traffic counting) as a primary data collection method. Therefore, the risk of bias assessment of these studies used a tool adapted by Ravensbergen and El-Geneidy (2022) from the Effective Public Healthcare Panacea Project for survey-based research in urban planning [67]. Guidelines and evaluation criteria are provided in the article mentioned above. The leading author was the only assessor of the 27 articles.

The risk of bias assessment includes eight categories (see Table 5). Rating in each category comprises strong, moderate, weak, not applicable, and cannot tell. In addition, a total or global rate is based on the number of weak ratings. If an article had no weak rating in all eight categories, it would receive a "strong" global score; if it had one weak rating, it would receive a "moderate" global rating, and a "weak" global rating if it had two or more weak ratings. A limitation of such a tool is that it does not assess qualitative and non-survey methods, analysis, and results. Therefore, the risk of bias assessment for a few articles is incomprehensive and may not be suitable in a few other cases (n=2).

3. Results

3.1 Geographical location and greenway types of the included articles

As explained in section 2.2, the first screening level identified 162 articles about the usage and users of greenways, which were all classified based on their trail type and location (Appendix A, Table A1). This list showed that 61.3% of the identified 'greenway usage' literature is US-based. The second highest number of studies originated from China (8% or 13 studies), showing significant disparities among countries. The biased outcome toward US-based journal articles could be ascribed to the 'greenway' term's origin [68]. Another plausible explanation is the multiplicity of synonyms for the term greenway. Database search using such a term will never capture all relevant literature because, as identified by Hellmund and Smith (2006) [8], there are 30 synonyms for greenways

designations [8]. Such a number would multiply when considering other languages and resources. As a result, database search using additional greenway synonyms (e.g., linear parks or parkways or rail-trails), languages, and publication outlets (e.g., books, reports, and dissertations) in identifying studies about the use of greenways as ATCs will certainly yield unidentified literature. These unidentified studies could add, substantiate, or contradict offered inferences in this article.

Analysis of the 162 articles showed that 63 journals contribute to publishing greenway usage articles (See Appendix A, Table A2). Such a wide interest indicates the multidisciplinary nature of the greenway usage literature. Despite the wide variety and disciplines among these journals, there is a clear focus on topics related to landscape and urban planning, public health (especially physical activity), tourism, and transportation.

Analysis of the 27 articles identified patterns in their origin, research design, data collection method(s), and sources (see Tables 3 and 4). Like phase one findings, included phase two articles that had transportation usage or active commuters of greenways as a part of their study were mostly US-based (see Table 3). Expectedly, an analysis of 27 articles revealed that natural trails were not a greenway type examined by those studies. Such a finding affirms that the transport quality of greenways is likely in (sub)urban contexts.

Table 3. Articles that had the transportation function of greenways as a part of their study. Articles (1 to 10), colored orange, are active travel corridors, and articles (11 to 15), colored blue, are waterways, and articles (16 to 19), colored black, are rail-trails, and articles (20 to 27), colored green, are multipurpose greenways.

No.	Identified articles (phase two)		Country	Region/City
1	(Frank et al., 2021)	[34]	Canada	Vancouver
2	(Krizek and Johnson, 2007)	[69]	USA	Minneapolis and St. Paul
3	(Anderson et al., 2019)	[70]	USA	New Orleans, LA
4	(Auchincloss et al., 2019)	[71]	USA	Philadelphia, Pennsylvania
5	(Dill et al., 2014)	[72]	USA	Portland, Oregon
6	(Krizek et al., 2007)	[63]	USA	Minneapolis, Minnesota
7	(Taylor and Coutts, 2018)	[73]	USA	Metro Los Angeles, California
8	(Chang, 2020)	[74]	Taiwan	Taichung
9	(Fitzhugh et al., 2010)	[75]	USA	Knoxville TN
10	(Hirsch et al., 2017)	[76]	USA	Minneapolis, Minnesota
11	(Wolff-Hughes et al., 2014)	[47]	USA	Knoxville, TN
12	(Chi and Lin, 2019)	[77]	China	Guangzhou
13	(Shafer et al., 2000)	[11]	USA	Houston and Austin, TX
14	(Wolch et al., 2010)	[46]	USA	Chicago, Dallas, and Los Angeles
15	(Burbidge and Goulias, 2009)	[78]	USA	A suburb near Salt Lake City, Utah
16	(Sims-Gould et al., 2019)	[66]	Canada	Vancouver
17	(Evenson et al., 2005)	[39]	USA	Durham, North Carolina
18	(Gobster et al., 2017)	[79]	USA	Chicago
19	(Cook et al., 2016)	[80]	USA	Durham, North Carolina
20	(Jestico et al., 2017)	[65]	Canada	Greater Victoria region
21	(Chen et al., 2019)	[38]	USA	Greater Cincinnati region
22	(Zhao et al., 2019a)	[81]	USA	Seattle
23	(Ermagun et al., 2018b)	[82]	USA	Several cities
24	(Hankey et al., 2012)	[83]	USA	Minneapolis, MN
25	(Mundet and Coenders, 2010)	[43]	Spain	Girona and many others
26	(Lowry and Loh, 2017)	[84]	USA	Seattle, Washington
27	(Pettengill et al., 2012)	[51]	USA	Vermont, New Hampshire, and Maine

3.2 Study types of greenway usage

Results identified four study types of greenway usage. Analyzing how greenways are used includes the type of use, volumes, frequency, duration, time of visit, intensity, companion preferences, traveled distance, perceptions, attitude perceptions, and more. Methods to measure greenway usage include questionnaires, observations, Global Positioning System (GPS), self-tracking applications, automated and manual counters, interviews, accelerometers, and more.

With that in mind, the first study type focuses on examining the factors influencing the use of greenways. These factors are numerous, ranging from individual to environmental factors (Subsections 4.1 to 4.5 discusses them in detail). Furthermore, the greenway's proximity, accessibility, design, and condition are also factors that could influence greenway usage (see Subsections 4.3 and 4.4). The second study type concentrates on the effect of greenways' implementation or improvement or proximity on surrounding residents and business owners, including their attitude, physical activity, travel behavior (including route choice), social interactions, income, and financial benefits (e.g., travel and healthcare cost savings), and more.

The third study type examines greenway usage's environmental, health, social, ecological, transportation, and economic impact. For instance, tourism (e.g., measuring trail demand) and users' expenditures are frequently examined factors in studies about the economic impact of greenway usage [85-87]. The ecological impact of trail usage on wildlife, soils, and vegetation is another example of such a study type [88-90]. Even though the second and third types may sound similar, they are different. The former includes non-users and focuses on surrounding residents to the site of interest. However, the latter analyzes the impact of existing greenway usage (not users per se), which could be positive, negative, or neutral. The fourth study type voices stakeholders' concerns and assesses their satisfaction level to improve existing greenway conditions by analyzing their perceptions and preferences. These four study types were common in the greenway usage literature.

3.3 Research designs and methods of included articles

Research design (experimental, cross-sectional, longitudinal, case study, and comparative), methods, examined variables, data types, study location, and greenway type all add to the complexity of greenway usage studies. Analysis of the 162 journal articles showed that 31.5% of them studied multitype greenways (see Figure 3). Those studies examined greenways that traverse through multiple settings or studied two or more types of greenways. Additionally, ATCs and rail trails are mostly US-based studies (See Appendix A, Table A1).

Most of the 27 studies used quantitative research strategies. Furthermore, nearly 52% used cross-sectional research designs (see Table 4). Similar to Evenson et al. (2005) [39] and Wolff-Hughes et al. (2014) [47] conclusions, these results suggest a need for more qualitative research to study, for instance, the influence of trail sitting and design on their usage and users' perceptions. In addition, results show that comparative research designs were not used in the 27 articles. Considering how globalization influences the standardization of open space planning and designs, cross-cultural or cross-national studies may, for example, assess the transportation performance of greenways that share similar characteristics. Such an evidence gap could be considered a future research direction that assesses the applicability of greenway planning and designs in contexts of varying nationalities or cultures.

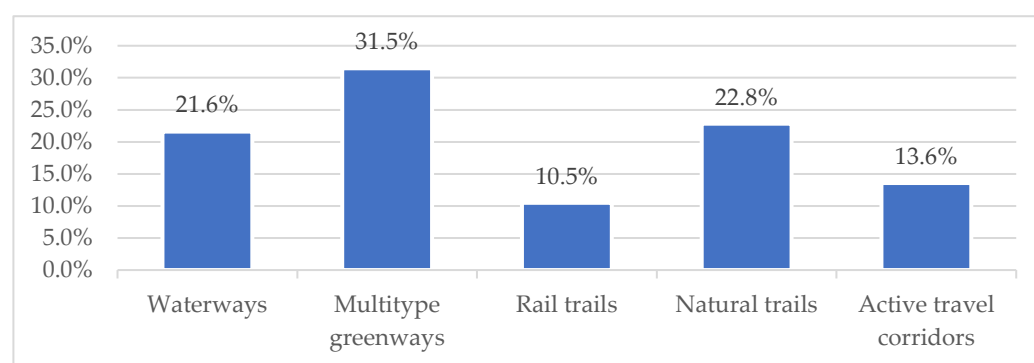


Figure 3. Studied greenway types in the 162 journal articles (phase one).

