ANALYSIS OF WALKABILITY MEASUREMENT TOOLS (WMTs)

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ABSTRACT

ANALYSIS OF WALKABILITY MEASUREMENT TOOLS (WMTs)

Walking is the most basic act of human which makes all equal and liberates them in the built environment. For defining how walking friendly the area is, walkability is an issue started to be discussed from its several different aspects. Although walkability is studied from several different disciplines, it has neither accurate definition nor definite criteria.Starting from 1990s, walkability has started to be measured with hard-copy walkability measurement tools (WMTs) and followed by web-based walkability measurement tools. In the literature, WMTs are generally used as a tool to measure the walkability level of the selected case. However, there are few studies which tries to understand and examine the background process of these WMTs.The aim of this thesis is to categorize and define the background idea of walkability measurement tools by criticizing their keystones and their main ideas. The mapping, clustering, tabling and analyzing processes are the main devices to develop critical analysis. In tabulation, two specific charts are composed: Comprehensive Data Chart and Content Analysis Chart. Under Comprehensive Data Chart, properties of WMT are defined and categorized. In Content Analysis Chart, each tool's content of WMTs are compared and criticized. Finally, the thesis developed a critical analysis for defining, comparing and understanding each and every single WMT.

ÖZET

YÜRÜNEBİLİRLİK ÖLÇÜM ARAÇLARININ (YÖA) ANALİZİ

Yürümek insanların en temel hareketi olup onları herkes ile eşit kılar ve yapılı çevrede özgürleştirir. Bir alanın ne kadar yürüme dostu olduğunu ifade etmek için geliştirilen "yürünebilirlik" terimi, farklı açıları ile birçok farklı disiplin tarafından çalışılmaya başlanmıştır. Her ne kadar çok farklı alanlarda çalışılsa da, yürünebilirliğin henüz kabul görmüş evrensel bir tanımı ve ölçütü bulunmamaktadır.1990'lardan itibaren yürünebilirlik, basılı yürünebilirlik ölçüm araçları (YÖA) ve sonrasında da elektronik yürünebilirlik ölçüm araçları ile ölçülmeye başlanmıştır.Literatüre bakıldığında bu YÖAlar çoğunlukla seçilmiş bir bölgenin yürünebilirlik seviyesini ölçmek için kullanılmaktadır. Ancak, bu araçların arka plan sürecini kapsamlı şekilde inceleyerek anlamaya ve irdelemeye çalışan çok az sayıda çalışma bulunmaktadır. Bu tezin amacı, yürünebilirlik ölüm araçlarının temel taşları ve ana fikirlerini eleştirel bir bakış açısı aracılığı ile yürünebilirliği nasıl ele aldıklarını gruplandırmak ve tanımlamaktır. Haritalandırma, gruplandırma, tablolaştırma ve analiz süreçleri eleştirel analizi geliştirmede ana araçlar olmuştur. Tablolaştırma süresinde iki adet tablo oluşturulmuştur: Kapsamlı Veri Tablosu ve İçerik Analiz Tablosu. Kapsamlı Veri Tablosunda, yürünebilirlik ölçüm araçlarının özellikleri belirtilmiş ve gruplandırılmıştır. İçerik Analiz Tablosunda ise yürünebilirlik ölçüm araçlarının içerikleri karşılaştırılmış ve eleştirilmiştir. Sonuç olarak, bu tez her bir yürünebilirlik ölçüm aracını tanımlamak, karşılaştırmak ve anlamak için eleştirel bir analiz geliştirmiştir.

To my mother Demet Paykoç,

made me who I am

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LIST OF ABBREVIATIONS

ANC	Active Neighborhood Checklist
GWI	Global Walkability Index
IMI	Irvine Minnesota Inventory
NEWS	Neighborhood Environment Walkability Scale
PANES	Physical Activity Neighborhood Environment Scale
PEDS	Pedestrian Environment Data Scan
PERS	Pedestrian Environment Review System
PEQI	Pedestrian Environment Quality Index
PIN3	PIN 3 Neighborhood Audit Tool
SPACES	Systematic Pedestrian and Cycling Environmental Scan
SWAF	Scottish Walkability Assessment Form
WMT	Walkability Measurement Tool
WSAF	Walking Suitability Assessment Form

CHAPTER 1

INTRODUCTION

This chapter covers the general introduction of the thesis. The background of the thesis is described. First, the problem definition is given. Secondly, the main aim of the thesis is mentioned referring to the problem. Following, the significance of the study and which aspects of this study are important is discussed. Afterwards, the research questions of the thesis are given and the scope of the study is described in detail. The research methods used in thesis are also described. Lastly, the structure of the thesis is summarized.

1.1. Background of the Study

Walking is the most basic and the easiest act of human and other living creatures. It is also an act which liberates human because that there are no limitations for this activity except any health related problems. All human walk for different purposes. Due to the reason that it is performed by every individual, walkimg may seem as an objective act. However, the experience of each individual or each person live while walking may differ which makes walking as subjective term. Also, people with different needs and abilities like children, elderly, disabled walk in their everyday routines. Through walking, people from different needs become equal somehow. There can be several different aims for walking so that it has several different dimensions which affect walking. Indeed especially in walking without any target, it might be shaped according to several different reasons or dependents. There are some social factors that have impact upon walking as well as the physical factors. When these physical and social factors are encouraging, individuals tend to walk more. Contrarily, when these factors are discouraging, individuals seek to choose other modes of transportation. When the factors encourage the act of walking, this type of environment might be defined as "walking friendly". Especially with the development of several modes of transportation, walking tried to be brought to the fore by being studied by different disciplines with the term "walkability" like architecture, urban planning, public health, medicine, transportation, recreation, philosophy, and sociology.

Although the topic and concept walkability started be studied by several different disciplines with different scholars, there are still problems and gaps related to categorization in academia. One of the problems is the lack of clear definition of the term itself. Second gap is that walkability still has no clear set of criteria to evaluate and criticize scientifically by several disciplines. The other problem can be the integration of walkability tools into field of urban design and planning with a participatory approach.

Although there are other problems and failures in the emerging field of walkability discourse, it is attempted to be measured with developed walkability measurement tools (WMTs). In addition to some global WMTs like Walk Score, NEWS or SPACES, there are also some local WMTs developed for Turkey, İzmir, Karşıyaka by Çubukçu, Hepgüzel, Önder, and Burak (2014). These walkability measurement tools are told to measure walkability but their main aim can not only be defined as analyzing walking but also gathering data about walking and everyday life related issues. With the acceptance of walking activity being as a measurable act, then it becomes a theme that can be also quantifiable. In other words, all walkability measurement tools accept the idea that walking is an act that can be measured and can be quantifiable at the end with numeric results. In everyday life, mainly physical aspects or things are measured like weight, distance, or volume. In addition to being physical formations, they are also social issues (Porter, 1995). When things are measured with numbers, they are actually exposed to a mathematical process that is actually very structured, clearly defined, standardized and rule-based. Through this defined rules and a well-structured system, a universal and a uniform discipline can be created all around the world. Due to the reason that numbers are so general, they can be easily shared with each and every location (Porter, 1995). In some aspects, the reliance to these numbers and quantification minimizes the requirement of personal data and individual faith. For Porter (1995), quantification is also a way of communication that exceeds local boundaries and can be reproduced and continued independently of who produced it. To put it differently, it provides a global network so that quantification can be labelled as one of the pioneer approaches in that manner. It does not also mean that quantification is directly opposite to nature. In nature, the traces of numbers, logic and uniform organization can also be seen in rivers, limits of lands (Porter, 1995). Moreover, as to the presence in its nature, as Otis Dudley Duncan cited (Porter, 1995); numbers also exist in the social process and it can be evaluated as a great and critical instrument to direct people and nature. In today's modern era, the numbers obtained can be achieved via computers that rely on mechanical processes. In their very own nature, this process is explicit and well-structured. When these quantification methods are also used in walkability measurement methods, it is discussed by some researchers if it is true to quantify or digitize walking or not. However, in this thesis, it is not a problem if it is quantifiable or not, but the main concern is to analyze the background idea of these tools. There is not such acceptance or rejection if the walkability can be a concept that can be measured or not. In other words, through analysis, it is attempted to develop a critical understanding of these tools.

1.2. Aim and Importance of the Study

This thesis aims to understand general understanding of walkability measurement tools. Also, it tries to compare hard-copy and web-based tools to see whether there is a difference between their understandings of walkability. By making a detailed analysis and data collection for each tool, a comparison is made. During the analysis of each walkability measurement tool, there is an issue in which it is being awarded of either walkability is a concept that can be quantifiable or can be measured, and then turned out into numeric results at the end. Another aim of this thesis is to comprehend which aspects of walking act are covered in walkability measurement tools. In other words, this research aims to make out the missing aspects of walking in the tools if there is.

In the studies on walkability measurement tools, there are generally three different types of studies. The first research type is the validation of the selected walkability measurement tool by re-applying it. These studies are the approval of each WMT without any doubt. The second type of research is the comparison of two or more selected case areas by using the same walkability measurement tool. It is comparing some focused sites, rather than criticizing the tool itself. The last research type is the comparison of two or more walkability measurement tools by using the same case study area. Those have limited perspectives in content analysis and comparison.

However, there is no such comprehensive research for understanding the background theoretical framework of these walkability measurement tools. This research aims to fill the two gaps in the literature. The first possible gap is developing an attempt to understand the background idea of the each tool with a critical analysis. The second contribution can be the developing a scientific approach to understand the design process and ideas of walkability of the institutions with their developers involved in decision-making process of built environment. With the help of these outcomes, this thesis tries to tackle the issue of walkability with its different aspects and background ideas. Through developing a critical lens towards walkability measurement tools, it is also aimed to put into words that either real aim of WMTs is to measure walking or for other reasons.

1.3. Research Questions

The main focus of this thesis is to understand the background idea of walkability measurement tools with a critical and detailed analysis. The first research question is "What is the underlying idea of each walkability measurement tool – understanding of walkability, expressions, aim and strategy, publications and other studies, scientific algorithms, data sources, evaluation criteria, scoring procedure, operating methods, final result presentation, user profile, and locations the tool is available?". The second research question is "What are the aspects generally covered in WMTs – physical, psychological, and socio-spatial? Are there any missing aspects in WMTs?". Actually, the first research question seeks to understand which parts are covered within the scope of the walkability measurement tools, whereas the second research question aims to analyze which aspects are missing in the walkability measurement tools.

1.4. Scope of the Study

Under the scope of this thesis, walkability measurement tools are analyzed from a critical point of view. Before the analysis of walkability measurement tools, literature of walkability and walkability measurement tools are covered. Rather than focusing each and every single walkability measurement tool that are currently existing, the widely used and well accepted ones – *hard-copy and web-based WMTs* – are chosen. In other words, less used walkability measurement tools are not covered in that thesis. While analyzing the selected tools, it is not in the focus of the thesis that whether walkability quantification should be made or not. It can be a focus of another research that if the act of walking can be quantifiable or not; or walkability measurement tools are an approach towards quantifying walkability. Different than the other studies, this thesis aimed to understand the background of the WMTs rather than directly comparing them or making a case study with them. During the analysis, the content of each tool was found and analyzed in detail but they are not covered as a part of thesis due to privacy and copyright related issues.

As limitations of this study, it is harder to obtain data about the hard-copy walkability measurement tools compared to web-based walkability measurement tools due to the reason that they are generally only covered in research papers or journal articles; not taking part in web as web-based WMTs. Another limitation of the study is to reach evaluation process details of most of the tools – especially the hard-copy walkability measurement tools.

1.5. Methods of the Study

Within the limits of the thesis, the tools that used to measure walkability are analyzed. There seems to be two categories in WMT: one hard-copy and web-based (digital). There are many existing hard-copy walkability measurement tools in the literature starting from 1990s which differs in terms of their type (either being a checklist, audit, or index), the criteria they set, the user profile, the questions, and the area that they search. With the integration of technology into everyday lives with the common usage of mobile phones, these hard-copy walkability measurement tools started to evolve into mobile apps as web-based walkability measurement tools *(Walk Score, Walkability Asia, Walkshed, Maponics, Rate My Street and Walkonomics)*. There are several analytical studies that use these walkability measurement tools only as tools for the selected case or validation, but there are studies that focuses on the background formation and evaluation of these tools. This thesis will focus on understanding their theoretical and practical formations (*their understanding of walkability, how they express themselves, their aim, and the quotes of the developer firm*), their specific engines and algorithms, data sources, focused issues, reference evaluation criteria, scoring procedure, the way they present the final walkability result or scores, and the tool's operating methods.

For the comprehensive literature review, the following sources and scientific databases were reviewed: Google Scholar, Google, Science Direct, EBSCOhost, Elsevier and Taylor and Francis. In addition to these academic databases, print-out resources and World Wide Web were also searched.

For representing the methodology of the thesis, a diagram can be seen below (Figure 1.1).

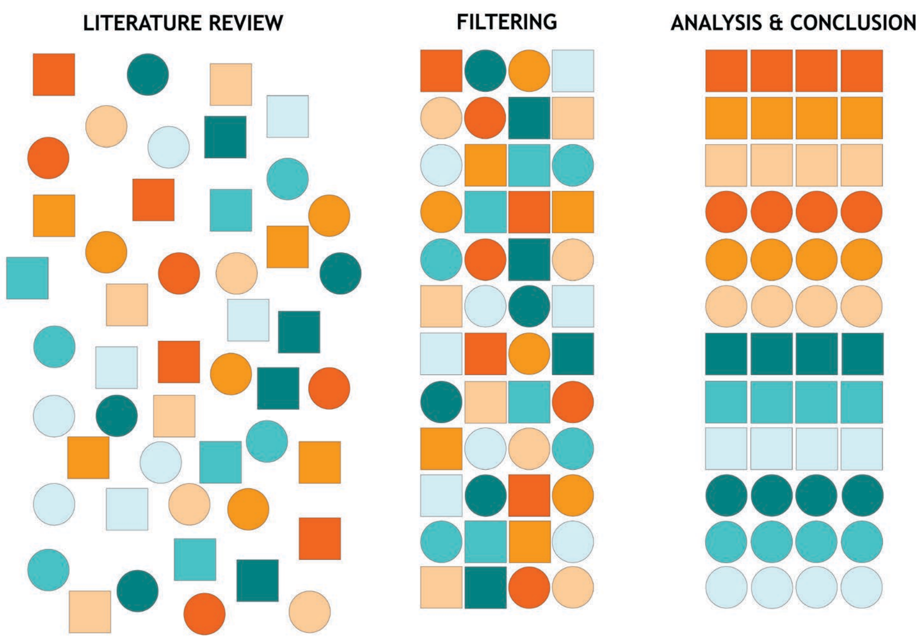

Figure 1.1. Conceptual Diagram of the Thesis

From the very beginning of the thesis research, a comprehensive literature review was conducted to cover all walkability measurement tools (*hard-copy and web-based*) that exist between 2015 and 2019. While collecting data about both hard-copy and web-based walkability measurement tools, academic papers, journal papers and thesis (in which the tools are whether used as a method for a specific case study or introduced and compared in a literature review), and the web (in which mainly the tool's websites or other websites that contain information about a specific tool are covered) were searched. After collecting all the data about the tools, there is like a lot of data that are related to each other which is symbolized on the left hand side of the conceptual diagram.

After data collection process was completed, an analytical filter (*which called critical analysis*) was developed and applied by the author to cluster all the data collected and group them according to main subjects. Through the application of this critical filter, all selected tools were analyzed in detail according to their main and distinct characteristics to understand their main background idea.

Following the application of critical filter, it was started to group or cluster all the collected data about WMTs under common headings. During this clustering process, it was decided to compose two main charts which both allows to make comparison between each walkability measurement tool. The first chart is Comprehensive Data Chart that covers the main characteristics and properties of WMTs. The main aim of Comprehensive Data Chart is to see which issues or entities are covered in WMTs. Rather than being a critical chart, it is composed through the concrete collected data from the literature. While composing the chart, the first step is to define the upper titles which allows researchers to understand the background idea of each WMT about walking and walkability. The upper titles are defined as developer of the tool, the main research area of the tool developer, the target profile that the WMT defines, the methodological details, types of the questions and criteria, and the additional materials that the tool have. The main idea behind these upper titles is to make analysis on and understand by whom the tool is developed, the real aim of the tool developer, the target user profile that the tool addresses, methodological details of the tools which contains three different stages – data collection, in-auditing and evaluation – the types of the questions and presence of supplementary equipments. After the upper titles were defined, sub-titles were set to make more detailed comparison between.

The second chart is Content Analysis Chart which includes the questions or criteria of each tool. The main aim behind this chart is to see the missing aspects of WMTs in terms of their content. Different than Comprehensive Data Chart, Content Analysis Chart was generated through a critical lens towards the covering of each WMT. The first step is to write down each single question or criteria of each WMT in a single comparative sheet. After documenting the content of each WMT, the literature was covered to see what topics are covered in WMTs. The main aim behind this is to cluster the content of each WMT under some groups. In other words, as second phase; criteria of each tool was clustered under some groups. Following the clustering of content, the criteria of each tool was turned out into same format – phrase version. For being able to make a detailed analysis and comparison, sub-groups are also composed under each group. As the last step of Content Analysis Chart, each group was assigned a symbol to make the chart more readable. In addition to symbolization, theming – perception and abstract, user, environment-based, physical, function, network, policy – was also made according to the common features of the groups. This theming and and symbolization process allows researchers to make more detailed and easier comparison between WMTs.

When the charts were finalized, a numeric and descriptive analysis were made to each chart separately. After this separate analysis, a more detailed analysis and commanding was made through tackling these two charts as a whole. Following the analysis of these charts, some other issues that have importance in WMTs were also analyzed.

In addition to making a detailed analysis about WMTs main characteristics and content to understand their understanding of walkability, a new method – Comprehensive Data Chart and Content Analysis Chart – is also generated which can also be applied to other WMTs in the future.

1.6. Structure of the Thesis

In the first chapter, the introduction of the thesis is described in details by focusing on the problem definition of the research, its aim and importance, the research questions and the methods of the thesis. In second chapter, current literature of walkability is given by highlighting origins of walkability, definitions of walkability, multidisciplinarity characteristics of walkability, important academic papers and references of walkability, its elements and aspects. In the third chapter, the hard-copy and web-based walkability measurement tools are defined and covered, besides some detailed information is given for each of the tools. Also, the comparative charts are developed for an extensive analysis: Comprehensive Data Chart and Content Analysis Chart. In forth chapter, the detailed numeric and descriptive findings from this charts as a response to the research questions are defined. In the fifth and the last chapter overall comparative analysis and comprehensive discussion are conducted. Also, the contribution to the literature of this thesis and probable future works are underlined and listed.

CHAPTER 2

WALKABILITY

Starting from the very first emergence of the human beings, walking is the most basic act which can be conducted by each and every individual without any supplementary requirements. It is also one of the most preferred and common types of physical activity. The reason why walking is so much preferred and conducted is due to its cheapness and feasibility by everybody (Aghaabbasi, Moeinaddini, Shah, Shekari, and Kermani, 2018). Although it is a very basic act, there are two different modes of walking: walking for transportation and recreational walking (Zuniga-Teran, Orr, Gimblett, Chalfoun, March, Guertin, and Going, 2017). Both of these two types of walking are affected by the built environment. For choosing walking as a mode of physical activity when compared to other modes, walking should be safe, interesting, comfortable, and useful (Bereitschaft, 2018).

Along with the integration of technology into our everyday lives starting from 1990s, our daily habits also evolved and changed accordingly. The most remarkable two outcomes of this integration and evolvement are the changes in our telecommunication and transportation activities. Mainly, our activity of walking started to be altered because of more usage of automobiles. Moreover, the cities tended to grow towards the suburbs, especially with the effects of capitalism. Also, one of the greatest problems of the communities in today's world is traffic congestion (Azmi, Karim, and Ahmad, 2013). For increasing the level of accessibility in urban life while also reducing the need to travel, professionals from the urban design field made a proposal that brings the origin and final destination of the travel close together (Mumford, 1956). In addition to the traffic and transport related proposals to traffic congestion problem, increasing the density of neighborhoods is another suggestion which can reduce the distance of transportation, increase the level of walking acts, and minimize the overall usage of automobiles (Azmi, Karim, and Ahmad, 2013).

As one of the most mentioned properties of liveability in urban environment (Ghadimkhani, 2011), walkability is in the vocabulary of many academicians and researchers. It actually gained importance after World War II in both Europe and the United States after the automobile invasion and rapid urbanization. Jane Jacobs can be listed as one of the critics who fights for street life and walkability by creating a focus on the benefits of safe, diverse, and lively streets. Lynch, with his book entitled 'The Image of the City' (1961) can also be mentioned as the one who drew great importance to the experience of walking and the mental maps (Pak and Verbeke, N.D.). It has become a buzzword in today's urban planning jargon due to the increased importance assigned to sustainability and green-smart transportation as the New Urbanism started to spread out (Azmi and Karim, 2012; Azmi, Karim, and Ahmad, 2013), New Urbanism is a movement that emerged in 1980s through focusing on the physical features of built environment that creates the traditional neighborhoods in which the act of walking is the main property of active streets (Biernecka-Lievestro, 2014). Walkability is one of the principles that is promoted on the website of New Urbanism as a benefit to urbanism (Fitzsimons, 2013). As it was cited by Fitzsimons (2013), Advocate Dan Burden estimates that the walkability movement started in 1983, but the concept and term came afterwards in 1992-93. Also, as it was cited by Pak and Verbeke (N.D.), it is also possible to trace the origins of walkability to Howard's Garden City and Drummond's Chicago Plans with both setting people in the center of their designs rather than automobiles, mixed use within walking limits and use of natural elements as a reference to sustainability.

Walkability has started to be used and discussed in several different references, which are mainly from transportation and planning disciplines. At first, walkability was used by the Institute of Transportation Engineers' Journal in 2000 as an aspect of American Highway Capacity Manual (HCM) through including the pedestrians, the presence and physical qualities of the sidewalks, and crosswalks with the aim of providing a logical method to assess transportation facilities. After that, Do (2002) also used walkability in her article entitled 'US Federal Highway Administrations' Pedestrian Facilities Users' Guide', which focuses on possible enhancements that can be conducted related to transportation design. For developing this guide, walkability checklists are used for identifying the spots with pedestrian problems. Afterwards, some pedestrian plans started to be proposed which also cover walkability like City of Portland Pedestrian Master Plan designed in 1998, which aims to cover the issues related to both land planning and transportation of Portland (Fitzsimons, 2013).

The term “walkability” was spread out from the field of transportation, urban design, and urban planning to other several disciplines starting from the public health and preventive medicine on the basis that features of the built environment have a direct impact upon the walking frequency of individuals (Choi, 2012; 2013; 2014). The aim of covering walkability in health-related disciplines like psychology, gerontology and endocrinology is to more deeply analyze which factors of the built environment affect walking. As the planning and transportation-related disciplines focus on more empirical and quantitative aspects of walkability, health disciplines firstly tried to collect information about the behavior of the collective patterns and its direct relation to the built environment. In other words, it was aimed to create a focus on the experience of the walkers: “how walking constructs narratives, generates impressions, (re)produces habits and identities, or how walking formulates lived experiences or life practices in a broader sense” (Choi, 2012; 2013; 2014). The very first usage of the term “walkability” or “walkable” was by Sallis, Bauman and Pratt in 1998 in which they proposed walkability as a “potential physical activity promotion partner” to Partnership for a Walkable America (Fitzsimons, 2013). Secondly, walkability was included in the public health discipline by King and his colleagues in 2002, in their review that covers the individual level of physical activity concepts from disciplines that might be related like social psychology and urban planning. In addition to the direct usage of the term “walkability”, walkability indices and scales are started to be proposed by Moudon and Lee in 2003 and Saelens, Sallis and Frank in 2003 (as cited in Fitzsimons, 2013). It should also be noted that these are not the first papers that discuss walkability as a measurement of the physical environment, but they are the ones that used walkability as a measurable aspect in relation to the physical activity and the built environment. After being used and discussed by the fields of transportation, urban design, and health, walkability is also be discussed by different disciplines that will be analyzed in detail in the following part.

