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Evaluation of Urban Sustainability Based on Transportation and Green Spaces: The Case of Limassol, Cyprus

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Abstract: Promoting urban sustainability has been on the agenda of researchers, planners, and policymakers. This paper uses quantitative and qualitative approaches to evaluate the sustainability of the Cypriot city of Limassol through transportation and green spaces indicators. The quantitative approach relies on a geostatistical evaluation of six indicators to describe the transportation sector and the proximity and provision of urban green spaces. The qualitative approach is based on a questionnaire (N = 387) conducted in the city. Results showed that car trips represent more than 90% of the modal share, and around 90% of the city's transportation infrastructure is designed for cars. In terms of urban green spaces, only 5% of the areas with the highest population density are within 300 m of a green space > 2 ha. The questionnaire confirmed that 71% of the residents are not satisfied with the conditions provided by the city to walk and cycle, while 76% are not satisfied with the green spaces available in the city. This study contributes to informing planners and decision-makers about the need to promote walking, cycling, and greening policies to make Limassol and other similar cities more sustainable.

Keywords: urban sustainability; transportation; walking and cycling; urban green spaces; sustainable development

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1. Introduction

Around 75% of the European population live in urban areas, and estimates predict that the urban population will rise to around 84% by 2050 [1]. Cities are considered a leading cause of the world's natural resource depletion, creating environmental, social, and economic challenges. The problems associated with urbanization have drawn the attention of planners, decision-makers, and researchers worldwide to make cities more sustainable. The concept of sustainable development initially included in the Brundtland Commission Report (1987) is defined as a type of development which meets current needs without diminishing the ability of future generations to meet their own needs [2]. The need to make cities more sustainable has been recognized since the publication of that Report [3]. Urban spaces are inherently complex, and defining urban sustainability and sustainable urban development indicators is challenging due to the many entities and phenomena that interact in these spaces. Urban sustainability can be understood as an adaptive process of addressing environmental, social, economic, and governance issues in an integrated way [4].

Nonetheless, these dimensions are vague and open to a wide range of interpretations. The global sustainable development strategy, established by United Nations in 2015, clarified the meaning and the range of that issues. In particular, the Sustainable Development Goal (SDG) 11 focuses on making cities and human settlements inclusive, safe, resilient, and sustainable [5]. This SDG includes target goals and decision-making support to achieve urban sustainability.

Many authors have analyzed the various dimensions associated with urban sustainability to define and measure this concept more objectively [6]. The environmental dimension of urban sustainability is considered the most relevant and adopted dimension [2,6]. From an environmental perspective, urban sustainability focuses on air and water pollution, noise, biodiversity loss, urban green spaces (UGS), energy efficiency, non-car transportation, greenhouse gas emissions, and climate change [6]. As defined in the 2030 UN framework, sustainable transportation and UGS are two dimensions with significant influence on the environmental dimension of urban sustainability. In the case of SDG 11, target 2 specifies: "by 2030, provide access to safe, affordable, accessible, and sustainable transportation systems for all", while target 7 states: "by 2030, provide universal access to safe, inclusive and accessible, green, and public spaces" [5].

As highlighted by Thomas et al. [7], transportation has been one of the most prominent themes in urban sustainability due to its adverse environmental impacts, namely greenhouse gas (GHG) emissions, air pollution, and noise. In Europe, around 27% of GHG emissions came from the transportation sector, making it the second biggest source of GHG emissions after energy production [8]. Of these, 72% are produced by road transportation and, among road transportation, cars account for 61% of these emissions [9]. To achieve climate neutrality by 2050, the European Green Deal states that a 90% reduction in GHG emissions from transportation by 2050, concerning 1990, will be needed. Cars are also a major source of urban air pollutants, including particulate matter (PM), nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds [10]. For example, road transportation was the main source of NO_x, being responsible for 39% of these emissions [11]. Air pollution is considered by the World Health Organization (WHO) as the most hazardous type of pollution in urban areas, associated with many harmful health impacts, morbidities, and premature mortality [12]. Road traffic is also the biggest source of noise pollution in Europe, which according to the WHO, is the second most hazardous environmental problem. Around 100 million people are exposed to road traffic noise above the EU's threshold of 55 decibels for daily exposure [13]. Other environmental burdens associated with the intensive use of cars include traffic congestion, urban sprawl, habitat damage, and consumption of space [14]. The intensive use of the car is also a cause of sedentary lifestyles and physical inactivity, which are leading risk factors for various health problems and premature mortality [15].

Transitioning to more sustainable mobility is vital for increasing urban sustainability and minimizing the adverse impacts of cars' intensive use in daily trips. Sustainable mobility is a concept that aims for a modal shift towards more sustainable forms of mobility, including public transportation and active modes, such as walking and cycling [3,16,17]. In European cities, about 30% of the trips made by car are shorter than 3 km, and 50% are shorter than 5 km [18], thus, walking and cycling could replace many short car trips. It has been shown that bicycles are, in general, an efficient mode of transportation for distances from 4 to 7 km or 20 min of riding [19,20], while walking is, in general, more appropriate for short urban trips up to 0.8 km or 10 min of walking [20,21]. Public transportation, which usually involves active travel to and from stops, could be used for longer trips. Choosing a specific mode of transportation relies on various interconnected reasons (trip purpose and characteristics, socio-demographics, habits, status, etc.), but urban features often have a determinant role. This includes the provision of conducive environments for walking and cycling, such as safe, well-maintained, and appropriate sidewalks and cycling infrastructure and facilities [22,23], and efficient public transportation systems in terms of frequencies, schedules, spatial coverage, and commuting times [17].