Table 4. Research design, data collection method(s) and sources, and survey sample size of the included articles in phase two (n=27).

N o.	Included articles (phase two)	RD. *	Data collection method(s) and sources (brief)	QNR sample size **
1	(Frank et al., 2021)	A	A questionnaire for surrounding residents of two neighborhoods (experimental and control groups) and a two-day travel diary (pre-post study).	524
2	(Krizek and Johnson, 2007)	B	Travel behavior inventory (survey) administered by the regional planning agency. Additionally, a 24-hour travel diary, interviews via phone calls, and GIS map layers from the Minnesota Dept. of Transportation.	1,653
3	(Anderson et al., 2019)	B	Intercept Survey, systematic observations, and ArcGIS 10.3.	122
4	(Auchincloss et al., 2019)	A	An intercept survey, systematic observations, and validated Path Environment Audit Tool. Secondary data collection sources were automated pedestrian and bicycle counts, census data, and crime incidents data.	165
5	(Dill et al., 2014)	A	A survey (via flyers & mail), accelerometers, and person-based GPS for treatment and control groups. GIS map layers and meteorological records were secondary data sources.	843 T.
6	(Krizek et al., 2007)	B	An intercept survey was administered by Hennepin County and ArcGIS.	1486
7	(Taylor and Coutts, 2018)	B	A Survey was sent to three schools nearby the greenway.	342
8	(Chang, 2020)	B	Onsite evaluations via the Environmental Assessment of Public Recreation Spaces (EAPRS) tool and onsite surveys.	769
9	(Fitzhugh et al., 2010)	A	Manual count survey of pedestrians, cyclists, and more pre-post greenway improvement (included intervention and Control Neighborhoods).	N/A
10	(Hirsch et al., 2017)	C	Collected data from the American Community Survey, historical maps, StreetMap Premium 2010 roads database, and Census Transportation and Planning Products for 116 tracts in Minneapolis, Minnesota.	N/A
11	(Wolff-Hughes et al., 2014)	B	Survey, infrared trail counters, and ArcGIS.	616
12	(Chi and Lin, 2019)	D	Two intercept survey at different months, observations (guided by post-occupancy evaluation method), and structured interviews	99
13	(Shafer et al., 2000)	B	Intercept survey in three greenways and mail-back questionnaire.	1004
14	(Wolch et al., 2010)	B	Survey of neighboring residents, assessment of trailside neighborhood characteristics for three (identified) different greenways, and census data.	490
15	(Burbidge and Goulas, 2009)	C	Three activity diaries were conducted at different times. Also, an intercept survey was conducted to identify factors that may hinder trail usage.	426 + 31 total
16	(Sims-Gould et al., 2019)	B	Questionnaire and semi-structured interviews for three schools and ArcGIS. Census data were collected as secondary data sources.	41
17	(Evenson et al., 2005)	A	A telephone survey and ArcGIS.	366

18	(Gobster et al., 2017)	C	Infrared counters and observations. Meteorological records and census data (American Community Survey) were used as secondary sources.	N/A
19	(Cook et al., 2016)	A	Intercept surveys and manual count of trail users for a pre-post-study.	3,546 T.
20	(Jestico et al., 2017)	B	Crowdsourced data from BikeMaps.org and observational data that includes manual counts for cyclists and motor vehicles at 32 intersections.	313 T.
21	(Chen et al., 2019)	B	Intercept survey results from two nonprofit organizations and data from several built environment variables were collected from multiple sources.	734
22	(Zhao et al., 2019a)	C	Automated counter data and meteorological records from several sources.	N/A
23	(Ermagun et al., 2018b)	C	Inductive loop and passive infrared sensors (automated traffic counters) and meteorological records from multiple sources.	N/A
24	(Hankey et al., 2012)	B	Collected non-motorized traffic counts and independent variables from several governmental, academic, and public sources.	N/A
25	(Mundet and Coenders, 2010)	B	A QNR (filled by the interviewer or self-administered by the participant).	1261
26	(Lowry and Loh, 2017)	D	A GIS tool and data were collected from the Puget Sound Regional Travel Study 2014 and the master plan by the Seattle Dept. of Transportation 2014.	N/A
27	(Pettengill et al., 2012)	B	On-site surveys in three different greenways.	841 T.

* Research designs (RD) are A: Experimental, B: Cross-sectional, C: Longitudinal, and D: case study.

** Sample size of questionnaires (QNR). AT traffic count data were assigned N/A. Total (T).

3.4 Risk of bias assessment results

Table 5 summarizes the risk of bias assessment for the included 27 articles. The global rating of all studies revealed that 44.4% were strong, 48.1% were moderate, and 7.4% were weak (See Figure 4). Examining the sample's representation of the target population and randomization of the study design were the primary reasons for the global "moderate" ratings. Articles with a "weak" global rating, specifically for Sims-Gould et al. (2019) and Pettengill et al. (2012), did not control well for confounders in addition to the two factors mentioned above. However, since these studies were mostly qualitative, the adopted assessment criteria may not be suitable despite using questionnaires. In addition, some studies used a questionnaire and AT traffic counting (e.g., Cook et al., 2016). In such cases, the risk of bias assessment considered both methods, especially in the data collection methods category, since the former is self-reported data, and the latter is measured data. Cells with a "cannot tell" rating were cases that had incomplete or inaccessible information (e.g., secondary survey data sources). In other cases, specifically, Jestico et al. (2017), the sample's representation (from crowdsourced data) of the targeted population is unknown.

Table 5. Risk of bias assessment for the included 27 articles.

No.	Journal Articles	Selection bias	Study design	Confounders	Blinding	Data-collection methods	Withdrawals and dropouts	Intervention integrity *	Analyses	Global rating
1	(Frank et al., 2021)	S	S	S	S	M	M	S	S	S
2	(Krizek and Johnson, 2007)	M	M	M	M	S	N/A	N/A	S	S
3	(Anderson et al., 2019)	M	W	M	M	S	N/A	N/A	S	M
4	(Auchincloss et al., 2019)	M	S	S	M	S	N/A	M	S	S
5	(Dill et al., 2014)	S	S	S	S	S	M	M	S	S
6	(Krizek et al., 2007)	C	W	M	M	M	N/A	N/A	S	M
7	(Taylor and Coutts, 2018)	M	W	M	M	M	N/A	N/A	S	M
8	(Chang, 2020)	S	W	M	M	M	N/A	N/A	S	M
9	(Fitzhugh et al., 2010)	N/A	S	S	N/A	S	N/A	M	S	S
10	(Hirsch et al., 2017)	M	M	M	M	S	C	S	S	S

11	(Wolff-Hughes et al., 2014)	C	W	M	M	S	N/A	N/A	S	M
12	(Chi and Lin, 2019)	W	M	M	M	M	N/A	N/A	S	M
13	(Shafer et al., 2000)	C	W	M	M	M	N/A	N/A	S	M
14	(Wolch et al., 2010)	M	W	M	M	M	N/A	N/A	S	M
15	(Burbidge and Goulias, 2009)	M	S	M	M	M	M	S	S	S
16	(Sims-Gould et al., 2019) **	W	W	W	M	M	N/A	N/A	M	W
17	(Evenson et al., 2005)	S	S	M	S	M	S	S	S	S
18	(Gobster et al., 2017)	M	M	M	N/A	S	N/A	N/A	S	S
19	(Cook et al., 2016)	C	M	W	M	S	N/A	M	M	M
20	(Jestico et al., 2017)	C	W	M	M	M	N/A	N/A	S	M
21	(Chen et al., 2019)	M	M	M	M	S	N/A	N/A	S	S
22	(Zhao et al., 2019a)	N/A	M	M	N/A	S	N/A	N/A	S	S
23	(Ermagun et al., 2018b)	N/A	M	M	N/A	S	N/A	N/A	S	S
24	(Hankey et al., 2012)	N/A	W	M	N/A	S	N/A	N/A	S	M
25	(Mundet and Coenders, 2010)	M	M	W	M	M	N/A	N/A	M	M
26	(Lowry and Loh, 2017)	M	M	W	M	S	N/A	N/A	M	M
27	(Pettengill et al., 2012) **	W	W	W	M	M	N/A	N/A	M	W

S: strong, M: moderate, W: weak, C: cannot tell, N/A: not applicable.

* Measuring the consistency of intervention exposure (i.e., greenway) in experimental studies was assessed based on calculating the distance from participants' home addresses to the constructed greenway(s). Such criterion was based on several studies that evidenced the influence of greenways proximity on physical activity and active travel.