2.1. The Definition of Walkability

Although walkability is a term that was started to be used with the New Urbanism movement, there is still no single criteria for the term (Shamsuddin, Abu Hassan, and

İlani Bilyamin, 2012). The lack of a single definition of walkability in academic literature at this point may be a consequence of it being a non-academic movement (Fitzsimons, 2013). Another reason of not having a single common definition for walkability can be the result that all disciplines that study on walkability have their own terminology, like engineering, planning, transportation, and health. Whereas the general meaning is valid for all, there cannot be a “correct” definition in which all different disciplines split the difference (Abley, 2005).

Due to the reason that there is no single definition for walkability, there are some attempt proposals for the term in which each academician and researcher who studies walkability proposes his or her own. Current literature about walkability is covered to see the definitions and it is seen that although each definition proposal seems the same, there are slight differences between them which depends upon the point of view of the researcher.

2.2. Multidisciplinarity of Walkability

Because walkability is an issue that has several different concerns, it has been studied from several disciplines such as transportation, urban planning and health. Through being studied by different disciplines, the different perspectives of the issue were taken into consideration (De Cambra, 2012). As stated by Moudon and Lee (2003) in Fitzsimons (2013), the multidisciplinary research of walkability can guide researchers to a better understanding of several aspects, like both the behavioral and the environmental aspects of the physical activity. Because having a walkable environment started to receive a great attention due to its several benefits and advantages, there is an increasing need for knowledge and scientific research about walkability (Choi, 2013; 2014).

Until today, walkability has been studied by these following disciplines: philosophy, anthropology, sociology, anthropology, psychology, medicine, and engineering, in which both qualitative and quantitative aspects of walking are covered as a whole (Barros, 2014), and architecture and urban design. Also, in recent years, it has also discussed within the discipline of transport policy framework (Sdoukopoulos, Verani, Nikolaidou, Tsakalidis, Pitsiava-Latinopoulou, Mikiki, Mademli, and Pallas, 2017). While urban designers' main concern and focus are the built environment, walking activity, and pedestrians, anthropology deals with walking behavior from the idea that "walking is an individual behavior conducted in the environment" (Choi, 2012). Also, the preventive medicine field searches for the walking activity-health beneficial aspect relation (Choi, 2014). This difference point of view toward the analysis of walkability can provide a better and detailed analysis with its all aspects.

2.3. Walkability in Literature

Since walkability is studied by several disciplines, there are many different research projects, articles, or theses in terms of their perspective, theoretical framework and content. Generally, walkability researches can be grouped into four broad themes (Andrews, Hall, Evans, and Colls, 2012) as follows: a) measuring walkability and potential facilitators of walkability (demographic and social variables related to the social composition of places: age, ethnicity, socio-economic status, and the contextual factors of places: availability, land use designations, sidewalks, and crossings), b) walkability and diverse quantifiable outcomes (walking rates, distances, and health status), c) perceptions of walkability (familiarity, and safety) and d) evaluations on producing and forming of walkable environments.

Due to the increasing number of walkability researches in the literature, the new following clustering can be made. The first group can be a case study that covers research papers in which walkability assessment of a selected case or built environment is conducted to see whether the area is walkable or not. By making an assessment, either a tool is conducted in a single area for obtaining a detailed understanding about the selected case or a tool is conducted to more than one area to make comparison between the two. The second group can be grouped as computer based modeling and GIS (geographic information system). In this group the case related research papers using GIS to evaluate the walkability are listed. Also, model based approaches developing to evaluate walkability are clustered under this heading. The third group can be listed as health-related aspects (obesity, cardiovascular disease, hypertension, and BMI) of walkability. It covers the health problems like heart attack or obesity to prevent by the act of walking.

The fourth group is method development and validity of walkability measurement methods. In that cluster, two types of research papers are listed. The first group contains papers that focused on the methods used to assess walkability. Under this group, walkability of the selected case is analyzed with a tool. As the second group, the existing measurement methods are applied in a single environment or in multiple cases to validate the results that are obtained from that tool. The fifth cluster is valid for the outcomes and the benefits of walkability. In that group of papers, the related concerns of walkability and the benefits of walking act like economic and social are the focus. Some of the main issues covered in those papers are the social impacts, benefits of walkability and how walkability affects the economic relations in built environment. The sixth part is about the perception of walkability under which the individual aspects related to walkability are covered like the feeling of safety and the level of attractiveness. The seventh group can be about the physical activity and walkability relation. Under this cluster, how walkable neighborhoods can contribute to the physical activity level and active living of people is discussed. The eighth cluster is about the specific target profile in walkability (adults, older adults, children, youth, and women). The main aim of these papers is to understand the specific choices of user with their profiles. The ninth and last group is on the walkability measurement tools both web-based and hard-copy ones. There are some studies focusing on identifying or representing a new tool. This group of walkability papers covers the identification of tools rather than applying them in a real case. In terms of their format and type, two more categories can also be added to walkability research groups as follows. The first category is the review and evaluation papers. There are several papers that make a review about walkability from different perspectives like either the walkability measurement tools include the assessment of the sidewalks within their scopes. This group of research provides an overall understanding about walkability measurement tools and walkability through making comparison and review about the current literature. The second group is the theses and dissertations (bachelor, master and doctoral).In addition to research papers or journals, these dissertations from different education levels studying about walkability.

2.4. The Elements of Walkability

The main content of the walkability measurement tools are the questions asked to the respondents. These questions are actually the criteria that the tool developer set according to his understanding of walkability. In other words, the main content of WMTs which are the questions can be named as the criteria of the tool. In addition to being defined as criteria, the scope of each tool can also be described as it's elements, factors or parameters.

As there are several different disciplines studying walkability, the elements of the walkability varies according to different scholars. In other words, there are several different criteria proposals for the elements of walkability by varying researchers from different disciplines. For example, if an urban designer sets a criteria for defining elements of a walkability proposal, his focus can be on the land use, whereas if a health practitioner develops a proposal, then the focus is on the characteristics of the built environment that promotes and discouraging walkability.

There is a chart that shows all the different criteria or parameters that are used for walkability that is collected from different research and papers (Table 2.1). It also demonstrates that how numerous different criteria, factors and elements are used for the assessment of walkability.

There are several papers or research studies that try to propose it's own criteria for making a walkability assessment. In other words, there are several different content for analyzing walkability accordingly. Because that walking is such a subjective term, each criteria differs in terms of how it's developer looks to issue of walkability. In addition to the criteria proposals in the current literature, there are some criteria presentations with diagrams as follows from different references as below (Figure 2.1 and Figure 2.2).

2.5. Aspects of Walkability

The first aspect of walkability is contributing to *public health* – overall health and well-being of individuals- from different aspects (Ghadimkhani, 2011). It is proved that walkability can be described as a predictor of public health (Frank, Schmid, Sallis, Chapman, and Saelens, 2005). In other words, it contributes to the overall health of individuals so that walkability is taken into consideration as the key determinant in health studies (Booth, Creatore, Moineddin, Gozdyra, Weyman, Matheson, and Glazier, 2012; Frank, Sallis, Conway, Chapman, Saelens, and Bachman, 2006; Sarkar, Webster, and Gallacher, 2014) and center of the cure to health-related problems (Lee, McAlexander, and Banda, 2011). By encouraging physical activity for individuals, it improves the public health and well-being living in that particular environment (Sallis, Sealens, Frank, Slymen, Cain, Chapman, and Kerr, 2009; Sallis, Spoon, Cavill, Engelberg, Gebel, Parker, Thronton, Lou, Wilson, Cutter, and Ding, 2015; Doyle, Kelly-Schwartz, Schlossberg, and Stockard, 2006; Leyden, 2003; Battista and Manaugh, 2017; Lefebvre-Ropars, Morency, Singleton, and Clifton, 2017; Dyck, Cardon, Deforche, and Bourdeaudhuij, 2009; Duncan, Aldstadt, Whalen, Melly, and Gortmaker, 2011; Greenwald and Boarnet, 2001; Berrigan and Troiano, 2002). It is obvious that walkability literature considerably concentrated on its relationship between health-related aspects and walkability. One can say that one of the greatest reasons behind this increasing concentration is the scary increase in level of obesity all around the world (Saelens, Sallis, and Frank, 2013). Another reason why health the discipline seeks to research walking is that it is the most basic, easiest, and common type of physical activity (Choi, 2012). There are several studies which aims to prove that walkability can have a positive impact on obesity, reduce the level of obesity, and minimize the Body Mass Index (BMI) (Berke, Koepsell, Moudon, Hoskins, and Larson, 2007; Booth, Pinkston, and Carlos Paston, 2005; Brown, Yamada, Smith, Zick, Kowaleski-Jones, and Fan, 2009; Ghadimkhani, 2011; Frank, Andresen, and Schmid, 2004; Gauvin, Richard, Craig, Spivock, Forster, Laforest, Laberge, Fournel, Gagnon, Gagne, and Potvin, 2005; Lopez, 2004; Papas, Alberg, Ewing, Lezlsouer, Gary, and Klassen, 2007; Powell, Auld, Chaloupka, O'Malley, and Johnston, 2007; Sallis, Sealens, Frank, Slymen, Cain, Chapman, and Kerr, 2009; Smith, Brown, Yamada, Kowaleski, Zick, and Fan, 2008; Spence, Cutumisu, Edwards, and Evans; 2008;

Table 2.1. Factors That Affect Walkability in Urban Neighborhood (Source: Ranasinghe, Amarawickrama, Rathnayake, Randeniya, and Rathnasiri, 2015, p. 294)

Factors	Source	Factors	Source
Socio demographic factors		**Convenience & Comfort**	
1.Age			
2.Gender		44. Cleanliness of the roads	
3.Ethnicity		45.Variety of activities within buffer	
4.Education level of the respondent	Lawrence et al (2007), Ester et al (2006), Lilah et (2005), Ayşe & John (2012)46.	46. Number of houses with opened windows facing either side of the road	
5.Employment		47.Way finding signage	
6.Per capita income		48.Walking path modal conflict	
7.Household size		49. Ambient sound	Lawrence et al (2007), Kevin (2010), Southworth (2005), Krambeck & Shah (2006), Ester et al (2006), Saelens & Handy (2008), Ayşe & John (2012), Steven (2005),Litman (2005),
8.Number of employees		50.Foul air	
9.Physical Ability to walk		51.Continuity of sidewalks	
10.Auto ownership		52.Sidewalk width	
Mixed land use diversity		53.Paving treatment of sidewalk	
11.Residential Commercial Educational & recreation Administrative Agricultural	Cervero & Kockelman (1997), Sallis et al. (2005), Steven (2005), Lawrence et al. (2007), Forsyth et al. (2007), Saelens & Handy (2008), Ewing & Cervero (2010), Ayşe& John (2012)	54.Width of Home access road	
		55. Maintenance of walking path	
		56.Shade & cover from harsh climate	
		57.Clear route	
		58.Vehicle parking facilities	
		59.Price of parking	
		60.24hour convenience stores	
Accessibility	Lawrence et al (2007), Ester et al (2006), Lilah et al (2005), Steven (2005), Sapawi & Said (2012), Krizek et al (2010)	61.Walking trail length	
12.Number of foot paths		62.Covered walkways	
13.Condition of foot paths		63.Places for casual contacts	
14.Covered access from fences		**Safety**	
15.Number of significant barriers		64.Personal safety	
16.Development patterns		65.Number of crime watch signs	
17.Regional accessibility		66.Reported crimes	
Connectivity		67.Road accidents	
18.Street connectivity (number of intersec-tions within buffer)		68.Undesirable land use & activities	Krambeck& Shah (2006), Saelens & Handy (2008), Ayşe & John (2012), Steven (2005), Sapawi & Said (2012) Ariffin & Zahari,(2013), Southworth,(2005), Foster & Giles, (2008), Leslie et al.,(2005), Troy & Grove, (2008),
19.Street pattern	Lawrence et al (2007), Kevin (2010), Southworth (2005), Krambeck (2006), Ester et al (2006), Saelens & Handy (2008), Ayşe & John (2012)	69.Abandoned buildings & lands	
20.Connectivity between uses		70.People present in streets	
21.Number of bus services per day		71.Vehicle speed	
22.Linkage of transport modes		72.Noise mitigation signals	
23.Efficiency of transport service		73.Unattended dogs within buffer	
24.Block size		74.Enough street lighting	
25.Block length		75.Level of entrapment	
Density		76.Level of visibility	
26.Residential density	Lawrence et al (2007), Ayşe & John (2012), Steven (2005), Southworth (2005)	77.Canopies which block the view	
27.Employment density		78.Presence of back lanes	
28.Road density		79.Volume/ noise safety	
29.Population density		**Aesthetic**	
30.Retail Floor Area ratio		80.Attractive architectural design	
Company		81.Presence of street trees	
31.Walking with another person	Troy & Grove, (2008),	82.Number of places to exercise	
32.Walking with pets		83.Variety in routes	Lawrence et al (2007), Kevin (2010), Southworth (2005), Saelens & Handy (2008), Steven (2005), Sapawi & Said (2012)
33. Number of relatives within the buffer		84.Narrow & crowded streets	
Pedestrian facilities		85.Landscaping treatments either side of road	
34.Presence of sidewalks		86.Naturally attractive places	
35.Disability infrastructure	Lawrence et al (2007), Ayşe & John (2012), Steven (2005), Schlossberg et al.,(2007), Ariffin & Zahari, (2013), Senevirathna & Morrall, (2013)	87.Availability of plazas	
36.Availability of crossings		88.Park intensity	
37.Feed bus service		89.Visual complexity	
38.Public park within neighborhood		90.Transparency of fronting structures	
39.Street lighting		91.Coherence of built form	
40.Number of bus halts		**Weather**	
41.Open sewers along walking path		92.Preferred walking time	Lawrence et al (2007), Saelens & Handy (2008)
42.Street furniture		93.Rainy	
43.Quality amenities in public parks			

Figure 2.1. Different Methods of Measuring Walkability
(Source: Shashank and Schuurman, 2019, p.147)

Figure 2.2. Walkability Framework Showing the Nine Neighborhood Design Characteristics Resulted in Walkability
(Source: Zuniga-Teran, Orr, Gimblett, Chalfoun, Marsh, Guertin, and Going, 2017, p.64)

Spence, Cutumisu, Edwards, Raine, and Smoyer-Tomic, 2009; Vandergrift and Yoked, 2004; Wang, Kim, Gonzalez, MacLeod, and Winkleby, 2007; Sarkar, Webster, and Gallacher, 2018; Howell, Farber, Widener, and Booth, 2017; Yamamoto and Jo, 2018). In addition to weight-related problems in health, walkability has benefits on other types of physical problems, like cardiovascular disease (Coffee, Howard, Paquet, Hugo, and Daniel, 2013; Sarkar, Webster and Gallacher, 2018; Yamamoto and Jo, 2018), hypertension (Coffee, Howard, Paquet, Hugo, and Daniel, 2013; Ghadimkhani, 2011), heart disease and stroke (Ghadimkhani, 2011; Yamamoto and Jo, 2018), cardio metabolic disease (Sarkar, Webster, and Gallacher, 2018), diabetes (Ghadimkhani, 2011; Sarkar, Webster, and Gallacher, 2018; Yamamoto and Jo, 2018; Howell, Farber, Widener, and Booth, 2017) and some types of cancer (Ghadimkhani, 2011). In addition to its benefits on physical wellness, walkability also contributes to mental well-being of individuals (Ghadimkhani, 2011; Brath, Kim, Savage, Bronskill, Rochon, and Stall, 2019; Yamamoto and Jo, 2018).

The second aspect of walkability is *economic*-related aspects of both neighborhood scale and urban everyday life (Battista and Manaugh, 2018; Lefebvre-Ropars, Morency, Singleton, and Clifton; 2017). The literature argues the following points. The first economic benefit is that the more walkable the neighborhood is, the more people come and make the commercial areas attraction points (Biernecka-Lievestro, 2014; Ghadimkhani, 2011). In other words, if the neighborhood is walkable, it means that the social capital of that neighborhood is also high (Kwon, Lee, and Xiao, 2017). The second benefit that is related to walkability is the increased level of house prices or rent prices in that neighborhood. According to Biernecka-Lievestro (2014), Quercia, Aiello, Schifanella, and Davies (2015) and Olitsky, Lerman, and Avineri (2017), it is found that there is a strong relation between the level of walkability and the residential rents and housing values like adding from 5 to 10 percent to prices and 80 percent sale increase. The third and last positive impact of walkability on economy is that it helps residents to save money via choosing walking as a mode of transportation rather than public transportation or private cars (Ghadimkhani, 2011).

The third aspect of walkability is much more *social* related. First, it develops the social equity in urban life. Scholars developing research for understanding the social aspects of walkability are Lefebvre-Ropars, Morency, Singleton, and Clifton (2017), and Sugiyama, Cole, Koohsari, Kynn, Sallis, and Owen (2019). These studies argues that walkability increases the level of interaction between the residents and individuals.

Moreover, when the level of interaction increases, the social life also strengthens automatically like knowing and trusting each other, and taking actively part in urban social life (Fitzsimons, 2013). Some scholars including Ghadimkhani (2011), Kwon, Lee, and Xiao (2017), and Berg, Sharmeen, and Wejis-Perree (2017) believe that walkability contributes to community cohesion, which can be described as the increased and more qualified relationships between people.

The fourth aspect of walkability is the *efficient planning* decisions (Ghadimkhani, 2011; Nilles and Kaparis, 2018). With walkability in the neighborhoods, there is an more efficient land use planning that resulted in reduced land waste and the minimization of distances between the destinations. For including the walking paths in the design, land use planning is done accordingly after a research development. Also, the walking distance and duration between facilities are tried to be minimzed. In addition to the efficient land usage, there is also mixed land use in which private (housing units) and public facilities (restaurants, hospitals, cinemas, others) are located together in balance in walkable environments (Ghadimkhani, 2011**)**. As land usage becomes more efficient and destinations become closer, there is also traffic efficiency in walkable environments (Nilles and Kaparis, 2018).

The fifth aspect of walkability is about *environmental features* – which is mainly about sustainability and energy efficiency. In more detail, walkability actually promotes sustainability through the increased level of pedestrian activity and the increasing level of active transportation. Walkable neighborhoods develop environmental outcomes (Battista and Manaugh, 2018). With numeric evidence, it can be said that "a case in point is that replacing one's light-bulbs with energy-saving ones once a year saves as much carbon as living in a walkable neighborhood does in a week" (Quercia, Aiello, Schifanella, and Davies, 2015). With decreased energy consumption, and reducing car usage and emission of hazardous wastes, walkable environments decrease the ecological footprint and limit urban sprawl (Olitsky, Lerman, and Avineri, 2017).

Some other aspects of walkability are *the individuals' perception of walkability and their level of creativity*. Also, more walkable neighborhoods pay more attention to creative industries and their workers. It is also proved that more creative firms choose to be located in more walkable areas (Bereitschaft, 2018).

CHAPTER 3

WALKABILITY MEASUREMENT TOOLS (WMTs): COMPREHENSIVE DATA CHART AND CONTENT ANALYSIS CHART

In this chapter, the thesis dwells on the existing selected walkability measurement tools. Starting from introducing the main assessment techniques used in the built environment, methods to evaluate walkability are given. Afterwards, the main characteristics and properties of the hard-copy and web-based walkability measurement tools are given.

Mainly, there are three broad techniques to assess the performance of the built environment (Weinberger and Sweet, 2012). The first technique is reviewing, which is applied to existing situations and may include audit and rating as well as other assessment tools. It develops options for and assesses how well proposed options improve walkability qualitatively. The second method is auditing that can be applied to existing and proposed designs. It identifies deficiencies against recognized standards and can propose solutions. It is ideal for identifying maintenance issues and simple remedies, both qualitatively and quantitatively. The third and last method is rating, which can be defined as a tool for scoring walkability for an environment or facility. It can be used on existing or proposed designs, and enables a practitioner to compare different walking environments quantitatively (Figure 3.1).

3.1. Walkability Measurement Tools (WMTs)

Starting from the 1970s in the time where sustainability was started to be discussed in the field of architecture and urban planning, the issue of walkability was also

Performance Design Technique	Procedure	Situation	Identifies Problems	Analyse Deficiency	Proposes Solutions	Undertaken by	Relative Cost	May Require	Example Methodology	Discussion
Reviewing	Qualitative	Existing	Yes	Yes	Yes	Professional	High	Everything below plus: safety records, traffic surveys, more observation	Good practice	Can include other tools such as auditing and/or rating
Auditing	Qualitative and Quantitative	Existing and Proposed	Yes	No	Sometimes	Technician / Advocate / Community	Medium	Everything below plus: camera, and consultation.	• LTNZ Safety Audit • Living Streets DIY Community Street Audits	Can include elements of rating
Rating	Quantitative	Existing and Proposed	Yes	No	No	Technician	Low	Mapping, site visit, incidentals such as pen paper, calculator, level, measuring tape etc	• RAMM • Cycle for Science • PERS	Attempts to infer a level of performance from a qualitative process that is transferred to a quantitative assessment

Figure 3.1. Reviewing, Auditing and Rating Comparison
(Source: Abley, 2005, pp. 5)

starting to be searched as one of the focus topics under sustainability. The aim of discussing the issue of walkability is to make the cities and urban environment more liveable and people-friendly. Although there are several methods for assessing the built environment, there is still no one uniform measurement of walkability. Through using objective and subjective variables, research studies try to quantify walkability on different geographic scales from neighborhood to street level (Biernecka-Lievestro, 2014; De Cambra, 2012). The measurement or assessment of walkability has been done by these following several methods: audit tools, checklists, inventories, level-of-service scales, and surveys (Cambra, 2012). Through one of these selected methods, researchers can quantify the walkability of selected cases with the help of variables (Biernecka-Lievestro, 2014).

For doing research on how walkable is the specific street, neighborhood, or city, there were some studies that investigated the relation between the act of walking in the built environment via using several different methods such as audits, tools, scales, instruments, checklists, inventories, level-of-services, survey questionnaires, or indices which are indeed hard-copy walkability measurement tools (Maghelal and Capp, 2011).

These above listed walkability measurement tools are actually important to identify and to quantify the variables of walkability. In other words, for creating a concrete definition and set of criteria of walkability, standardization is important for future studies to use the same operational definition and investigate the physical environment-walking relation by using same variables.

The most common methods for measuring the walkability, their properties, and problems are as follows. The first method is survey, which allows the researcher to measure how built environment attributes are perceived (Cambra, 2012), but it has some problems with reliability, validity, low response rates, and a biased sample of respondents (Duncan, Aldstadt, Whalen, Melly, and Gortmaker, 2011). The second method is direct observation that can be the most reliable method for collecting data (Cambra, 2012) and can be very laborious (time-intensive) (Duncan, Aldstadt, Whalen, Melly, and Gortmaker, 2011). The third technique is unobtrusive indicators or measures in which data is collected without the awareness of an individual, which analyzes the physical properties, archive data, some records from instructions, and other individual documents (Choi, 2012). The fourth technique is GIS technologies, which help in the mapping and analyzing data regardless of how it is collected (Cambra, 2012). The criteria can be assessed objectively using this system (Dyck, Deforche, Cardon, and Bourdeaudhuij, 2009) but it requires specialized expertise, can be time-intensive, and GIS data layers may not be accessible for certain geographic regions (Duncan, Aldstadt, Whalen, Melly, and Gortmaker, 2011). The fifth method is motion detectors, which are mainly accelerometers and pedometers that can capture the physical activity objectively (Meester, Dyck, Bourdeaudhuij, Deforche, and Cardon, 2013). The last method is self-reported measures, which may have a same-source bias, including validity and reliability (Duncan, Aldstadt, Whalen, Melly, and Gortmaker, 2011) (Figure 3.2).

