



The development of walkability in the historic centre of Enna: the case of the Saint Tommaso neighbourhood

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Abstract

Generally the proneness to walk in the urban centre is a more widespread practice and it is protected by various measures in order to reduce the vehicular traffic and the noise, the environmental pollution, the safety and also the economical aspects. This research shows an evaluation of the walk ability index related to the historical district of the city of Enna characterized by the presence of an adult population, numerous historical buildings and architectural heritage, as well as by a medium-high slope of the road infrastructures due to the orography. The research was carried out using three different approaches. Data acquisition was facilitated by the dissemination of user satisfaction questionnaires and direct surveys in the area. The comparison of the results obtained with the various methods shows how, in a preventive way, the aspects related to the transport at urban historical centre can be taken care in order to improve the wellbeing produced by the pedestrian activity.

The present work aims to highlight the potential and the critical aspects of some urban streets of the historical city centre of Enna in order to be able to guarantee to everyone an easy pedestrian mobility and therefore potentially a greater modal choice of the transport system “slower “than vehicles.

Keywords: walk ability, pedestrian route, simulation, accessibility, assessment.

1. Introduction

Pedestrian movements are often defined as “soft/slow mobility”. Pedestrian mobility is the first mode of the urban mobility, unlike private motorized transport, because it does not involve the exploitation of non-renewable resources, the production of polluting emissions and gas emissions greenhouse in the atmosphere, but rather brings benefits in terms of health and social cohesion. Being able to move on foot, in fact, is always necessary even when you do it in order to use motorized systems (for example to use local public transport) and is frequently sufficient for carrying out different travels completely.

The pedestrian mobility often clashes with the territorial scale that do not allow easy accessibility or practicability of urban crossings.

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Generally moving on foot is easy to carry out in "non-vertical" cities, ie where the slopes do not create states of fatigue, and it is also easily implemented in small cities where the radius of distances does not exceed 2 kilometers or where the presence of environmental or ecological islands together with the presence of protected routes for people with reduced mobility, allow access to activities of daily life (schools, local public transport, public services, commercial exercises, etc.). In terms of the urban scale, the practice of walking allows individuals to establish a direct relationship not mediated with city spaces and, if distributed, helps to widen access to opportunities urban areas and to make the use of cities easier, easier and more pleasant.

Although walking is a spontaneous action, the introduction of the car and urban dispersion have affected the urban development of the main cities of the world since the last post-war period, and this practice has been gradually restricted to some specific environments, until it becomes an unusual activity in the daily routine of citizens. Several studies have analysed the motorized component for years, leaving out that of the weak road users. They have also involved greater planning to make motorized transport, assigning only marginal spaces to pedestrians. The concept of walkability is connected to the presence, distribution and raw accessibility of urban facilities: spatial quality and the ability to accommodate and encourage mobility pedestrians of the urban environment and in particular of the street influence the way people do they perceive and use cities.

Widely the concept of "walkability" wants to define the quality of accessibility or how much an urban environment is able to encourage walking and to offer itself as a platform for a daily life based on pedestrian mobility. Improving pedestrian traffic means intervening on those extrinsic characteristics of people as a requirement of urban space that contributes to improving the quality of the human life (Talen, 2002) (Frank, et al., 2009). Walkability assumes the value of complex indicator able to evaluate the state of the places and becomes an instrument of the orientation of the action design aimed at improving the livability of the city. Furthermore the walkability measure is a difficult to define due to the multi-dimensional and multi-scale nature that the concept underlies. Therefore the measure of the walkability levels is defined classifying the ability of a space to be travelled on foot.

In the last decades several methods and tools have been proposed measurement and evaluation of urban walkability that allowed to deepen the knowledge about the relationships of interdependence between the organization of urban space and spatial behaviours of individuals (Blečić, Cecchini, Congiu, Fancello, & Trunfio, Evaluating walkability: a capability-wise planning and design support system, 2015a).

The simulation of pedestrian behavior in urban areas has always been difficult to monitoring: several theories have been developed over the decades, often using tools for or neural analysis or fuzzy logic in agreement with (Ottomanelli, Caggiani, Iannucci, & Sassanelli, 2010).

At the micro-urban (street) and direct relationship between the individual and the context are to be found those microelements that influence the sense of safety and security (Giuffrè, Campisi, & Tesoriere, 2017) in terms of perception, efficiency, the benefit of the route and the real opportunity to access and use the spaces. Considering different contexts, the variability of the pedestrian is also influenced by the presence of possible obstacles and architectural barriers especially for people with disabilities in accordance with (Pecchini & Giuliani, 2015). Often the purpose of the walking movement affects the propensity to choose this mode of transport. In accordance

with(Habibian & Hosseinzadeh, 2018), while density is a more effective criterion than design to encourage people to walk for non-educational trips, this is not the case for educational trips.

In this context, an important role can be played by information technology which, thanks to the development of advanced technologies, allows the processing of geo-referenced data that can be shared on web platforms accessible to most of the population and institutions.

The present research lays the foundations for the evaluation of some portions of the urban viability of the city of Enna starting from the comparison of three walkability scales and indexes and data of the recorded data that were subsequently inserted with geo-referencing. The examined area has been chosen for the criticalities that characterize it, i.e. for the high slopes, the reduced geometry of the infrastructures and the often adverse weather-climatic conditions that contrast with the landscape and architectural richness of the area itself.

2. Data and Method

In order to define how much users find the investigated area easily navigable, socio-economic data of the city of Enna were observed in the first instance. A questionnaire was put forward to detect not only the propensity of people living in Enna to walk but also the perception of walking on some areas from the point of view of some parameters reported in the chart below. Generally the walkability is defined by pyramidal steps that provide the basis for the development of the main parameters in a hierarchical way. In particular the urban design characterizes its attention to the levels of the pyramid varies according to the person who is walking. Therefore the parameters investigated are related to the fact that an area can be described in terms of hierarchical pyramidal shape in which the following attributes can be considered from the top to the bottom.

Specifically, in terms of an enjoyable step, the urban environment adds an element of joy for walking, through the presence of art, entertainment and more services. Considering comfortable step, the urban environment minimizes physical discomfort from walking, from things you get crowding, tiredness, rain, sun and darkness, through the supply of design elements that minimize that discomfort. The urban environment gives priority partial walking to a minimum the time needed to reach on foot hide, especially in relation to other ways of transport, like the engine vehicles. The convenient step is linked to the concept of the urban environment priorities walking by minimizing the time required to walk to destinations, particularly in relation to other modes of transportation, such as motor vehicles. Finally the safe is attributed to the urban environment protects people who walk from crime and traffic, both and through the streets, also in terms of accessible space.

The benefits produced by the walkability activity can be defined considering the economic, the social and the environmental aspects summarized in the Table 1 below.