On the other hand, UGS and green infrastructure, in general, have been widely associated with urban sustainability [3]. UGS can be defined as public and private open spaces covered by vegetation, which are directly or indirectly available for users, providing recreational and leisure functions [24]. Urban green infrastructure provides multiple environmental benefits with positive impacts on human physical and psychological health and well-being. This includes regulating the urban thermal balance, carbon sequestration, cleaning the air from pollutants, noise attenuation, and biodiversity preservation [25,26]. UGS can regulate urban environments via air cooling due to shade and evapotranspiration. This cooling effect helps decrease air temperature and the urban heat island effect, leading to important energy savings [27,28]. UGS can also capture and securely store carbon through biotic sequestration, which is important in climate change mitigation [29,30]. For example, Nowak et al. [30] estimated that urban trees in the USA store a total of 643.2 million tons of carbon, with a carbon sequestration rate of 3.06 tons/ha/year. UGS are also known for their role in cleaning the air by retaining, absorbing, and filtering some harmful gases to human health. It has been demonstrated that vegetation performs a sink function for significant quantities of health-damaging fine and ultra-fine particles, significantly reducing the concentration of PMs [31,32]. UGS have effectively reduced the concentrations of other air pollutants, such as CO, NO_2, SO_2, and O_3 [33,34]. Urban vegetation is also known for attenuating noise, namely from traffic. Green spaces are an alternative to artificial sound barriers due to the sound absorption properties of leaves and wooden parts of the plants, particularly at mid and high-frequency ranges [35]. This noise attenuation effect has been consistently demonstrated in various studies [35,36].

Further, UGS provide habitats to different species, increasing city biodiversity [37] whilst helping preserve soil and mitigating storm runoff [38]. In addition to the environmental benefits, UGS foster social interactions and provides recreational opportunities, bringing physical and mental health benefits [39,40]. For example, during the pandemic of COVID-19, Falco et al. [41] found that higher green space extension was associated with fewer contagions, hospitalizations, and deaths. The study by Akpinar [42] also shows that the availability of UGS is linked to increased levels of physical activity, which helps mitigate health problems associated with sedentary lifestyles.

In summary, transportation and UGS have a critical and complementary role in the environmental performance of urban sustainability. With this in mind, this paper evaluates the Cypriot city of Limassol's sustainability by focusing on these two critical dimensions. The evaluation includes a mixed approach, combining quantitative (geostatistical) and qualitative (questionnaire) analyses. Through six indicators, the quantitative analysis shows, at the most disaggregated level available, the modes of transportation for commuting, car ownership, the density of the transportation infrastructure, the proximity to public transportation, as well as the provision of UGS in terms of proximity to the residential areas and green space per capita. The qualitative analysis is based on a questionnaire (N = 387) conducted in the city to understand the residents' perceptions about their transportation habits, their view about the conditions for walking and cycling, and the green spaces available in the city. This study is part of a master's degree in Sustainable Built Environment at the University of Minho. The research aimed to answer two research questions: Q1: whether and to what extent Limassol is a city that promotes active transportation? Q2: whether and to what extent the availability of urban green spaces is enough in Limassol?

The rest of the paper is organized as follows: Section 2 describes the materials and methods adopted in this study. The results are presented in Section 3 and discussed in Section 4. Finally, Section 5 summarizes the main conclusions of this study.

2. Materials and Methods

2.1. Case Study

Located on the southern coast of Cyprus and with a population of approximately 136,000 inhabitants [43], Limassol is the island's second largest city. The port of Limassol is the main commercial port of Cyprus, and the city is one of the island's main industrial hubs and tourist destinations. Limassol experienced rapid growth after the Turkish invasion in the 1970s when thousands of Greek Cypriots from the North were forced to move to the South. With the invasion, the population of Limassol rose by 30%, and the city underwent a drastic urban change with the development of significant residential areas to accommodate the refugees [44,45]. The city started to sprawl significantly as these new residential areas were built in very peripheral areas due to the low soil cost and the lack of planning regulations. With refugees seeking affordable housing blocks, a general decline of the historical center of Limassol began after the war.

On the other hand, the rapid urban sprawl caused a propensity for ever-expanding the road network, which strongly encourages car usage [45]. Urban growth stretched west to east along the coast, expanding towards the north hills. Major urban redevelopments of the center and coastal areas took place between the 2000s and 2010s and included the port's regeneration, the rehabilitation of certain buildings, and the creation of some pedestrian areas, green areas, and corridors [45].

Limassol is an interesting case study to evaluate urban sustainability due to wider contemporary issues related to the insular condition, fast urban sprawl, increased industrial and commercial activity, rapid tourism growth, diverse urban characteristics (coastline, center, and fringes), and city center decline [46]. In addition, Cyprus has the target to reduce CO_2 emissions by 24% by 2030, compared to 2005 [47,48]. Around 30% of the island's carbon emissions come from the transportation sector and from these, 67% are released from road vehicles [48]. To decarbonize transportation, a shift from private vehicles to public transportation and active modes is necessary, namely in urban spaces, where 67% of the island population lives [49]. Therefore, this study may help Limassol and similar cities achieve greater urban sustainability by evaluating specific indicators and collecting resident opinions about active travel and UGS. This evaluation may help planners and decision-makers in adopting policies to improve urban sustainability.

2.2. Method and Data

In this study, the urban sustainability of Limassol is evaluated by performing quantitative and qualitative analysis. The first consists of a geostatistical evaluation using the most disaggregated data available to characterize the transportation sector and the city's proximity and provision of UGS. The indicators used to describe the transportation sector and its respective rationale are the following:

(i) Modal share: shows the percentage of people using a specific mode of transportation, including walking and cycling, by considering the total of all journeys taken. Modal share has been commonly used in transportation planning as an evaluator of mobility and as an indicator towards renewable and non-polluting sources of mobility [20,50].