** Qualitative studies (affected rating).

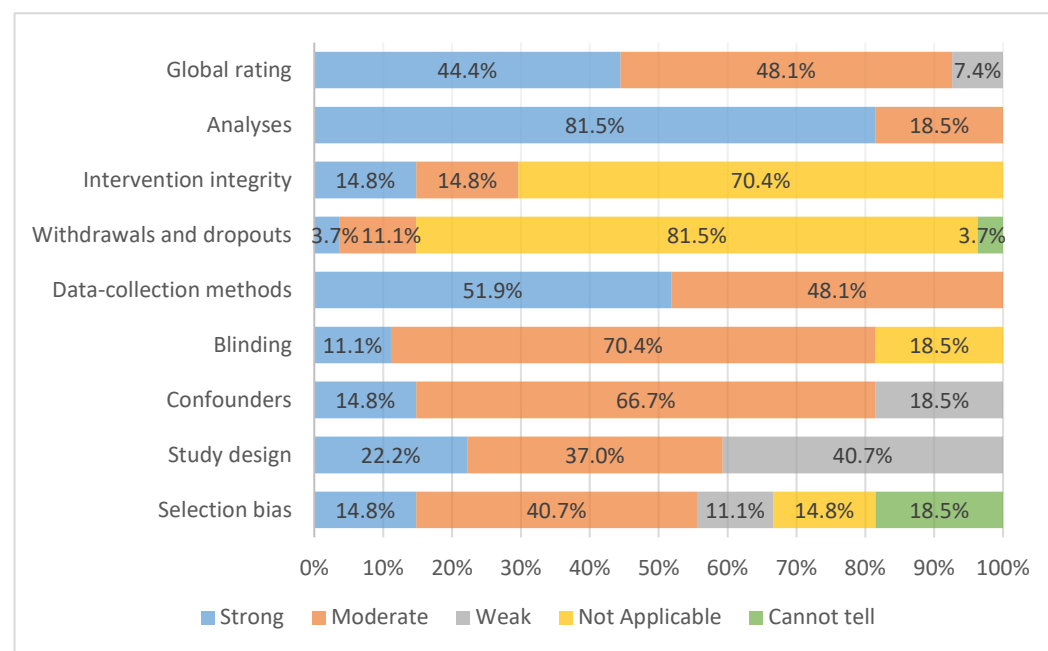


Figure 4. A summary of the risk of bias assessment.

3.5 Main variable categories

As shown in Figure 5, ten variable categories (or themes) were identified as influences on the transportation function of greenways based on the 27 articles. Variables (or codes) under each category (or theme) represent the factors examined by the 27 articles (left column). Senes et al. (2017) literature review of factors influencing greenway usage influenced the classification of the variable categories [22]. Figure 5 shows which variables were examined most, which were least examined, and which identified variables were statistically found influencing across the 27 articles. Furthermore, Figure 5 indicates which influences had a significant relationship, effect, or difference with a study's dependent

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4. Influences on greenways usage as active transportation corridors

4.1. Socioeconomic and demographic influences

Socioeconomic and demographic factors are the most examined variables compared to all other categories. By sheer number, gender, age, ethnicity, employment, income, and education are common factors examined by most of the 27 journal articles (See Figure 5). Nonetheless, few of them found those variables statistically significant factors in their influence on using greenways as ATCs. Analysis of their results revealed several patterns. Regarding gender, women are less likely to use greenways for transportation than men [38, 47, 69, 72, 74]. Women were also found to spend less time and travel shorter distances using active travel compared to men in a suburban area within Salt Lake City, Utah, post greenway construction [80].

The older the person (older than 40 in most cases), the less frequently they make utilitarian trips along greenways [34, 47, 63, 74, 77, 78]. These results could be supported by Hirsch et al. (2017) finding that the percentage increase of workers aged 18–34 between 2000 and 2010 in Knoxville, TN contributed significantly to the growth of bicycling for transportation [76]. The same could be applied to Hankey et al. (2012) finding that focused on Minneapolis, MN, residents over the age of 65 or under the age of 5. They found that a high percentage of those age groups did not affect pedestrian and bicycle traffic [83].

In terms of ethnicity, it is a non-significant factor in most cases except for Frank et al. (2021) and Hankey et al. (2012). The former concluded that being white increased individuals' likelihood of bicycling for transportation [34]. However, such a conclusion does not represent Vancouver's demographics since more than 75% of experimental and control groups were identified as white. The latter found that neighborhoods with high percentages of non-white residents reported higher bicycle traffic counts [83]. In conclusion, more research is needed to understand the influence of ethnicity on AT via greenways.

Except for Burbidge and Goulias (2009) and Hirsch et al. (2017), the remaining articles did not find employment status as an influencing factor in using greenways as ATCs. Employment was measured at both the individual and tract levels. At the individual level, Burbidge and Goulias (2009) found a significant correlation between employment and active travel post greenway construction, suggesting that employed participants were more likely to be active commuters. At the tract level, Hirsch et al. (2017) found that the increase in professional employment contributed to the increased cycling for transportation, but not necessarily via greenways. More research is needed to understand greenways' relationship with employment densities and status.

On another note, studies suggested that individuals with a median household income level are more likely to be utilitarian users of greenways [38, 46, 47, 83]. As for education, most studies did not find it an influencing factor, except a few suggested that higher educational attainment results in higher levels of trail use [46, 83] and bicycle commuting [76]. In short, utilitarian users of greenways are more likely to be educated young men (less than 40 years old) from a median household income.

Marital status and whether a household is with/without children influence the likelihood of using greenways as ATCs. Studies that considered these factors found that users who were never married are more likely to be utilitarian users of greenways [46, 47]. However, in terms of children, the results are inconclusive. Furthermore, single-parent households with children are less likely to use greenways for commuting [46]. Nevertheless, one study found that the odds of active travel trips for those close to greenways increase in households with children [69]. Aside from having or not having children, the likelihood of using greenways as ATCs increases with those who have never married.

Carsharing membership increased after the construction of the Comox Greenway in downtown Vancouver [34]. This result supported their conclusion of an increase in AT trips, especially for those who live within 300 m of the Comox Greenway. The same was found in a longitudinal study in West Valley City, Utah, a suburban area within Salt Lake City. Furthermore, post-greenway implementation, participants who hold a driver's

license and own one and more vehicles were significantly more likely to walk for transportation [78].

The last two less commonly examined variables that influence the use of greenways are social connectedness (qualitatively measured) and length of residency (see Figure 5). Most school students living near the Arbutus Greenway in Vancouver value its contribution to facilitating casual social encounters with friends and family while facilitating access to nearby destinations, especially food [66]. A study in Taichung, Taiwan, found a similar conclusion [74]. It also found that participants who had lived in the neighborhood longer were likelier to participate in AT. To conclude, greenways with accessible utilitarian opportunities can further increase the likelihood of social connectedness, which motivates their use as ATCs.

The remaining variables in the socioeconomic and demographic categories were less common and non-significant in their relationship or influence on using greenways as ATCs (see Figure 5). However, these variables were examined to characterize the study sample(s), support research findings, and facilitate future extension or comparisons of study outcomes. These variables are language, area of residence (street location), property ownership, vehicle ownership, bicycle ownership, homeownership, population density, and employment density, employment status. In short, not all the listed variables in Figure 5 were statistically tested to measure their influence on the propensity of using greenways as ATCs. Yet, they were important measures to contextualize and ground results.

4.2. Weather and temporal influences

Weather and time influence the use of greenways as ATCs (See Figure 5). Weather variables include air temperature, rain, humidity, snow, sunshine (daylight), sky cover, visibility, and wind. All those variables influence the transportation function of greenways except sky cover [79, 81-83]. Interestingly, weather variables can increase and decrease the use of greenways. For example, with temperature, rising greenway use rates were recorded between 4°C to 24°C to a plateau at about 27°C [79]. The same study found that anything below 4°C and above 32°C resulted in sharp drops in daily greenway use.

However, rain, humidity, wind, and snow negatively correlate with urban trail use [79, 81-83]. Rain affects walking and cycling at an hourly rate rather than aggregate daily level [81]. Moreover, according to the same study, even though rain is not an insurmountable barrier to greenway use, it negatively affects concurrent and anticipated active travelers by an hour earlier. Furthermore, rainfall delay's effect on active travel (e.g., trail surface) can last two to three hours, impacting weekday active travelers more severely than their weekend counterparts [81].

Depending on the geographical location, greenway type and location, trip purpose, day of the week, and mode of non-motorized transport, active travelers respond differently to temperature, rain, humidity, wind, and snow [82]. An example of geographical location's effect is the drop in bicyclists' demand on greenways by 179.8% in cold regions during the winter compared to the summer season [82]. Overall, the impacts of weather variables, while consistent in severe conditions, several studies recorded variations in greenway use under 'favorable conditions.'

As shown, weather variables cannot be disjointly discussed from temporal variables, which comprise the month (seasons), time of the day (hourly), weekday(end), and national holidays (See Figure 5). Utilitarian trips via greenways are affected by all temporal factors, as shown in Figure 5. Several studies found that AT via greenways usually occurs during weekdays [38, 43, 78, 81]. Moreover, those commuters are often more tolerant of weather impacts than weekend users whose trips are mostly recreational at an hourly level [38, 81]. Additionally, if bicyclists make a trip in the afternoon and on the weekend, they are likelier to make a 40% longer trip to include a greenway on their route [63]. The same study explained that such travel behavior results from fewer time constraints. As for federal holidays, one study reported that pedestrians' and bicyclists' demands are low

during those times, with variations depending on geographical location [82]. Moreover, holiday users' frequency of trips (including the utilitarian ones) via greenways was among the lowest rates compared to other user profiles [43]. While considering the direct link between weather and temporal variables, the latter also impacts greenway use rate, including as ATCs, and travel behavior.

4.3. Contextual influences

Depending on a study's objectives, most scholars (in the 27 articles) incorporated many contextual variables to represent and explain causal effects found in their studies objectively. Due to typical time, money, and data constraints in scientific research, scholars usually select a few environmental measures as a baseline that facilitates the replication, extension, and comparison with similar studies, especially in other geographical locations. Therefore, due to the complexity and multiplicity of the environmental factors that influence the use of greenways, many authors, such as Wolch et al. (2010) [46], concluded their research by specifying the variables best predict an outcome (i.e., the likelihood of active commuting via urban trails).