Table 1: Impact of Walkability

<i>Improve</i>	<i>Possible impacts</i>	
	<i>Reduction</i>	<i>Increase</i>
	<i>Economical Impacts</i>	
Accessibility(especially for non drivers)	transportation cost	Parking efficiency Local business activity and employment

		Support for transit and other alternative modes Tourism Health cost saving from improved exercise Psychological effect
<i>Social Impact</i>		
Accessibility for people with transport disadvantages opportunities to preserve cultural resources	external transportation costs	Neighbourhood interaction and community cohesion Exercise
<i>Environmental Impact</i>		
Aesthetics	Land needed for road and parking facilities Energy consumption Pollutante missions (air,water,etc..) "Heat island" effects	Open space preservation

The survey was administered to a sample of 534 users or about 5% of the Enna citizens. It has investigated the variability of the sample through diversification by age and gender. It also defined the main nodes of origin and destination of the transport network of the area investigated both for reasons of home-work, home study and home entertainment. At the same time, it was also obtained a screening of the transport methods used for the various causes of displacement.

The present work has been carried out to make users more aware of the positive effects of walking with respect to the use of private vehicles and above all to allow users to reach sites of high historical-cultural interest considering the main city details .

The proneness to walk is widely discussed in the literature in agreement with(Moura, Cambra, & Gonçalves, 2017). In order to be able to determine the walkability index of the investigated area, 3 different methods have been used, which gradually include more and more variables and are described in the following paragraphs. Walking also brings life to streets and liveable streets contribute to safer urban environments.

The contribute of walking to community safety, accessibility and social inclusion have emerged as a particular challenge to the design of the urban environment(Evans, 2009)(Nigro, Petrelli, Ušpalytė-Vitkūnienė, & Žilionienė, 2018) as over the past century pedestrian access has declined steadily in most cities (Forsyth & Southworth, 2008). From the environmental point of view, walking is a "green" mode of transport, as it has a low environmental impact, without air and noise pollution. The presence of walkable environments and transit systems may create alternatives to private car usage, thus reducing traffic congestion, noise and emissions.

In terms of the economic perspective, each pedestrian has a cost linked to walking action. Generally it can be associated with less energy and resources consumption when compared to other means of transport. Other economic benefits include thriving of local businesses such as street shopping and tourism and, at a larger scale, public health savings. Many recent health studies have demonstrated that walking can promote mental and physical health, including cardiovascular fitness and reduced stress, constituting a moderate intensity physical activity. Several countries' public health officials have adopted, over the last years, guidelines to encourage people to accumulate at least 30 minutes of moderate physical activity on preferably all days of the week, but it has been observed that a large proportion (30-60%) of the population maintains a sedentary lifestyle (Bourdeaudhuij, Teixeira, Cardon, & Deforche, 2005).

1.1 Walk Score Methodology

Walking not only often reduces the costs related to the movement but also reduces the health problems and the phenomena of environmental pollution.

This research has been tackled in a mountainous context where the paths are often characterized by the presence of stairs or stretches on a medium-high slope. Walk Score is a methodology implemented by a private company that provides judgments related to the walkability regarding the real estate purchase. It was applied to today in the United States, Canada and Australia (Walk-Score & CrunchBase-Profile, 2013).

The Walk Score method, like described on Table 2, measures the walkability of any address, the Transit Score measures access to public transport, and the Bike Score measures if a location is good for cycling. It was developed with the Walk Score advisory board and has been validated by leading academic researchers. Points are awarded based on the distance of services in each category. Services within 5 minutes walk (about 400meter or 0.25 miles) are the maximum points. A decay function is used to give points to more distant services, without data points after a 30-minute walk. Walk Score also measures the interconnection between pedestrians evaluating population density and road metrics such as block length and intersection density.

The transit score is a patented measure of how well a place is served by public transport. The transit score is based on data released in a standard format by public transport agencies.

In order to calculate a transit score, it is necessary to assign a value of "utility" to the neighbouring transit routes based on the frequency, type of route (rail, bus, etc.) also taking into account the distance from the nearest stop on the route.

The "usefulness" of all neighbouring routes is summed and normalized with a score between 0 and 100. The Bike Score indicates if an area is good for cycling. For a given location, a bicycle score is calculated by measuring the bicycle infrastructure (lanes, paths, etc.), hills, destinations and road connectivity and the number of bike commuters.

Table 2: Score scalerelated to Walk,Transit and Bike actions

<i>Walk Score</i>	<i>Description</i>	<i>Bike Score</i>	<i>Description</i>	<i>Transit Score</i>	<i>Description</i>
90- 100	Walker's Paradise Daily errands do not require a car	90–100	Biker's Paradise Daily errands can be accomplished on a bike	90–100	Rider's Paradise World-class public transportation
70–89	Very Walkable Most errands can be accomplished on foot.	70–89	Very Bikeable Biking is convenient for most trips.	70–89	Excellent Transit Transit is convenient for most trips.
50–69	Somewhat Walkable Some errands can be accomplished on foot	50–69	Bikeable Some bike infrastructure	50–69	Good Transit Many nearby public transportation options.
25–49	Car-Dependent Most errands require a car.	0–49	Somewhat Bikeable Minimal bike infrastructure	25–49	Some Transit A few nearby public transportation options

0–24	Car-Dependent Almost all errands require a car.	0–24	Minimal Transit It is possible to get on a bus
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This American approach was used in order to evaluate the real estate sale considering the parameters of benefit and / or criticality the ease with which the properties can be easily reached and liked with the various modes of transport. This first analysis limits the assessment of the concept of walkability as it does not take into consideration some urbanistic and geometrical functional characteristics of the road infrastructures to be monitored. Therefore the result obtained can give a rough idea of the various sections of streets monitored and based on generalized concepts.

2.2 Walkability Index 7C's

The walkability of a community has been conceptualized as “the extent to which characteristics of the built environment and land use may or may not be conducive to residents in the area walking for either leisure, exercise or recreation, to access services, or to travel to work” (Leslie, Cerin, DuToit, Owen, & Bauman, 2007) or in simpler terms, “the extent to which the built environment is walking friendly”(Abley & Turner, 2011). The latter definition is used in the scope of this research, implying the clarification of what can constitute a “walking friendly” environment. This question has been addressed in the work by Transport for London (COST358, 2010), where the pedestrian concern and needs were classified under 7 main factors in accordance with (Moura, Cambra, & Gonçalves, 2017)like described on Table 3.

Table 3: 7C's walkability parameters

<i>7C index</i>	<i>Definition</i>
Connectivity	Parameter linked to pedestrian environment (such as interface, joinnet work..)
Convenience	Parameter linked to appropriate/ useful/suitable aspects
Comfort	Linked to easy, pleasant, protected, relaxed, sheltered, untroubled concepts.
Conviviality	linked to sociable parameters.
Conspicuous	The extent to which the pedestrian environment is obvious; clear; discernible; distinct; perceptible.
Coexistence	The extent to which the pedestrian and other transport modes can exist at the same time and place with order and peace.
Commitment	The extent to which there exist engagement, liability and responsibility towards the pedestrian environment.

2.3 Potential Walkability Index

Urban texture accounts for building density and typology ranging from dense continuous urban context with the presence of urban park, squares or green spaces, to low density referred to scattered urban context, and to undeveloped land, terrain vague, abandoned or obsolete spaces, buildings and green open spaces in accordance with(Cervero, Sarmiento, Jacoby, Gomez, & Neiman, 2009).