The hard-copy walkability measurement tools aim at the same target, which is measuring the walkability with some different properties in each: the unit that they are measuring (like point, street, segment, area or neighborhoods), the target research profile (children, adult or disabled), the space type that is measured (public space like city center, private space like residential area or commercial spaces like offices), the type of questions (close-ended or open-ended), their data model (sources they use like user reviews, crowd-sourcing or concrete data sources), the main understanding of walkability they have (either as physical, psychological or socio-spatial). The hard-copy tools are mainly used by researchers to conduct a case study in the selected case that means that they are not that much available by all citizens and may be hard to understand and use. However, after the integration of technology into our everyday lives and mobile phones started to spread into each and every person, these hard-copy walkability measurement tools started to be evolved into web-based or mobile walkability measurement tools. This evolution in the measurement tools means the walkability can be measured by every individual person in the public and made the tools more accessible by everybody.

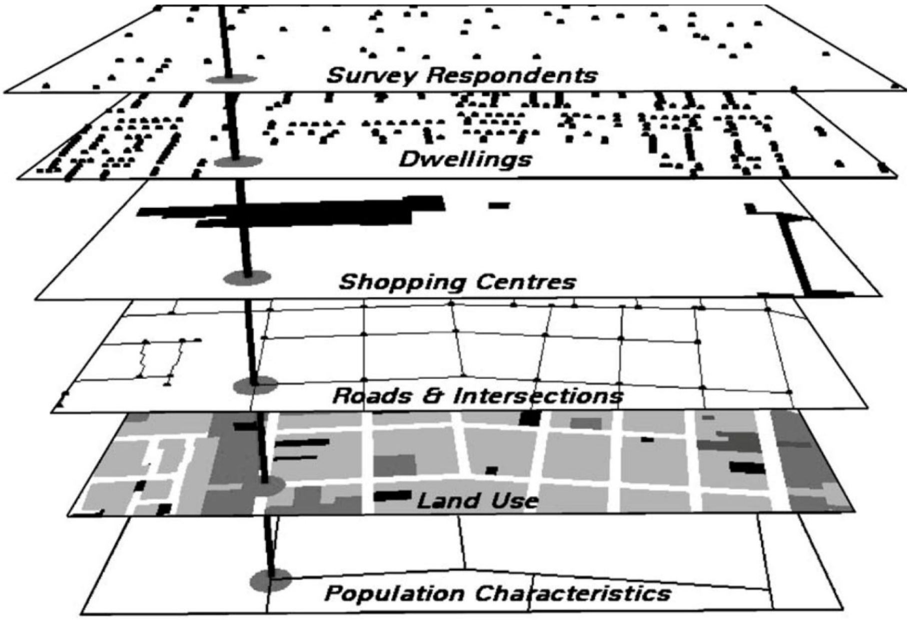

Figure 3.2. A Simplified Model of a GIS
(Source: Leslie, Coffee, Frank, Owen, Bauman, and Hugo, 2007, p. 114)

However, when the problems of all the measurements of walkability are checked, there are actually two critical points about data collection instrument development (Cambra, 2012; Choi, 2012). The first critical point is improving the measurement of the built environment, whether it is observed or perceived data. The method for how to measure the built environment, for which specific kind of observed data needs to be developed, and, in the case of perceived data, the composition of the questions in the survey method, also need to be more sophisticated in order to best obtain the necessary data. The second important issue is boundary setting of the area for study is a key challenge, since it requires methods for aggregating street-level data that take into account individual perceptions of neighborhood boundaries and can redefine the area using more precise locations in the urban fabric.

Nowadays, there is an increasing interest in using digital methods to measure urban features and walkability. These digital methods include virtual technologies like Remote Sensing, Google Street View, and Microsoft Visual Earth (Dobesova and Krikva, 2012; Shatu and Yiğitcanlar, 2018). Also, some websites were established to measure walkability which are actually trending among several different professions like real estates, health-care agencies, and environmentalists (Quercia, Aiello, Schifanella, and Davies, 2015). The benefits of these digital measurement methods can be faster operation, cost effectiveness, and a safer quality to collect data (Shatu and Yiğitcanlar, 2018).

Regardless of either the walkability measurement tool is hard-copy or in digital format, there is a scale that is used in research. There are two main scales in measurement methods: macro-scale and micro-scale. Most of the tools conduct analysis on macro-scale in which the focus is one of the following: population, housing density, land use mix, street-network connectivity, and transit accessibility. In other words, in macro-scale, the analysis is conducted on a bigger scale. Contrarily, other tools and methods have their focus on more street level qualities like building façade continuity, enclosure, and visual complexity (Bereitschaft, 2018). Although there are each type of tools either from macro-scale or micro-scale, it is argued by researchers that the walkability assessment should be conducted in segment level rather than in whole street level (Su, Zhou, Xu, Ru, Wang, and Weng, 2019). In short, macro-scale generally focuses on the physical, objective, and quantitative aspects whereas micro-scale generally focuses on the perceptual, subjective, and qualitative aspects of walking and the built environment. As it is argued by Riggs (2015), even the quantitative methods show that a space is walkable, that space cannot evaluated by a pedestrian as walkable, which is in fact not walkable.

In the following part, first, existing hard-copy walkability measurements existing in the literature starting from when walkability was measured are given. After the analysis of hard-copy walkability measurement tools (WMTs), the web-based walkability measurement tools (WMTs) are described with their main properties and characteristics. Although there are several different tools are developed to measure walkability, the ones that are used as tools in this research are the ones that are mostly mentioned or cited in the current literature.

3.1.1. Hard-Copy Walkability Measurement Tools (WMTs)

The measurement of walkability was started with the hard-copy tools which are mainly assessing the "person – environment – act of walking" relation. The hard-copy WMTs are mainly used by researchers, academicians, institutes, or authorities. They mainly aim to assess how the case study area is walkable from the experimental subject (Maghelal and Capp, 2011).

The hard-copy walkability measurement tools were clustered broadly into two by Maghelal and Capp (2011). The first cluster is the tools which assess the walkability like the scales, level-of-services and indices, which quantifies the amount of built-environment features and properties into a single number in which they categorize the physical environment as low, average or highly walkable or suitable to walk. The second cluster is the tools such as audits, surveys, and checklists that aim to measure the number and amount of built-environment properties that either encourage or discourage the act of walking. As general properties of the walkability tools, *audits* aim to measure the quantity of the built environment associated with walking. Whereas audits have a more quantitative approach, *indices* and *level-of-services* (LOS) grade the locations, areas, or segments as "less or more suitable for act of walking" (Maghelal and Capp, 2011). The checklists different than others are used to evaluate the built environment according to the items in the tool as existing or not.

In following part, mostly used, researched and cited hard-copy tools are described with their main characteristics. In Appendix A, more detailed properties of hard-copy WMTs are given according to following titles: development and aim, scope and content, and methodology (data collection, after auditing process, scoring and other versions).

3.1.1.1. Active Neighborhood Checklist (ANC)

Active Neighborhood Checklist was developed by Christine Hoehner and Ross Brownson in February 2011. It is an observational tool that was actually designed to assess the main street-level properties of the neighborhood physical environment that might be related to the physical activity of people (Active Living Research, 2011). Actually, Active Neighborhood Checklist is a refinement of the existing walking audit tools using a systematic process that weighted various forms of quantitative and qualitative evidence (The Robert Wood Johnson Foundation and The Centers for Disease Control and Prevention, February, 2011). As general features of Active Neighborhood Checklist, it has a simple format with daily language, words, and keywords. In addition to this, it has item specificity, and when compared to other tools, it has relatively short length. This shortness was intended to make the tool much more user-friendly for community stakeholders and authorities (The Robert Wood Johnson Foundation and The Centers for Disease Control and Prevention, February; 2011, Active Living Research, 2011).

3.1.1.2. Global Walkability Index (GWI)

Global Walkability Index (GWI) was developed by Holly Virginia Krambeck in 2006 for World Bank (Juremalani and Chauhan, 2017). There are several methodologies exist in Asia for assessing walkability, and these tools differ from each other with their emphasis either on qualitative or quantitative assessment, components, sampling, and scoring. Global Walkability Index is the most comprehensive tool (CAI-Asia Center, 2011). Global Walkability Index provides a qualitative analysis of the walking conditions, including safety, security, and convenience of the pedestrian environment (Juremalani and Chauhan, 2017; Gota, Fabian, Mejia, and Punta, N.,D.; Minhas and Podder, 2017; Babu, Tadepalli, and Tadepalli, 2016).

3.1.1.3. Irvine Minnesota Inventory (IMI)

Irvine Minnesota Inventory (IMI) is an audit tool which measures the features of built environment that may have a relation with the active living (Irvine Minnesota Inventory, N.D.). It measures the built environment properties that affect the level of physical activity, especially walking (Active Living Research, 2005; MIDSS Measurement Instrument Database for the Social Sciences, N.D.)

IMI was developed from 2003 to 2005 by a team of researchers at the University of California (State of Place, N.D.). The members of team members are Kristen Day, Marlin Boarnet, Mariela Alfonzo, and Ann Forsyth (Active Living Research, 2005). After its development, it was tested at the University of California and at the University of Minnesota (Irvine Minnesota Inventory, N.D.). This study was actually funded by Robert Wood Johnson Foundation, through a decade-long partnership with Active Living Research (State of Place, N.D.).

There are several comments and remarks on Irvine Minnesota Inventory (IMI). One of the most telling comments on IMI is that it is the most reliable and comprehensive measure and community audit tool (Schopflocher, VanSpronsen, and Nykiforuk, 2014; Jensen, Brown, Smith, Brewer, Amburgey, and Mcliff, 2017). It also has fine details and established reliability (Werner, Brown, and Gallimore, 2010). Its comprehensiveness comes from arranging thematically, covering over twenty topics that evaluate and measure the properties of streets, buildings, amenities and facilities, views, architectural and design properties (Boarnet, Forsyth, Day, and Oakes, 2011).

3.1.1.4. Neighborhood Environment Walkability Scale (NEWS)

Neighborhood Environment Walkability Scale (NEWS) is a self-report measure which was developed to evaluate the perceived neighborhood environmental characteristics that can have a relation with walking for transport and walking as leisure time activity (Cerin, Leslie, Owen, and Bauman, 2008; Adlakha, Hipp, and Brownson, 2016). NEWS is used frequently to assess the perceptual properties of the built environment (Oyeyemi, Sallis, Deforche, Oyeyemi, Bourdeaudhuij, and Van Dyck, 2013). It is a ninety eight-question instrument and tool that evaluates the neighborhood perception that can be related to physical activity like residential density, land use mix (including both proximity and accessibility), aesthetics, traffic and crime safety, and neighborhood satisfaction (Active Living Research, 2002; MIDSS Measurement Instrument Database for the Social Sciences, N.D.).

3.1.1.5. Pedestrian Environment Data Scan (PEDS)

Pedestrian Environment Data Scan (PEDS) is an observational audit tool and a protocol which collects information and data about the physical built environment at the micro-scale level (Clifton, N.D.; Fisher, Richardson, and Holster, 2010). As it is a built environment audit tool, it is applied at the segment or path scale (Lopez-Bernal, N.D.).

3.1.1.6. Pedestrian Environment Review System (PERS)

There are several definitions and descriptions developed for what is Pedestrian Environment Review System (PERS) as follows. It is an assessment tool which analyzes the quality of a given environment in terms of how it meets the needs of pedestrians, with the ‘standard’ pedestrian defined by TRL, the software developers, as “towards the vulnerable end of the spectrum” (Waite, 2010). As defined by TRL, *a systematic process to assess the pedestrian environment within a framework that promotes objectivity* (Allen and Clark, N.D.; VECTOS: Transport Planning Specialists, 2015; Gleave, 2014). It is also described as a holistic method used to identify deficiencies primarily in existing pedestrian environments, although it has the flexibility to be used as a tool during the design process (Gould, 2011). Another description is that it is a walking audit tool which is now part of the multi-modal street audit assessment tool (Transport for London, N.D.). By Thornton (2012), it is also defined as a tool that practitioners can use to audit the walking environment and analyze the results, providing good graphical presentation, quick win lists, and clear mapping of issues and required works. Another description is that it is a tool that measures the quality of the pedestrian environment through subjective review, and provides an objective measure to pedestrian quality. The auditing process allows for an overall review of pedestrian accessibility to and from a given location (VECTOS: Transport Planning Specialists, 2015). Also, it is defined as an assessment toolkit developed by TRL that enables the pedestrian environment to be reviewed under a wide range of topics like links, crossings, routes, public transport, interchanges, and public space (The Historic Buildings and Monuments Commission for England, 2008).

Moreover, Wedderburn Transport Planning Limited (2017) defined the tool as audit tool used to assess the level-of-service and quality provided across a range of pedestrian environments and used to obtain a comprehensive understanding of what its like to experience an area on foot (Wedderburn Transport Planning Limited, 2017). It can also be defined as walking audit tool that assess the mechanics of the pedestrian environment, as well as condition of the walking environment (Transport for London, 2008). The last definition proposed is a dynamic software application used to assess and audit the quality of any pedestrian environment that can assist in the identification of opportunities to improve pedestrian walking routes, public spaces, and infrastructure (Aurecon Australia, 2010).

3.1.1.7. Pedestrian Environment Quality Index (PEQI)

Pedestrian Environmental Quality Index (PEQI) is a comprehensive observational tool with a systematic review of street and intersection factors in the environment (Bialick, 2011; Scully, N.D).

It is also a both qualitative and quantitative tool to identify the related information about the street environment which may affect person's travelling behaviors and decisions through the numerical, textual, and photographic means (City of Austin Planning and Development Review Department, N.D.).

3.1.1.8. Physical Activity Neighborhood Environment Scale (PANES)

Physical Activity Neighborhood Environment Scale (PANES) is a short-form environment measure composed of seventeen-items which uses single items instead of multi-item scale and assesses the perceived neighborhood environment for walking and bicycling (O'Connor, Leach, Mama, and Lee, 2015; Sallis, Kerr, Carlson, Norman, Saelens, Durant, and Ainsworth, 2010; Sallis, N.D.)

3.1.1.9. PIN 3 Neighborhood Audit Tool

PIN3 Neighborhood Audit Tool is one of the well-known examples of public health instruments which was developed by different research groups (Poortinga, Calve, Jones, Lannon, Rees, Rodgers, Lyons, and Johnson, 2017). This forty three-itemed instrument evaluates the street-level properties that may have relation to the activity of walking and bicycling (Active Living Research, 2009). In addition to this, with its reliability, it is used to assess the walkability and bikeability of the geographical areas like neighborhoods and streets (Suminski, Wasserman, Mayfield, Thelen, and Egger, N.D.).

3.1.1.10. Scottish Walkability Assessment Form (SWAF)

SWAT is one of the studies developed under Well-Being in the West (WWW) which is a multi-disciplinary research project that was designed to evaluate whether a pedometer-based walking program, in combination with a physical activity consultation, would increase and maintain walking behavior over a twelve-month period (Millington, Thompson, Rowe, Aspinall, Fitzsimons, Nelson, and Mutrie, 2009). Specifically, as development process of SWAT, it took place in Glasgow covering a twenty five km street area and the participants evaluated the local environment using SWAT and GIS information system (Belfast Healthy City: A World Health Organization, 2014). The study aims to examine the complicated relation between behavior, health and environment along with the cost-effectiveness of this approach and participants' interference (Millington, Thompson, Rowe, Aspinall, Fitzsimons, Nelson, and Mutrie, 2009).

3.1.1.11. Systematic Pedestrian and Cycling Environmental Scan (SPACES)

Systematic Pedestrian and Cycling Environmental Scan (SPACE) is one of the very first environmental audit instruments that are developed to analyze and measure the built environment that may have relation with physical activity (Transportation Research Board Institute of Medicine of the National Academies, 2005). It is actually an observational infrastructure tool that may promote the activity of walking and cycling (A Guide to: Systematic Pedestrian and Cycling Environment Scan (SPACES), N.D.). SPACES was designed to be used in Australia (Clifton, Smith, and Rodriguez, 2007).

3.1.1.12. Walking Suitability Assessment Form (WSAF)

Walking Suitability Assessment Form (WSAF) is an audit that was developed to evaluate the built environment features that might have impact upon the safety feeling of users. Within it’s scope, it also covers physical properties of walkability.

3.1.2. Web-Based Walkability Measurement Tools (WMTs)

With the integration of technology into everyday lives, especially with the emergence of mobile phones, the hard-copy walkability measurement tools evolved into digital walkability measurement tools. The digital walkability measurement tools may be web-based or mobile-app. There are currently six web-based walkability measurement tools in which some of them have mobile-app versions. They all measure the walkability but somehow their user profile, criteria, data sources, algorithms, measured unit types, and type of the tool differ as follows.

In the following chapter, six walkability measurement tools will be mentioned with their main properties: Walkshed, Rate My Street, Maponics, Walkonomics, Walkability Asia, and Walk Score. More detailed information about each web-based WMT can be found in Appendix B under the following titles: the general information, the data model of the tool – sources, the criteria of the tool and the locations / countries the tool is available will be defined. Under the general information about the tool, the following will be described: what is the tool, the history of the tool, the aim of the tool, the general features of the tool, the quotes by the firm or the developer, the general information about the developer, and the other research conducted by the developer. In the data model – sources of the tool, the following information will be included: which data sources are used, how the data is collected and the scientific algorithms/formulas being used after data collection. In the criteria of the tool, the questions/criteria, the scaling/rating/grading, and the user profile will be expressed. In the last part, the locations / countries the tool is available will be listed.

3.1.2.1. Maponics

Maponics is a product of Maponics LLS which is a twelve-years-old Vermont-based firm specializing in location-based data provision (Aquino, 2013). It is also the market leader for comprehensive databases and geospatial analysis which underpins today's location-based services and analytics. They create geographic boundaries for areas and neighborhoods where people spend their everyday lives like neighborhood boundaries, shopping boundaries, ZIP code boundaries, and school boundaries (Maponics Identifies 10 Best Neighborhoods for Generation Y., 2014). With these boundary settings, they help consumers and business to understand the walkability of neighborhoods, school attendance zones, subdivisions, and other areas (Marlow, 2013). In addition to boundary setting for specific zones, then they lay lifestyle and demographic data on top of these defined areas (Resmer, 2013). While analyzing these location-based boundaries and demographic and social data related to definite areas, they also analyze access to amenities and walking routes with some additional factors like street types, optimal routes, speed limits, and intersection complexity to make these applications as in real-life. Also, with this approach, the insight into the character of the area can be enhanced (Marlow, 2013). In specializing on the walking activity, they also generate walkability ratings on five-point scale with the usage of a complex algorithm developed by themselves (Hagey, 2013). During the literature review process about Maponics, the firm was changed to Pitney Bows, which is mainly a data provider firm.

For understanding the ideas about the walkability of the developer firms, some important quotes of Maponics team members are as follows. Paul Gallagher who is the Vice President of Marketing and Product in Maponics, says that new generation who wants to buy or rent a house wants to live in neighborhoods which can be easily moved around by walking, bike or public transportation so that they try to ensure the broadest walkability rankings through sharing it with the ones from real estate profession, city planning and policy makers from different locations (Maponics Surpasses Walk Score in Coverage, 2014). He also added that with their walkability, public transportation, and bikeability analysis, Maponics can provide which locations are much more compatible for the ones who do not choose cars as a mode of transportation. Through this data, they can also provide the market's most common and worldwide information (Marlow, 2013). As Darrin Clement stated who is both the founder and CEO of Maponics, making an analysis about the points of interests area in a neighborhood is only the one side of the coin, whereas understanding how walkable the area is the other side which adds a geo-spatial meaning to urban space (Marlow, 2013). Lastly, as the Vice President of Sales and Business Development of Maponics, Mark Friend, said, their main concern is to provide walkability ranking and data to real estate professionals because studies have found that houses located in a highly walkable areas have higher values and much more desirable by homebuyers and renters so that it makes that information important to real estates (RET Staff, 2014).

As it is seen, the walkability understanding of Maponics members are mainly covering the following issues: the economic relation between walkability and house prices, how the lifestyles changed in younger generations in a car-free style and the walkability – POIs and accessibility relation. In other words, walkability has important impact over house prices both for selling and rentals for Maponics. Also, it can be understood that their main target user profile is younger generation that wants to live in more walkable and car-free areas. They also mention that geo-spatial meaning can be given through the point-of-interests (POIs) in the selected area. To say it more comprehensively, they mainly highlight the issue that they are data-providers for different purposes like real-estates, young generation and about POIs for all living people in the specific area.

There are several customers, companies, and firms from four to five industries that works with Maponics and use the data they provide. Many of them are today's web, social media, mobile, and real estate brands, including over seventy percent of the top real estate. The data they use from Maponics are for social and mobile marketing purposes (Aquino, 2013). They rely on Maponics to power ultra-local interactive search, mapping, tracking, and ad-targeting platforms (Marlow, 2013). Some of the well-known firms are: Century 21 Real Estate, Estately, Citysearch®, Fannie Mae®, FoursquareinfoUSA®, JiWire, LPS, Realtor.com, RPR™, Trulia®, Twitter, Yellow Book USA®, Zillow®, ZipRealty™, and Zvents®.

In addition to only offering new products, tools, or apps, Maponics also make some research by using their tools they invented before. There is such a study of Maponics in which they identified the ten best neighborhoods in terms of their walkability level for Generation Y (Maponics Identifies 10 Best Neighborhoods for Generation Y, 2014) in which they checked the two hundred and fifty walkable cities and also made cross-referencing with the Bikeability Score and the Public Transit Score within the Maponics' Commuter Access Score.

3.1.2.2. Rate My Street

Rate My Street is a website that allows people to rate the street, point, or specific location they select according to the criteria set by the tool (Nash, 2010). In other words, this new tool allows users to evaluate their streets in terms of walkability issues. This can be a quantification approach of users' perceptions about the qualities of the street or what makes it good with their comments (Neto, 2015). As they define themselves in TRL website, it is an easy-to-use website which utilizes Google Maps and Google Street View for promoting users to give feedbacks on their living environment with using a five-star rating system. Rate My Street can also be a complementary tool to TRL's other very well-known street audit software – PERS (Pedestrian Environment Review System) (Rate My Street, N.D.).

Rate My Street was developed in United Kingdom by the firm TRL (UK's Transport Research Laboratory) in 2015. At the very beginning, Rate My Street only performed a service in the United Kingdom, but afterwards, it opened up to all world with the beginning of Google Maps usage as the base of the tool (Nash, 2010; Neto, 2015).

TRL is actually owned by the Transport Research Foundation (TRF), a non-profit company and established for the research, consultancy, and advice on transportation issues. Under the scope of TRF, TRL is a center that searches for future transport with innovative research, technology, and software solutions to transportation-related issues with evidence-based processes. TRL was established in 1933 and privatized in 1996. The main areas of TRL includes transportation safety, vehicle engineering and simulation, investigations and major incident forensics, human factors and behavioral science, intelligent transport systems, infrastructure asset management, and sustainability and climate change. Today, TRL has more than thousand clients across hundred and forty-five countries. The other tools of TRL in addition to Rate My Street are PERS (Pedestrian Environment Review System), CERS (Cycling Environment Review System) and FERS (Freight Environment Review Software) under the street auditing title. The other products of TRL include tools about junction and signal design, traffic and control, strategic modeling, safety, economic appraisal, and asset management (Rate My Street, N.D.).