Variables under this subsection are more or less similar to those found in walkability and cyclability indices (e.g., Global Walkability index, Clean Air Asia Walkability and Cyclability index, and the Copenhagenize index). Such a conclusion substantiates the considerable impact of contextual factors on the use of greenways, especially as ATCs. The 27 articles examined contextual variables that included residences' proximity to nearby facilities, the number of jobs accessible by transit, intersection density, tract-level cycling infrastructure, and block lengths [38, 63, 65, 66, 69, 76, 83]. Other studies measured the proximity from home to utilitarian destinations, convenience (e.g., bicycle facilities at destination), and the safety of reaching the nearest greenway from participants' home addresses [73, 91]. Furthermore, Wolch et al. (2010) focused on the land-use mix, neighborhood vegetation cover, street connectivity, and accessibility barriers (i.e., railroads, rivers, and traffic) [46]. The measurement unit in all cases is different, ranging from physical measurements of neighborhood conditions to inquiring about residents' perceptions like Evenson, Herring, and Huston (2005) [39]. Additionally, they all focused on the physical features of the surrounding neighborhoods, not urban design qualities such as imageability, legibility, coherence, enclosure, transparency, and more. Since neighborhood walkability and cyclability variables were frequently examined among the 27 articles, the involvement of planning and design professionals/scholars was a common pattern.

While considering the observations mentioned above, the review of variables under this subsection was divided into three parts: environmental, accessibility, trail intersections, and vehicle traffic variables (See Figure 5):

The influence of the environmental variables on using greenways as ATCs was inconclusive in many cases. In many others, it was used to characterize the study area(s) objectively and function as supportive evidence. Several studies indicated that walkability and cyclability variables influence the use of greenways as ATCs [38, 46, 69, 83, 91]. Other scholars who focused on school students/adolescents did not predict the probability of using those urban trails for daily commutes [66, 73]. In addition, scholars such as Dill et al. (2014) measured the length of bike lanes, the number of crosswalks, the percentage of streets with sidewalks, and slopes greater than 4% within a ¼ mile to objectively describe environmental conditions of participating households [72]. The same applies to variables such as road characteristics and topography (not trail slope) since they were used to describe and compare study area conditions.

Many scholars examined land use mix's influence on greenways usage for transportation since it is a proxy for a neighborhood's walkability. For example, Wolch et al. (2010) found that land-use diversity and neighborhood vegetation cover is associated with an increased greenway use duration [46]. However, they concluded that it contradicted several other studies [23, 92]. That said, Hankey et al. (2012) found that one unit increase in

the land-use mix (The Entropy Index) increased bicycle traffic count by 85% [83]. Thus, the inconclusive results about the land use mix's effect on greenways usage for AT warrant further investigation.

The same inconclusive outcome holds with the perception of neighborhood safety (i.e., crime). Several authors found it negatively correlated with trail use and duration [39, 46, 71]. In contrast, Taylor and Coutts (2018) did not find it a factor that predicted students' likelihood of using greenways to go to school [73]. Moreover, Hankey et al. (2012) did not find that the average number of violent crimes per year in an area affects the pedestrian and bicycle traffic counts in Minneapolis, MN [83]. Therefore, there is no general agreement on the influence of neighborhood safety on greenways' usage for commuting purposes, thus, warranting further research.

Based on the review of the 27 articles (See Figure 5), greenways' distance from home is the most examined independent variable (aside from gender and age), assuming that most trips originate from a place of residence. Such an important measure changes how results are interpreted and later expanded or replicated in other geographical locations. On the one hand, several authors concluded that distance from home strongly influences the propensity to use urban trails as ATCs [46, 63, 66, 73, 91]. Additionally, proximity to a greenway increased the likelihood of active commuting [34, 69, 74]. Similarly, several studies found that the construction of greenways increased AT volumes and durations of surrounding neighborhoods [76, 80]. Such a percentage increase, like in the case of Hirsch et al. (2017), coincided with the construction of cycling infrastructure such as an off-road trail network [76]. On the other hand, several studies found that greenways' distance from residents' home addresses was a non-significant factor in neither using greenways as ATCs [47, 78] nor increasing the AT rate post-construction [39, 72, 93]. Such mixed results confirm that greenway's location, neighborhood walkability and cyclability, users' perceptions, and attitudes are other factors that play a major role in using greenways as ATCs.

Greenways' proximity to participants' residences was not the only factor in measuring its physical accessibility. Several studies reported that greenway's proximity and connectivity to utilitarian destinations, neighborhood retail, and many other urban facilities are significantly associated with their use as ATCs [11, 66, 69, 77, 83, 84, 91]. However, two studies found that the influence degree varies considerably between pedestrians and cyclists [69, 83]. For example, proximity to water bodies significantly influenced pedestrian traffic volumes, unlike bicyclists [83]. That said, proximity to an urban center [72, 83], public transit, and bicycle share services [38] were significantly associated with the increased utilitarian trips via greenways for pedestrians and bicyclists. While distance is the common denominator among all reviewed factors, few studies measured the influence of time spent reaching the nearest greenway from participants' home addresses on its utilitarian functionality. One out of two studies found it a statistically significant factor in using greenways to access daily commutes [77]. Contrastingly, Hankey et al. (2012) did not find that the number of jobs accessible by public transit affects pedestrian and bicycle traffic counts [83]. In conclusion, several studies found that greenways' proximity and connectivity to daily commutes, shops, public transit stops/stations, and bicycle share services significantly influenced the use of greenways as ATCs.

Despite the importance of greenways' proximity to home and daily commutes, studies have shown that people are willing to endure a slight increase in trip distance to benefit from commuting via greenways. For example, Krizek et al. (2007) found a positive relationship between the traveled distance on trails and the calculated difference in traveled distance between participants' chosen and shortest routes to the desired destination [63]. Furthermore, based on their study findings, there is an expected increase of 0.03% in the difference between the chosen and shortest route to the desired destination for every meter traveled along a greenway. So, if 1000 m was traveled along a greenway, there is an approximately 30% increase in taken trip distance compared to the shortest route to the desired destination. Though on average (1,486 trips of all types but mainly recreation), it is a 67% increase over the shortest route distance (approximately 4.21 km) [63]. These

average distances are 40% higher than Guttenplan and Patten's (1995) 3 km conclusion [91]. Those differences could be attributed to the higher percentages of urban trail commuters in Guttenplan and Patten's (1995) sample size. In addition, studies found statistically significant evidence that utilitarian users travel shorter distances (less than 3.21 km) on greenways than recreational users [38, 43]. Thus, the travel distance margin of increase is expected to be higher with recreational users compared to their utilitarian counterparts. To conclude, the greenways system and its associated (or perceived) benefits can affect active travel behavior.

Another aspect of urban trails' accessibility is their safety, partly discussed by the greenway's intersections (between trail-trail and trail-road) and vehicle traffic variable categories (See Figure 5). One study found that the frequency of reported cyclist-related accidents is higher at trail-road intersections than at trail-trail counterparts [65]. The same study found that cycling incidents are significantly associated with cycling and vehicle traffic volumes and trail sight distance. In addition, installing a rectangular rapid flash beacon (RRFB) did not make these intersections safer since it did not influence motorists' behavior to stop upon activation by active travelers [70]. Despite these alarming findings, street connectivity, which partially includes intersection density, was positively associated with the propensity of trail use as ATCs [46]. Furthermore, while trip distance is positively associated with the number of intersections, one study found that cyclists are willing to tolerate a route with more intersections for the benefit of using a greenway to reach the desired destination [63]. In conclusion, intersections to and at greenways are both a safety concern and the desired attribute to improve urban trails' accessibility; thus, its design and management elements are vital to mitigate its risks.

4.4. Influences of greenway characteristics and conditions

Greenways' location (i.e., urban or rural), dimensions (e.g., width), conditions (e.g., maintenance), safety (e.g., conflict among users), and provided amenities and facilities (e.g., toilets) are all factors that influence its use as ATCs [11, 38, 43, 46, 47, 51, 66, 71, 77, 82, 83, 91]. As concluded in the previous subsection, greenways' proximity and accessibility to residential areas and daily commutes are paramount to the success of their utilitarian function. Therefore, rural greenways (natural trails) and ones that are physically inaccessible from utilitarian opportunities are more likely to function as recreational and physical activity destinations [11, 38, 47, 51, 91]. Moreover, the geographical location was also found to cause significant variations between bicyclists' and pedestrians' volumes as they respond differently to weather conditions [81, 82]. The same applies to contextual factors. For example, Hankey et al. (2012) found that off-street trails had much larger bicycle traffic volumes than on-street facilities [83]. However, the same study also found that off-street trails did not affect pedestrian traffic volumes. Therefore, greenways' location can considerably limit their usability as ATCs, and such influence may vary between pedestrians and cyclists.

While greenways' dimensions can generally include several measurements, such as slope, most journal articles found its width to influence its utilitarian function. Furthermore, several journal articles found that greenways' width is associated with participants' perceived comfort and conflict among users [43, 66]. Moreover, white line separators were ineffective at mitigating such conflict [66]. Therefore, Guttenplan and Patten (1995) recommended a minimum width of 3 m and an optimum width of 4.6 m [91].