The frequency of services and activities along the path intends to capture aspects of security (related to the presence of people and storekeepers) as well as aspects of attractiveness resulting from a high density of activities, which is one of the most stressed aspects of walkability. Transparency and permeability of urban space (public

and private) aim to describe if and how the urban environment stimulates interaction with the pedestrian, from complete integration to the presence of filter spaces and transition obtained by architectural and natural elements, to the separation with walls and fences. Finally, there are two attributes related to landscape aspects, environmental, architectural and urban, relevant for the pleasantness of the walk: the two attributes register a qualitative evaluative judgement related to the presence (more or less intense) of enjoyable or disturbing elements along the path and in the surroundings. The proposed base model was developed for application in 4 different work scales: the global, macro, mesoscale and microscale. The model was tested in three of them: the city of Enna (global scale); the Saint Tommaso neighbourhood (macroscale) and along a path composed by the section of the main street of Saint Tommaso district(microscale). The global scale walkability assessment makes use of the following derived expression for the calculation of the “Potential Walkability”: described by Eq.(1)

$$Potential\ Walkability\ (PW)=(z.score)*Land\ Use\ Mix+(z.score)Gross\ Residential\ Density + (z.score)\ Street\ Density \quad (1)$$

The potential walkability was calculated for all Enna’s parishes, and at this scale, the availability of statistical information regarding commuting travel patterns (CENSUS 2001) allowed confronting the model’s results with the resident’s transportation modal choices. The evaluation scales were analysed considering the following attributes showed on Table 4.

Table 4: Walkability evaluations in terms of macro and microscale in accordance with(De Cambra, 2012)

<i>scale</i>	<i>Index</i>
Walkability Macro	WM= 0,0476*Street connectivity+0,0476*Public transport coverage+0.0476 *Network integration+0.0476 *Land Use Mix+0.0476*Residential density +0.0476*Essential land use coverage+0,1429*Pedestrian infrastructure coverage+0,1429* Convivial points coverage+0,1429*sense of Place +0,1429*Traffic capacity +0.1429*Pedestrian friendly street proportion
Walkability micro	Wmicro =0,1428*Pedestrian Network Continuity+0,1428*Sidewalk width +0,0357*Amenities+0,0357*Trees+0,0357*Climate protection +0,0357*Lighting +0,0714*Blind buildings+0,0714*Transparent Building +0,1428*Path enclosure+0,0714*Conflicts+0,0714*Sidewalk buffer width+0,0714*Maintenance+0,0714*Clean-lines

The application of the macroscale base model reported a walkability score of 50,0 (max 100), is the individual contribution of each walkability definition, assessable in the output. In terms of microscale, a short path (about 2220 m) has been verified considering the main direction. The route consisted of 43 segments with the main direction characterized by the Via Roma and sections 2-5-6-7-8-9-10. The sections examined are all one-way so the values obtained correspond to the direction used (in monitoring case from Via Roma 188 towards Via Libertà). On the meaning, or on the interpretation, of the results, a higher score for the practicability in an area or in a road does not necessarily mean that more people will walk or walk there. Instead, it means that the area or the road meet certain requirements to a certain extent. In other words, it means that some attributes of the built environment that are believed to promote a pedestrian environment are more present or more evident in one area/street than in

others. This procedure has internal limits to the model because it is characterized by a lack of scientific evidence to support the choice of indicators and their threshold. In terms of limitations external to the model, the most relevant was the lack of information on travel behaviour and travel patterns that limit the final judgment. The results of the global scale can be useful to characterize entire urban areas in terms of potential pedestrian traffic and to compare urban settings. In terms of planning, they can be useful in general-level studies. The results of the macroscale can be useful to classify the existing or proposed neighbourhoods in terms of practicability. In terms of planning, this can be useful for identifying critical areas of intervention, for assessing the impacts of urbanization and for benchmarking / monitoring purposes. The results of the mesoscale can be useful to address both the general planning of transport systems and the pedestrian accessibility of services and public facilities (schools, health centres, sports and recreational activities) or for real estate prospecting. Microscale outputs can be useful for identifying intervention needs and providing a benchmark for comparative analysis. In terms of urban planning, it can be useful to evaluate intervention alternatives.

The physical characteristics of the urban environment are often lacking in the evaluation of the practicability as they do not consider some qualitative aspects such as the sense of closure, imagine activities and "vivacity" (Mehta, 2008).

Generally, the assessments in the literature aim to identify how much a place (a street, a neighbourhood) is per se practicable, due to its physical characteristics and organization. In particular, walkability score is an aggregate that groups together three components:

- the number of urban destinations / opportunities within walking distance;
- their distances;
- the quality of pedestrian routes to these destinations.

The quality of the pedestrian paths is assessed on different attributes relevant to pedestrian traffic, in relation to the characteristics of the roads and the surrounding environment that can contribute to making the routes efficient, pleasant, safe and attractive. The basic assumption of the assessment model is that a person or an inhabitant located at a point in the space will be able to walk a number of times towards the available destinations and from this will obtain a β benefit defined by the following substitution function characterized from a certain constant-elasticity:

$$\beta(x) = (\sum_{i=1}^n Xi^{\rho})^{1/r} \quad (2)$$

where n is the number of available destinations, Xi is the number of times the resident visits the i-th destination and $1/(1 - \rho)$ is the elasticity of substitution among destinations.

We impose the following constraint on the pedestrian:

$$\sum_{i=1}^n ciXi \leq M \quad (3)$$

where ci is the "cost" the pedestrian foregoes to reach the destination i, and M is the available budget with a conventional constant value. Finally, it is necessary to define the "cost" term of a route (ci in eq. (3)), which in our case takes into account both the length and the attributes relevant for its quality for pedestrians. So the cost of a route composed of p edges is defined as:

$$c = c_0 + \sum_{k=1}^r lk (1 - (\sum_{l=1}^r wl * ak,l^r))exp1/r \quad (4)$$

where c_0 is the fixed cost, lk is the length of the k -th edge in the path, ak,l $[0,1]$ is the value of that edge's l -th attribute, wl is the weight of the attribute ($\sum wl = 1$), and r is a parameter with $1/(1 - r)$ being the elasticity of substitution among attributes. The variable part of the expression (4) yields unit cost of 1 when all attributes are at their minimum (i.e. 0), and approaches 0 when attributes approach the maximum of 1. Among all the alternative routes between an origin and a destination, the least costly one is used in eq. (3). Finally, the walkability value corresponds to the maximum benefit the person located at that point may attain, given the assumptions of the behavioural model in (2), (3) and (4).

$$w = \max \beta(x) \quad (5)$$

As we have said, this procedure is executed for each node of the graph, and thus to each node will be attached a walkability score w .