3.1.2.3. Walk Score

Walk Score is a web-based neighborhood measurement tool for evaluating and supporting walkability, and pedestrian access to transportation (Hirsch, Moore, Evenson, Rodriguez, and Diez Roux, 2013).

Under the Walk Score, there are three different grading: Walk Score, Transit Score, and Bike Score. The Walk Score (measures walkability), the Bike Score (measures the suitability of the location for bicycling), and the Transit Score (measures access to public transit) (Chandra, Braughton, Galicia, Sanchez, Medina, and Aldrete, 2016). All these three grading are open to public access.

Walk Score measures the definite area's efficiency for supporting the walking activity (Hirsch, Moore, Evenson, Rodriguez, and Diez Roux, 2013). Starting from its first emergence, Walk Score is a widely used common measurement data system in walkability literature and research (Barnes, Winters, Ste-Marie, McKay, and Ashe, 2016). In other words, Walk Score measures how daily routines and living activities performed on foot can be supported by this particular neighborhood (Gilderbloom, Riggs, and Meares, 2015). By using a similar method to SMARTRAQ model by Frank, Walk Score also focuses on land use mix, density, and street-grid density with analogue parameters (Gilderbloom, Riggs, and Meares, 2015).

For other researchers of Walk Score, public accessibility (Duncan, Aldstadt, Whalen, Melly, and Gortmaker, 2011; Cole, Dunn, Hunter, Owen, and Sugiyama, 2015), attempts to promoting walkable neighborhoods (Yin, Cheng, Wang, and Shao, 2015) and which properties of neighborhood does Walk Score measures (Paez, Moniruzzaman, Bourbonnais, and Morency, 2013; Brewster, Hurtado, Olson, and Yen, 2009) were admitted.

With a more detailed understanding, Walk Score is a web-based walkability measurement that summarizes the neighborhood characteristics for being defined as "walkable" like for the following criteria or properties: pedestrian accessibility to retail, entertainment, natural, and other amenities. In addition to these, network connectivity of the street grid is one of the parameters of their measurement (Harvey, Aultman-Hall, Hurley, and Troy, 2015). Further than having a street connectivity in the selected neighborhood, having an open space is another parameter (Cannuscio, Hillier, Karpyn, and Glanz, 2014). To put it in different way, Walk Score is an index that analyses the issue of walkability with its several aspects like accessibility, location (which defined by the neighborhood's coordinates), and street network characteristics (Arribas-Bel, 2014).

Walk Score was originally a project that was developed by Seattle, Washington-based Front Seat Management Company in 2012 (Arribas-Bel, 2012; Duncan, Aldstadt, Whalen, Melly, and Gortmaker, 2011). This company developed an algorithm to measure the walkability of each neighborhood (Xu and Wang, 2015). There is also an academic partnership with researchers such as Larry Frank and Reid Ewing (Gilderbloom, Riggs, and Meares, 2015).

Before its formal opening, Front Seat Management Company began to measure and publish walkability maps of cities, neighborhoods, and streets via walkscore.com. In 2007, this private company started to measure walkability scores of streets, neighborhoods, and cities, and Walk Score got its current situation (Çubukçu, Hepgüzel, Önder, and Tümer, 2015). During its foundation process, RWJF and Rockfeller

Foundation were the financial supporters of this project (Braun, Rodriguez, Evenson, Hirsch, Moore, and Diez Roux, 2016). As mentioned by Front Seat Management, Walk Score is maintained by a grant-funded thirteen civic software companies and incubators, and it was originally developed for real estate purposes (Carr, Dunsinger, and Marcus, 2010). In addition, Walk Score is now a part of Redfin which is a web-based real estate database (https://www.walkscore.com/about.shtml; February 17, 2019, Walk Score, 2019).

Walk Score actually aims to "promote walkable neighborhoods" (Arribas-Bel, 2014). And as mentioned in their website (Walk Score, 2019), their vision is to make easier for individuals to make evaluation about walkability and transportation with numbers, such as: Beds: 3 Baths: 2 Walk Score: 84.

3.1.2.4. Walkability Asia

Walkability Asia is the initiative of Clean Air Asia Organization. The aim of Walkability Asia is to improve walkability and pedestrian services across key Asian countries and cities (CAI Asia – Walkability App, N.D.; CAI Asia Walkability App, N.D.; CAI Asia – Walkability App (Older IOS Version), N.D.; Dotzoo Inc., N.D.).

There are several key properties that can describe Walkability Asia. It allows users to survey the streets of paths walked on and contribute invaluably to support different initiatives. In other words, it enables walkers to score data or rate a footpath, sidewalk, or pedestrian area (Mukherjeel, 2012). Actually, both its website format and the mobile app format are free to use for all, but in the mobile app, it askes users to login. Parthaa Bosu, Representative of the CAI-Asia India Office, stated that this application is the first of its kind, developed with the idea to promote and communicate that safe walking is everyone's right - regardless of age, gender, education and background (Mukherjeel, 2012).

Walkability Asia is a mobile app that is both free for IOS and Android operating systems with the name "Walkability". It was first developed on January 15, 2014, with nine questions and six answers for each question. Photos can be added as feedback to each question (CAI – Asia Walkability App APK Download*,* 2014). This mobile app enables users to report problem on a footpath or the lack of one, neighborhood streets, open manholes, fear of unsocial elements, or rise in fatal accidents in particular street corners (Ayub, 2012).

Before the development of Walkability Asia Mobile App, Walkability Asia was communicated improvements in walkability in Asian countries, provided a broad list of sources that would enable public participation, guided public and the private sector's decision-making towards sound policy benefiting pedestrians. In other words, the website of Walkability Asia really works as an informative website related to walkability in Asian cities. The target of the website is to increase the public awareness and consciousness on walking as a preferred low-emission mode of transport (New Mobile (Free) Technology to Aid Pedestrians Launched – Comment on the Walkability of Chiang Mai's Streets, N.D.).

For understanding the policies and the background idea of Walkability Asia, it can be beneficial to understand it's developer firm, Clean Air Initiative for Asian Cities (CAI-Asia). CAI-Asia is was established in 2001 as a multi-stakeholder initiative and as premier air quality network for Asia by the Asian Development Bank, World Bank, and USAID – Unites States Agency for International Development (Puskar, 2013). Since 2007, CAI-Asia has been registered U.N. Type II Partnership with more than two hundred thirty organizational members and eight country networks (China, India, Indonesia, Nepal, Pakistan, Philippines, Sri Lanka and Vietnam) (New Mobile (Free) Technology to Aid Pedestrians Launched – Comment on the Walkability of Chiang Mai's Street, N. D). The aim of CAI-Asia is to promote better air quality and liveable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy, and other sectors (Mukherjeel, 2012). CAI-Asia was honored with the Distinguished Environmental Group Award on the occasion of 439th Foundation day of the City Pasig (held in 01 August 2012) (Walkability Asia, 2012). Individuals can also join CAI-Asia by registering at Clean Air Portal (Cruz, 2011). It's headquarter is located in Manila, the Philippines, with offices in China and India (Cruz, 2011). CAI-Asia is supervised by a Partnership Council non-stock and non-profit organization. The firm is governed by its Articles in Incorporation, By-Laws and Operations Manual approved by its Board of Trustees (BoT) (Puskar, 2013). The structure and the strategy of CAI-Asia can be seen in the following figures (Figure 3.3) (Bathan, 2010):

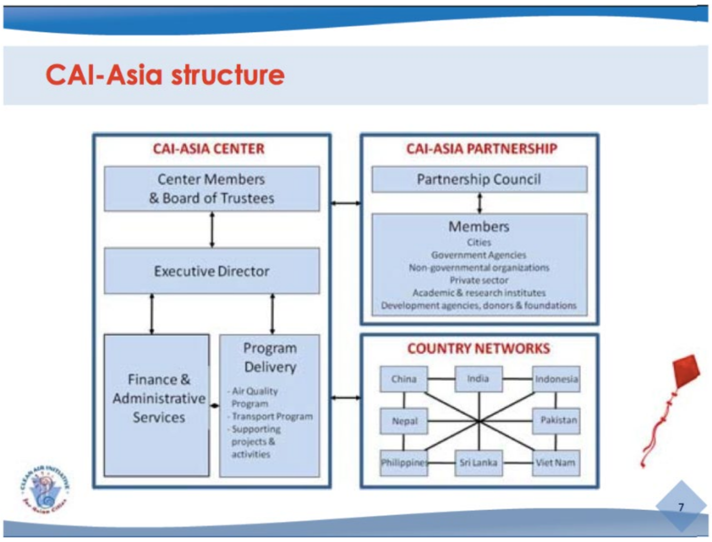

Figure 3.3. The Structure and the Strategy of CAI-Asia
(Source: Bathan, 2010, p. 2)

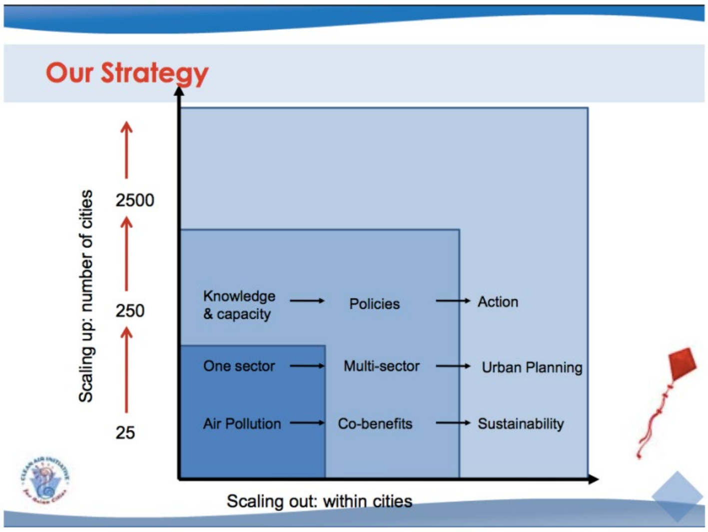

Figure 3.3. (cont.).

To date, CAI-Asia published walkability assessment reports in twenty three Asian cities and continued to make better walking infrastructures part of the development agenda of Asian cities with support from Asian Development Bank, Shakti Foundation, and many other partner organizations (Mukherjeel, 2012). It also introduced the concept of tricycle upgrading through micro-finance for more efficient and less-polluting four-stroke motorcycle engines in Pasig City through it's partnership for Clean Air back 2011 (Walkability Asia, 2012). There is a flagship event of CAI-Asia: Better Air Quality Conference (BAQ) in which more than two hundred air quality stakeholders participate (Cruz, 2011). Other activities conducted by CAI-Asia are also covered that are under the following titles (Bathan, 2010): air pollution and gas emissions, transportation, industry and energy, and others.

For better understanding of both CAI-Asia and Walkability Asia, it can be informative to look for the research of these formations. There are three different types of research and publications in which CAI-Asia or Walkability Asia are somehow included. The first type of research is the ones in which CAI-Asia conducted these research. The second type of research is the one which are workshops conducted by CAI-Asia. The third type of research is the one conducted by Walkability Asia.

There are also newsletters of CAI-Asia published every month which focuses on the environment related problematic issues in Asian cities and solution proposals to them by authorities and stakeholders.

3.1.2.5. Walkonomics

Walkonomics is a United Kingdom-based walkability app developed by Adam Davies and Carsten Moeller and founded in 2011. It firstly began as an application on the Internet as an open database before mobile app (Study Group: Urban Environmental Walking Research and Measurement, 2016). The concept of Walkonomics was pioneered by an American company - Walk Score (Reid, 2013). The developer of the tool is Space-O Technologies from Ahmedabad, India (Walkonomics Description, N. D). It ranks and evaluates streets and neighborhoods while combining publicly available data with crowd-sourcing and user generated reviews for the ratings of the streets (Mott, 2012). In Walkonomics, it is believed that the future cities and the future life will be walkable. That is why Walkonomics founded to turn this "walkable future" idea into reality with the technology developed, tools used and communities attended which makes urban environment where people want to walk (Walkonomics – About, 2011). They also believe that with this app, walkability can be improved and the enjoyment of the walking experience can be increased all around the world. In other words, Walkonomics tries to provide the tool that makes people want to walk as much as possible (Ewell, 2015). Different than other walkability apps, Walkonomics also rates and maps the "pedestrian-friendliness" of the streets and neighborhoods. The tool also allows people to check the walkability ratings by the post code (Tarasova, 2012). Also, Walkonomics is a web-based app that rates the combination of walking and ergonomics (Dalton, 2015). Moreover, rather than only rating the walkability of streets through physical characteristics, it leads people to find the most beautiful and greenest route between the most walkable routes (App for Off the Beaten Path*,* 2016). While finding the most beautiful and greenest route, it letters users to decide the balance between the beauty or the most scenic route and the speediest one (Rudgard, 2015). In The Guardian, Walkonomics was selected as one of the best iPhone Apps of the week (Walkonomics App: Best Walking Route, N.D.).

According to the founder of Walkonomics, Adam Davies, the very first aim of Walkonomics is to save the environment (Vomiero, 2015). One of the other aims of Walkonomics is to quantify the pedestrian experience in a more detailed way (Goodyear, 2013). Comprehensively, the tool aims to gather the collected data from the citizens and publics with crowd-sourcing process which lead to a more detailed process of the index based on the walkability criteria set by Walkonomics (Perrotta, 2013). In addition to the general aims concerning environmental issues, pedestrian experiences, and the walkability related concerns, Walkonomics aims to rate the pedestrian-friendliness of each street under "walkability" (Andrey, 2013). Related to the pedestrian-friendliness term, it also aims to discover the most aesthetic route to the walker's destination by taking into account time and users' preferences (Vomiero, 2015). As Davies mentioned, Walkonomics aims to create a new mapping platform that offers most walkable routes, not only based on the distance, but also some other criteria in which personalized routes for users can be offered according to their needs and demands (Mott, 2012). For obtaining and offering these pedestrian-friendly routes, the aim in the data refinement process is to make the one route more beautiful than the others (Park Points, 2015). With its crowd-sourcing data collection process, Walkonomics also aims to create an online space where people (citizens), government, and companies can share their ideas with suggestions, discussions, and recommendations for improvements to the streets (Stefanini, 2015). With the usage of GPS system, Walkonomics also helps users to see and follow the route offered out of many (Walkonomics Description*,* N.D.).

When the general features of Walkonomics checked, it can be listed as followings (Davies, N.D.). Users can find the most beautiful route from the walking route results in the city searched. By using the slider property, users can also find the faster routes that still includes beautiful streets. Users can finds the fastest walking route for any city and town in the world. Walkonomics' WalkHood property map shows the places and points that the one can walk to in five minutes. Information can be found on nearby places within walking distance. The statistics about how long the walk will take, how many calories the walker will burn, and how much CO2 that the user will save can be seen. The pedestrian-friendliness of the nearby streets and areas can be checked. The search results are shown in a map with color-coded markers. Users can add their own ratings and comments about street walkability, including photos. Logging in via Facebook, Twitter, and e-mail undertakes the walkability audits and crowd-sources local people's ideas for improving the streets. The application is available in Spanish, German, and English. There are free mobile apps of Walkonomics both for Android (launched in October, 2012) and iOS (launched in 2013).

The search can be done by location, place name, or post code of the searched areas (Fretwell, 2013).

Adam Davies is the founder of Walkonomics who is a U.K. resident with a background in transport, planning, geography, and computer science (Goodyear, 2013). He has more than ten years' experience in Sustainable Transport and Retail Location analysis, a degree in Human Geography, a master's in Urban Sociology and training in Computer Science. Before developing Walkonomics, he worked in the United Kingdom, Europe, and Africa with their local communities, government, and private sector for creating walkable environments. He also worked with the United Nations, Transport for London (TfL), Department for Transport, Commission for Architecture, and the Built Environment and the Royal National Institute for the Blind. He also worked for the project "Shared Space" streets, disabled people's access, climate change, and understanding the links between obesity and the built environment. Carsten Moeller is the co-founder of Walkonomics with more than twenty years' experience as a software engineer. He is the creator of OSM2PO, which is the popular Java-based software that converts OpenStreetMap data into a routable graphic (Walkonomics – About, 2011).

There are several quotes of Adam Davies about walkability, walkability related issues, and Walkonomics. They can provide a base for better understanding of Walkonomics. As he stated, Walkonomics is developed for finding the walking paths in which the focus is not only on the quickest route, but also on the most beautiful, safest, most tree-lined, and funniest route, which means that their focus is actually on the subjective experience (Goodyear, 2013). He also added that walkability does not mean to get a place within the quickest time, but it is about the quality of streets that an individual is walking (Vomiero, 2015). After becoming a father, he also said that his newborn baby liked tree-lined areas more when he took his soon out in the pram so that Davies started to think that it would be practical to have information about where the trees are located in an area (Caccamo, 2015). Adam Davies also added that there are several studies that show that houses located in more walkable areas have house prices that are thirty thousand and more (Dean, 2011), and 77 percent of people want to live in more walkable areas, which increases the retail sales 80 percent (Foster, 2013).

As it is seen, the walkability understanding of Walkonomics CEO Adam Davies mainly covers the two following issues: the subjective pedestrian experience while walking and walkability, and house prices interaction. Also by adding his personal experiences, ideas, and thoughts, he mainly focuses on the slider property of Walkonomics. In other words, for him, the act of walking is much more dependent on personal experiences and the quality of the walking environment. Also, he mentioned that doing a research on walkability and house prices relation is very current issue under urban design discussions.

There are three different types of publications or research that can be listed under Walkonomics research. The first type of research is the one which are directly conducted by Walkonomics. The second type of research is the one conducted by another researcher, but in the research, Walkonomics is used as the tool. The third type of research is neither conducted by Walkonomics nor Walkonomics being used as the tool, but only published in Walkonomics webpage.

3.1.2.6. Walkshed

Walkshed is a web application tool that uses high technology to calculate and map walkability. Also, Walkshed is the great invention and personal research project of Aaron Ogle, a software developer at Azavea in Philadelphia (Walkshed, 2016). Walkshed is based on a walkability surface that evaluates the quality and diversity of urban opportunities that are accessible without any friction (like rivers, topological constraints, freeways, railway tracks and cul-de-sacs) within a one-mile-radius (During, 1996). In 2009 at Walk21 Conference, Walkshed Philadelphia was launched as an online application which enables users to calculate the walkability of any Philadelphia street, according to users' personal preferences (Avencia Launches Walkshed.org to Calculate and Map Walkability Based on Individual Preferences*,* 2016).

Actually, the concept of "walkshed index" was originated from Alan Durning, who is working on carbon pricing, housing affordability, and democracy reform in Sightline Institute. Wiktionary (2019) defines the term 'walkshed' as the area that is within the defined walking range of a specific place (12 March 2019).

According to the definition made by Alan Durning, "walkshed index" *is a tool that scores a location based on the quantity and the diversity of amenities within a one-mile radius* (About Walkshed, 2010).

After Durning put his ideas into words, Walk Score implemented his idea accordingly and became the first application concerning these issues. It was built as an online application which can automatically calculate walkability with its location or address-based approach on its proximity to different amenities. According to the comments and critiques about Walk Score, it is fantastic application with its methodology but it also has some limitations. For developing these limitations, Walkshed Philadelphia and New York were developed by Aaron as a part of Azavea's ten percent research project program.

Aaron Ogle from the firm Avencia first developed the application for Philadelphia then New York by using open government data from New York. For New York, a new version for five small towns were developed by the company and submitted into Big Apps Contest (Wink, 2009).

The developer of Walkshed is Avencia, which is an award-winning firm. It is actually Philadelphia-based geographic analysis and software development firm that specializes in creating innovative location-based software tools. With these tools, Avencia tries to enhance and guide decision-making processes of the designers. According to their main concept and belief, location-based technologies and developments can encourage the creation of more dynamic and energetic communities (Avencia Launches Walkshed.org to Calculate and Map Walkability Based on Individual Preferences, 2016). With their initiative invention, Walkshed, they integrated geographic analysis and their software background with the help of advanced technology usage to analyze, calculate, and map walkability (Wink, 2009).

3.1.2.7. Mobile Application Versions of Web-Based Walkability Measurement Tools (WMTs)

Currently, there are six existing web-based walkability measurement tools. Walkshed and Rate My Street do not have mobile application versions for the mobile phones or tablet computers but the others, Maponics, Walkonomics, Walkability Asia, and Walk Score, have mobile application versions also. The detailed information related to each tool that can be found in Google Play Store and iTunes is as follows: the app name, the developer of the tool, the category that the app is listed under, the apps' last update time and its' version, the language in which the app is available, the price of the app, the available operating systems of the app, the app images, the description given by the operators, Google Play Store and iTunes.

3.2. Charts of Walkability Measurement Tools (WMTs)

Starting from the research of the thesis, related data about walkability and walkability measurement tools are covered and collected separately. As a result, for seeing them as a whole which also enables a comparison to be made and deep analysis, two charts are composed: Comprehensive Data Chart and Content Analysis Chart. As an approach for finding an answer to Research Question 1, Comprehensive Data Chart is composed to better understand each tool's understanding of walkability, which also enables a comparison to be made between them and bring the details of each tool into light. In this chapter, these two charts are represented. Again, as an approach to find a response to Research Question 2 that aims to see which aspects of walkability are covered and which ones are missing in walkability measurement tools (WMTs), Content Analysis Chart is composed. In short, Comprehensive Data Chart is generated from the direct information without any critical lens, while Content Analysis Chart is formed after filtering, theming, and symbolizing the elements of the each tool.

Below, the schematic representations of Comprehensive Data Chart (Figure 3.4) and Content Analysis Chart (Figure 3.5) are given with different color-coding for providing a better readability of the following charts. Two different colors are assigned to each chart. The green tones represent the Comprehensive Data chart, whereas the orange tones represent the Content Analysis Chart. They aim to give the information about which chart you are reading. If the dark-green color is seen, it means that it is Comprehensive Data Chart. When the medium-green is seen, it means it refers to hard-copy walkability measurement tools in Comprehensive Data Chart. When light-green is seen, it means that it is web-based walkability measurement tools in Comprehensive Data Chart. When dark-orange is seen, it means that it is Content Analysis Chart. The medium-orange represents the hard-copy walkability measurement tools and the light-orange represents the web-based walkability measurement tools in Content Analysis Chart.

3.2.1. Comprehensive Data Chart

After completing the detailed literature review about both web-based and hard-copy walkability measurement tools, the collected data were analyzed, filtered, and clustered into some groups in which some comparison can be made between the tools. The final version of this analysis, filtering and clustering, resulted in the Comprehensive Analysis Chart.

In this chart, there are no any interferences, but they are all taken from references. In other words, they are all concrete data; the interferences and comments will be made in the conclusion part of the thesis. The references used for each information are written down just next to the information in parenthesis. The reference types are as following: directly from the tool, academic article, academic article by tool developer(s), website article, website article by tool developer(s), website, the tool's website, the tool developer's website, the tool developer's master thesis, guide by tool developers, and no information. While giving the references in parentheses, it is written both the type of the reference and from which reference the information was taken.