(ii) Car passenger ownership: indicates the number of passenger cars (private motorized vehicles) per 1000 inhabitants. Car ownership is a widely used motorization indicator, which significantly influences the distance travelled by the given mode of transportation [51] and is known for preventing the use of other modes, including walking and cycling [20].

(iii) Density of transportation infrastructure: measures the total length of all types of transportation routes to the total area of the study area (km/ha), as well as the number of bicycle rental stations and public transportation stops/stations to the total area of the study area (n°/ha). This indicator reflects the existing transportation infrastructure endowment [52] and may also influence travel behavior. For example, it has been shown that high road density encourages car ownership and car trips [53].

(iv) Proximity to public transportation: measures the walking distance to access bus stops (Cyprus has no rail transport), as well as bicycle rental stations from any origin, such as residential buildings, schools, and shopping. As adopted in other studies, proximity was defined as a linear walking distance of 400 m to bus stops [54–56] and 300 m to access bicycle stations [57,58]. Previous studies have shown that, in general, longer distances are correlated with a lower probability of walking to access public transportation [54].

As UGS are strongly changeable in terms of their characteristics (size, type of vegetation, amenity uses, public/private, etc.), in this study, they were defined as the sum of all public urban green infrastructure, including urban parks (parks, pocket parks, botanical and heritage gardens), sports fields, recreational and urban gardening facilities (such as community gardens), greenways, and corridors, namely for cycling and walking [59]. The two indicators used to describe UGS and its respective rationale are as follows:

(i) Proximity to UGS: measures the accessibility to green spaces and considers the proximity of the population to green spaces. As adopted in previous studies [60–62] and following the recommendation of the WHO [63], the availability of green space was evaluated as the percentage of the population living within a 300 m linear distance, which corresponds to around 500 m on foot for an adult, to the boundary of a green space with at least 2 ha in size. This distance ensures the development of green and healthy cities as well as the active living of residents [63].

(ii) UGS per capita: measures the total average provision of UGS per capita (sq. m/inhabitant). Although strongly changeable from city to city, this metric has been widely used in the literature [64] and can be compared with the standard provision of green space per capita in other parts of southeastern Europe.

The objective indicators' evaluation is based on data extracted from travel surveys, census, previous publications, national/municipal databases, and open data sources, such as OpenStreetMap to obtain specific GIS data. For each main sustainability dimension, the respective data sources are listed, the methods used to analyze data are explained, and some indicators' performance is compared with the respective performance at the national and EU level.

The qualitative approach relies on a questionnaire (N = 378) administered to the residents to understand their perceptions and needs about the transportation options and UGS available in Limassol. The questionnaire consisted of a mix of single choice, multiple-choice, ranking, and open-ended questions divided into three main parts. The first aimed at collecting demographic data such as age, gender, and education level. The second part was about active transportation and included 13 questions. The intended goal was to understand the modal share of the surveyed population and examine their perceptions and habits about driving, the use of active modes of transportation in general, and about the conditions provided by the city to cycle and walk. Finally, the third part aimed at understanding how people perceive the provision and benefits of UGS, how frequently they visit these spaces, and what measures may encourage them to visit these spaces more regularly. This third part was composed of 10 questions.

The subsequent step consisted of defining a statistically significant sample of the population living in Limassol. The sample size was calculated through the widely used Cochran's formula shown in Equation (1):

$$n = \frac{\frac{z^2pq}{e^2}}{1 + \frac{1}{N}\left(\frac{z^2pq}{e^2} - 1\right)} \quad (1)$$

where n is the sample size, N is the population size, z is the critical value (1.96) for the 95% confidence level, p is the sample proportion (0.5), q is equal to 0.5 ($q = 1 - p$), and e is the margin of error (0.05).

As the population living in Limassol in 2018 was around 136,000 [43], a sample of 383 individuals is required. The last step of the work was the administration of the questionnaire. The questionnaire was created through Google Forms and was administered online in Greek. As Fonseca et al. [23] highlighted, online questionnaires made the survey accessible to more people, stimulating the participation of those with more extreme attitudes regarding the asked topics. The questionnaire was available via a link shared on multiple pages and social media platforms, such as the official Facebook page of Limassol, schools, and scouts groups, consisting of more than 50,000 members, with the majority (93%) being citizens of Limassol. The questionnaire was administered from August to November 2020. The option of an online questionnaire was justified by the pandemic of COVID-19, which reached Cyprus in March 2020, and by the need to disseminate the questionnaire.

3. Results

3.1. Quantitative Evaluation—Active Modes of Transport

The private car is the dominant means of transportation in Cyprus. Regarding modal share, car trips represent 85% of daily commuting in Cyprus, while the remaining modes have much lower shares (Figure 1A). Public transportation only represents 2% of the trips, while active modes correspond to 13% of the trips as follows: walking 12% and cycling 1% [65]. In Limassol, car trips represent 91.8% of the modal share, a percentage above the national average [47]. Limassol's general use of private cars is challenging due to excessive traffic congestion, extensive noise, high CO_2 emissions, and traffic accidents [66]. In turn, walking, cycling, and public transportation have very low shares of the total number of trips. Bus trips in the city only correspond to 1.8% of the modal share, leaving 5.7% for walking and 0.7% for cycling [47].

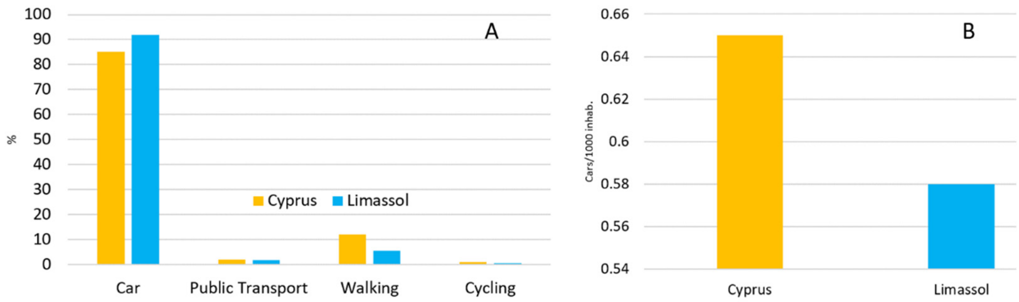

Figure 1. Modal share (**A**) and car ownership (**B**) in Cyprus and Limassol. Sources: [47,65,67].