Resolving eq. (2) such that (3), the benefit is maximum when:

$$X_i = \frac{c_j^{r-1} * M}{\sum_{j=1}^n c_i^{r-1}} \quad (6)$$

In order to define the walkability score for an entire urban area, the procedure consists of the explanation of all the least expensive routes, in terms of eq. (4), between all the source nodes and all destination nodes; it also consists to the calculation of the practicability score based on the eq. (2) and (6) for each source node, using the least expensive routes to all available destinations as routes; and finally it is linked to the interpolation of the walkability scores of the nodes on a raster grid of a given resolution. The present research work has also been carried out acquiring functional geometric information of a part of the city's urban road network, which lies within the city's SaintTommaso neighbourhood and is about 4 km long with the 50% located on the main direction called via Roma. The values of the attributes have been collected through direct observation of the streets between July and October 2018, in situ and using the panoramic photos available through Google Street View. These are often determining aspects of the relation between the street environment and the behaviour of pedestrians, and regard elements and urban conditions which objectively and subjectively influence the choices and the attitudes of people in space. Some are requirements easy to observe, recognise and measure: cyclability (the possibility of bicycle riding on or along the road), number of car lanes, car speed limit, one-way streets, on-street parking, path slopes, paving quality and degree of maintenance, lighting. Other attributes instead refer to conditions and combination of features which require an evaluative judgement by an attentive observer. So it is useful to briefly explain their meaning.

The width of the sidewalk or pedestrian area is a qualitative evaluation of the effective possibility to walk without obstacles (physical or perceptive). The values range from wide sidewalk to complete lack of pedestrian space, and have been defined based on the number of individuals able to comfortably walk side by side. The interpolation is carried out using the Inverse Distance Weighting method. The attribute shelter and shade evaluates the possibility to take shelter given the physical configuration of urban space; it considers both environmental and architectural features that allow pedestrians to shelter from the rain, wind or sun. The attribute separation of pedestrian route from car

roadway relates to the presence of physical or perceptual elements, horizontal or vertical, which increase pedestrians' safety and comfort (planting strips, raised planters, trees, stakes, walls, etc.). The sedibility evaluates the possibility to seat and linger along the walk, where seating opportunities include benches as well as other urban elements not specifically designed for this purpose but used by people to sit on (stairways, walls, fountain borders, etc.).

3. Results and Discussion

The city of Enna is located in the centre of Sicily and the historic centre is at an average altitude of 931 m asl. The city covers about 358 km². The resident population in the municipality of Enna consists of 27,243 inhabitants. The historical centre, in particular, is inhabited by about 65% of the population and in particular about 22% is resident in the investigated area. The population density of the city of Enna is about 76 inhabitants / km².

The sample analysed through the questionnaire consists of 534 units of which 62% are women and 38% are men. The sample is heterogeneous from the point of view of the age group (from 18 to over 62) with a peak of 29-39 age units and the sample is characterized by 83% of people with driving licenses for more than 5 years. In terms of educational aspect, about 34% have a master or bachelor degree while 32% have a high school degree. In order to better understand the attitude to motor activities, it is the same whether the sample used tobacco (30% of the sample) and had motor problems (about 8%) in order to calibrate the O / D matrix of the movements of the users, the place of residence (origin) and the place of work/study (destination) were requested, in order to calibrate the O / D matrix of the movements of the users, arriving as described below on graphs. The area subject to study is located in high Enna and easily accessible from other areas such as low Enna, Pergusa or other. The area called Enna Alta is characterized by the presence of a strong concentration of schools from nursery schools to high schools and by the majority of urban institutions about 80% of the population working in the sector moves every day to Enna Alta. The Saint Tommaso district results from the presence of nursery and primary schools and the presence of some offices and shops. Therefore, through the questionnaire, the different movements of the sample investigated from / to Enna centre to the other parties were analysed, both for participation in House / Study and Work and Home / Leisure scope of transport obtaining a report in Figure 1.

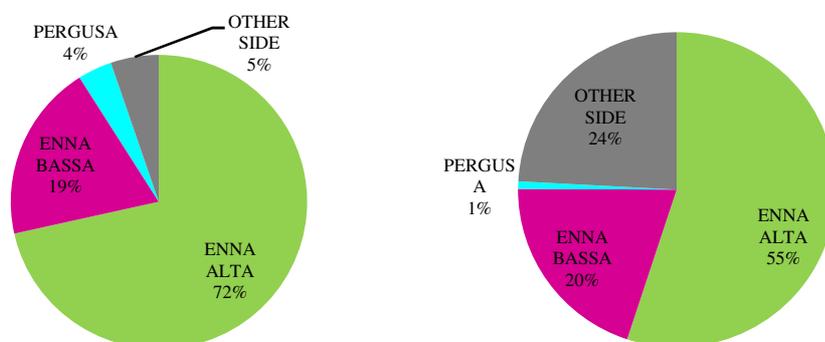


Figure1: Distribution of habitants in terms of home side (left) and work side (right)

The estimated active population is around 19,000 units while the unemployed population is around 8100 units. The Enna population is also increased by the rate of resident and commuter students attending the University located in Enna bassa. Considering the average shifts in the hour of peak from the inhabitants of the Saint Tommaso area, equal to about 4900 or about 18% of the population living in the municipality of Enna, towards the other destinations it is possible to define a distribution value as shown.

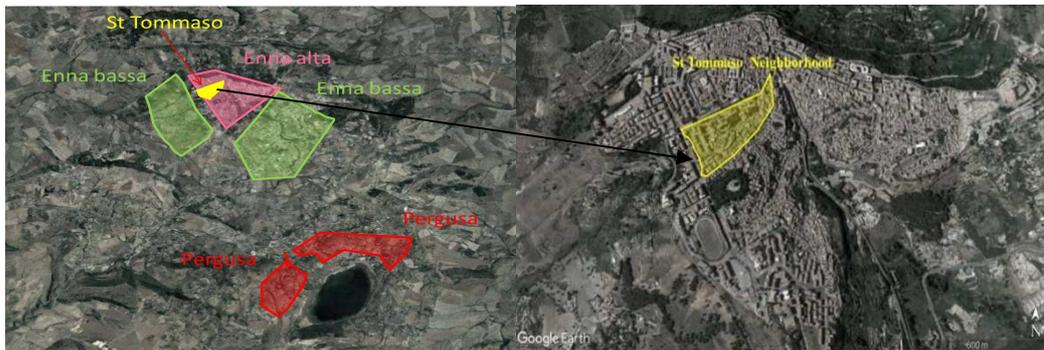


Figure 2: Main Enna districts and Saint Tommaso area (yellow)

Referring to the results obtained through the questionnaire and carrying out surveys in the area shows that during the peak hour (around 7: 30-8: 30 am) during the weekdays the population resident in the SaintTommaso district moves about 40% to Enna alta, 20% to Enna bassa, 15% outside the city and 5% near Pergusa.

In addition, about 20% of the population residing in the neighborhood remains in the same or around 300 m. This percentage mostly refers to the elderly and housewife population like described on Figure 3.

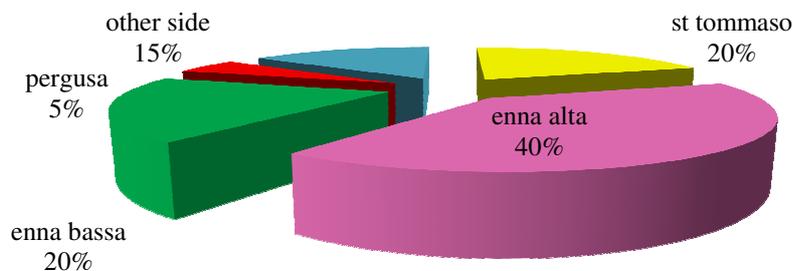


Figure 3: Distribution of the habitant transport demand from Saint Tommaso area to others

Likewise, the modal choice for the different displacements of destination origin was investigated for the two reasons mentioned above, obtaining the following represented in the Figure 4 right and left.