	DEVELOPER	AIM & INTEREST	TARGET PROFILE	METHODOLOGY	QUESTION FORMATIONS	PRESENCE OF GUIDES
HARD-COPY						
WEB-BASED						

Figure 3.4. Schematic Chart of Comprehensive Data Chart

	PERCEPTION/ABSTRACT	USER	ENVIRONMENT-BASED	PHYSICAL	FUNCTION	NETWORK	POLICY
HARD-COPY							
WEB-BASED							

Figure 3.5. Schematic Chart of Content Analysis Chart

3.2.1.1. Groupings of Comprehensive Data Chart

After all the literature review was filtered in Comprehensive Data Chart, there are six main groups composed with some sub-groups underneath of each as following. The first main group is developer which covers its type and its details. The second group is aim and interest which contains the tool developer’s interest area and their general aim. The third main group is the target profile of the tool in which it involves the users, the technological and location-based adaptation and the geographic adaptation. The forth main group is methodology of the tools which covers data collection (methods – details – usage of numeric data – number of team members – auditor privacy – maps being used), in-process (criteria weight – engines and algorithms being used – in-process scoring) and evaluation (scoring definitions of the tools – scoring definitions of the developesrs – final scoring –ranging the final score – visualization). The fifth main group is question formations, which contains different question types of the following: open-ended and close ended (two-option responses – one best answer – rating scale – ordered choice – “other, please specify” – items in series – paired comparisons – matching – check all that apply – lists – ranking). The sixth and last main group is presence of guides which includes user guide/manual and scoring guide. Detailed information about each group is given in the following part.

3.2.1.1.1. Developer

In the “Developer” grouping of the Comprehensive Data Chart, by whom the tool was developed both in terms of its type and detailed information was given in details as in Table 3.1.

The information given in the type and details of the tool developer are as following. There are several different types of tool developers as below. In firm, the tool can be developed by either a private firm or a governmental firm. In individual researchers, the tool can be developed by a single person. In research team, the tool can be developed by a team of researchers either from the same organization and area of interest or not. In government facility, the tool can be developed by a facility of governmental institutions. In research project outcome, the tool can be the direct output of a previously conducted research project. In the details of the developers part, the name of tool developers are given for each type – either the name of the firm, individual researchers, research team members, the governmental facility or the research project in which the tool arose.

3.2.1.1.2. Aim and Interest

In the "Aim and Interest" group of the Comprehensive Data Chart, information about tool developers' main interest or research area was given. In addition to the interest area, the general aim of the tool or the tool developers was listed. The Quotes grouping can be seen in Table 3.1.

The information given in the interest area and general aim are as following. The interest area covers the main interest area or research area of the tool developer. The general aim covers the quotes used by tool developers in their webpages, in their interviews or speeches were given in "inverted commas". Their direct quotes may cover their aims or some other ideas about the tool or walkability. Also, direct quotes from other references which define the aim of the tools are also written down.

3.2.1.1.3. Target Profile

In the "Target Profile" group of the Comprehensive Data Chart, information about the users, the target location for which the tool was mainly developed, if there is a presence of an adapted version of the tool and the scale of criteria are given. The Target Profile grouping can be seen in Table 3.1.

The information given in the users, adaptation, and scale of criteria are as following. In users, there are can be five different types of users as following: adult – children – parent – elderly – disabled. However, none of the web-based and hard-copy walkability measurement tools set one of these users as their target. Indeed, rather than setting a target user profile, they set a target geographic area. In that column, the target geographic area of each tool can be seen. In technological and location-based adaptation; in some tools, there can be some adapted versions either for different locations and/or for being adapted to a technological process (Ex. adaptation from printout version to hand held devices). In that column, these adapted versions of tools can be seen. In geographic adaptation; the criteria of each tool may be the same for the adapted versions or can be changed accordingly. In this column, either the criteria change for adapted versions –

which means the criteria is local – or the criteria remains same for all adapted version – *which means the criteria is global* – is given.

3.2.1.1.4. Methodology

In the "Methodology" group of the Comprehensive Data Chart, information about the data collection methods, the weight of criteria, number of team members while collecting data, auditor privacy, and maps being used in the tool are given. The Methodology grouping can be seen in Table 3.1.

The information given in the data collection, usage of numeric data, number of team members, auditor privacy, and maps being used are as following. In data collection, the methods, their details, and other points related to data collection are covered. In methods, there are several different data collection methods used by walkability measurement tools as follows: numeric data, direct sampling, open source (open data), crowd-sourcing, software, priorization, observation, questionnaire, GIS data, self-report, and on-street. As the details of data collection methods, the information is given if there is a special program developed for the tool, if there is a special data source from which the data is obtained or if there is a special data that is collected from the source like crime rate. In addition to auditors' scoring, the usage of numeric data (statistical information) by the tool is also given in the quantification chart. This information is given as yes/no in the quantification part due to the fact that the detailed information about what type of statistical data is used is given in Methodology-Data Collection part. The number of team members or people required or proposed to take action while collecting the data with the tool is given, which is actually directly related with the social aspect of walking. If the information is (-) in that column, it means that there are no active people during data collection process, but the data is collected directly via data sources. In other words, (-) means there is no auditor. While being an auditor in data collection process, the auditor privacy is also important if the tool asks for the auditors' name, ID, e-mail (the requirement of log-in) or address, if there an assigned ID for each auditor for collecting data or no information is required for being an auditor. This column covers which information is asked from auditors for being a data collector. As maps being used, in most of the tools, either it is hard-copy or web-based; maps are used as a part of data collection process. Either this map is updateable online map or printout map information is given in that column. In-process phase of the tools, the weighting of each criteria, specific calculation methods being used, and the scoring methods being used are covered. In criteria weight, the importance, ratio, or weighting of each criterion sometimes differs in each tool. Either each and every criterion of the tool is same or different is given in that column. If there is any special engine or algorithm is developed or specially being used in the methodological process of the tool, it is also noted down with the names of these engines, algorithms, and calculation methods. The several different methods of in-process scoring are listed for each tool in the chart. The in-process scoring methods found are as follows: ordinal, likert, nominal, multiple choice, yes/no, checking, review, and algorithmic scoring. In evaluation part, information about the words both used in the tool and by developers that make a reference to quantification, the tool's scoring procedure as final result, if they range the final score, and if they visualize the final result are given. In definitions of scoring, the words used that may make reference to quantification both in the tool and by developer are analyzed. The words used in the guide or in the questions (criteria) in the tool that can make reference to quantification are listed. The words used by developers (either in their website, article or in their speech or interview) that can make reference to quantification are listed. The several different methods used in final scoring are listed for each tool in the chart. The final scoring methods found are as following: ordinal, likert, ranging and review. If the tool ranges the final score obtained, this is also noted down in the chart. The sample for this ranging is as following (in Walk Score): ninety-hundred: Walkers' Paradise – seventy-eighty nine: Very Walkable – fifty-sixty nine: Somewhat Walkable – twenty five-forty nine: Car Dependent – zero-twenty four: Car Dependent. If the tool makes visualization to the final result in such a way, this information is given with the names of the visualization methods which can be also interpreted as a way of quantification.

3.2.1.1.5. Question Formations

In the “Question Formations” part of the Comprehensive Data Chart, information about the type of questions is given. The Methodology grouping can be seen in Table 3.1.

The information given in the question formations are all collected directly from tools. The information for each question type is mentioned with (+) – *existing* or (-) – *not-existing*. The open-ended questions are the ones which are open to auditors’ ideas like starting with how or what. The difference between open-ended questions with multiple choices and close-ended with multiple choices is that open-ended ones are generally about ideas and opinions which means they are more subjective, whereas close-ended ones are mainly about the objective and concrete data. The close-ended questions can be one of the following: two-option responses, one best answer, rating scale, ordered choice, “other, please specify”, items in series, paired comparisons, matching, “check all that apply”, lists, and ranking.

3.2.1.1.6. Presence of Guides

In the “Presence of Guides” part of the Comprehensive Data Chart, information about the existence of user guide/manual and scoring guide are given. The Presence of Guides grouping can be seen in Table 3.1.

The presence of both user guide/manual and scoring guide are given with (+) – *existing* and (-) – *not-existing*. User guide/manual covers the presence of a manual or an user guide attached to the tool which gives general information about the methodology of the tool, whereas scoring guide covers the existence of a scoring guide attached to the tool which works as a guide for scoring and the scoring procedure.

3.2.2. Content Analysis Chart

As the first analysis chart, the content (criteria) of each tool either belongs to web-based or hard-copy cluster are analyzed. The aim of Content Analysis Chart is to understand each tool's scope, which issues are covered, and which points are missing when all are compared.

3.2.2.1. Phases of Content Chart Composition

The Content Analysis Chart was composed of five steps. Each step will be described with detailed information below. In Phase 1, criteria of each tool was copied and pasted into a single Excel sheet. In the first column in the chart, the cluster which the tool belongs to is written – either web-based or hard-copy. In the second column, the number of tools are listed. The third column is composed of the names of the tools within an alphabetical order. In each row directly next to each single tool, its content or criteria is listed. In some tools in which there are some titles, subtitles, and subgroups for criteria and questions, all are given. In addition to this, in the tools in which the questions have multiple choices are also listed in that chart. In Phase 2, criteria of all tools were analyzed and the criteria of the tools are grouped under twenty four titles as follows (in alphabetical order): accessibility, aesthetics, buildings, connectivity, crossings, disability, facilities and amenities, finding way and navigation, land use and density, lighting, neighborhood characteristics, obstruction, pavement/sidewalk, pedestrian, policy, public space, public transportation, safety, speed, street characteristics, topographic qualities, traffic, walking and cycling, and walking paths. While grouping each and every single question and/or criteria of each tool, they are directly copied and pasted. In Phase 3, the questions and criteria which were directly copied-pasted and clustered under groups are turned out into a single "phrase" format. Because that each tool's criteria differs from others in terms of question forming, it is needed to turn them into a single format. A sample of this question transformation is as follows: *Does the neighborhood have a center?* → *Having a center*

Table 3.1. Comprehensive Data Chart

	#	TOOL NAME	DEVELOPER TYPE
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	INDIVIDUAL RESEARCHERS **(WEBSITE - ACTIVE LIVING RESEARCH, 2011)**
	2	GLOBAL WALKABILITY INDEX	INDIVIDUAL RESEARCHER **(JUREMALANI & CHAUHAN, 2017 - ACADEMIC ARTICLE)**
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	RESEARCH TEAM **(WEBSITE - ACTIVE LIVING RESEARCH, 2005)**
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	INDIVIDUAL RESEARCHERS **(OSCAR & RAMIREZ-LOPEZ, 2017, ADLAKHA, HIPP & BROWNSON, 2016, SALLIS, N.D. & ACTIVE LIVING RESEARCH, 2002 - ACADEMIC ARTICLES & WEBSITE)**
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	INDIVIDUAL RESEARCHERS **(TOOLS & MEASURES: PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS) TOOL, 2004 - WEBSITE ARTICLE & PENTELLA, 2009 - ACADEMIC ARTICLE)**
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	FIRM **(ALLEN & CLARK, N.D. - WEBSITE ARTICLE, TRANSPORT FOR LONDON, N.D. - WEBSITE & TRL, 2003 - WEBSITE)**
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	GOVERNMENT FACILITY **(CITY OF AUSTIN PLANNING & DEVELOPMENT REVIEW DEPARTMENT, N.D. - WEBSITE & BATTEATE, N.D. - WEBSITE ARTICLE)**
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	INDIVIDUAL RESEARCHERS **(SALLIS, KERR, CARLSON, NORMAN, SEALENS, DURANT & AINSWORTH, 2010 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)**
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	RESEARCH TEAM **(EVENSON, SOTRES-ALVAREZ, HERRING, MESSER, LARAIA & RODRIGUEZ, 2009 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)**
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	RESEARCH PROJECT OUTCOME **(MILLINGTON, THOMPSON, ROWE, ASPINALL, FITZIMONS, NELSON & MUTRIE, 2009 - ACADEMIC ARTICLE)**
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	RESEARCH PROJECT OUTCOME **(CALGARY REGIONAL PARTNERSHIP, N.D. & A GUIDE TO: SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENT SCAN (SPACES), N.D. - WEBSITE)**
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	INDIVIDUAL RESEARCHERS **(CLIFTON, SMITH & RODRIGUEZ, 2007 - ACADEMIC ARTICLE)**

(cont. on next page)

Table 3.1 (cont.)

	#	TOOL NAME	DEVELOPER DETAILS
HARD-COPY	1	**ACTIVE NEIGHBORHOOD CHECKLIST**	CHRISTINE HOEHNER & ROSS BRWONSON **(WEBSITE - ACTIVE LIVING RESEARCH, 2011)**
	2	**GLOBAL WALKABILITY INDEX**	HOLLY VIRGINIA KRAMBECK **(JUREMALANI & CHAUHAN, 2017 - ACADEMIC ARTICLE)**
	3	**IRVINE MINNESOTA INVENTORY TOOL (IMI)**	KRISTEN DAY, MARLIN BOARNET, MARELA ALFONZO & ANN FORSYTH (UNIVERSITY OF CALIFORNIA) **(WEBSITE - ACTIVE LIVING RESEARCH, 2005)**
	4	**NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)**	BRIAN E. SAELENS & JAMES SALLIS **(OSCAR & RAMIREZ-LOPEZ, 2017, ADLAKHA, HIPP & BROWNSON, 2016, SALLIS, N.D. & ACTIVE LIVING RESEARCH, 2002 - ACADEMIC ARTICLES & WEBSITE)**
	5	**PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)**	KELLY CLIFTON (UNIVERSITY OR MARYLAND), ANDRIA LIVI (UNIVERSITY OF MARYLAND) & DANIEL RODRIGUEZ (UNIVERSITY OR NORTH CAROLINA) **(TOOLS & MEASURES: PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS) TOOL, 2004 - WEBSITE ARTICLE & PENTELLA, 2009 - ACADEMIC ARTICLE)**
	6	**PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)**	TRANSPORT RESEARCH LABORATOR (TRL), TRANSPORT FOR LONDON (TfL) & LONDON BOROUGH OF BROMLEY **(ALLEN & CLARK, N.D. - WEBSITE ARTICLE, TRANSPORT FOR LONDON, N.D. - WEBSITE & TRL, 2003 - WEBSITE)**
	7	**PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)**	SAN FRANCISCO DEPARTMENT OF PUBLIC HEALTH (SFDPH) **(CITY OF AUSTIN PLANNING & DEVELOPMENT REVIEW DEPARTMENT, N.D. - WEBSITE & BATTEATE, N.D. - WEBSITE ARTICLE)**
	8	**PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)**	JAMIS F. SALLIS & B. E. AINSWORTH **(SALLIS, KERR, CARLSON, NORMAN, SEALENS, DURANT & AINSWORTH, 2010 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)**
	9	**PIN3 NEIGHBORHOOD AUDIT TOOL**	KELLY R. EVENSON, DANIELA SOTRES-ALVAREZ, AMY M. HERRING, LYNNE MESSER, BARBARA A. LARAIA & DANIEL A. RODRIGUEZ **(EVENSON, SOTRES-ALVAREZ, HERRING, MESSER, LARAIA & RODRIGUEZ, 2009 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)**
	10	**SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)**	WALKING FOR WELLBEING IN THE WEST (WWW) **(MILLINGTON, THOMPSON, ROWE, ASPINALL, FITZIMONS, NELSON & MUTRIE, 2009 - ACADEMIC ARTICLE)**
	11	**SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)**	TERRI J. PIKORA, BILLIE GILES-CORTI, MATTHEW W. KNUMAN, FIONA C. BULL, KONRAD JAMROZIK & ROB J. DONOVAN **(CALGARY REGIONAL PARTNERSHIP, N.D. & A GUIDE TO: SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENT SCAN (SPACES), N.D. - WEBSITE)**
	12	**WALKING SUITABILITY ASSESSMENT FORM (WSAF)**	JAMES EMERY, CAROLYN CRUMP & PHILIP BORS **(CLIFTON, SMITH & RODRIGUEZ, 2007 - ACADEMIC ARTICLE)**

(cont. on next page)

Table 3.1 (cont.)

	#	TOOL NAME	AIM & INTEREST
			INTEREST AREA
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	EPIDEMIOLOGY **(WEBSITE - https://www.researchgate.net/profile/Christine_Hoehner)** // PUBLIC HEALTH & CHRONIC DISEASE PREVENTION **(WEBSITE - https://brownschool.wustl.edu/Faculty-and-Research/Pages/Ross-Brownson.aspx)**
	2	GLOBAL WALKABILITY INDEX	URBAN PLANNING **(WEBSITE - https://dspace.mit.edu/handle/1721.1/34409)**
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	HEALTH & WELL BEING OF URBAN ENVIRONMENT **(WEBSITE - DATA GEEKS & PLACE LOVERS UNITE!, N.D.)**
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	BEHAVIORAL SCIENCES, PEDIATRICS & HEALTH PSYCHOLOGY **(WEBSITE - https://depts.washington.edu/uwgenped/directory/briansaelens & http://sallis.ucsd.edu/)**
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	TRAVEL BEHAVIOUR, TRANSPORTATION SYSTEMS & LAND DEVELOPMENT, HISTORIC PRESERVATION, URBAN ENVIRONMENT & BEHAVIOUR **(WEBSITE - https://www.linkedin.com/in/kellyjclifton/,https://www.linkedin.com/in/andrea-livi-smith-8937533/ & https://isa.unc.edu/people/faculty/rodriguez/)**
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	RESEARCH, CONSULTANCY & ADVICE ON TRANSPORTATION ISSUES // TRANSPORTATION SAFETY, VEHICLE ENGINEERING & SIMULATION, INVESTIGATIONS & MAJOR INCIDENT FORENSICS, HUMAN FACTORS & BEHAVIORAL SCIENCE, INTELLIGENT POLYGON SYSTEMS, INFRASTRUCTURE ASSET MANAGEMENT, SUSTAINABILITY & CLIMATE CHANGE **(DEVELOPER'S WEBSITE - https://trlsoftware.co.uk/products/street_auditing/ratemystreet)**
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	HEALTH **(SAN FRANCISCO DEPARTMENT OF PUBLIC HEALTH, PROGRAM ON HEALTH, EQUITY & SUSTAINABILITY ENVIRONMENTAL HEALTH SECTION, 2008 - ACADEMIC ARTICLE BY TOOL DEVELOPER)**
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	PHYSICAL ACTIVITY **(WEBSITE - http://sallis.ucsd.edu/)**
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	PHYSICAL ACTIVITY EPIDEMIOLOGY, BIOSTATICS, STATISTICAL SCIENCE, WOMEN'S HEALTH, COMMUNITY HEALTH SCIENCES, CITY & REGIONAL PLANNING **(WEBSITE - https://activelivingresearch.org/pin3-neighborhood-audit-instrument)**
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	PHYSICAL ACTIVITY LEVEL & HEALTH **(WEBSITE - https://www.ncbi.nlm.nih.gov/pubmed/19041275)**
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	HEALTH PROMOTION, URBAN FUTURES & PHYSICAL ACTIVITY **(CALGARY REGIONAL PARTNERSHIP, N.D. & A GUIDE TO: SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENT SCAN (SPACES), N.D. - WEBSITE)**
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	TRAVEL BEHAVIOUR, TRANSPORTATION SYSTEMS & LAND DEVELOPMENT, HISTORIC PRESERVATION, URBAN ENVIRONMENT & BEHAVIOUR **(WEBSITE - https://www.linkedin.com/in/kellyjclifton/,https://www.linkedin.com/in/andrea-livi-smith-8937533/ & https://isa.unc.edu/people/faculty/rodriguez/)**

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Table 3.1 (cont.)

	#	TOOL NAME	AIM & INTEREST
			GENERAL AIM
HARD-COPY	1	**ACTIVE NEIGHBORHOOD CHECKLIST**	ASSESS THE MAIN STREET-LEVEL PROPERTIES OF THE NEIGHBORHOOD PHYSICAL ENVIRONMENT WHICH MIGHT BE RELATED TO THE PHYSICAL ACTIVITY OF PEOPLE **(ACTIVE LIVING RESEARCH, 2011- WEBSITE)**
	2	**GLOBAL WALKABILITY INDEX**	PROVIDING A QUALITATIVE ANALYSIS OF THE WALKING CONDITIONS INCLUDING SAFETY, SECURITY & CONVENIENCE OF THE PEDESTRIAN ENVIRONMENT **(JUREMALANI & CHAUHAN, 2017; GOTA, FABIAN, MEJIA & PUNTA, N.D.; MINHAS & PODDER, 2017; BABU, TADEPALLI & TADEPALLI, 2016 - ACADEMIC ARTICLES)**
	3	**IRVINE MINNESOTA INVENTORY TOOL (IMI)**	TO COLLECY DATA BY IN-PERSON FIELD OBSERVATION WHILE ALSO INCLUDING BOTH MICRO-SCALE & MACRO-SCALE PROPERTIES OF THE PHYSICAL & BUILT ENVIRONMENT **(LEE & TALEN, 2014 - ACADEMIC ARTICLE)** // TO RESPOND THE NEEDS FOR RELIABLE TOOLS & METHODS FOR EVALUATING PHYSICAL & BUILT ENVIRONMENT PROPERTIES THAT MIGHT HAVE RELATION WITH THE ACTIVITY OF WALKING OR BICYCLING **(BOARNET, DAY, ALFONZO, FORSYTH & OAKES, 2016 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)** // TO MEASURE ENVIRONMENTAL FEATURES THAT MIGHT HAVE A RELATION WITH PHYSICAL ACTIVITY, MOSTLY WALKING **(BORANET, FORSYTH, DAY & OAKES, 2011 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)** / TO COLLECT DATA ON BUILT ENVIRONMENT CHARACTERISTICS THAT MIGHT BE LINKED TO PHYSICAL ACTIVITY **(PREMIER'S COUNCIL FOR ACTIVE LIVING NEW SOUTH WALES & NSW CENTRE FOR PHYSICAL ACTIVITY & HEALTH, 2007 - WEBSITE)** // TO MEASURE A GREAT VARIETY OF BUILT ENVIRONMENT CHARACTERISTICS THAT MAY HAVE POTENTIAL TO HAVE LINK TO ACTIVE LIVING, MOSTLY WALKING **(ACTIVE LIVING RESEARCH, 2015 & MIDSS MEASUREMENT INSTRUMENT DATABASE FOR THE SOCIAL SCIENCES, N.D. - WEBSITE)** // TO CREATE AN OBJECTIVE MEASURE OF THE PHYSICAL ENVIRONMENT CHARACTERISTICS THAT MIGHT HAVE IMPACT UPON PHYSICAL ACTIVITY INCLUDING BOTHE INTENTIONAL WALKING & RECREATIONAL WALKING **(WEBSITE - DATA GEEKS & PLACE LOVERS UNITE!, N.D.)**
	4	**NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)**	TO ASSESS THE ENVIRONMENTAL ITEMS THAT MAY INFLUENCE PHYSICAL ACTIVITY **(ROSENBERG, DING, SALLIS, KERR, NORMAN, DURANT, HARRIS & SEALENS, 2009 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)** // TO MEASURE PERCEPTION OF RESIDENTS ABOUT THE ENVIRONMENTAL FACTORS RELATED TO THEIR LOCAL AREA **(OSCAR & RAMIREZ-LOPEZ, 2017 - ACADEMIC ARTICLE)** // TO ASSESS SEVERAL ASPECTS OF THE PERCEIVED SUITABILITY OF NEIGHBORHOODS FOR THE ACTIVITY OF WALKING **(STARNES, MCDONOUGH, TAMURA, JAMES,**
	5	**PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)**	EVALUATE THE PHYSICAL ENVIRONMENT FACTORS WHICH MAY AFFECT THE ACTIVITY OF WALKING **(FISHER, RICHARDSON & HOLSTER, 2010; CLIFTON, N.D.- ACADEMIC ARTICLE)** // TO MEASURE THE ENVIRONMENTAL PROPERTIES THAT MAY HAVE A RELATION WITH THE ACTIVITY OF WALKING IN VARIOUS ENVIRONMENTS IN U.S. **(CLIFTON, N.D.; CLIFTON & SMITH, N.D. & LOPEZ-BENAL, N.D. - ACADEMIC ARTICLE)** // ADDRESSING PEDESTRIAN CONCERNS WHILE ALSO MINIMIZING THE COST & THE TIME **(CLIFTON, N.D.; CLIFTON & SMITH, N.D. & LOPEZ-BENAL, N.D. - ACADEMIC ARTICLE)**

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Table 3.1 (cont.)