Regarding car ownership, as shown in Figure 1B, Limassol has an index of 0.58, i.e., 580 cars per 1000 residents, which is lower than the national average (0.65) [47,67]. Cyprus has one of the highest vehicle ownership rates in the EU, and the number of passenger cars/inhabitants increased from 0.59 in 2016 to 0.65 in 2020 [67].

The density of the transportation infrastructure also indicates that Limassol was designed as a car-centric city. As shown in Figure 2, only 11% of the street network is for exclusive pedestrian use, while cycle lanes correspond to less than 2% of the street network. Around 88% of the street network was designed for cars, although many streets have sidewalks for pedestrian use. In addition, cycle lanes and pedestrian-only streets are not integrated into a comprehensive network. Many of the pedestrian and cycling infrastructure borders or are close to the coastline. Limassol has one bicycle sharing service in operation (Nextbike Cyprus). The study area has 41 active Nextbike Cyprus stations, most concentrated along the coastal promenade, around the Marina and tourist attractions and services in the city center. The average number of bicycle rental stations is low (0.008 stations/ha). The study area has around 400 bus stops and stations, corresponding to an average of 0.08 stops/ha. With the exception of the northern and southwestern parts, bus stops are relatively well distributed within the city.

Regarding the proximity to bus stops and bicycle stations, Figure 3 shows the catchment areas of 400 m to bus stops (A), the catchment areas of 300 m to bicycle rental stations (B), and the population density at the most disaggregated level currently available, which is the population in a 1 km square grid [43]. Considering that most people reach public transportation by foot and even transfers between different transports would be almost impossible without walking, the proximity to bus stops and bicycle stations is critical for using these modes.

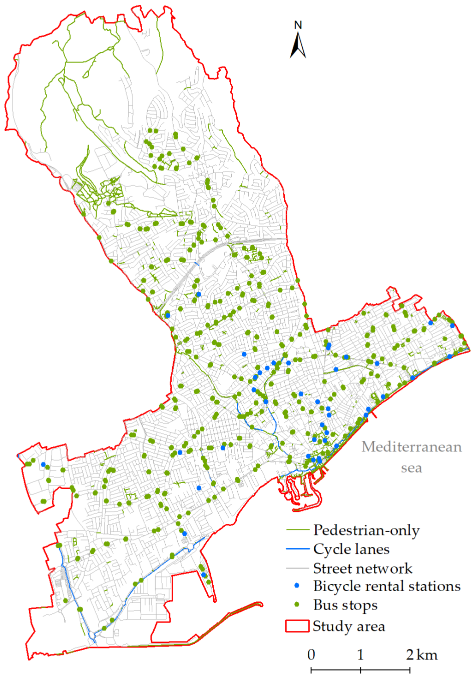

Figure 2. Transportation infrastructure in Limassol. Source: [68,69].

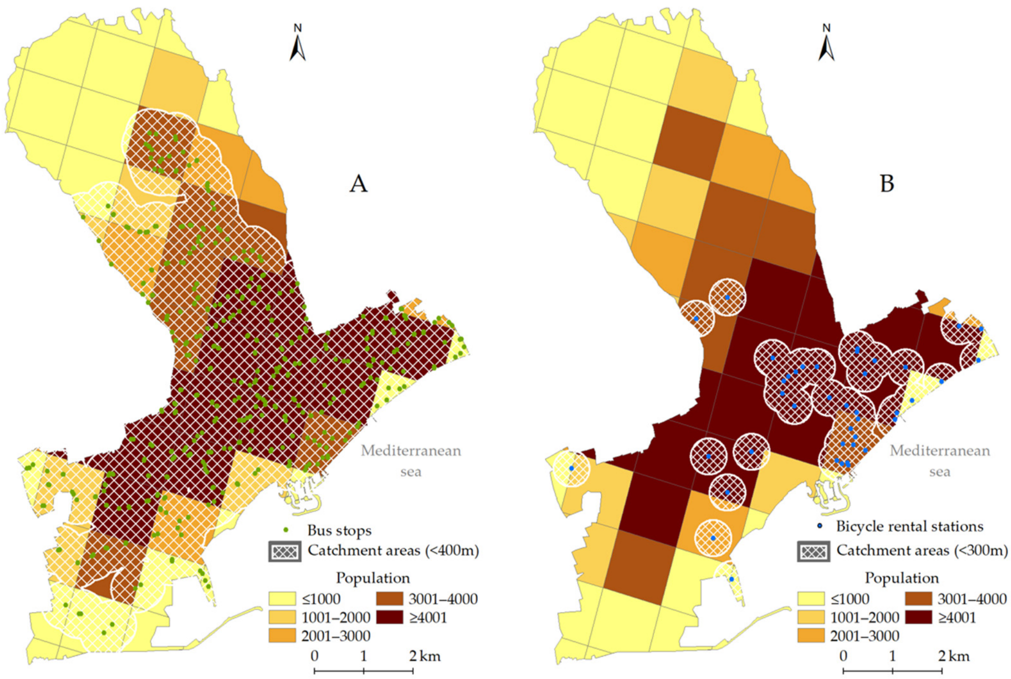

Figure 3. Proximity to bus stops (**A**) and bicycle rental stations (**B**). Source: [43,68,69].