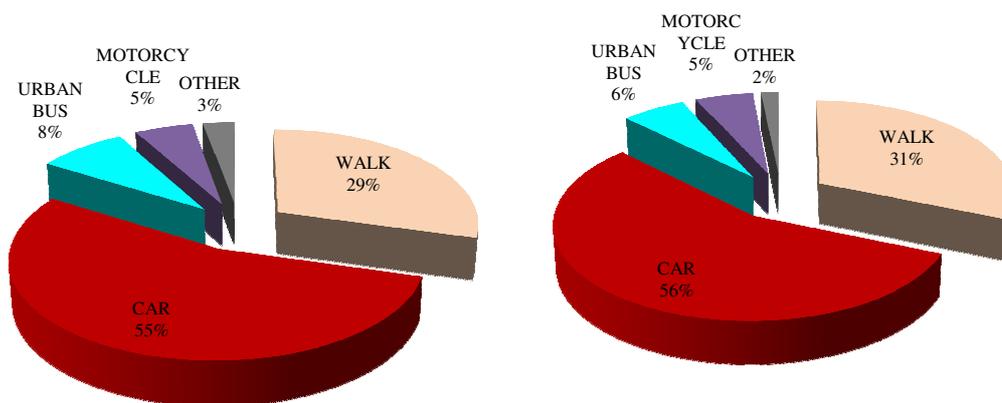


Figure 4: Distribution of transport mode in Enna city centre and Saint Tommaso area

It is possible to notice how more than half of the interviewed sample moves with the private vehicle for the different causes of displacement. This percentage is followed by a 29-31% relative to walking mobility which confirms a good propensity of the users to perform physical activity. However, the road system status that is not always maintained and is characterized by high slopes and a climate often with low temperatures and fog/rain. The study also estimated that about 70% of the interviewed sample never uses a public vehicle to move around the urban area. The investigated area is 47% of the sample of users investigated, not easy from the point of view of accessibility, while only 18% and 4% are accessible or very accessible like describe on Table3. This is due to the dislocation of the investigated area, to the present low maintenance and the strong presence of structural elements that create a barrier in handling such as the absence in some parts of the sidewalk or the slope of high roads. In terms of safety, i.e. from the point of view of possible accidents or possible thefts, the interviewed sample answered for 31% that the area is partially safe, while for 21% and 13% respectively the area is safe or very safe .

The distribution spread in the various responses is partly motivated by the low percentage of accidents between vehicles and pedestrian vehicles recorded in the area over the last twenty years and by the low number of jams.

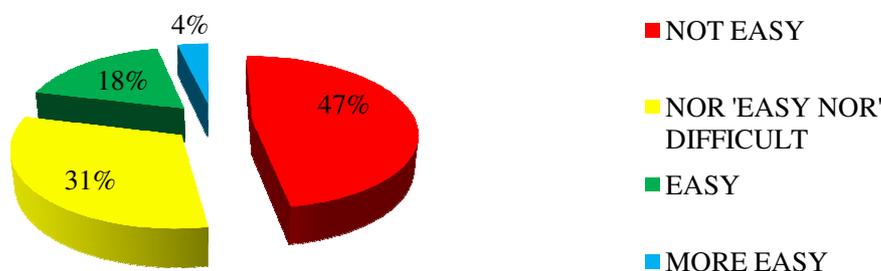


Figure 5: Definition of easy access to urban area

Considering the safety aspect, therefore, it is linked to the number of accidents that occurred in the area studied and the perception by users, what has been shown in

Figure6 has been obtained. It denotes that 31% of users interviewed and heard in safety and 27% safe with security problems. It can therefore be said that about 50% has a not entirely positive perception of the areas experienced due to both direct events due to the lack of pedestrian protection systems.

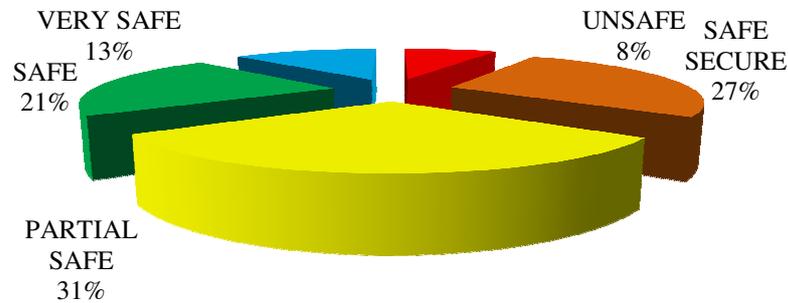


Figure 6: Definition of safety access to urban area

In order to be able to understand the perception of the beneficial effect of the walk activities from the health point of view, a question related to wellbeing during the walk was introduced obtaining only a 40% overall positive or very positive result. This perception of non-health derives both from the lack of education to the topic and also from the presence of environmental and geometric-functional obstacles present in the paths that reduce the positive response, like described on Figure 7below.

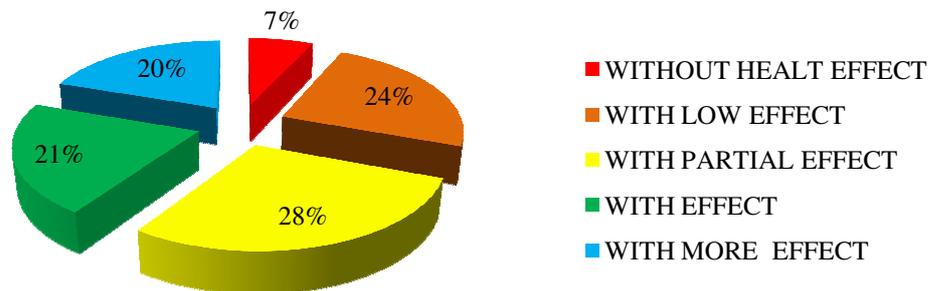


Figure 7: Definition of the health effect made by walk activities

From the point of view of the overall efficiency of the infrastructures where it is possible to walk, both the investigated area and the historical centre have had the same answers as shown in the following Figure 8. The result is corroborated by the urban structure uniformly distributed.

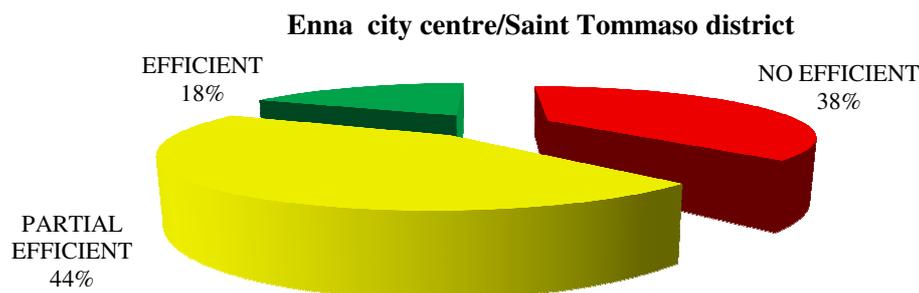


Figure 8: Efficient access in the city centre and in SaintTommaso neighborhood

The considered road network develops in about 3 km with a main axis that covers about 70%.