	#	TOOL NAME	AIM & INTEREST
			GENERAL AIM
HARD-COPY	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	"AS DEFINED BY TRL, A SYSTEMATIC PROCESS TO ASSESS THE PEDESTRIAN ENVIRONMENT WITHIN A FRAMEWORK THAT PROMOTES OBJECTIVITY." // "A WALKING AUDIT TOOL WHICH IS NOW PART OF THE MULTI-MODAL STREETAUDIT ASSESSMENT TOOL." **(ALLEN & CLARK, N.D.- ACADEMIC ARTICLE; VECTOS: TRANSPORT PLANNING SPECIALISTS, 2015 - WEBSITE & STEER DAVIES GLEAVE, 2014 - ACADEMIC ARTICLE)** // A HOLISTIC METHOD USED TO IDENTIFY DEFICIENCIES PRIMARILY IN EXISTING PEDESTRIAN ENVIRONMENTS, ALTHOUGH IT HAS THE FLEXIBILITY TO BE USED AS A TOOL DURING THE DESIGN PROCESS **(GOULD, 2011 -ACADEMIC ARTICLE)** // TO PROVIDE A COMPREHENSIVE & HOLISTIC ASSESSMENT, EVALUATION & DEMANDS ON APPRECIATION OF THE QUALITATIVE ASPECTS OF GOOD STREET DESIGN **(GOULD, 2011 -ACADEMIC ARTICLE)** // TO PROVIDE A FRAMEWORK FOR REGARDING THE PEDESTRIAN ENVRIONMENT DESIGN **(GOULD, 2011 - ACADEMIC ARTICLE)** // TO PROVIDE AN EFFICIENT & OBJECTIVE TOOL FOR BEING USED BY LOCAL AUTHORITIES FOR ASSESSING THE PEDESTRIAN PROVISION **(ALLEN & CLARK, N.D. - ACADEMIC ARTICLE)** // TO ALLOW COST EFFECTIVE EVALUATION OF CONDITIONS LEADING TO EFFECTIVE TARGETING OF RESOURCES TO DELIVER ACCESSIBLE & INCLUSIVE PEDESTRIAN NETWORKS **(TRL LAUNCHES PEDESTRIAN REVIEW SOFTWARE AT TRAFFEX, 2003 - WEBSITE)**
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	TO MEET THE NEEDS FR A PRACTICAL METHOD FOR ASSESSING THE EXISTING BARRIERS TO ACTIVITY OF WALKING & EVALUATING THE QUALITY OF THE BUILT PEDESTRIAN ENVIRONMENT **(SAN FRANCISCO DEPARTMENT OF PUBLIC HEALTH, PROGRAM ON HEALTH, EQUITY & SUSTAINABILITY ENVIRONMENTAL HEALTH SECTION, 2008 - ACADEMIC ARTICLE BY TOOL DEVELOPER)** // TO GUIDE & HELPING TO FAMILIARIZE THE NEIGHBORHOOD CHARACTERISTICS, OPPORTUNITIES & CONSTRAINTS IN PLANNING FOR THE FUTURE IMPROVEMENTS **(PEQI, N.D. - WEBSITE)**
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	TO COLLECT NATIONALLY REPRESENTATIVE & INTERNATIONALLY COMPERABLE & VALID PREVELANCE ESTIMATES ON PHYSICAL ACTIVITY FROM A DIVERSE SET OF COUNTRIES **(SALLIS, KERR, CARLSON, NORMAN, SEALENS, DURANT & AINSWORTH, 2010 - ACADEMIC ARTICLE BY TOOL DEVELOPER)**
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	TO EVALUATE THE BUILT ENVIRONMENT IN URBAN & RURAL NORTH CALIFORNIA **(ACTIVE LIVING RESEARCH, 2009 - WEBSITE)**
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	TO OBJECTIVELY ASSESS & EVALUATE THE WALKABILITY ASPECT OF THE PHYSICAL ENVIRONMENT IN THE WEST GLASGOS, SCOTLAND **(MILLINGTON, THOMPSON, ROWE, ASPINALL, FITZIMONS, NELSON & MUTRIE, 2009 & BELFAST HEALTH CITY: A WORLD HEALTH ORGANIZATION, 2014 - ACADEMIC REPORT)** // TO PROMOTE PUBLIC HEALTH & WELL-BEING BY RELATING IT WITH ACTIVITY OF WALKING **(ALBERS, WRIGHT & OLWOCH, 2010 - ACADEMIC ARTICLE)**
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	TO MEASURE THE PHYSICAL ACTIVITY RELATED ASPECTS OF BUILT ENVIRONMENT **(PIKORA, BULL, JAMROZIK, KNUIMAN GLES-CORTI & DONOVAN, N.D.; LEE & TALEN, 2014 & PIKORA, GILES-CORTI, KNUMAN, BULL, JAMROZIK & DONOVAN, 2006 - ACADEMIC ARTICLES)** // TO EVALUATE THE PHYSICAL ENVIRONMENT IN LOCAL NEIGHBORHOODS FOR ACTIVITY OF WALKING & CYCLING **(PREMIER'S COUNCIL FOR ACTIVE LIVING NEW SOUTH WALES & NSW CENTRE FOR PHYSICAL ACTIVITY & HEALTH, 2007 - WEBSITE)**
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	TO EXAMINE & TO EVALUATE THE CHARACTERISTICS THAT MAY HAVE RELATION WITH PEDESTRIAN SAFETY **(CLIFTON, SMITH & RODRIGUEZ, 2007 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)**

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Table 3.1 (cont.)

	#	TOOL NAME	TARGET PROFILE				
			USERS				
			ADULT	CHILDREN	PARENT	ELDERLY	DISABLED
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	ST. LOUIS, WASHINGTON **(TOOL)**				
	2	GLOBAL WALKABILITY INDEX	ASIA **(CAI-ASIA CENTER, 2011 - WEBSITE)**				
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	EQUIVALENT NEIGHBORHOODS IN SIZE **(TOOL)**				
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	USA **(OSCAR & RAMIREZ-LOPEZ, 2017 - ACADEMIC ARTICLE)**				
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	USA **(SHAY, RODRIGUEZ, CHO, KLIFTON & EVENSON, 2009 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)**				
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	NO INFORMATION				
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	NO INFORMATION				
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	NO INFORMATION				
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	NORTH CAROLINA **(ACTIVE LIVING RESEARCH, 2009 - WEBSITE)**				
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	GLASGOW; SCOTLAND **(MILLINGTON, THOMPSON, ROWE, ASPINALL, FITZIMONS, NELSON & MUTRIE, 2009 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)**				
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	AUSTRALIA **(CLIFTON, SMITH & RODRIGUEZ, 2007 - ACADEMIC ARTICLE)**				
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	NO INFORMATION				

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Table 3.1 (cont.)

	#	TOOL NAME	TARGET PROFILE	
			TECHNOLOGICAL & LOCATION-BASED ADAPTATION	GEOGRAPHIC ADAPTATION
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	NO INFORMATION	NO INFORMATION
	2	GLOBAL WALKABILITY INDEX	NO INFORMATION	NO INFORMATION
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	NO INFORMATION	NO INFORMATION
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	MEXICO, SAHARAN AFRICA, REPUBLIC OF COREA, CHINA, AUSTRALIA & INDIA + YOUTH + ABBREVIATED **(KIM, CHOI, MA, HYUNG, MIYASHITA & LEE, 2016 - ACADEMIC ARTICLE, CERIN, LESLIE, OWEN & BAUMAN, 2008 - ACADEMIC ARTICLE, MIDSS MEASUREMENT INSTRUMENT DATABSE FOR THE SOCIAL SCIENCES, N.D. - WEBSITE)**	GLOBAL (SAME FOR ALL LOCATIONS)
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	NO INFORMATION	NO INFORMATION
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	NO INFORMATION	NO INFORMATION
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	NO INFORMATION	NO INFORMATION
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	NO INFORMATION	NO INFORMATION
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	HANDHELD DEVICES **(EVENSON, SOTRES-ALVAREZ, HERRING, MASSER, LARAIA & RODRIGUEZ, 2009 - ACADEMIC ARTICLE OF TOOL DEVELOPER)**	NO INFORMATION
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	NO INFORMATION	NO INFORMATION
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	NEW ZEALAND **(OLIVER, WITTEN, BIAKELY, PARKER, BADLAND, SCHOFIELD, IVORY, PEARCE, MAVOA, HICNKSON, SWEETSUR & KEAMS, 2015 - ACADEMIC ARTICLE, A GUIDE TO: SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENT SCAN (SPACES), N.D. - WEBSITE & BADLAND, OPIT, WITTEN, KEAMS & MAVOA, 2010 - ACADEMIC ARTICLE)**	NO INFORMATION
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	NO INFORMATION	NO INFORMATION

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			DATA COLLECTION	
			METHODS	DETAILS
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	OBSERVATION **(TOOL)**	-
	2	GLOBAL WALKABILITY INDEX	VERBAL QUESTIONNAIRE **(TOOL)**	-
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	OBSERVATION + GIS DATA **(PREMIER'S COUNCIL FOR ACTIVE LIVING NEW SOUTH WALES & NSW CENTRE FOR PHYSICAL ACTIVITY & HEALTH, 2007 - WEBSITE)**	**GIS DATA:** DENSITY, INTERSECTION PATTERNS, STREET LENGTH, STREET PATTERN **(PREMIER'S COUNCIL FOR ACTIVE LIVING NEW SOUTH WALES & NSW CENTRE FOR PHYSICAL ACTIVITY & HEALTH, 2007 - WEBSITE)**
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	SELF-REPORT **(CERIN, LESLIE, OWEN & BAUMAN, 2008 & ADLAKHA, HIPP & BROWNSON, 2016 - ACADEMIC ARTICLES)**	-
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	OBSERVATION **(CLIFTON, N.D., FISHER, RICHARDSON & HOLSTER, 2010 - ACADEMIC ARTICLES)**	-
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	ON-STREET **(TRL PERS AUDIT TEAM, 2008 - WEBSITE ARTICLE OF TOOL DEVELOPER)**	-
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	OBSERVATION **(BALLICK, 2011 - ACADEMIC ARTICLE & SCULLY, N.D. - WEBSITE ARTICLE)**	-
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	QUESTIONNAIRE **(TOOL)**	-
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	QUESTIONNAIRE **(TOOL)**	-
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	SELF-REPORT **(BELFAST HEAKTHY CITY: A WORLD HEALTH ORGANIZATION, 2014 - WEBSITE ARTICLE)**	-
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	OBSERVATIONAL + GIS DATA **(CALGARY REGIONAL PARTNERSHIP, N.D - WEBSITE)**	**GIS DATA:** TRAFFIC VOLUME & SPEED, STREET & INTERSECTION DESIGN, THE LOCATION OF LOCAL DESTINATIONS (SUCH AS PARKS, SHOPS & PUBLIC TRANSPORT POINTS) **(CALGARY REGIONAL PARTNERSHIP, N.D - WEBSITE)**
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	NO INFORMATION	-

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			DATA COLLECTION	
			USAGE OF NUMERIC DATA	NUMBER OF TEAM MEMBERS
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	NO INFORMATION	INDIVIDUAL **(TOOL)**
	2	GLOBAL WALKABILITY INDEX	NO INFORMATION	IN TEAM - AT LEAST TWO **(TOOL)**
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	YES **(PREMIER'S COUNCIL FOR ACTIVE LIVING NEW SOUTH WALES & NSW CENTRE FOR PHYSICAL ACTIVITY & HEALTH, 2007 - WEBSITE)**	INDIVIDUAL **(TOOL)**
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	NO INFORMATION	INDIVIDUAL **(TOOL)**
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	NO INFORMATION	TEAM OF 2 **(TOOL)**
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	NO **(TRL PERS AUDIT TEAM, 2008 - WEBSITE ARTICLE)**	INDIVIDUAL **(TRL PERS AUDIT TEAM, 2008 - WEBSITE ARTICLE OF TOOL DEVELOPER)**
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	NO **(SAN FRANCISCO DEPARTMENT OF PUBLIC HEALTH, PROGRAM ON HEALTH, EQUITY & SUSTAINABILITY ENVIRONMENTAL**	TEAM OF 2 **(CITY OF AUSTIN PLANNING & DEVELOPMENT REVIEW DEPARTMENT, N.D. - WEBSITE)**
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	NO INFORMATION	NO INFORMATION
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	YES **(SUMINSKI, WASSERMAN, MAYFIELD, THELEN & EGGER, N.D. - ACADEMIC ARTICLE)**	NO INFORMATION
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	NO **(BELFAST HEALTHY CITY: A WORLD HEALTH ORGANIZATION, 2014 - WEB ARTICLE)**	NO INFORMATION
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	YES **(A GUIDE TO: SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENT SCAN (SPACES), N.D. - WEBSITE)**	INDIVIDUAL **(A GUIDE TO: SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENT SCAN (SPACES), N.D. - WEBSITE)**
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	NO INFORMATION	INDIVIDUAL **(TOOL)**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			DATA COLLECTION	
			AUDITOR PRIVACY	MAPS BEING USED
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	AUDITOR ID **(TOOL)**	PRINOUT MAP **(TOOL)**
	2	GLOBAL WALKABILITY INDEX	TEAM NAMES **(TOOL)**	PRINOUT MAP **(TOOL)**
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	OBSERVER NAME-SURNAME **(TOOL)**	UPDATEABLE ONLINE MAP **(TOOL)**
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	#ID **(TOOL)**	NO INFORMATION
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	NAME **(TOOL)**	NO INFORMATION
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	NO INFORMATION	UPDATEABLE ONLINE MAP **(TRL PERS AUDIT TEAM, 2008 - WEBSITE ARTICLE OF TOOL DEVELOPER)**
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	TEAM NUMBER **(TOOL)**	NO INFORMATION
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	NO INFORMATION	NO INFORMATION
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	RATER ID **(TOOL)**	NO INFORMATION
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	NO INFORMATION	NO INFORMATION
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	AUTHOR ID **(TOOL)**	PRINOUT MAP **(TOOL)**
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	DATA COLLECTOR NAME **(TOOL)**	NO INFORMATION

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			IN PROCESS	
			CRITERIA WEIGHT	ENGINES & ALGORITHMS BEING USED
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	NO INFORMATION	NO INFORMATION
	2	GLOBAL WALKABILITY INDEX	SAME **(DRISTI, N.D. - ACADEMIC ARTICLE)**	EQUAL WEIGHT RATING METHOD **(DRISTI, N.D. - ACADEMIC ARTICLE)**
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	NO INFORMATION	STAT TRANSFER & SPSS **(TOOL)**
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	NO INFORMATION	SUBSCALING **(CERIN, SEALENS, SALLIS & FRANK, 2006 - ACADEMIC ARTICLE OF TOOL DEVELOPER)**
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	NO INFORMATION	LIKERT SCALE **(PENTELLA, 2009 - ACADEMIC ARTICLE)**
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	DIFFERENT FOR EACH **(TRANSPORT FOR LONDON, N.D. - WEBSITE OF TOOL DEVELOPER)**	PERS V.2 SOFTWARE **(TRL PERS AUDIT TEAM, 2008 - WEBSITE ARTICLE)**
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	DIFFERENT FOR EACH **(SAN FRANCISCO DEPARTMENT OF PUBLIC HEALTH, PROGRAM ON HEALTH, EQUITY & SUSTAINABILITY ENVIRONMENTAL HEALTH SECTION, 2008 - ACADEMIC ARTICLE BY TOOL DEVELOPER)**	SPECIFIC MICROSOFT DATABASE **(SAN FRANCISCO DEPARTMENT OF PUBLIC HEALTH, PROGRAM ON HEALTH, EQUITY & SUSTAINABILITY ENVIRONMENTAL HEALTH SECTION, 2008 - ACADEMIC ARTICLE BY TOOL DEVELOPER)**
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	NO INFORMATION	LIKERT SCALE RANGING **(SALLIS, KERR, CARLSON, NORMAN, SEALENS, DURANT & AINSWORTH, 2010 - ACADEMIC ARTICLE OF TOOL DEVELOPER)**
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	NO INFORMATION	NO INFORMATION
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	NO INFORMATION	NO INFORMATION
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	NO INFORMATION	NO INFORMATION
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	SAME **(EMERY, CRUMP & BORS, 2003 - ACADEMIC REFERENCE)**	NO SPECIFIC SCORING **(CLIFTON, SMITH & RODRIGUEZ, 2007 - ACADEMIC ARTICLE)**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			IN PROCESS	
			IN PROCESS SCORING	
HARD-COPY	1	**ACTIVE NEIGHBORHOOD CHECKLIST**	NOMINAL (YES/NO & CHECKING)	YES/NO + CHECKING FROM GIVEN CHOICES **(TOOL)**
	2	**GLOBAL WALKABILITY INDEX**	ORDINAL (LIKERT) + NOMINAL (YES/NO & CHECKING)	FROM 1 TO 5 + YES/NO + ONE POINT FOR EACH BOX CHECKHED + DIVIDED PERCENTAGE BY 10 + FROM 1 (RARELY) TO 3 (USUALLY) **(TOOL)**
	3	**IRVINE MINNESOTA INVENTORY TOOL (IMI)**	NOMINAL (YES/NO & MULTIPLE CHOICE)	YES/NO + SELECTING BETWEEN GIVEN CHOICES **(TOOL)**
	4	**NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)**	NOMINAL (MULTIPLE CHOICE & CHECKING) + ORDINAL (LIKERT)	MULTIPLE CHOICE (5 OPTIONS + 4 OPTIONS) + CHECKING APPROPRIATE OPTION + 5 LIKERT SCALE **(TOOL)**
	5	**PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)**	NOMINAL (CHECKING & YES/NO)+ ORDINAL (LIKERT)	CHECKING + YES/NO + 4 LIKERT SCALE **(TOOL)**
	6	**PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)**	ORDINAL (LIKERT)	FROM -3 TO +3 **(TRANSPORT FOR LONDON, N.D. - TOOL DEVELOPER)**
	7	**PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)**	NOMINAL (CHECKING) + ORDINAL (LIKERT)	CHECKING + LIKERT SCALE (4 & 10) **(TOOL)**
	8	**PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)**	ORDINAL (LIKERT)	4 POINT LIKERT **(SALLIS, KERR, CARLSON, NORMAN, SEALENS, DURANT & AINSWORTH, 2010 - ACADEMIC ARTICLE OF TOOL DEVELOPER)**
	9	**PIN3 NEIGHBORHOOD AUDIT TOOL**	NOMINAL (CHECKING)	CHECKING **(TOOL)**
	10	**SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)**	NO INFORMATION	NO INFORMATION
	11	**SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)**	NOMINAL (CHECKING)	CHECKING **(TOOL)**
	12	**WALKING SUITABILITY ASSESSMENT FORM (WSAF)**	NOMINAL (LIKERT) + ORDINAL (YES/NO)	LIKERT SCALE + YES/NO **(TOOL)**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			EVALUATION	
			TOOLS' DEFINITIONS OF SCORING	DEVELOPERS' DEFINITIONS OF SCORING
HARD-COPY	1	**ACTIVE NEIGHBORHOOD CHECKLIST**	ASSESS, DATA, WEIGHTED, ANALYZING, CODE **(TOOL)**	-
	2	**GLOBAL WALKABILITY INDEX**	RESULT, ASSIGNED POINTS, SCALE, DIVIDE PERCENTAGE, POINT **(TOOL)**	FINAL RESULT **(KRAMBECK, 2006 - TOOL DEVELOPER'S MASTER THESIS)**, COMPERABLE RESULT **(KRAMBECK, 2006 - TOOL DEVELOPER'S MASTER THESIS)**, SCORED **(KRAMBECK, 2006 - TOOL DEVELOPER'S MASTER THESIS)**
	3	**IRVINE MINNESOTA INVENTORY TOOL (IMI)**	SCALE **(TOOL)**	EVALUATE **(BOARNET, DAY, ALFONZO, FORSYTH & OAKES, 2006 - ACADEMIC ARTICLE OF TOOL DEVELOPER)** & MEASURE **(BOARNET, FORSYTH, DAY & OAKES, 2011 - ACADEMIC ARTICLE OF TOOL DEVELOPER)**
	4	**NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)**	SCALE, CHECK MARK **(TOOL)**	MEASURES **(CERIN, LESLIE, OWEN & BAUMAN, 2008 - ACADEMIC ARTICLE OF TOOL DEVELOPER)**
	5	**PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)**	RATE **(TOOL)**	MEASURES **(CLIFTON, N.D. & CLIFTON & SMITH, N.D. - ACADEMIC ARTICLES OF TOOL DEVELOPER)**
	6	**PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)**	-	ASSESS **(TRANSPORT FOR LONDON, 2008 - WEB ARTICLE OF TOOL DEVELOPER)**, EVALUATE **(TRL PERS AUSIT TEAM, 2008 - WEB ARTICLE OF TOOL DEVELOPER)**, SCORING **(TRL PERS AUSIT TEAM, 2008 - WEB ARTICLE OF TOOL DEVELOPER),** WEIGHTING SYSTEM **(TRL PERS AUSIT TEAM, 2008 - WEB ARTICLE OF TOOL DEVELOPER)**, PRIORITIZE **(TRANSPORT FOR LONDON, N.D. - WEB ARTICLE OF TOOL DEVELOPER)**, ASSIGNING PERS SCORE **(TRANSPORT FOR LONDON, N.D. - WEB ARTICLE OF TOOL DEVELOPER)**, OVERALL SCORE **(TRANSPORT FOR**
	7	**PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)**	-	ASSESS, DATABASE, SCALE, SCORING, WEIGHTED, MEDIAN VALUE **(SAN FRANCISCO DEPARTMENT OF PUBLIC HEALTH, PROGRAM ON HEALTH, EQUITY & SUSTAINABILITY ENVIRONMENTAL HEALTH SECTION, 2008 - ACADEMIC ARTICLE BY TOOL DEVELOPER)**
	8	**PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)**	-	LIKERT SCALE **(SALLIS, KERR, CARLSON, NORMAN, SEALENS, DURANT & AINSWORTH, 2010 - ACADEMIC ARTICLE OF TOOL DEVELOPER)**, RANGING **(SALLIS, KERR, CARLSON, NORMAN, SEALENS, DURANT & AINSWORTH, 2010 - ACADEMIC ARTICLE OF TOOL DEVELOPER)**, SCORING **(CARLSON & SALLIS, 2014 - GUIDE BY TOOL DEVELOPERS)**, MEAN **(CARLSON & SALLIS, 2014 - GUIDE BY TOOL DEVELOPERS)**
	9	**PIN3 NEIGHBORHOOD AUDIT TOOL**	NUMBER, AMOUNT **(TOOL)**	-
	10	**SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)**	NUMBER, HEIGHT **(TOOL)**	-
	11	**SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)**	NUMBER, AVERAGE,CODING, ASSESSMENT, TICK **(TOOL)**	-
	12	**WALKING SUITABILITY ASSESSMENT FORM (WSAF)**	NUMBER **(TOOL)**	FINAL SCORE & MINIMUM SCORE **(EMERY, CRUMP & BORS, 2003 - ACADEMIC ARTICLE OF TOOL DEVELOPERS)**

(cont. on next page)

Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY EVALUATION	FINAL SCORING
HARD-COPY	1	**ACTIVE NEIGHBORHOOD CHECKLIST**	NO INFORMATION	NO INFORMATION
	2	**GLOBAL WALKABILITY INDEX**	NO INFORMATION	NO INFORMATION
	3	**IRVINE MINNESOTA INVENTORY TOOL (IMI)**	NO INFORMATION	NO INFORMATION
	4	**NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)**	NO INFORMATION	NO INFORMATION
	5	**PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)**	NO INFORMATION	NO INFORMATION
	6	**PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)**	ORDINAL (RANGING)	COLORING **(TRL PERS AUDIT TEAM, 2008 - WEBSITE ARTICLE)**
	7	**PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)**	ORDINAL (RANGING)	OVER 100 **(SAN FRANCISCO DEPARTMENT OF PUBLIC HEALTH, PROGRAM ON HEALTH, EQUITY & SUSTAINABILITY ENVIRONMENTAL HEALTH SECTION, 2008 - ACADEMIC ARTICLE BY TOOL DEVELOPER)**
	8	**PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)**	NO INFORMATION	NO INFORMATION
	9	**PIN3 NEIGHBORHOOD AUDIT TOOL**	NO INFORMATION	NO INFORMATION
	10	**SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)**	NO INFORMATION	NO INFORMATION
	11	**SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)**	NO INFORMATION	NO INFORMATION
	12	**WALKING SUITABILITY ASSESSMENT FORM (WSAF)**	NO INFORMATION	NO INFORMATION

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			EVALUATION	
			RANGING THE FINAL SCORE	VISUALIZATION
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	NO INFORMATION	NO INFORMATION
	2	GLOBAL WALKABILITY INDEX	NO INFORMATION	NO INFORMATION
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	NO INFORMATION	NO INFORMATION
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	NO INFORMATION	NO INFORMATION
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	NO INFORMATION	NO INFORMATION
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	NO INFORMATION	NO INFORMATION
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	YES (ONLY NUMERIC) **(SAN FRANCISCO DEPARTMENT OF PUBLIC HEALTH, PROGRAM ON HEALTH, EQUITY & SUSTAINABILITY ENVIRONMENTAL HEALTH SECTION, 2008 - ACADEMIC ARTICLE BY TOOL DEVELOPER)**	NO INFORMATION
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	NO INFORMATION	NO INFORMATION
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	NO INFORMATION	NO INFORMATION
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	NO INFORMATION	NO INFORMATION
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	NO INFORMATION	NO INFORMATION
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	NO INFORMATION	NO INFORMATION

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Table 3.1 (cont.)