The spatial analysis shows that 88% of the city is within 400 m of bus stops, including all the most densely populated areas. In turn, the proximity to bicycle rental stations is much lower as only 20% of the area is within 300 m of a station. The areas with greater proximity are those located around the Marina, along the coastal promenade and in some parts of the city center near tourist and leisure attractions.

3.2. Quantitative Evaluation—Urban Green Spaces

Regarding green infrastructure, Limassol has a total area of around 171 ha in the various typologies mentioned in Section 2.2. From these, only four UGS are greater than

2 ha: (i) the Polemidia National Forest Park (Figure 4, A), with 125 ha, it is the largest UGS of Limassol but has a peripheral location in the urban fringes; (ii) the Molos Lemesos (Figure 4, B), with around 10 ha, this multifunctional UGS is located in the seafront of Limassol, between the old port and the Olympion beach; (iii) the Limassol Municipal Garden (Figure 4, C), with around 10 ha, this UGS, which includes the refurbished zoo, is also located in the seafront of Limassol; and (iv) the linear park along the Garyllis river (Figure 4, D), which links the north sectors of the city with the center and the old port.

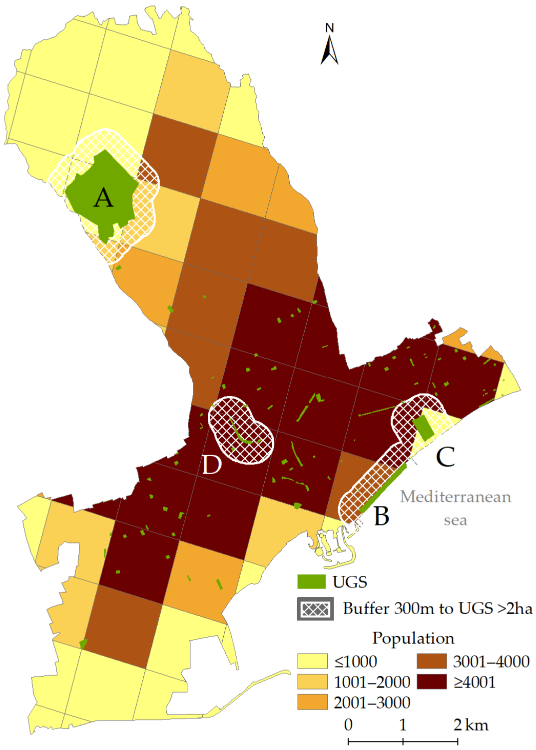

Figure 4. Urban green spaces and population density in Limassol. Sources: [43,68].

The spatial analysis showed that only around 12% of the area is covered by at least one UGS > 2 ha within 300 m. Further, only 13% of the areas with the highest residential density (>4001 inhabitant/grid) are within 300 m from a UGS > 2 ha. This is explained not only by the reduced number of UGS > 2 ha in the city but also by their peripheral location in relation to the most densely populated areas. In addition, the only UGS with at least 20 ha (the Polemidia National Forest Park) is, on average, three times more distant from the most populated areas than the recommended by the WHO for parks of this size, which is 2 km [63].

Finally, regarding UGS per capita and using the most recent disaggregated population data available [43], Limassol has an average of 12.6 sq. meters/inhabitant. This average value performs similarly to the observed in other Southern European cities [70], but hides the inequitable distribution of these spaces within the city.

3.3. Qualitative Evaluation

3.3.1. Sample Description

The qualitative evaluation was performed through a questionnaire administered in the city. The questionnaire resulted in a total of 387 valid responses. The number of collected responses was slightly greater than the minimum sample size required (383). As shown in Table 1, the majority of respondents were females (61%), belonging to the age group of 18–34 (58%), who had an undergraduate degree (67%).

Table 1. Sample description.

Variables	Attributes	Questionnaire		City	
		Total	%	Total	%
Gender	Female	236	61.0	52,579	52.1
	Male	151	39.0	48,421	47.9
Age	<18	18	4.7	20,916	20.7
	18–34	224	57.9	25,692	25.5
	35–54	110	28.4	28,705	28.4
	≥55	35	9.0	25,687	25.4
Education	Undergraduates	259	67.0	N.A.	-
	Graduates	128	33.0	N.A.	-

Source: [71].

The sample's sociodemographic characteristics do not differ much from the population living in Limassol in 2011 (there is no more recent disaggregated demographic data available) in some variables (people aging 35–54). However, there are deviations in some variables. For example, the elderly and young population are underrepresented, while females are overrepresented. These deviations are mostly explained by the difficulty in targeting specific groups with online questionnaires.

3.3.2. Qualitative Evaluation—Active Modes of Transport

Concerning travel habits, 95% of the participants in this study declared using a private car as the main mode of transportation. This percentage is above the car share observed in Cyprus (85%) and Limassol (92%). When asked about the average driving distance, a significant portion of the respondents (24%) were unaware of the distance travelled per year, while others reported the following average driving distances: <10 thousand km/year (31%), 10–15 thousand km/year (18%), 15–20 thousand km/year (12%), and >20 km thousand/year (15%). Aside from the intensive use of cars, 72% of the respondents were unaware that driving is expensive and unsustainable.

In addition to the very high driving habits, many respondents expressed their willingness to replace car trips with more sustainable modes. For example, in the age class 25–34 years old, 85% of regular car users expressed their willingness to switch to active transportation. When asked about specific actions that could reduce car trips in the city, 50% of the participants identified the provision of more efficient public transportation as the most promising measure. The city's low number of bus lanes, increased travel times, and the lack of online information about schedules and bus lanes were the main public transportation problems identified. Improving the conditions provided by the city to walk and cycle was also emphasized by 40% of the participants for their potential to reduce car trips. This includes several measures to make the city more pedestrian and bicycle-friendly, namely, creating more bicycle lanes and pedestrian routes. The remaining reported measures were more related to actions to discourage the daily use of cars, such as raising fuel taxes, adopting congestion taxes in some areas, and improving traffic control, among others.