This network has been divided into homogeneous sections of about 200 meters, taking into account the street numbers of the area. The analysis was first tackled through the acquisition of the functional geometrical characteristics of the individual sections and therefore by calculating an overall walkability coefficient. Subsequently the analysis was extended, also evaluating aspects related to urban planning as shown below.

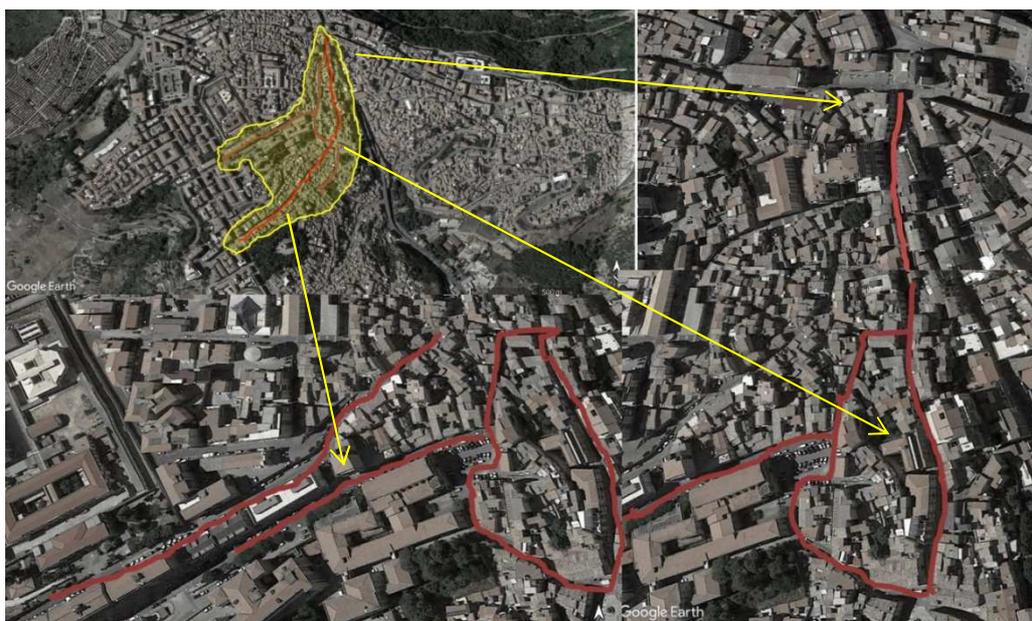


Figure 9: Investigated area and relative road sections

The dissemination of the questionnaire has therefore highlighted the critical issues present and the propensity of the population to walk in the historical city center. Some aspects related to the perception of danger and cultural aspects will be discussed more in the future. These aspects with also the sustainable policy of Local Authorities can reject the use of the car and at the same time to promote maintenance actions of the heavily damaged sections in order to make it easier and safer for users to use the road.

If the evaluation of popular opinions are fundamental for the dissemination of walkability, in a complementary way it is useful to evaluate the state of the infrastructures and their boundary conditions as shown by the results of the three

methods applied to the case study. In particular, it was considered appropriate to divide into 43 sections the infrastructural network examined considering sections of homogeneous type as defined in Figure 10. Each section has a beginning and an end corresponding to the odd house numbers present in the network.

The first evaluation was carried out taking into account the Walkscore method, obtaining the following shown in the graphs 11 and 12.

The graphs on figure 2 and 3 show that the sections with a higher attribute in value are those directly connected to the main road arteries instead the oldest area and characterized by inaccessible streets and often unreachable through a medium have the lowest ratings. These values are recurrent because the urban structure of the investigated city is impervious both for the reduced width of the roads and for the high slope due to the orography.

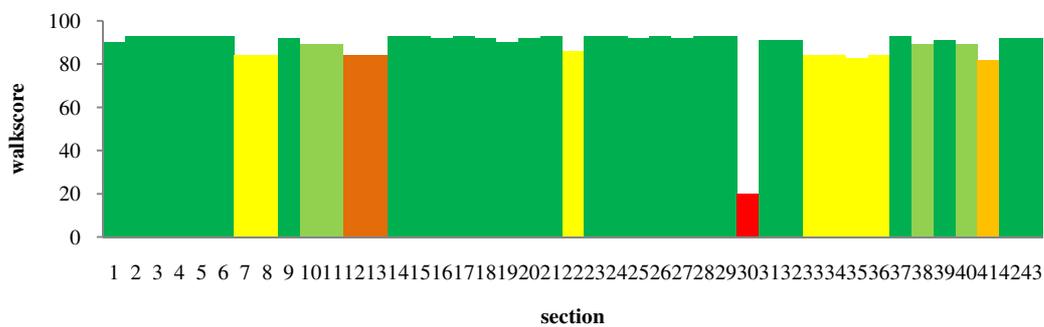


Figure 10: Walk score values related to Saint Tommaso infrastructures

As you can see, there are a few sections characterized by a low score of the indicator and in particular are those characterized by the highest slope of the entire infrastructure system considered and the geometry of the lane with a single extremely low travel direction.

These critical issues are also spread in the sections from 26 to 39 as they are not passable to public transport and often also to vehicles over 1.80 m wide and therefore these sections are difficult to reach with some modes of transport both public and private vehicles. The following graph on Figure 11 shows how the connections with the means of transport are less easy as we move away from the historical centre, since we do not have a capillarity in the diffusion of these services.

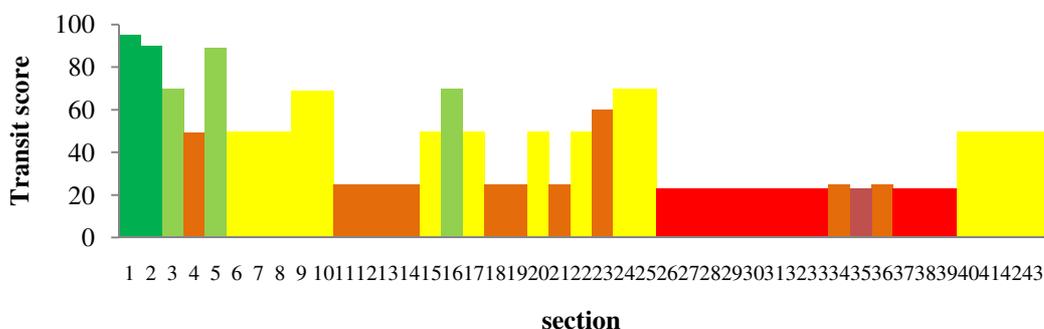


Figure 11: Transit score values to Saint Tommaso infrastructures

This type of approach shows how the sections closest to the main streets or near the best maintained building structures have indices with higher value. In order to consider aspects related to the interconnection of areas but also to the propensity of the population to walk on foot, the evaluation of the parameters defined by the 7 C's method was reached, reaching the highest values both in terms of conviviality (about 80%) and connectivity (about 60%) like described on Figure 12.