Several articles examined greenways' conditions, safety, facilities, and amenities by inquiring about users' perceptions. Greenways' conditions, mainly maintenance, were perceived as factors that affected users' preference to access daily destinations via urban trails [38, 43, 71]. Issues raised as safety concerns also stemmed from poorly maintained greenways. For example, poor illumination in a greenway can partially result from unmaintained lighting fixtures and dense vegetation, which lowers the sense of safety [66]. Safety concerns also come from user conflicts and vehicle traffic, poorly designed

crosswalks, congestion, social disorder (e.g., vandalism), and surface materials (e.g., suitability for commuter bikes). All these safety issues influenced greenway use as ATCs [11, 38, 43, 46, 66, 71, 91].

As for the facilities and amenities, the former can, in some cases, be seen as a barrier since the type of facilities in an area can affect how and when it is used [77]. Moreover, the provision of facilities (e.g., toilets, bicycle lane, parking, access to showers and dressing rooms at workplaces and schools, and more) and amenities (e.g., maps, phone charging stations, cross-signals, signage, trees, Wi-Fi hotspots, and more) were all perceived as influencing factors to the use of greenways as ATCs [43, 66, 71, 83, 91]. In contrast, greenways' aesthetic and natural quality (e.g., scenic views) did not influence their usage for transportation [74]. In short, users' perception of the quantity and quality of greenways' facilities and amenities and their sense of safety can affect the propensity of its usage for commuting purposes.

4.5. Travel behavior and individual influences

Based on the 27 articles (See Figure 5), examinations of travel behaviors mostly focus on ATCs (one of the greenway types). An explanation of such a study pattern is the expected high transportation impact of such a greenway type.

As previously discussed, variations in active travel behavior due to the proximity of a greenway is a key-dependent variable measured by several scholars (See Figure 5). However, the number and minutes of active commuter trips per day or week are not the only examined behaviors. Previous subsections also discussed traveled vs. shortest route distance to the desired destination, trip purpose, and motorists' behavior.

Another predictor of using greenways as ATCs is the mode of transport used to reach the perceived nearest greenway from participants' home addresses. Studies revealed that greenway arrivals via non-motorized modes of transport are more likely to use them as ATCs [38, 47, 77]. Aside from those measures, examinations of participants' travel behavior are partially used to characterize a study sample and support research findings. In short, travel behavior is a key indicator of the influence of greenways and a predictor of urban trails' usage as ATCs.

Intrinsic motivation to engage in active travel significantly predicted greenways' usage as ATCs [46]. Additionally, incentives influence motivations, especially ones from schools and employers. For example, employers' provision of shower facilities, bicycle parking, and more are associated with higher levels of commuters to work via greenways [91]. Since intrinsic motivations are a significant predictor of using greenways as ATCs, incentives from schools and employers could increase the rate of active commuters via urban trails.

The perception of users and nonusers of greenways is the most examined factor in the individual variable category. The perception of greenways' safety, comfort, accessibility, and more were all found as influencing factors in using greenways as ATCs [11, 38, 43, 46, 66, 71, 73, 77]. Amongst all variables, perceived safety and distance from a greenway in Wolch et al. (2010) case study increased the likelihood of converting nonusers to users by approximately 10% [46]. Studying the perception of nonusers may contribute to increasing greenway usage, including as ATCs.

Several case studies reported that the perception of utilitarian users could considerably differ from other user types. For example, in examining greenway's contribution to the quality of life, commuters' perceptions significantly differed from other user types [11]. Furthermore, commuters valued greenways' reduction of pollution, transportation costs, time spent to reach daily commutes, and providing alternatives to cars at a significantly higher level than other user groups. Another example is a study that found differences in the perception of greenway attractiveness and maintenance between recreational and utilitarian users. The former had a significantly low likelihood of agreeing that the Greater Cincinnati region trails were attractive and well-maintained [38]. In conclusion,

even though not all 27 articles applied a stratified analysis of users' perception based on greenway use purpose, those who analyzed their findings via such a method found noticeable differences among their user types, which asserts the variations of users' priorities and needs.

Another form of examining individual variables was via greenway users' attitudes, especially regarding active travel via urban trails. One study found that those with a positive attitude towards walking and bicycling were likelier to use greenways as ATCs [72]. Such findings can be linked to discussions about intrinsic motivation. Residents' attitudes were also linked to their accessibility to utilitarian destinations via greenways. Lowry and Loh (2017) explained in a case study of Seattle, Washington, that cyclist types in terms of their stress tolerance levels, are significantly affected by the type, characteristics, and connectivity of bicycle networks, thereby, accessibility to utilitarian destinations [84]. In short, attitudes towards active travel can predict the probability of using greenways as ATCs.

Simultaneously, several studies manifested the differences among user groups. Chen et al. (2019) found that recreational users were less likely to agree about commuting via greenways even if on-street connectivity with trails was enhanced [38]. A study of the Girona greenways in Spain also found significant differences between greenway user profiles. The calculated percentages showed significant proportion differences between commuters and other user profiles seeking restaurants/bars/cafes, accommodation, transport, and shops [43]. These differences affirm the varying needs of different greenway user groups, including active commuters.

The last two individual variables are the rate of moderate to vigorous physical activity (MVPA) and physical activity (PA) indicators (e.g., metabolic equivalent and Body mass index). These variables are health-focused, and healthy individuals are more likely to be commuters via greenways [46] (Wolch et al., 2010). Interestingly, several studies found no increase in the rate of MVPA after building a new greenway [39, 71, 72]. In contrast, other studies reported increased MVPA after implementing a new greenway [33]. Therefore, the variation of MVPA before and after implementing a greenway is inconclusive. Another way to analyze MVPA was by comparing users from two greenway design types. While using METs as a unit of measure, one study found that users of linear greenway forms expended more energy than the loop variant (medians: 630 vs. 569 MET-min-wk-1) [47]. Aside from those measurements, BMI was used to characterize the study sample. In short, while an increase in MVPA due to implementing a new greenway is inconclusive, health-related measures were important indicators of the probability of commuting via urban trails.

4.6 Summary

Based on the review of the 27 articles, active commuters via greenways have an increased likelihood of being younger than 40 years old, educated, never married, and from the middle class. They also have intrinsic motivation and a positive attitude towards active travel, which incentives such as end-of-trip bicycle facilities could influence them.

Active commuters' trips via greenways are usually made daily during weekdays, alone, and with less time spent on greenways, especially when compared to recreational uses. While both user types tolerate a slight increase in trip distance to benefit from greenway usage, active commuters' travel distance margin of increase is less than recreational users.

As for the factors affecting the transportation function of greenways, their location, weather, width, safety, maintenance, and available facilities were major influences. The same applies to the walkability and cyclability of their surrounding neighborhoods (including safety, comfort, and accessibility). Furthermore, greenway's proximity and connectivity to home addresses and other daily commutes (e.g., utilitarian and recreational facilities), specifically less than 400 m, significantly increased their usage as ATCs.

Therefore, greenway arrivals via non-motorized modes of transport were more likely to use them for commuting purposes.

5. Discussion

One of the major issues regarding identifying relevant literature was determining what is and is not a greenway in the urban context. As illustrated by Kullmann (2011), linear parks in cities can exist in several forms, and it usually involves a regeneration/restoration of underperforming and abandoned city infrastructure [94]. However, would all regeneration/restoration efforts automatically transform these streets and abandoned infrastructure into greenways? Due to the overlapping agendas and characteristics between urban greenways (i.e., ATCs) and other policies and design approaches, such as complete streets, identifying urban greenway(s) projects and literature may lead to subjective interpretations that prevent a clear exchange of ideas and evidence-based research.

In addition to the intrinsic qualities of greenways [5], several scholars and city plans highlighted unique characteristics of transportation-led greenways or ATCs [20, 35–37, 95]. Unlike complete streets, where all modes of transport are made comfortable, safe, convenient, and accessible for all ages and abilities [96], ATCs prioritize active commuters in many respects. Primarily, such prioritization is achieved via the creation of quiet and slow streets, implementation of traffic-calming measures, provision of pedestrian and bicycle facilities and amenities, street vegetation, wayfinding signages, and linkages to recreational and utilitarian destinations. The highest level of prioritization would be to prevent automobile access for the majority or the entire day (via pedestrianization).

Another notable difference is that ATCs are not only about narrowing or reducing automobile traffic speeds and lanes to adding or widening sidewalks and cycle routes. Therefore, we are offering the following definition: ATCs or transportation-led greenways are designed or reclaimed transport infrastructure (due to their abandonment or underperformance) within (sub)urban areas that prioritize safety, comfort, and accessibility for active commuters while performing several functions such as placemaking and ecological services. Despite ATCs' multifunctionality, their high transportation impact (or value) differentiates them from other urban greenway types [37].

5.1 Proposed conceptual framework

A conceptual framework that synthesizes research findings and relates to existing behavioral change theories and conceptual frameworks was developed to enhance understanding of the factors influencing people's decision to walk or cycle for transportation via greenways (see Figure 6). Doing so also identified future research directions that may inform greenway planning and management, including as ATCs.