	#	TOOL NAME	QUESTION FORMATIONS				
			OPEN-ENDED	CLOSE-ENDED			
				TWO-OPTION RESPONSES	ONE BEST ANSWER	RATING SCALE	ORDERED CHOICE
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	+	+	+	-	-
	2	GLOBAL WALKABILITY INDEX	-	-	-	-	+
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	-	+	-	-	+
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	-	-	-	+	+
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	-	+	+	+	+
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	-	-	-	+	-
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	+	+	+	+	-
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	+	-	-	+	-
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	-	+	+	+	-
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	NO INFORMATION				
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	-	+	+	+	-
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	+	+	+	-	-

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Table 3.1 (cont.)

	#	TOOL NAME	QUESTION FORMATIONS						
			CLOSE-ENDED						
			"OTHER, PLEASE SPECIFY"	ITEMS IN SERIES	PAIRED COMPARISONS	MATCHING	CHECK ALL THAT APPLY	LISTS	RANKING
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	+	-	-	-	+	-	-
	2	GLOBAL WALKABILITY INDEX	-	-	-	-	-	-	-
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	-	-	-	-	-	-	-
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	-	+	-	-	-	-	-
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	-	-	-	-	+	-	-
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	-	-	-	-	-	-	-
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	-	-	-	-	+	-	-
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	-	-	-	-	-	-	-
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	-	-	-	-	+	-	-
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	NO INFORMATION						
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	-	+	-	-	+	-	-
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	-	-	-	-	-	-	-

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Table 3.1 (cont.)

	#	TOOL NAME	PRESENCE OF GUIDES	
			USER GUIDE / MANUAL	SCORING GUIDE
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	+	-
	2	GLOBAL WALKABILITY INDEX	+	-
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	+	-
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	-	-
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	+	-
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	-	-
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	-	-
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	-	+
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	-	-
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	-	-
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	+	-
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	-	-

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Table 3.1 (cont.)

	#	TOOL NAME	DEVELOPER	
			TYPE	DETAILS
WEB-BASED	1	MAPONICS	FIRM **(ACQUINO, 2013 - WEB ARTICLE)**	MAPONICS LLC. **(ACQUINO, 2013 - WEB ARTICLE)**
	2	RATE MY STREET	FIRM **(TOOL'S WEBSITE - https://trlsoftware.co.uk/products/street_auditing/ratemystreet)**	TRANSPORT RESEARCH LABORATORY (TRL) **(TOOL'S WEBSITE - https://trlsoftware.co.uk/products/street_auditing/ratemystreet)**
	3	WALK SCORE	FIRM **(ARRIBAS-BEL, 2012 & DUNCAN, ALDSTADT, WHALEN, MELLY & GORTMAKER, 2011 - ACADEMIC ARTICLES)**	FRONT SEAT MANAGEMENT COMPANY LLC. **(ARRIBAS-BEL, 2012 & DUNCAN, ALDSTADT, WHALEN, MELLY & GORTMAKER, 2011 - ACADEMIC ARTICLES)**
	4	WALKABILITY ASIA	FIRM **(CAI ASIA - WALKABILITY APP, N.D. - WEBSITE, CAI ASIA WALKABILITY APP (OLDER IOS VERSION), N.D. - WEBSITE, DOTZOO INC. N.D. - WEBSITE)**	CLEAN AIR ASIA **(CAI ASIA - WALKABILITY APP, N.D. - WEBSITE, CAI ASIA WALKABILITY APP (OLDER IOS VERSION), N.D. - WEBSITE, DOTZOO INC. N.D. - WEBSITE)**
	5	WALKONOMICS	INDIVIDUAL RESEARCHERS **(TOOL'S WEBSITE - WALKONOMICS-ABOUT, 2011)**	ADAM DAVIES & CARSTEN MOELLER **(TOOL'S WEBSITE - WALKONOMICS-ABOUT, 2011)**
	6	WALKSHED	FIRM **(TOOL'S WEBSITE - WALKHED, 2016)**	AARON OGLE **(TOOL'S WEBSITE - WALKHED, 2016)**

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Table 3.1 (cont.)

	#	TOOL NAME	AIM & INTEREST
			INTEREST AREA
WEB-BASED	1	**MAPONICS**	LOCATION-BASED DATA PROVISION // COMPREHENSIVE DATABASES & GEOSPATIAL ANALYSIS // GEOGRAPHIC BOUNDARIES **(AQUINO, 2013 - ACADEMIC ARTICLE)**
	2	**RATE MY STREET**	RESEARCH, CONSULTANCY & ADVICE ON TRANSPORTATION ISSUES // TRANSPORTATION SAFETY, VEHICLE ENGINEERING & SIMULATION, INVESTIGATIONS & MAJOR INCIDENT FORENSICS, HUMAN FACTORS & BEHAVIORAL SCIENCE, INTELLIGENT POLYGON SYSTEMS, INFRASTRUCTURE ASSET MANAGEMENT, SUSTAINABILITY & CLIMATE CHANGE **(DEVELOPER'S WEBSITE - https://trlsoftware.co.uk/products/street_auditing/ratemystreet)**
	3	**WALK SCORE**	REAL ESTATE **(CARR, DUNSINGER & MARCUS, 2010 - ACADEMIC ARTICLE & DEVELOPER'S WEBSITE - https://www.walkscore.com/about.shtml)**
	4	**WALKABILITY ASIA**	INFRASTRUCTURE **(MUKHERJEEL, 2012 - WEBSITE)** // AIR POLLUTION & GAS EMISSION - TRANSPORTATION - INDUSTRY & ENERGY - WASTE **(BATHAN, 2010 - ACADEMIC ARTICLE)**
	5	**WALKONOMICS**	TRANSPORTATION - PLANNING - GEOGRAPHY - COMPUTER SCIENCE **(GOODYEAR, 2013 - WEBSITE)**
	6	**WALKSHED**	GEOGRAPHIC ANALYSIS & SOFTWARE FIRM -INNOVATIVE LOCATION BASED SOFTWARE TOOLS **(AVENCIA LAUNCHES WALKSHED.ORG TO CALCULATE & MAP WALKABILITY BASED ON INDIVIDUAL PREFERENCES, 2016 - WEBSITE)**

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Table 3.1 (cont.)

	#	TOOL NAME	AIM & INTEREST
			GENERAL AIM
WEB-BASED	1	MAPONICS	“AS MORE AND MORE STUDIES SHOW THAT HOME BUYERS AND RENTERS - PARTICULARLY MILLENNIAL - WANT TO LIVE IN COMMUNITIES THAT ARE EASILY NAVIGATED ON FOOT, BY PUBLIC TRANSIT OR ON A BIKE, WE KNOW IT'S IMPORTANT TO PROVIDE THE WIDEST COVERAGE WE CAN. THIS ENABLES REAL ESTATE PROFESSIONALS, CITY PLANNERS AND POLICY MAKERS TO VIEW RELEVANT DATA FOR A VARIETY OF GEOGRAPHIES ACROSS THE COUNTRY.” BY PAUL GALLAGHER (VICE PRESIDENT OF MARKETING & PRODUCT AT MAPONICS) **(MAPONICS SURPASSES WALK SCORE IN COVERAGE, 2014 - WEBSITE)** // “WE KNOW THAT YOUNGER GENERATIONS ARE EMBRACING A CAR-FREE LIFESTYLE. OUR WALKABILITY, PUBLIC TRANSPORTATION AND BIKEABILITY DATA, PROJECTED ONTO OUR REAL- LIFE GEOGRAPHIES, DELIVERS RELEVANT INFORMATION ABOUT WHICH AREAS ARE THE MOST AMENABLE TO PEOPLE WHO CHOOSE NOT TO RELY ON THEIR CARS. WE'RE PROUD TO PROVIDE THE MARKET'S MOST EXTENSIVE DATA ABOUT THIS GROWING TREND.” BY PAUL GALLAGHER (VICE PRESIDENT OF MARKETING & PRODUCT AT MAPONICS) **(MARLOW, 2014 - WEBSITE)** // “IT'S ONE THING TO HAVE POINTS OF INTEREST IN AN AREA - FOR RECREATION, FOR CULTURE, FOR SHOPPING AND DINING - BUT ANOTHER THING ALTOGETHER TO UNDERSTAND HOW ACCESSIBLE THEY ARE. WALKABILITY GIVES A GEO-SPATIAL MEANING TO THE CONCEPT OF 'STREET SMARTS.'” BY DARRIN CELEMENT (FOUNDER & CEO OF MAPONICS) **(MARLOW, 2013 - WEBSITE)** // “WE'RE DELIGHTED TO PROVIDE WALKABILITY RANKINGS TO A WIDE ARRAY OF REAL ESTATE PROFESSIONALS THROUGH RPR. STUDIES ARE FINDING THAT HOUSING IN PEDESTRIAN- FRIENDLY AREAS HAS HIGHER PROPERTY VALUES AND IS MORE DESIRABLE FOR HOMEBUYERS AND RENTERS. THIS IS IMPORTANT INFORMATION FOR THE REAL ESTATE MARKET, FOR OBVIOUS REASONS." BY MARK FRIEND (VICE PRESIDENT OF SALES & BUSINESS DEVELOPMENT OF MAPONICS) **(RET STAFF, 2014 - WEBSITE)** // HELPING CONSUMERS & BUSINESS TO UNDERSTAND THE WALKABILITY OF NEIGHBORHOODS, SCHOOL ATTENDANCE ZONES, SUBDIVISIONS & OTHER AREAS **(MARLOW, 2013 - WEBSITE)**
	2	RATE MY STREET	ALLOWS USERS TO EVALUATE THEIR STREETS IN TERMS OF WALKABILITY ISSUES **(DEVELOPER'S WEBSITE - https://trlsoftware.co.uk/products/street_auditing/ratemystreet)** // PROMOTING USERS TO GIVE FEEDBACKS ON THEIR LIVING ENVIRONMENT WITH USING A FIVE-STAR RATING SYSTEM **(DEVELOPER'S WEBSITE - https://trlsoftware.co.uk/products/street_auditing/ratemystreet)**
	3	WALK SCORE	"OUR VISION IS FOR EVERY PROPERTY LISTING TO READ: BEDS: 3 BATHS: 2 WALK SCORE: 84. WE WANT TO MAKE IT EASY FOR PEOPLE TO EVALUATE WALKABILITY & TRANSPORTATION WHEN CHOOSING WHERE TO LIVE" **(DEVELOPER'S WEBSITE - ttps://www.walkscore.com/about.shtml)** // EVALUATING & SUPPORTING WALKABILITY & PEDESTRIAN ACCESS TO TRANSPORTATION **(HIRSCH, MOORE, EVENSON, RODRIGUEZ & DIEX ROUX, 2013 - ACADEMIC ARTICLE)** // PROMOTE WALKABLE NEIGHBORHOODS **(ARRIBAS-BEL, 2014 - ACADEMIC ARTICLE)**
	4	WALKABILITY ASIA	IMPROVE WALKABILITY & PEDESTRIAN SERVICES ACROSS KEY ASIAN COUNTRIES & CITIES **(CAI ASIA - WALKABILITY APP, N.D. - WEBSITE, CAI ASIA WALKABILITY APP (OLDER IOS VERSION), N.D. - WEBSITE, DOTZOO INC. N.D. - WEBSITE)** // INCREASE THE PUBLIC AWARENESS & CONSCIOUSNESS ON WALKING AS PREFERRED LOW-EMISSION MODE OF TRANSPORT **(NEW MOBILE (FREE) TECHNOLOGY TO AID PEDESTRIANS LAUNCHED - COMMENT ON THE WALKABILITY OF CHIANG MAI'S STREETS, N.D. - WEBSITE)**
	5	WALKONOMICS	"IN THE LONG TERM, THE WALKONOMICS DATASET IS BUILT IN SUCH A WAY THAT IT PROVIDES A STREET NETWORK AND CAN BE USED TO FIND WALKING ROUTES, HE SAYS. "ONE ULTIMATE AIM IS TO PROVIDE WALKING DIRECTIONS THAT ARE BASED NOT JUST ON THE QUICKEST WALKING ROUTE, BUT ALSO OTHER FACTORS LIKE THE MOST BEAUTIFUL ROUTE, THE SAFEST ROUTE, THE MOST TREE-LINED ROUTE OR THE MOST FUN ROUTE." THERE IS CLEARLY A LONG WAY TO TRAVEL BEFORE THE APP FULFILLS THIS IDEAL. STILL, WALKONOMICS' FOCUS ON THE SUBJECTIVE EXPERIENCE OF THE PEDESTRIAN IS WELCOME.” BY ADAM DAVIES (FOUNDER OF WALKONOMICS) **(GOODYEAR, 2013 - WEBSITE)** // “WALKABILITY ISN'T ABOUT BEING ABLE TO GET SOMEWHERE IN FIVE MINUTES. IT'S ALSO ABOUT THE QUALITY OF THE STREETS YOU'VE BEEN WALKING DOWN” BY ADAM DAVIES (FOUNDER OF WALKONOMICS) **(VOMIERO, 2015 - WEBSITE)** // “WHEN HE WAS A NEWBORN BABY, I WAS OFTEN TAKING HIM OUT IN THE PRAM, AND HE REALLY LIKED TREE-LINED AREAS. WHENEVER HE WASN'T SEEING TREES, HE WAS CRYING. SO, I WAS THINKING IT WOULD BE USEFUL TO KNOW WHERE ALL THE TREES ARE IN THE LOCAL AREA.” BY ADAM DAVIES (FOUNDER OF WALKONOMICS) **(CACCAMO, 2015 - WEBSITE)** // "RESEARCH SUGGESTS THAT PEOPLE WHO LIVE IN MORE WALKABLE AREAS WALK 30 MINUTES MORE [A WEEK] THAN THOSE WHO DON'T. THERE'S ALSO A STUDY WHICH LINKS HOW WALKABLE A STREET IS TO HOUSE PRICES. WALKABILITY CAN ADD ABOUT £30K TO THE AVERAGE HOUSE PRICE." BY ADAM DAVIES (FOUNDER OF WALKONOMICS) **(DEAN, 2011 - WEBSITE)** // “LIVING IN A PEDESTRIAN FRIENDLY STREET CAN INCREASE THE VALUE OF THE HOME BY UP TO £30,000 & 77% OF PEOPLE WANT TO LIVE IN SUCH AN AREA” & “WALKABLE STREETS ALSO APPARENTLY BOOST RETAIL SALES BY UP TO 80%.” BY ADAM DAVIES (FOUNDER OF WALKONOMICS) **(FOSTER, 2013 - WEBSITE)** // SAVING THE ENVIRONMENT **(VOMIERO, 2015 - WEBSITE)** // QUANTIFY THE PEDESTRIAN EXPERIENCE IN A MORE DETAILED WAY **(GOODYEAR, 2013 - WEBSITE)** // GATHER THE COLLECTED DATA FROM THE CITIZENS & PUBLICS WITH CROWD-SOURCING PROCESS WHICH LEAD TO A MORE DETAILED PROCESS OF THE INDEXABSED ON THE WALKABILITY CRITERIA SET **(PERROTTA, 2013 - WEBSITE)** // RATE THE PEDESTRIAN FRIENDLINESS OF EACH STREET UNDER THE TITLE OF WALKABILITY **(WEBSITE - http://technicity.osu.edu/share-your-interesting-links-on-cities- and-technology/walkonomics-aims-to-rate-the-pedestrian-friendliness-of-streets)** // DISCOVER THE MOST AESTHETIC ROUTE IN THE WALKER'S DESTINATION WITH TAKING INTO ACCOUNT TIME & USERS' PREFERENCES **(VOMIERO, 2015 - WEBSITE)** // CREATING NEW MAPPING PLATFORM WHICH OFFERS MOST WALKABLE ROUTES NOT ONLY BASED ON THE DISTANCE BUT ALSO SOME OTHER CRITERIA IN WHICH PERSONALIZED ROUTES FOR USERS CAN BE OFFERED ACCORDING TO THEIR NEEDS & DEMANDS **(MOTT, 2012 - WEBSITE)** // CREATING ON ONLINE SPACE WHERE PEOPLE (CITIZENS), GOVERNMENT & COMPANIES CAN SHARE THEIR IDEAS WITH SUGGESTIONS, DISCUSSIONS & RECOMMENDING IMPROVEMENTS TO THE STREETS **(STEFANINI, 2015 - WEBSITE)**
	6	WALKSHED	ENABLING USERS TO CALCULATE THE WALKABILITY OF ANY PHILADELPHIA, ACCORDING TO USERS' PERSONAL PREFERENCES **(AVENCIA LAUNCHES WALKSHED.ORG TO CALCULATE & MAP WALKABILITY BASED ON INDIVIDUAL PREFERENCES, 2016 - WEBSITE)**

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Table 3.1 (cont.)