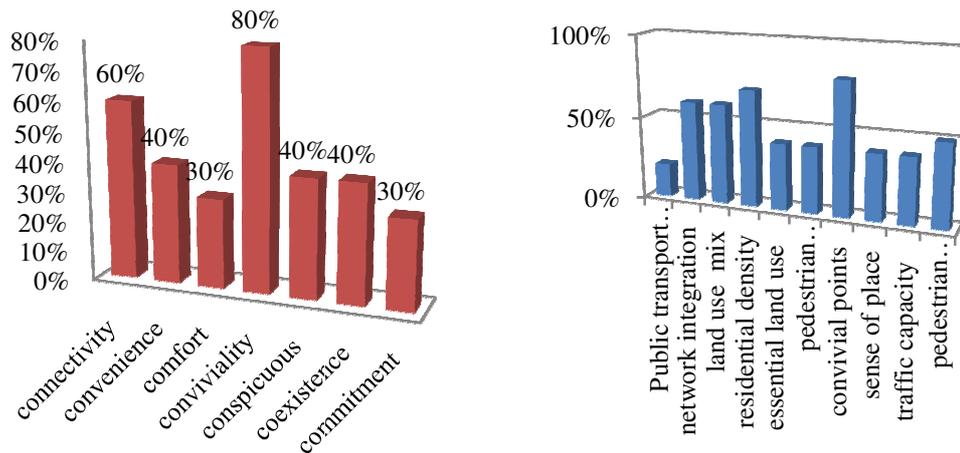


Figure12: General evaluation in macro-scale terms related to all the sections examined considering 7C components (left)and general components (right)

This assessment was largely supported by the questionnaire described above. In particular, the variation of the 7 parameters along the main direction via Roma is shown in the Figure 13.

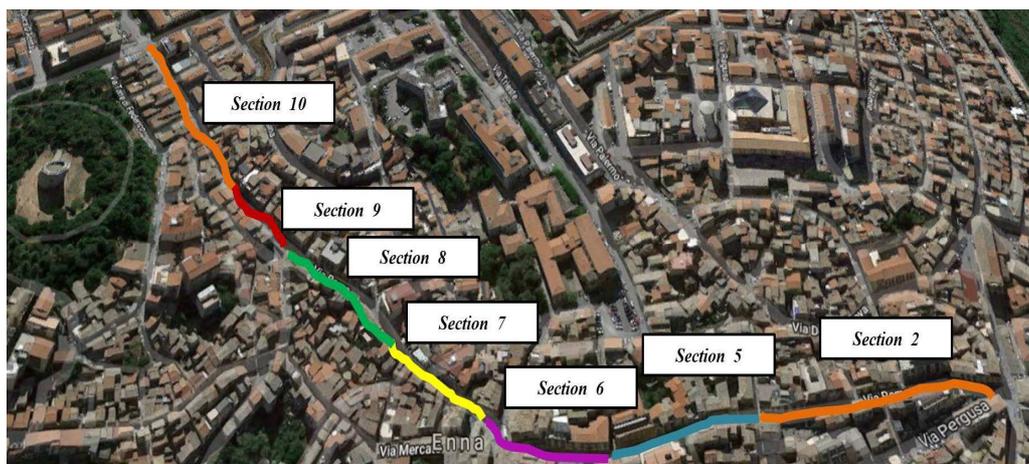


Figure13: Via Roma area and relative sections

Specifically, the evaluations carried out along the sections relating to via Roma are shown, from which we can denote a significant variation of the parameters listed above. The variability is due to the presence of commercial activities in the sections and

therefore greater pedestrian and vehicular flow but also to a different conformation of the road superstructure with the presence of sidewalks of variable width and presence of conflict elements. As shown in Figure 14, sections 2,5 and 6 present among the major problems connected to Conflicts and Sidewalk buffer. Section 6 is featured also by Maintenance problem.

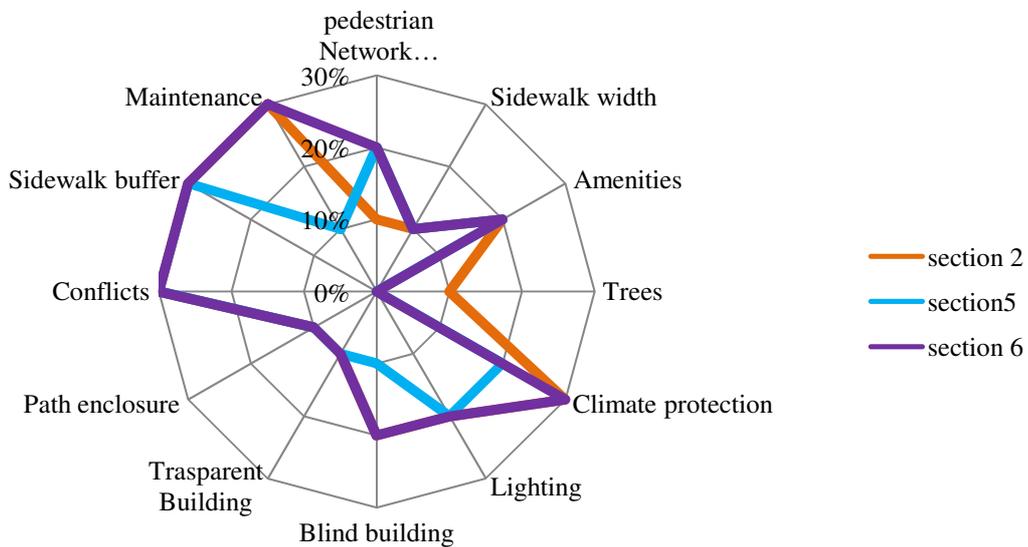


Figure14: Evaluation of walkability index on sections2-5-6

The following sections, namely 7,8,9 and10, like described on Figure15,show the major problems related to maintenance and climate protection due to the diversification of the urban and building context with the greater presence of shops and offices compared to the previous and subsequent sections. In particular the sections 8-9-10 are related predominantly by maintenance and climate protection problems.