Before the use of greenways as ATCs, the systematic review results showed that an individual's health status, perception, preferences, motivations, and attitude towards walking and bicycling for transportation are significant influencing factors to their use for such purposes [11, 38, 43, 46, 77, 84]. However, concepts highlighted by the Social Cognitive Theory [56] were not considered in the most relevant literature (see Table 3). Concepts such as self-efficacy (confidence to perform the action and overcome barriers like bicycling along traffic), behavioral capability (knowledge and skill to AT), and observational learning (Behavioural acquisition via observing the activities and results of performing that behavior) can affect bicycling behavior [57]. Alfonzo's (2005) social-ecological framework explained that feasibility factors such as age, weight, physical mobility, time available, trip cost, responsibility for children, elderly, or other commitments could also affect one's decision to drive an automobile or walk [54]. Awareness and availability of AT modes (e.g., bicycle ownership) are positively related to bicycling [97]. Therefore, when considering walking or cycling for transportation as a behavior, individual factors can significantly influence that behavior.

Social support for AT, having a spouse or colleagues who actively travels, subjective norms for AT, and perceived support from an employer positively influence walking and cycling for transportation [57]. In the case of children, parents' schedules, attitudes, and participation in AT as well as perceptions of neighborhood safety and security, are among the factors influencing children's active commuting to school [57, 98]. Studies about the Sociocultural factors in SA revealed additional, yet crucial, dimensions that may affect AT, which include religious beliefs, perceptions of privacy, and social norms [27, 99, 100]. Alfonso (2005) classified these sociocultural factors as moderators at the group level, which are part of an individual's life cycle circumstances. Would the provision of greenways influence the attitudes of residents living in automobile-centric societies towards AT? In short, sociocultural factors are important considerations in understanding travel mode choice decisions.

Several theories and conceptual frameworks identified security, safety, accessibility, cost, comfort, and pleasurability of the built environment as influences on active commuting [53, 54, 57, 101]. These influences overlap with several walkability and bikeability theories and conceptual frameworks that relate urban form and design qualities to walking and bicycling behavior. These include, but are not limited to, Jeff Speck's General Theory of Walkability [102], Ewing and Handy's (2009) conceptual framework [103], and Saelens et al. (2003) ecological model of neighborhood environment [59]. As evidenced in Subsection 4.3, urban greenways located within walkable neighborhoods influence their usage for commuting purposes. Thus, their integration into, for instance, transportation plans to improve intermodal passenger transport efficiency could maximize their potential as ATCs.

Reforming urban laws to build healthy, equitable, resilient, safe, and walkable environments is an essential form of change to enable AT via greenways. According to the UN-Habitat (2016), urban law is *"the broad ranging collection of diverse policies, laws, decisions and practices that govern the management and development of the urban environment."* [104]. Urban management and development dimensions are important because several scholars argued that projects such as the High Line in New York, US, the Promenade Plantée in Paris, France, and the Atlanta BeltLine, in the US are drivers of gentrification and economic inequality (e.g., displacement of locals, small businesses, and industry) [105–109]. Therefore, urban laws are crucial to balance public and private interests when building a framework for implementing walkable and bikeable urban environments.

AT facilities (e.g., bicycle parking, shower/locker rooms), incentives, and support from workplaces/schools/municipal bodies influence active commuting to daily commutes [57, 91]. Advocacy for AT through political support, social media engagement in communication about their benefits, educational programs, community events, and more can increase participation in active commuting [110]. The review of the 27 articles showed who typically commutes via greenways and where, when, and with whom. Therefore, future studies may focus on who is not commuting via greenways (omitted selection) and how to address the challenges associated with such groups or conditions. Non-users of greenways are one of many stakeholders who may directly or indirectly be affected by the design and regulations of such facilities. For these reasons, stakeholders' participation in the research, planning, and management of greenways is vital.

The proposed framework in Figure 6 is based on existing travel behavior change theories, conceptual frameworks, and the systematic review results. As such, it contributes to enhancing the understanding of individual and environmental domains. Specifically, how they integrate and interact, responding to a need stressed by several scholars [111]. Unlike leisure walking and bicycling, active commuting (to work, school, delivery of goods, meeting a friend, and more) has a defined destination. Therefore, the proposed conceptual framework is built around a hypothetical trip with a defined origin and destination. In that framework, a person(s)' walking or cycling for transportation via greenways to access a desired destination is the dependent variable, which is similar to the most relevant literature (see Table 3). The rest of the factors are moderators (e.g.,

outdoor temperature) and independent variables (e.g., gender). The red dotted line represents the context in which the origin, destination, and route connecting both exist. In short, the presented conceptual framework builds an understanding of the influences on a person(s)' decision to incorporate greenways in their journey to daily commutes.

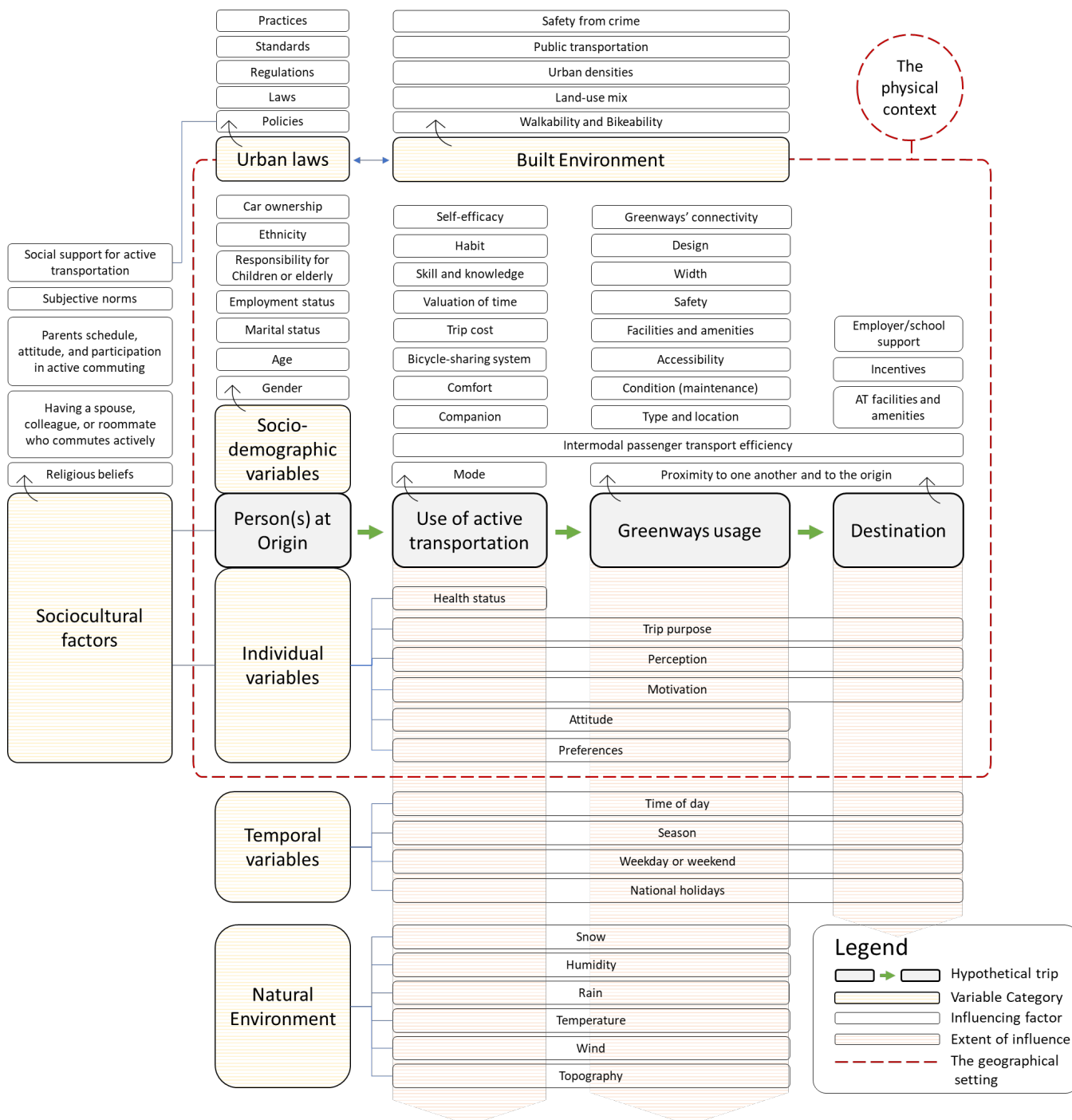


Figure 6. A conceptual framework that illustrates the influences on greenways usage as active transportation corridors. It is a developed version of the one published by Zawawi et al. (2022a; 2022b).

6. Conclusions

This research has evidenced that influences on the use of greenways as ATCs are multidimensional, transcending disciplinary boundaries. The two-level screening criteria in the systematic literature review identified 162 peer-reviewed journal articles that focused on greenways' use and users in its first level. Each of the 162 articles was categorized

based on their greenway type and location to facilitate access to available evidence for practitioners and academics in this field. The second screening criteria identified 27 articles that mainly had greenways usage for AT as a part of their study. Their review highlighted (I) the characteristics of active commuters via greenways, (II) the nature of their trips, and (III) the influences on the transportation function of greenways. These results emphasized the differences between active commuters via greenways and other user types regarding characteristics, perceptions, behaviors, and needs. Simultaneously, forming generalized patterns about commuters via greenways can be challenging due to the complexity and multidimensionality of the influencing factors.