According to the questionnaire, 71% of the participants claimed by an improvement of the general conditions to walk and cycle (Figure 5). When asked about specific actions, 65% of the respondents identified creating a network of well-connected pedestrian and cycle lanes as the most promising and needed measure to increase active travel. These respondents would like to have dedicated bicycle lanes and appropriate pedestrian routes connecting critical areas of the city (public transportation stations, main service areas, city center, etc.) to make walking and cycling more convenient and a viable alternative to cars. The need to plant more street trees for shading was the second most highlighted measure (15%). The need to improve traffic safety was pointed out as the third most important measure to encourage active travel. For 8% of the respondents, the city needs more efficient policies to prevent illegal car parking on streets and sidewalks and reduce traffic speed limits to create a safer environment to walk and cycle. As shown in Figure 5, around 13% of the subjects highlighted other reasons to increase the use of active modes, which include the provision of incentives to buy and use bicycles, better maintenance of pedestrian and bicycle routes, restricted car access to some parts of the city, among others.

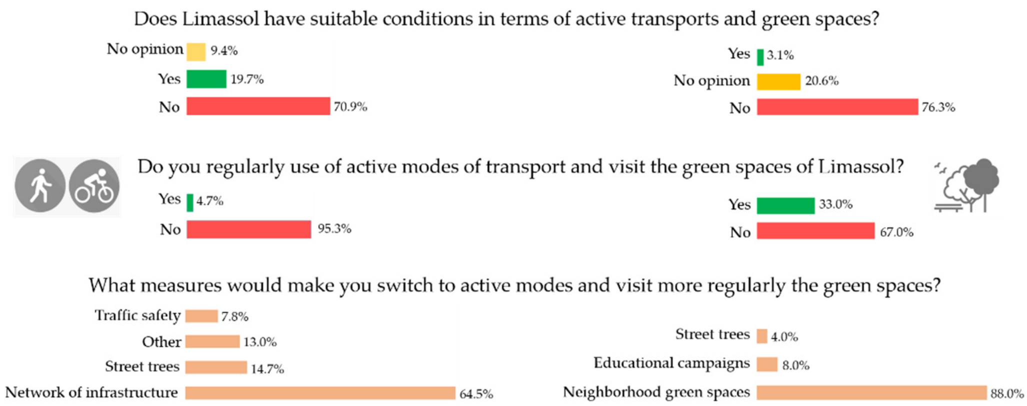

Figure 5. Main findings obtained from the questionnaire. Source: Questionnaire administered in Limassol (2020).

3.3.3. Qualitative Evaluation—Urban Green Spaces

According to the questionnaire, 95% of the subjects were aware of green spaces' environmental and social benefits (air quality, cooling effect, social interaction). However, when asked about their satisfaction with UGS, around 76% of participants expressed that they were dissatisfied or very dissatisfied with the provision of UGS in the city, while only 3% declared that green spaces were sufficient (Figure 5).

Regarding the proximity to UGS, around 86% of the participants said they lived at a distance greater than 500 m on foot from the nearby green space. From these, 97% would like a green space closer to their residential areas. When asked about the frequency of visiting these spaces, 33% of the participants said they never frequent UGS, while 34% only occasionally (monthly or less) visit these spaces. The remaining percentage is composed of daily and regular (weekly) visitors. The five most reported reasons to frequent these spaces were to relax (76%), to escape from daily routine (51%), to be closer to nature (50%), to undergo physical activity and exercise (48%), and to walk a dog (47%). When frequenting UGS, respondents declared to generally feel relaxed (86%), happy (57%), as well as safe and free (54%).

Drawing from the questionnaire results, 88% of the participants pointed out the creation of more urban parks as the action with more potential to increase the frequency of UGS and to alleviate environmental inequalities in accessing these spaces. Having nearby green spaces (within 500 m on foot) would significantly improve the frequency of these spaces. For the subjects involved in this study, travel distance was a significant barrier preventing a more regular frequency of UGS. In their view, creating more urban parks will reduce travel distances, improve accessibility, and encourage more people to visit these spaces. According to the questionnaire, the provision of nearby UGS (neighborhoods UGS) will increase the frequency of UGS up to 60% and reduce the proportion of non-visitors from 33% to only 1%. Respondents were generally available to help their local communities create neighborhood UGS. Other less mentioned actions with the potential to increase the frequency of UGS include educational and awareness campaigns to make evident why more green space is essential for the city and the need to plant more street trees to reinforce the overall urban green infrastructure.

4. Discussion

Active transportation and urban green infrastructure are two important components of urban ecosystems and are increasingly recognized as key to any urban planning policy focused on promoting urban sustainability and livability. The empirical study carried out in Limassol showed a poor sustainability performance on these two critical dimensions. The quantitative evaluation of the six selected indicators showed an unsustainable travel pattern and insufficient UGS provision. The qualitative evaluation showed that residents are very unsatisfied with the conditions provided for walking and cycling, as well as with the UGS available in the city. Therefore, the residents' perception matched the key findings obtained with the quantitative evaluation and provided additional evidence about some interventions that would make Limassol a more sustainable city.