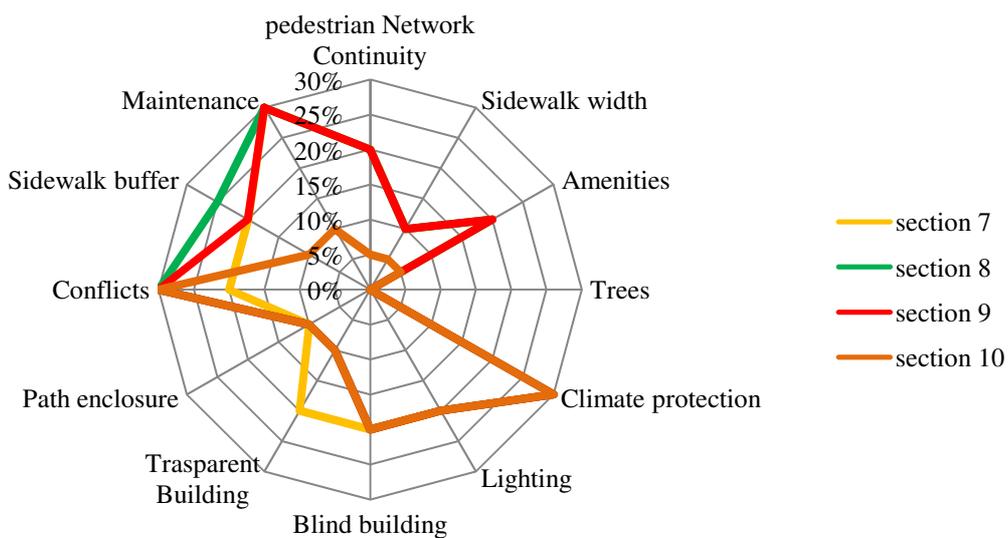


Figure15: Evaluation of walkability index on sections 7-8-9-10

This approach has therefore allowed the correlation of the parameters contained in the Walkscore method with other social and urban parameters belonging to one of the 7 factors C. In order to be able to evaluate in a considered way the potential of each section to be crossed on foot, the third method was used. Generally, the methods are oriented to return how much a place is walkable in itself, for its physical characteristics and for its organization, the third method applied to the area in question means that instead of evaluating how much a certain place is walkable in itself, the walkability score reflects how and towards where a person can take a walk starting from that place. For this reason, as we shall see, the walkability score is an aggregate that combines three components, in particular referred to the number of urban interest / opportunity destinations within walking distance; their distances and the quality of the pedestrian routes to these destinations. The quality of the routes pedestrian is assessed based on different attributes relevant to the walkability, which they refer to characteristics of the road and the surrounding environment that they are able to contribute to make the route efficient, pleasant, safe and attractive. The Table 5 below shows the evaluation scale adopted in accordance with (Blečić, Cecchini, Congiu, Fancello, Fancello, & Trunfio, Walkability explorer: application to a case-study, 2015b).

Table 5: WI score scale

<i>Value</i>		<i>Global WI</i>
0,1-0,2		Extreme/unsafe
0,2-0,3		High
0,3-0,4		Considerable
0,4-0,5		Moderate
0,5-0,6		Low
>0,6		Safe

The Figure 16 shows what is described in the Table5that denotes how the sections represented by the green colour all fall along the main road called via Roma and that more than 30% of the sections investigated is potentially not viable on foot due to the lack of sidewalks, high slope of the sections or poor maintenance.

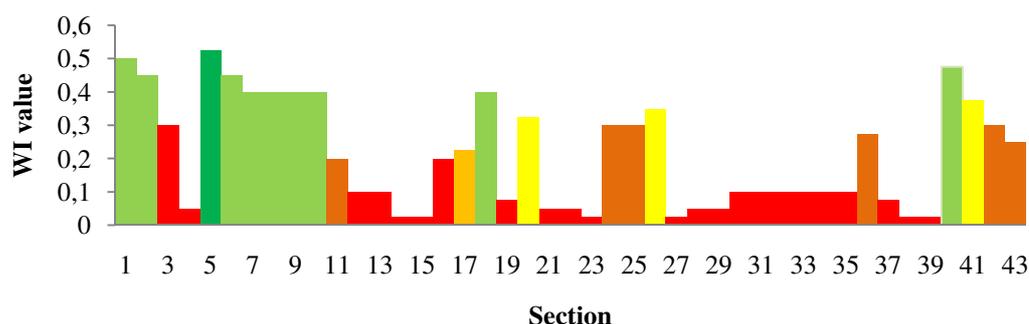


Figure 16: Evaluation of Walkability index considering maximum benefit and potential walkability

Some are easily observable, recognizable and measurable requirements: cycling (the possibility of cycling along the route), the number of driveways, the maximum speed, the one-way streets, the stops and parking areas along the road, the slope, the quality and the degree of maintenance of the flooring, the lighting. Other attributes instead refer to conditions and combinations of characteristics that require an evaluative judgment. It is helpful to briefly mention their meaning. The useful width of the pedestrian stretch is based on a qualitative assessment of the effective possibility of walking without obstacles (physical or perceptive). The possible values of the attribute range from very large sidewalks to the complete absence of space dedicated to pedestrians, and are defined according to the number of people side by side who can easily walk through space. The attribute of separation of the pedestrian area from the driveway is determined by the presence of physical elements, horizontal or vertical, which increase the perception of safety and comfort of the pedestrian (flowerbeds, trees, fences, walls, etc.). Then there are two attributes that concern the landscape, environmental and historical-architectural-urban aspects, which are important for the pleasantness of the walk: for these two attributes a qualitative evaluation judgment related to the presence is recorded (more or less intense) and prevalence of pleasant or disturbing elements. The attribute of the shelter registers the possibility of shelter from the rain, wind and sun, linked to the architectural configuration, and to the naturalistic elements and urban furniture. Another attribute is correlate to the pedestrian proneness to stop and sit considering the benches, chairs as well as other architectural elements or urban furniture not necessarily designed specifically for pedestrians, but still used by people to sit (stairways, walls, edges of the fountains, etc.). The presence of activities and services aims to capture safety aspects (linked to the presence of other people, traders and merchants) as well as attractiveness and liveliness linked to the density of commercial activities that are among the aspects of walkability more highlighted by various scholars (Cervero & Kockelman, Travel demand and the 3Ds: density, diversity, and design, 1997).

The integration with the urban context tries to describe how the urban environment surrounding the pedestrian path stimulates interaction with the pedestrian, from full integration to the presence of the filter and transition spaces obtained with architectural or naturalistic elements, to the separation with walls or thick fences. Finally, the urban context detects the type and density of the surrounding urban context, from dense context, to the presence of parks, squares and green spaces, to the low-density context of diffuse-type or to un-built or abandoned areas. Evaluating beyond the previous

parameters also parameters of attractiveness from the environmental and urban point of view and also taking into account the frequency of services and activities, considering appropriate weights for each parameter.

4. Conclusions

In this research, the concept of walkability was investigated considering three different methods that can be implemented at various scales and focused on the evaluation of a case study of a medium-sized Sicilian historical centre. It has been found that the approach based on the potentiality of the walkability associated with the analysis of the geometric dimensions of urban layouts represents a promising theoretical framework that can be made operational for the evaluation of different aspects relevant to the quality of life in the cities. The urban ability to walk can, in our opinion, be considered as correlated both to individual well-being, but at the same time able to produce indirect benefits also in relation to other abilities (for example, health, physical integrity, belonging, play, control of your environment ...) and therefore the general quality of life. The characteristics of walkability were explored in terms of the instrument's decision support, which resides in its capacity and flexibility to generate a complex spatial analysis and to make comparisons between the current situation and the estimated effects of the improvements of the road network and urban projects. It denotes how the judgment of the resident population is fundamental for the knowledge of the urban road infrastructures.

From the values obtained by the different methods of analysis we can see how the sections closest to the main road axes of the city are characterized by greater values as well as those of more recent maintenance while the internal areas retain a reduced geometry and often a mediocre state of maintenance that define possible negative impact for walkability.

The comparison of three different methods of analysis shows how the above-mentioned concepts can be evaluated with varying degrees of precision, thus providing the Administrations with a synthetic judgment and laying the foundations for further research aimed at a more incisive evaluation of walkability judgments.

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