Discussion of results identified four study types of greenway usage, highlighted methodological issues in literature reviews about the use of greenways, described the characteristics of ATCs or transportation-led greenways, proposed a conceptual framework that illustrates the influences on greenways usage as ATCs, and offered directions for future research in this field. The identified greenway usage literature was biased towards US-based journal articles due to the greenway term's origin, the multiplicity of synonyms, and the placed language and publication outlet limits in database search criteria. Furthermore, identifying urban greenway(s) projects and literature may result in subjective interpretations that inhibit clear communication of evidence-based research because ATCs and other policies and design approaches like complete streets have overlapping aims and characteristics. Therefore, to distinguish ATCs, a definition was proposed (See Section 5). In addition to the suggested future research directions in Sections 4 and 5, there is a need to (I) address the population gap in research about transportation usage of greenways (specifically, Middle East, Africa, and parts of Asia) and (II) examine the transportation impact of greenways using longitudinal and experimental studies that have objective AT behavior and physical activity measures.

An enhanced understanding of the influences on greenways' usage for transportation would increase their use, maximize their potential, and inform their planning, design, and management. Simultaneously, clarifying the state of existing literature about greenways' usage as ATCs helped identify knowledge gaps in this area, strengthen its knowledge base, and improve the accessibility of available evidence to decision-makers.

Author Contributions: Conceptualization, A.Z.; methodology, A.Z.; formal analysis, A.Z.; data curation, A.Z.; writing—original draft preparation, A.Z.; writing—review and editing, A.Z.; visualization, A.Z.; supervision, N.P., C.I.; project administration, A.Z.

Funding: This research received no external funding. However, the Editorial Office of the International Journal of Environmental Research and Public Health waived the open access article processing charge (APC). Therefore, the authors are thankful for the opportunity.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

6. Appendix A

Table A1. Articles that focused on the usage and users of greenways internationally (satisfied level one screening criteria). Articles (1 to 34) in blue are waterways, and articles (35 to 87) in green are multitype greenways. Articles (88 to 104), in black, are rail-to-trails, articles (105 to 141), in red, are natural trails, and articles (142 to 162), in orange, are active travel corridors.

No.	Identified articles (phase one)	Country	Region/City
1	(Coutts and Miles, 2017) [112]	USA	Southern Michigan
2	(Coutts, 2009) [113]	USA	Southern Michigan
3	(Chon and Shafer, 2009) [114]	USA	Houston and Austin, Texas

4	(Price et al., 2012a)	[115]	USA	Greenville County, South Carolina
5	(Lee et al., 2019)	[116]	USA	Austin and Houston, Texas
6	(Liu et al., 2018)	[117]	China	Guangzhou
7	(Wolff-Hughes et al., 2014)	[47]	USA	Knoxville, TN
8	(Gobster and Westphal, 2004)	[118]	USA	Chicago
9	(Chi and Lin, 2019)	[77]	China	Guangzhou
10	(Zhao et al., 2021)	[119]	China	Shanghai
11	(Wolff and Fitzhugh, 2011)	[120]	USA	Knoxville, Tennessee
12	(Shafer et al., 2000)	[11]	USA	Houston and Austin, TX
13	(Coutts, 2008)	[121]	USA	Lansing and Battle Creek, MI
14*	(Mowen et al., 1998)	[122]	USA	near Damascus, Virginia
15	(Reynolds et al., 2007)	[123]	USA	Chicago, Dallas, and Los Angeles
16	(Spruijt-Metz et al., 2010)	[124]	USA	Chicago, Dallas, and Los Angeles
17*	(Gordon et al., 2004)	[125]	USA	Monongalia County, West Virginia
18*	(Wolch et al., 2010)	[46]	USA	Chicago, Dallas, and Los Angeles
19	(Moore et al., 2012)	[126]	USA	Raleigh, North Carolina
20*	(Burbidge and Goulias, 2009)	[78]	USA	Suburban area within Salt Lake City, Utah
21*	(Yabes et al., 1997)	[127]	USA	Phoenix metropolitan area, Arizona
22	(Asakawa et al., 2004)	[128]	Japan	Sapporo
23	(Banister et al., 1992)	[129]	UK	Leeds and Liverpool
24	(Cleland et al., 2014)	[130]	Northern Ireland	The Connswater area of East Belfast
25	(Dallat et al., 2014)	[131]	Northern Ireland	The Connswater area of East Belfast
26	(Lee and Shafer, 2002)	[132]	USA	Houston, Texas
27	(Lee et al., 2020)	[133]	South Korea	Gwacheon
28	(Lindsey and Knaap, 1999)	[134]	USA	Indianapolis
29	(Pazin et al., 2016)	[135]	Brazil	Florianópolis
30	(Xie et al., 2021)	[136]	China	Wuhan
31	(Zhao et al., 2018)	[85]	China	Guangzhou
32	(West and Shores, 2011)	[137]	USA	Roanoke, Virginia
33	(Dorwart, 2015)	[138]	USA	Durham, North Carolina
34	(Burchfield et al., 2012)	[139]	USA	Knoxville, Tennessee
35	(West and Shores, 2015)	[140]	USA	Mecklenburg County, North Carolina
36	(Furuseth and Altman, 1991)	[141]	USA	Raleigh, North Carolina
37	(Bush, 2011)	[142]	USA	Cary, North Carolina
38	(Lindsey, 1999)	[41]	USA	Indianapolis, IN
39	(Mundet and Coenders, 2010)	[43]	Spain	Girona and many others
40	(Jestico et al., 2017)	[65]	Canada	Greater Victoria region
41	(Lindsey et al., 2008)	[23]	USA	Indianapolis, IN
42	(Zhao et al., 2019b)	[143]	China	Pearl River Delta
43	(Chen et al., 2017)	[144]	China	Shenzhen
44	(Liu et al., 2016a)	[145]	China	Shenzhen
45	(Lindsey et al., 2001)	[146]	USA	Indianapolis, IN
46	(Zhang et al., 2020a)	[147]	China	Maanshan
47	(Chen et al., 2019)	[38]	USA	Greater Cincinnati region
48*	(Larson et al., 2016)	[148]	USA	Atlanta, GA and San Antonio, TX
49	(Weber et al., 2017)	[149]	USA	Atlanta
50	(Palardy et al., 2018a)	[150]	USA	Atlanta
51	(Dilley et al., 2019)	[151]	USA	Winston-Salem, North Carolina
52	(Lindsey and Nguyen, 2004)	[42]	USA	Use of Greenway Trails in Indiana
53	(Keith et al., 2018)	[152]	USA	Atlanta, GA and San Antonio, TX
54	(Reichhart and Arnberger, 2010)	[153]	Austria	Vienna

55	(Deyo et al., 2014)	[154]	USA	Indian Country
56	(Schneider et al., 2021)	[155]	USA	Minnesota, Illinois, Texas, and Florida
57*	(Zhao et al., 2019a)	[81]	USA	Seattle
58*	(Wang et al., 2014)	[156]	USA	Minneapolis, Minnesota
59	(Lindsey et al., 2007)	[157]	USA	Indianapolis, Indiana
60	(P. Lindsey and Lindsey, 2004)	[158]	USA	Indianapolis, Indiana
61*	(Lindsey et al., 2006)	[92]	USA	Indianapolis, Indiana
62*	(Troped et al., 2009)	[45]	USA	West Lafayette, Indiana, and Columbia, South Carolina
63	(Hankey et al., 2012)	[83]	USA	Minneapolis, MN
64*	(Ermagun et al., 2018a)	[159]	USA	Several cities
65*	(Ermagun et al., 2018b)	[82]	USA	Several cities
66	(Gobster, 1995)	[40]	USA	Metropolitan Chicago
67	(Clark et al., 2014)	[160]	USA	Southern Nevada
68	(Götschi and Loh, 2017)	[161]	USA	Multiple locations
69	(He et al., 2021)	[162]	China	Wuhan
70	(Hess et al., 2020)	[48]	USA	Raleigh, NC
71	(Huh et al., 2015)	[49]	South Korea	Gangnam-gu, Seoul
72	(Keith and Boley, 2019)	[163]	USA	Atlanta, Georgia
73	(Kelley et al., 2016)	[164]	Ireland	Multiple locations
74	(Kil et al., 2014)	[165]	USA	Florida (multiple locations)
75	(Kyle et al., 2004)	[166]	USA	Multiple locations
76	(Langford et al., 2015)	[167]	USA	Tennessee, Knoxville
77	(Librett et al., 2006)	[168]	USA	nationwide
78	(Liu et al., 2016b)	[169]	China	Shenzhen
79	(Lowry and Loh, 2017)	[84]	USA	Seattle, Washington
80	(Lumsdon et al., 2004)	[50]	UK	Multiple locations north of England
81	(Moudon et al., 2005)	[170]	USA	King County, Washington
82	(Pettengill et al., 2012)	[171]	USA	Vermont, New Hampshire, and Maine
83	(Wang et al., 2004)	[172]	USA	Nebraska
84	(Zhang et al., 2020b)	[173]	China	Multiple locations
85	(Ermagun and Lindsey, 2016)	[86]	USA	Central Ohio
86	(Wu et al., 2018)	[174]	USA	Wake County, central North Carolina
87*	(Price et al., 2012b)	[175]	USA	Spartanburg, South Carolina
88*	(Anna et al., 2012)	[176]	USA	South Carolina
89	(Harris et al., 2021b)	[177]	USA	Chicago
90	(Sims-Gould et al., 2019)	[66]	Canada	Vancouver
91*	(Troped et al., 2001)	[178]	USA	Arlington, MA
92*	(Merom et al., 2003)	[179]	Australia	Western Sydney
93*	(Evenson et al., 2005)	[39]	USA	Durham, North Carolina
94*	(Hughey et al., 2016)	[180]	USA	Greenville County, South Carolina
95*	(Maslow et al., 2012)	[181]	USA	Spartanburg, South Carolina
96*	(Gobster et al., 2017)	[79]	USA	Chicago
97	(Palardy et al., 2018b)	[182]	USA	Atlanta
98*	(Sim et al., 2020)	[183]	USA	New York City, Chicago, and Farmville
99*	(Abildso et al., 2007)	[184]	USA	Morgantown, WV
100*	(Betz et al., 2003)	[185]	USA	North-east Georgia
101	(Cook et al., 2016)	[80]	USA	Durham, North Carolina
102	(Reed et al., 2011)	[52]	USA	Spartanburg County, South Carolina
103	(Beiler et al., 2015)	[87]	USA	Union County, Pennsylvania
104	(Verlič et al., 2015)	[186]	Slovenia	Ljubljana