Based on the described results, the first research questions (Q1: whether and to what extent Limassol is a city that promotes active transportation?) can be answered as follows. According to the quantitative and qualitative evaluations, Limassol is an automotive city that does not promote active transportation. Car trips represent 92% of the modal share in the city and 95% of transportation options for the people involved in this study. The share of active travel in Limassol (and Cyprus) is much lower than the EU average. For example, in the EU, cycling has a modal share of around 8% [72], while the walking share in 10 EU countries ranged from 15% in Sweden to 26% in the UK [73]. Car dependency has grown significantly in Cyprus over the past decades, and car ownership increased by 12% from 2009–2018 [74], making Cyprus the third EU country with the highest car ownership rate [75]. This high car ownership rate results in the intense use of private cars for everyday travel, which ensures more than 80% of the total transportation in Cyprus, measured in passenger-kilometers [75,76]. According to Papaioannou et al. [74], cars are highly used in Cyprus for various reasons, including relatively high disposable income, low taxation on vehicle acquisition, low fuel cost, and low/absence of car parking charges. In addition, Cyprus has some characteristics that encourage the use of private vehicles, such as the geographical remoteness and isolation associated with the insular condition, the lack of rail transportation, and the relatively small island size, among others.

Nonetheless, these problems are not exclusive to Cyprus. For example, in other Mediterranean insular territories, such as Sardinia and Malta, private cars are also the most used mode of transportation [77,78]. In addition to the restrictions associated with the insular condition, there is evidence that mobility planning in these areas favored private transportation in relation to other modes, explaining the prevalence of car trips [77]. This is clearly seen in Limassol, where 88% of the street is devoted to cars.

Developing sustainable mobility in car-oriented islands is critical for improving the environmental sustainability of these territories [79]. In the case of Cyprus, the recent study carried out by Giannakis et al. [76] showed that land transportation is the third highest source of CO_2 emissions and, therefore, a critical sector to ensure a more sustainable development process within the island. The transition of Cyprus to a low-carbon economy highlights the urgency of taking in-sector action by promoting public transportation and active modes on daily urban trips. Redesigning urban spaces to favor active mobility remains a fool-proof way to make mobility more sustainable in Limassol. Corroborating recent research on active mobility in Mediterranean insular cities [80], this study found that the lack of infrastructure and traffic safety were among the main causes hindering a more frequent use of walking and cycling. Regarding infrastructure, the extension of pedestrian-only and bicycle lanes is residual, the infrastructure is disconnected and sparse. This problem was also perceived by the population involved in this study; 65% would only switch to active modes if a network of pedestrian routes and bicycle lanes was created. This finding corroborates previous studies showing that urban dwellers are willing to move towards greener modes if better public transportation services and cycling/walking conditions are provided [47,76]. Although the good proximity to bus stops, people would like a better and faster bus service, providing online information about schedules and bus lanes. In the case of active modes, the current bicycle infrastructure in the city does not suit the basic cyclists' needs, namely those that may use or are likely to use bicycles for daily commuting purposes (travel to school and to work). The number of bicycle rental stations is low, and their concentration on the seafront and around tourist attractions restricts their use for daily purposes. Many of the medium to high residential densities (>3001 inhabitant/grid) are not within 300 m from these stations. The overall poor cycling conditions result in a very low bicycle modal share (1%). Providing an infrastructure network for active mobility linking critical destinations, such as transportation hubs, and urban traffic generators, such as universities, schools, shopping centers, and the city center, would make walking and cycling safer, more convenient, and attractive for daily trips. Another reason to improve the conditions for walking and cycling is the overall commuting times. Based on data about the commuting time of employed people in the EU [81], Cyprus has the shortest average commuting times (19 min) and 76% of commuters have a one-way commuting of less than 30 min. Although these commuting times reflect the mobility pattern in the entire country, it is reasonable to argue that, to some extent, they may apply to Limassol. Considering that, on average, walking times of 10 min (0.8 km) and cycling times of 20 min (5 km) are widely accepted utilitarian walking and cycling distances [20], there is a significant potential to replace these short car trips with active travel.

The lack of traffic safety is another barrier preventing more people from walking and cycling. According to EC [82], vulnerable road users accounted for more than half of road traffic fatalities in Cyprus in 2020. This percentage is higher than that observed in the EU. Although cyclist fatalities only accounted for 2% of all road fatalities, probably due to the very low use of bicycles, the share of pedestrian fatalities was much higher in Cyprus (27%) than in the EU (19%). The relatively high number of pedestrian fatalities may indicate the lack of safe routes and sidewalks available for use. Improving traffic safety was also pointed out by 8% of the participants as having the potential to switch from car to active modes. This can be achieved in several ways, namely by reducing traffic speed and creating low-speed zones in critical areas (around large facilities, main residential areas, etc.), adopting other traffic calming measures (speed humps, pedestrian refugees, narrowing traffic lanes, etc.), providing suitable cycle lanes (separated, colored) and sidewalks, reducing and signalizing conflicting trajectories and crossings, and improving street lighting, among others. Another measure is the provision of street trees, which was identified by 15% of the participants in this study for their potential to replace car trips with active modes. Previous studies have shown that street trees encourage walking and cycling as a comfortable and attractive mode of transportation [83]. Limassol has a Mediterranean climate (Csa type according to Köppen classification) with summertime average temperatures over 26 °C, so street tree shade is an important amenity for walking and cycling comfortably. However, trees in urban environments can cause costly damage to built infrastructure and compromise walking and cycling as safe modes of transportation; they can block views, and create physical obstructions and slippery surfaces due to defoliated leaves, as well as buckled paving due to roots. To prevent these problems, street trees and the built infrastructure should be regularly maintained.