105	(Hughey et al., 2015)	[187]	USA	Greenville, SC
106*	(Mieno et al., 2016)	[188]	Japan	Hokkaido
107	(Greer et al., 2017)	[189]	USA	San Diego, California
108	(Sever and Verbič, 2018)	[190]	Croatia	Zagreb
109	(Sever et al., 2018)	[191]	Croatia	Zagreb
110	(Peterson et al., 2018)	[192]	USA	Interstate trail (New York to Maine)
111	(Senes et al., 2017)	[22]	Italy	Trentino-Alto Adige and Lombardy
112	(Arnberger et al., 2010)	[193]	Japan and Austria	Sapporo and Vienna
113	(Arnberger et al., 2018)	[194]	Germany	Freyung-Grafenau and Regen
114	(Arnberger and Haider, 2005)	[195]	Austria	Vienna
115	(Arnberger et al., 2017)	[196]	USA	St. Paul/Minneapolis, Minnesota
116	(Evju et al., 2021)	[197]	Norway	Bergen and Lillehammer
117	(Fisher et al., 2018)	[198]	USA	western Washington
118	(Jackson et al., 2003)	[199]	Canada	British Columbia
119	(Koemle and Morawetz, 2016)	[200]	Austria	Vienna
120	(Korpilo et al., 2018)	[201]	Finland	Helsinki
121	(Neumann and Mason, 2019)	[202]	Canada	British Columbia and Alberta
122	(Neuvonen et al., 2010)	[203]	Finland	Multiple locations
123	(Norman and Pickering, 2019)	[204]	Australia	South East Queensland
124	(Pettebone et al., 2013)	[205]	USA	California
125	(MacBride-Stewart, 2019)	[206]	New Zealand and UK	Multiple locations
126	(Manton et al., 2016)	[207]	International	Focus on Ireland (County Mayo)
127	(Martin et al., 2018)	[88]	USA	San Marcos, Texas
128	(Meijles et al., 2014)	[208]	Netherlands	Provinces of Friesland and Drenthe
129	(Mirzaalian and Halpenny, 2021)	[209]	Canada	Alberta
130	(Monz and Kulmatiski, 2016)	[89]	USA	Multiple locations
131	(Pickering and Rossi, 2016)	[210]	Australia	south-eastern Queensland
132	(Rosa et al., 2020)	[211]	Australia	Perth
133	(Santos et al., 2016)	[212]	Portugal	Lisbon
134	(Sever and Verbič, 2019)	[213]	Croatia	Zagreb
135	(Sterl et al., 2008)	[90]	Austria	Vienna
136	(Janowsky and Becker, 2003)	[214]	Germany	Stuttgart
137	(Zajc and Berzelak, 2016)	[215]	Slovenia	Multiple locations
138	(Zhai et al., 2018)	[216]	China	Shanghai
139	(Christie et al., 2007)	[217]	Great Britain	Multiple locations
140	(Beeco et al., 2013)	[218]	USA	Clemson Experimental Forest, South Carolina
141	(Frank et al., 2021)	[34]	Canada	Vancouver
142	(Ngo et al., 2018)	[35]	Canada	Vancouver
143*	(Krizek and Johnson, 2007)	[69]	USA	Minneapolis and St. Paul
144	(Anderson et al., 2019)	[70]	USA	New Orleans, LA
145	(Akpınar, 2016)	[219]	Turkey	Aydın
146	(Auchincloss et al., 2019)	[71]	USA	Philadelphia, Pennsylvania
147	(Deenihan et al., 2013)	[220]	Ireland	Mayo, Ireland
148*	(Dill et al., 2014)	[72]	USA	Portland, Oregon
149	(Frank et al., 2019)	[33]	Canada	Vancouver
150*	(Krizek et al., 2007)	[63]	USA	Minneapolis, Minnesota
151	(Reed et al., 2004)	[221]	USA	Sumter, South Carolina
152	(Taylor and Coutts, 2018)	[73]	USA	Metro Los Angeles, California

153	(Beach et al., 2019)	[222]	USA	Maryville, TN and Alcoa, TN
154	(Chang, 2020)	[74]	Taiwan	Taichung
155	(Chang et al., 2020)	[223]	Taiwan	Taichung
156	(Korver-Glenn et al., 2017)	[224]	USA	Houston, Texas
157	(Liu and Chuang, 2018)	[225]	Taiwan	Taichung
158	(Fitzhugh et al., 2010)	[75]	USA	Knoxville TN
159	(Harris et al., 2018)	[226]	USA	Chicago
160	(Harris et al., 2020)	[227]	USA	Chicago
161	(Harris et al., 2021a)	[228]	USA	Chicago
162	(Hirsch et al., 2017)	[76]	USA	Minneapolis, Minnesota

* Added journal articles from snowballing screened articles (n=27).

Table A2. The number of articles (phase one) per journal (n=162).

Journal title	No. of articles	Journal title	No. of articles
<i>Landscape and Urban Planning</i>	23	<i>Journal of Park and Recreation Administration</i>	1
<i>Journal of Outdoor Recreation and Tourism</i>	11	<i>Environment and Planning A</i>	1
<i>Urban Forestry & Urban Greening</i>	10	<i>European Journal of Public Health</i>	1
<i>Journal of Physical Activity and Health</i>	8	<i>Journal of Aging and Physical Activity</i>	1
<i>Preventive Medicine</i>	8	<i>Journal of Sustainable Tourism</i>	1
<i>International Journal of Environmental Research and Public Health</i>	6	<i>Journal of Urban Design</i>	1
<i>Journal of Environmental Management</i>	6	<i>Professional Geographer</i>	1
<i>Transportation Research Record</i>	6	<i>Urban Studies</i>	1
<i>Transportation Research Part D: Transport and Environment</i>	5	<i>Ecosystem Services</i>	1
<i>Sustainability (Switzerland)</i>	4	<i>Journal of Regional Analysis and Policy</i>	1
<i>Journal for Nature Conservation</i>	4	<i>Frontiers in Psychology</i>	1
<i>Journal of Urban Planning and Development</i>	3	<i>International Review for Spatial Planning and Sustainable Development</i>	1
<i>Preventing Chronic Disease</i>	3	<i>Tourism Management</i>	1
<i>Journal of Urban Planning and Development</i>	3	<i>Data in Brief</i>	1
<i>American Journal of Preventive Medicine</i>	3	<i>Leisure Sciences</i>	1
<i>Journal of Leisure Research</i>	2	<i>Environment International</i>	1
<i>American Journal of Health Promotion</i>	2	<i>Urban Affairs Review</i>	1
<i>International Journal of Behavioral Nutrition and Physical Activity</i>	2	<i>American Journal of Health Behavior</i>	1
<i>Journal of the American Planning Association</i>	2	<i>Journal of Environmental Planning and Management</i>	1
<i>Health & Place</i>	2	<i>International Journal of Sustainable Transportation</i>	1
<i>Accident Analysis & Prevention</i>	2	<i>Journal of Forest Economics</i>	1
<i>Journal of Transport & Health</i>	2	<i>Applied Geography</i>	1
<i>Journal of Environmental Psychology</i>	2	<i>Transport Policy</i>	1
<i>Accident Analysis & Prevention</i>	2	<i>Transportation</i>	1
<i>Journal of Transport Geography</i>	2	<i>Cities & Health</i>	1
<i>Land Use Policy</i>	2	<i>Games for Health Journal</i>	1
<i>Environment and Behavior</i>	1	<i>Environmental Justice</i>	1
<i>Landscape Research</i>	1	<i>Forests</i>	1
<i>Journal of Community Health</i>	1	<i>Cities</i>	1
<i>Land</i>	1	<i>City and Community</i>	1
<i>Environment and Planning B: Planning and Design</i>	1	<i>Computers, Environment and Urban Systems</i>	1
<i>Tourism Planning and Development</i>	1		

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