Based on the described results, the second research question (Q2: whether and to what extent the availability of urban green spaces is enough in Limassol?) can be answered as follows. The performed quantitative and the qualitative evaluations showed that Limassol has a relatively low number of green spaces, which are not equitably distributed by the city, and the areas with higher population densities do not have nearby UGS. The residents perceive this problem because only 3% declared their satisfaction with the UGS available in the city. This finding corroborates a previous study showing that the people less satisfied with the UGS are from cities located in Eastern and particularly Southern EU countries, with the population of Cyprus being the least satisfied [84]. The spatial coverage by UGS corresponds to 3.3% of the urban surface and to 12.6 sq. meter/inhabitant. These relatively low values were similar to those found in other Southern European cities [85]. As emphasized by Christoforidi et al. [85], the lack of UGS is more pronounced in cities of Mediterranean islands due to the negative effect of urban and tourism development, which is particularly the case of the city centers characterized by narrow streets, densely populated areas, with little or no green urban areas. The climate of Southern European may also limit the share of UGS due to irrigation pricing and water scarcity, namely during the summer months or in periods of drought [84]. This study also showed that Limassol's most densely populated areas are not within the minimum recommended 300 m from a 2 ha minimum UGS. This was also perceived by 86% of the participants in the questionnaire that declared to live at greater distances from a UGS. This problem results from the relatively low number of UGS available (only four above 2 ha) and their peripheral location. The most densely populated areas are those with the poorest coverage by UGS and far from these spaces. The lack of nearby UGS > 2 ha may prevent the population in general and some groups, especially elderly and disabled people, from frequenting these spaces regularly and may encourage them to drive instead of using active modes of transportation to access these spaces. In fact, there is general agreement that distance matters and UGS nearby, a concept usually interpreted as within a walkable distance, make these spaces more attractive and accessible, encouraging physical activity among residents [60]. Thus, the lack of nearby UGS could explain the relatively high percentage of respondents who do not frequent UGS. Therefore, Limassol is a city providing poor coverage and access to UGS, a problem that particularly affects the Southern European regions. For example, the study of Kabisch et al. [70] showed that except for some Nordic cities, which have up to 80% of the population living within 300 m of a 2 ha minimum UGA, the remaining European cities have modest percentages, being the lowest values (<15%) found in cities of the Southern and Southeastern Europe [70].

From this study, it is clear that urban planning needs to pay more attention to the provision of UGS to improve access and encourage the population to visit these spaces more regularly. Creating more nearby UGS can potentially increase the frequency of these spaces, but these measures should be complemented through awareness, marketing, and promotional campaigns. Although 95% of the respondents were aware of the benefits of frequenting these spaces, previous studies suggested that multifaceted UGS actions (built environment changes and promotion campaigns) are likely to have a more significant impact on the levels of frequency and physical activity on these spaces than changes to the built environment in isolation [86].

5. Conclusions

This study analyzed the extent to which Limassol is a sustainable city, focusing on two critical environmental indicators: transportation and UGS. The evaluation was based on geostatistical analysis using six main indicators, and on a questionnaire conducted in the city. Results indicated that Limassol performs poorly on the indicators evaluated and that respondents have a lower sustainability perception about the conditions provided to walk and cycle and about the provision of UGS. First, the lack of prioritization for walking and cycling is a main barrier, which is recognizably difficult to change. To achieve SDG 11 and the desired mindset to make cities inclusive, safe, resilient, and sustainable, Limassol needs to reach a more sustainable mobility pattern. For that purpose, implementing specific measures to promote active travel is indispensable. This includes redesigning urban spaces to favor active mobility and providing a network of walking and cycling infrastructure properly shaded by trees to make the use of these modes more convenient, safe, comfortable, and attractive. Second, Limassol has a relatively low number of UGS, which are not equitably distributed and are not nearby the most densely populated areas. The city's compact and dense urban structure makes providing more UGS with a challenging planning issue. The geospatial analysis and the questionnaire revealed that most residential blocks do not have access to at least 2 ha of public green space within 300 m of their homes. Creating more nearby UGS and enabling access by active modes is also vital to make the city more sustainable.

This study contributes to the research field by providing additional evidence about assessing urban sustainability in an insular city. The literature shows that this type of approach in insular cities is scarce [77,87] but necessary to help local entities create more sustainable and livable cities. Firstly, this study provides detailed information about the sustainability performance, which may help different target groups, namely urban planners and decision-makers, in adopting policies to make the city more sustainable. Secondly, the inclusion of urban residents' subjective opinions strengthens the evaluation of urban sustainability by considering their perceptions regarding their daily life and habits. In fact, combining quantitative and qualitative attributes has been recently proposed as a strategic decision-making process to achieve higher sustainability performance on island territories [88]. Thirdly, this study focuses on a problem recently identified by Geddes et al. [45], which is the lack of understanding of how planning should ensure a more sustainable and equitable future for port cities of Southeastern Europe. Fourthly, this study shows that the described approach based on geostatistical and spatial operations combined with a qualitative evaluation is an acceptable method to evaluate urban sustainability that can be replicated in other territories.

Finally, this study also has some limitations that should also be highlighted. From the environmental point of view, the evaluation of urban sustainability was focused on two dimensions (transportation and UGS) and on six indicators. In the topic of urban sustainability, other important dimensions were not examined, such as building energy efficiency and water efficiency. Further, the evaluation within the two dimensions does not include some relevant indicators. For example, the emissions associated with transportation (carbon, air pollutants, noise), the daily number of trips, and the average daily distance travelled were not evaluated due to the lack of data, but they strongly impact any city's environmental performance. Furthermore, UGS were evaluated in terms of provision and proximity but not in terms of quality. Aspects such as the provision of various facilities, the density of planting, the width of paths and the type of maintenance make an UGS more or less attractive for different groups. In addition, the benefits of UGS were considered at the source, while other potential benefits that spill over into adjacent urban areas (air purification, cooling, etc.) were not evaluated. Finally, the qualitative evaluation was based on a questionnaire that may contain inconsistencies between reported preferences and individual behaviors. In addition, the perceptions of some demographic groups, especially elderly people, are under-represented, and the results may not accurately represent their perceptions of the city.

Besides these limitations, this paper provides additional evidence about the critical role that transportation and UGS have on urban sustainability, the main factors limiting the city from obtaining a better performance, and the overall perceptions of the population living in Limassol. This may help urban planners and decision-makers make Limassol a more sustainable and livable city and inspire researchers to adopt similar approaches in other cities.

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