	#	TOOL NAME	TARGET PROFILE						
			USERS					TECHNOLOGICAL & LOCATION-BASED ADAPTATION	GEOGRAPHIC ADAPTATION
			ADULT	CHILDREN	PARENT	ELDERLY	DISABLED		
WEB-BASED	1	**MAPONICS**	USA **(WEBSITE - MAPONICS SURPASSES WALK SCORE IN COVERAGE, 2014)**					NO INFORMATION	GLOBAL (SAME FOR ALL LOCATIONS)
	2	**RATE MY STREET**	WHERE GOOGLE MAPS IS AVAILABLE **(DEVELOPER'S WEBSITE - https://trlsoftware.co.uk/products/street_auditing/ratemystreet)**					NO INFORMATION	GLOBAL (SAME FOR ALL LOCATIONS)
	3	**WALK SCORE**	USA, AUSTRALIA, NEW ZEALAND, ENGLAND, IRELAND, SEVERAL ADDRESSES IN CANADA **(BARNES, WINTERS, STE-MARIE, MCKAY & ASHE, IN PRESS & DUNCAN, 2013 - ACADEMIC ARTICLE)**					NO INFORMATION	GLOBAL (SAME FOR ALL LOCATIONS)
	4	**WALKABILITY ASIA**	LANZHOU, BANGALORE, BHAKTAPUR, BHUBANESWAR, CEBU, COLOMBO; SRI LANKA, DAVAO,HANOI, HO CHI MINH CITY; VIETNAM, HONG KONG, INDORE, CHENNAI, ISLAMABAD; PAKISTAN, JAKARTA; INDONESIA, KARACHI, KATHMANDU, KOTA; INDIA, MALE; MALDIVES, MANILA; PHILIPPINES, POKHARA; NEPAL, PUNE, RAJKOT, SAR; CHINA, SURAT, ULANBAATAR; MONGOLIA, VIENTIANE **(DEVELOPER'S WEBSITE - https://walkabilityasia.org/about/)**					NO INFORMATION	GLOBAL (SAME FOR ALL LOCATIONS)
	5	**WALKONOMICS**	BUENOS AIRES, CENTRAL LONDON, GLASGOW, HAMBURG, NEW YORK, PARIS, SAN FRANCISCO, SANTIAGO, TORONTO, WASHINGTON **(DAVIES, N.D. - TOOL DEVELOPER'S WEBSITE ARTICLE)**					NO INFORMATION	GLOBAL (SAME FOR ALL LOCATIONS)
	6	**WALKSHED**	NEW YORK & PHILADELPHIA **(CLARKE, 2013 - WEBSITE)**					NO INFORMATION	LOCAL (DIFFERENT FOR EACH LOCATION) **(TOOL'S WEBSITE - http://www.walkshed.org/)**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			DATA COLLECTION	
			METHODS	DETAILS
WEB-BASED	1	MAPONICS	NUMERIC DATA (BOUNDARY DATABASES) + INFORMATION GOING INSIDE BOUNDARIES) **(WEBSITE OF TOOL DEVELOPER - http://www.pitneybowes.com/us/data/boundary-data.html)**	**ADMINISTRATIVE:** CENSUS DATA, ZIP CODE BOUNDARIES, PARCEL BOUNDARIES, CADASTAL PLUS // **INDUSTRY:** COMMUNICATION SUITE, US CARRIER ROUTES, CREASTA ZONES, RISK DATA SUITE // **COMMUNITY:** NEIGHBORHOOD BOUNDARIES, RESIDENTIAL BOUNDARIES, SOCIAL PLACE BOUNDARIES, HOSPITAL BOUNDARIES, SCHOOL DISTRICT BOUNDARIES, METRO BOUNDARIES **(WEBSITE OF TOOL DEVELOPER - http://www.pitneybowes.com/us/data/boundary-data.html)**
	2	RATE MY STREET	DIRECT SAMPLING & OPEN SOURCE **(WEBSITE OF TOOL DEVELOPER - https://trl.co.uk/news/prev/4057)**	RATING & COMMENTS **(TOOL)**
	3	WALK SCORE	NUMERIC DATA FROM SEVERAL DATA SOURCES **(DUNCAN, ALDSTADT, WHALEN, MELLY & GORTMAKER, 2011; EL-GENEIDY, LIEROP & WASFI, 2016; LANGLOIS, WASFI, ROSS & EL-GENEIDY, 2016 & XU, WEN & WANG, 2015 - ACADEMIC ARTICLES)**	GOOGLE AJAX SEARCH APPLICATION PROGRAM INTERFACE (API) - LOCALEZE & CENSUS - OPEN STREET MAP - EDUCATION.COM - TRANSIT AGENCIES (OVER 200) **(DUNCAN, ALDSTADT, WHALEN, MELLY & GORTMAKER, 2011; EL-GENEIDY, LIEROP & WASFI, 2016; LANGLOIS, WASFI, ROSS & EL-GENEIDY, 2016 & XU, WEN & WANG, 2015 - ACADEMIC ARTICLES)**
	4	WALKABILITY ASIA	CROWD-SOURCING **(WEBSITE OF TOOL DEVELOPER - https://walkabilityasia.org/)**	RATING & MULTIPLE CHOICE **(TOOL)**
	5	WALKONOMICS	OPEN-DATA (DATASETS) **(VIVION, 2013 - WEBSITE ARTICLE)** + CROWD-SOURCING **(CAMUTI, 2015 & FRIENDLANDER, 2012 - WEBSITE ARTICLE)** + WALKOBOT (MODEL) **(GRAHAM RICHARD, 2013 - WEBSITE ARTICLE)**	**OPEN-DATA:** STREET WIDTHS, TRAFFIC LEVELS, 311 CLEANLINESS REPORTS, GRADIENTS, CRIME STATISTICS, PEDESTRIAN ACCIDENTS, HOW MANY STREETS ON EACH STREET **(VIVION, 2013 - WEBSITE ARTICLE)** // **CROWD-SOURCING**: RATINGS & REVIEWS **(CAMUTI, 2015 & FRIENDLANDER, 2012 - WEBSITE ARTICLE)** // **WALKOBOT:** FOR MODELLING WALKABILITY **(GRAHAM RICHARD, 2013 - WEBSITE ARTICLE)**
	6	WALKSHED	NUMERIC DATA **(CLARKE, 2013 - ACADEMIC ARTICLE)** + PRIORIZATION **(STEINIGER, POORAZIZI & HUNTER, 2017 - ACADEMIC ARTICLE)**	DIFFERENT DATA SOURCES **(CLARKE, 2013 - ACADEMIC ARTICLE)**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			DATA COLLECTION	
			USAGE OF NUMERIC DATA	NUMBER OF TEAM MEMBERS
WEB-BASED	1	MAPONICS	YES **(DEVELOPER'S WEBSITE - http://www.pitneybowes.com/us/data/boundary-data.html), RESMER, 2013 - ACADEMIC ARTICLE & ADRASHMINBURG, 2013 - ACADEMIC ARTICLE)**	43 EMPOLYEES OF MAPONICS TEAM (DATA COLLECTORS & EDITORS) **(RESMER, 2013 - WEBSITE ARTICLE)**
	2	RATE MY STREET	NO **(TOOL)**	INDIVIDUAL **(TOOL)**
	3	WALK SCORE	YES **(DUNCAN, ALDSTADT, WHALEN, MELLY & GORTMAKER, 2011, EL-GENEIDY, LIEROP & WASFI, 2016, LANGLOIS, WASFI, ROSS & EL-GENEIDY, 2016 & XU, WEN & WANG, 2015 - ACADEMIC ARTICLES)**	-
	4	WALKABILITY ASIA	NO	INDIVIDUAL **(TOOL)**
	5	WALKONOMICS	YES **(VIVION, 2013 - WEBSITE ARTICLE)**	INDIVIDUAL **(TOOL)**
	6	WALKSHED	YES **(TOOL'S WEBSITE - http://www.walkshed.org/)**	INDIVIDUAL **(TOOL WEBISTE - ABOUT WALKSHED, 2010 - http://www.walkshed.org/)**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			DATA COLLECTION	
			AUDITOR PRIVACY	MAPS BEING USED
WEB-BASED	1	**MAPONICS**	ADDRESS PRIVACY CONCERN **(AQUINO, 2013 - ACADEMIC ARTICLE)**	NO INFORMATION
	2	**RATE MY STREET**	NAME + TOWN-CITY **(TOOL)**	UPDATEABLE ONLINE MAP (GOOGLE) **(TOOL)**
	3	**WALK SCORE**	NO INFO REQUIRED	UPDATEABLE ONLINE MAP (GOOGLE) **(TOOL)**
	4	**WALKABILITY ASIA**	LOG-IN (E-MAIL & PASSWORD) - FOR MOBILE APP **(TOOL)**	UPDATEABLE ONLINE MAP (GOOGLE) **(TOOL)**
	5	**WALKONOMICS**	NO INFO REQUIRED	UPDATEABLE ONLINE MAP (GOOGLE) **(TOOL)**
	6	**WALKSHED**	NO INFO REQUIRED	UPDATEABLE ONLINE MAP (GOOGLE) **(TOOL)**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			IN PROCESS	
			CRITERIA WEIGHT	ENGINES & ALGORITHMS BEING USED
WEB-BASED	1	**MAPONICS**	NO INFORMATION	INTELLIGNET POLYGONS **(HAGEY, 2013 - ACADEMIC ARTICLE)**
	2	**RATE MY STREET**	SAME **(WEBSITE ARTCILE - https://www.noemiconcept.com/index.php/fr/departement-communication/news-departement-com/4392-notez-votre-rue-avec-rate-my-street.html)**	NO INFORMATION
	3	**WALK SCORE**	NO INFORMATION	SPECIAL DISTANCE-DECAY ALGORITHM **(BREWSTER, HUTRADO, OLSON & YEN, 2009, BROWN, PANTIN, LOMBARD, TORO, HUANG, PLATER-ZYBERK, PERRINO, PEREZ-GOMEZ, BARRERA-ALLEN & SZAPOCZNICK, 2013 & COLE, DUNN, HUNTER, OWEN & SUGIYAMA, 2015 - ACADEMIC ARTICLES)**
	4	**WALKABILITY ASIA**	NO INFORMATION	NO INFORMATION
	5	**WALKONOMICS**	NO INFORMATION	WALKOBOT **(GRAHAM RICHARD, 2013 - WEBSITE ARTICLE)**
	6	**WALKSHED**	DIFFERENT FOR EACH **(TOOL WEBISTE - ABOUT WALKSHED, 2010 - http://www.walkshed.org/)**	DECISION TREE CALCULATION ENGINE **(TOOL'S WEBSITE - ABOUT WALKSHED, 2010**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			IN PROCESS	
			IN PROCESS SCORING	
WEB-BASED	1	**MAPONICS**	ORDINAL (LIKERT)	FROM 0 TO 5 **(RET STAFF, 2014 - WEBSITE)**
	2	**RATE MY STREET**	ORDINAL (LIKERT) + REVIEW	5 STARS RATING + REVIEW **(TOOL)**
	3	**WALK SCORE**	ALGORITHMIC SCORING	ALGORITHMIC SCORING **(CHUDYK, WINTERS, MONIRUZZAMAN, ASHE, GOULD & MCKAY, 2015 & COLE, DUNN, HUNTER, OWEN & SUGIYAMA, 2015 - ACADEMIC ARTICLES)**
	4	**WALKABILITY ASIA**	NOMINAL (MULTIPLE CHOICE)	MULTIPLE CHOICE (BETWEEN 6 OPTIONS) **(TOOL)**
	5	**WALKONOMICS**	ORDINAL (LIKERT)	5 STARS RATING **(TOOL)**
	6	**WALKSHED**	ORDINAL (LIKERT)	FROM -5 TO +5 **(TOOL)**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			EVALUATION	
			TOOLS' DEFINITIONS OF SCORING	DEVELOPERS' DEFINITIONS OF SCORING
WEB-BASED	1	**MAPONICS**	-	WALKABILITY RANKING **(BY MARK FRIEND - VICE PRESIDENT OF SALES & BUSINESS DEVELOPMENTOF MAPONICS) (RET STAFF, 2014 - WEBSITE)**
	2	**RATE MY STREET**	OVERALL RATING, STREET'S RATING, OWN RATING, RATE THIS STREET **(TOOL)**	-
	3	**WALK SCORE**	GET SCORES **(TOOL'S WEBSITE - MAIN PAGE - www.walkscore.com)**	EVALUATE **(TOOLS' WEBSITE - https://www.walkscore.com/about.shtml)**
	4	**WALKABILITY ASIA**	NEARBY AREA SCORE, WALKABILITY SCORE **(TOOL)**	-
	5	**WALKONOMICS**	RATED, MAP & RATE **(TOOL)**	STATISTICS **(DAVIES, N.D. - WEBSITE ARTICLE BY TOOL DEVELOPER)**, RESULTS **(DAVIES, 2012 - WEBSITE ARTICLE BY TOOL'S DEVELOPER)**, OWN RATING **(DAVIES, N.D. - WEBSITE ARTICLE BY TOOL DEVELOPER)**, DATASET **(BY ADAM DAVIES IN GOODYEAR, 2013 - ACADEMIC ARTICLE)**, RESULTS **(DAVIES, N.D. - WEBSITE ARTICLE BY TOOL DEVELOPER),** FIVE-STAR RATING **(DAVIES, 2012 - WEBSITE ARTICLE BY TOOL'S DEVELOPER)**, OVERALL WALKABILITY SCORE **(DAVIES, 2012 - WEBSITE ARTICLE BY TOOL'S DEVELOPER)**
	6	**WALKSHED**	CALCULATE **(TOOL'S WEBSITE - MAIN PAGE - http://www.walkshed.org/nyc)**	SCORES **(TOOL'S WEBSITE - ABOUT WALKSHED, 2010)**, QUANTITY **(TOOL'S WEBSITE - ABOUT WALKSHED, 2010)**, RELATIVE WEIGHTS **(TOOL'S WEBSITE - ABOUT WALKSHED, 2010)**, ENGINE **(TOOL'S WEBSITE - ABOUT WALKSHED, 2010),** CALCULATED **(TOOL'S WEBSITE - ABOUT WALKSHED, 2010)**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			EVALUATION	
			FINAL SCORING	
WEB-BASED	1	**MAPONICS**	ORDINAL (LIKERT)	FROM 0 TO 5 **(RET STAFF, 2014 - WEBSITE)**
	2	**RATE MY STREET**	ORDINAL (LIKERT) + REVIEW	5 STARS RATING + REVIEW **(TOOL)**
	3	**WALK SCORE**	ORDINAL (RANGING)	FROM 0 TO 100 RANGE **(TOOL DEVELOPER'S WEBSITE - www.walkscore.com)**
	4	**WALKABILITY ASIA**	ORDINAL (RANGING)	FROM 0 TO 100 RANGE **(TOOL'S WEBSITE - http://www.dotzoo.net/walkability/)**
	5	**WALKONOMICS**	ORDINAL (LIKERT) + REVIEW	5 STARS RATING + REVIEW **(TOOL)**
	6	**WALKSHED**	ORDINAL (RANGING)	OVER 100 & HEAT MAP **(TOOL)**

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Table 3.1 (cont.)

	#	TOOL NAME	METHODOLOGY	
			EVALUATION	
			RANGING THE FINAL SCORE	VISUALIZATION
WEB-BASED	1	**MAPONICS**	NO INFORMATION	NO INFORMATION
	2	**RATE MY STREET**	NO **(TOOL)**	-
	3	**WALK SCORE**	YES (ONLY NUMERIC) **(TOOL DEVELOPER'S WEBSITE - www.walkscore.com)**	-
	4	**WALKABILITY ASIA**	YES (BOTH NUMERIC & VISUAL) **(TOOL'S WEBSITE - http://www.dotzoo.net/walkability/)**	COLORED PINS **(TOOL'S WEBSITE - http://www.dotzoo.net/walkability/)**
	5	**WALKONOMICS**	YES (BOTH NUMERIC & VISUAL) **(TOOL)**	COLORED PINS **(TOOL'S WEBSITE - www.walkonomics.com)**
	6	**WALKSHED**	YES (ONLY VISUAL) **(TOOL)**	HEAT MAP **(TOOL'S WEBSITE - MAIN PAGE - http://www.walkshed.org/nyc)**

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Table 3.1 (cont.)

	#	TOOL NAME	QUESTION FORMATIONS				
			OPEN-ENDED	CLOSE-ENDED			
				TWO-OPTION RESPONSES	ONE BEST ANSWER	RATING SCALE	ORDERED CHOICE
WEB-BASED	1	MAPONICS	-	-	-	+	-
	2	RATE MY STREET	+	-	-	+	-
	3	WALK SCORE	-	-	-	+	-
	4	WALKABILITY ASIA	+	-	+	-	-
	5	WALKONOMICS	-	-	-	+	-
	6	WALKSHED	-	-	-	+	-

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Table 3.1 (cont.)

	#	TOOL NAME	QUESTION FORMATIONS						
			CLOSE-ENDED						
			"OTHER, PLEASE SPECIFY"	ITEMS IN SERIES	PAIRED COMPARISONS	MATCHING	CHECK ALL THAT APPLY	LISTS	RANKING
WEB-BASED	1	MAPONICS	-	-	-	-	-	-	-
	2	RATE MY STREET	-	-	-	-	-	-	-
	3	WALK SCORE	-	-	-	-	-	-	-
	4	WALKABILITY ASIA	-	-	-	-	-	-	-
	5	WALKONOMICS	-	-	-	-	-	-	-
	6	WALKSHED	-	-	-	-	-	-	-

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Table 3.1 (cont.)

	#	TOOL NAME	PRESENCE OF GUIDES	
			USER GUIDE / MANUAL	SCORING GUIDE
WEB-BASED	1	MAPONICS	-	-
	2	RATE MY STREET	-	-
	3	WALK SCORE	-	+
	4	WALKABILITY ASIA	-	-
	5	WALKONOMICS	-	-
	6	WALKSHED	-	-

in neighborhood or How safe do you feel while walking in the area? → *Safety feeling*. The aim of this transformation is to convert each tool into same format in terms of its question formation. While their criterion and question formations changed, the group of each criterion remains same. In Phase 4, each group in which criteria were clustered are turned out into sub-groups. All criteria under each group were distributed to these sub-groups. For identifying sub-groups, different color codes were attached. The same color under a single group describes same subgroups. The sub-groups are as follows (in alphabetical order): accessibility (overall accessibility – access to services: distance and easiness), aesthetics (overall attractiveness and quality for walking and cycling – freeness from negative things and existence of abandoned buildings – presence of positive aspects – general maintenance – presence of view types and sights – interesting things to do – attractiveness of buildings), buildings (setback from street or sidewalk – physical aspects of buildings – overall quality of buildings – similarity of buildings), connectivity (complete streets and connectedness – cul-de-sacs – number of intersections – sidewalk continuity), crossings (presence and type of crossings – presence of crossing aids – physical qualities of crossings – easiness of crossings), disability (disabled access and infrastructure), facilities and amenities (presence and quality of different amenities – presence and quality of urban amenities – distance to amenities), finding way and navigation (easiness of wayfinding: general legibility – presence of wayfinding aids), land use and density (land use diversity – dominant land use – residential density and type of residential buildings – condition of land uses – vertical land uses), lighting (presence of outdoor lighting – coverage of lighting – lighting at night – quality of lighting), neighborhood characteristics (neighborhood characteristics – overall neighborhood satisfaction), obstruction (presence of permanent obstructions – presence of temporary obstructions – physical difficulties while walking and cycling – presence of temporary and permanent obstructions), pavement/sidewalk (physical dimensions of pavements and sidewalks – presence of kerb (curb – driveway cut) and qualities – maintenance of sidewalks – presence of sidewalks – overall condition and physical quality of sidewalks – presence of buffer and qualities), pedestrian (presence of people – physical activity level of people – presence of pedestrian aids – overall pedestrian friendliness), policy (general policy), public space (presence and quality of parks – having a center – overall condition of public spaces – presence of public spaces – usability of public space for activity by users), public transportation (availability of public transportation – public transport facilities (presence, type and properties) – walking distance to transit stops – number of motor vehicles to be used – quality of public transportation), safety (surveillance – presence of stray dogs – trip hazard – safety from crime – safety from traffic – overall feeling of safety – hedge height), speed (posted speed – posted speed limits – designs for lowering speed – over-drive (exceeding speed)), street characteristics (condition and quality of roads – type of roads), topographic qualities (hilliness – slope), traffic (motorists' behavior – number of (thru) lanes – on and off street parking – level of traffic – traffic calming devices and signs + traffic calming features – either traffic is one way or two ways – road properties: location, type, condition and number of driveways), walking and cycling (presence of bicycle lanes – presence of cycling paths – quality of cycling paths – easiness of bicycling and walking) and walking paths (availability of walking paths – quality of walking paths). In Phase 5, the first step is assigning each group a symbol. For example, for Accessibility; ¢ symbol was assigned. For each sub-group, these symbols were reproduced as it can be seen in the following example. Accessibility (¢): Overall Walkability → ¢andAccess to Services: Distance and Easiness → 2¢. These digits in front of symbols do not mean they are folds of the main symbol but they are totally different. In other words, they can be perceived as different symbols while belonging to same group. In Table 3.2, it can be seen which group is symbolized with which symbol. In other words, their detailed scope can be seen. After setting the symbols and scope of each group and sub-groups, the groups are deeply analyzed for dividing them into main themes. The themes in which the groups are clustered underneath are as following: <u>Perception/Abstract</u> which includes more perceptual aspects which are generally more subjective and changes from person-to-person (accessibility – connectivity – finding way and navigation – safety), <u>Environment</u>-<u>Based</u> which contains more space related aspects within the range that differs from how good the buildings look to the geographical qualities of neighborhood (aesthetics – buildings – neighborhood characteristics – public space – street characteristics – topographic qualities), <u>Physical</u> in which there are more concrete features of immediate surrounding which are mainly objective and do nott change from person-to-person (crossings – finding way and navigation – lighting – obstruction – pavement/sidewalks – walking paths), <u>Function</u> in which main function in both architectural scale (buildings) and neighborhood scale (parcel usage) are covered (facilities and amenities – land-use diversity), <u>Network</u> which includes more traffic and transportation related parameters (public transportation – speed – traffic – walking and cycling), <u>User</u> which is directly about the person (disability –

pedestrian), and Policy which covers the regulations and laws about walkability. The detailed coverings of each sub-title under each theme is as following.

There are four groups under Perception and Abstract (Table 3.3). The first group is accessibility with two sub-groups underneath. Overall walkability covers the general walkability assessment of the area in which the tool is conducted. Because walkability has several different parameters underneath, the level of how the searched area promotes the activity of walking may differ individually. Access to services: distance and easiness covers the distance (ex. Is it far or near to access restaurants?) and duration (ex. Does it take long to walk to cinema?) to facilities and amenities from home or work, how simple or hard is to access services by walking. Access to services not only covers by walking, but also other modes of transportation that can be used to access. Also, the existence or lack of infrastructure that may make accessibility harder is covered. The second group is connectivity with four sub-groups. Complete streets comprises in what degree the streets are connected and continuous for walking and cycling. Also, the general quality of the connected streets are involved. Cul-de-sacs means the ratio between dead-end street (cul-de-sac) presence and complete streets. Number of intersections refers to the general physical properties of intersections like the density of people in intersections, the number and in-between distances between intersections which promote connectivity. Also, the presence of traffic calming features existing at intersections and how this enables them to walk is discussed. Sidewalk continuity includes to what degree the sidewalks are connected to each other and their quality for simplifying the act of walkability. The third group is finding way and navigation with one sub-group. In easiness of wayfinding, the overall legibility (readability) quality while going around by walking for different users is discussed from the perspective how easy or hard it is. The fourth group is safety with seven sub-groups within the scope. Surveillance refers to the presence of surveillance, like camera or gatekeepers, and its effect on the general feeling of safety. In presence of stray dogs, the overall safety feeling if there is a presence of dogs in street is addressed. Trip hazard covers the risk of falling down while walking in safety feeling. Safety from crime contains the overall perception of safety from crime. In safety from traffic, the overall perception of safety from traffic (automobiles, density of traffic, motor vehicles) is discussed. Overall feeling of safety reviews the general safety feeling in the searched area from person-to-person. In hedge height, the presence of hedge by houses and their physical dimensions is discussed from the perspective of safety feeling. There are two groups under Users (Table 3.3). The first group is disability with only one sub-group underneath. Disabled access and infrastructure discusses the existence of infrastructure targeting especially disabled people and the quality of this infrastructure. The second group is pedestrian with four sub-groups. Presence of people covers the number of people in the neighborhood. Physical activity level of people refers to the physical activity level of people in the neighborhood. Presence of pedestrian aids discusses the existence of pedestrian aids that contributes to overall accessibility by walking. Overall pedestrian friendliness contains the perceived level of pedestrian friendliness in neighborhood.

There are six groups under Environment-Based (Table 3.3). The first group is aesthetics with seven sub-groups in it's scope. Overall attractiveness and quality (for walking and cycling) covers the general attraction level of the buildings and the neighborhood. It can either be the general attractiveness or what is perceived while walking and cycling. Freeness from negative things and presence of abandoned buildings contains the non-existence of bad things in the neighborhood like graffiti, litter, and odor which are generally physical, and also some bad conditioned buildings like abandoned or deserted. Presence of positive aspects includes the existence of positive aspects in the buildings like decorations in the buildings that add beauty to neighborhood's overall aesthetic quality and presence of some urban features that make the social life more beautiful like public art. General maintenance discusses the existence of gardening and verge items in the neighborhood and their overall quality. Presence of view types means the property of having a natural view in the neighborhood and the physical properties of views like openness and how good the view is for residents. Interesting things to do refers to the presence of facilities or activities that attract residents' attention while walking around. Attractiveness of buildings comprises the overall aesthetic properties of buildings existing in the neighborhood and how clean they are. The second group is buildings with four sub-groups under. Setback from street or sidewalk refers to the measurable and physical distance in between the buildings and the street or sidewalk. Physical aspects of buildings includes the objective and quantified properties of buildings in the neighborhood like their density in the neighborhood, their height, and number of stories they have. Overall quality of buildings means how attractive the buildings are in the neighborhood and the cleanliness of them. Similarity of buildings discusses how similar or different the buildings are in the neighborhood, which adds a value to the overall visual quality of the neighborhood. The third group is neighborhood characteristics with two sub-groups. Neighborhood identifiers includes the presence of landmarks or monuments in the neighborhood, which create a difference between one neighborhood and another.

In other words, the ability to identify the one enters a different neighborhood via the existence of banners or identifiers. Overall neighborhood satisfaction discusses how happy or satisfied the residents are in this neighborhood. The fourth group is public space with five sub-groups in its scope. Presence and quality of parks includes the existence, the overall maintenance, and aesthetic qualities of public parks in the neighborhood. Having a center refers to either the neighborhood has a center or not. Overall condition of public spaces deals with the general aesthetic and cleanliness properties of public spaces in the neighborhood. Presence of public spaces means the existence of different types of public spaces in the neighborhood. Usability of public space for activity by users is the criteria if the residents or visitors of the neighborhood can use the public spaces for their needs or social activities. The fifth group is street characteristics with two sub-groups underneath. Condition and quality of roads means the general circumstance and the overall quality of the roads in the neighborhood. Type of roads discusses the existence of different types of roads and their density in the neighborhood. The sixth group is topographic qualities with two sub-groups. Hilliness refers to the hilly quality of the neighborhood. Slope comprises the presence of slopes and their angle in the streets of the neighborhood. There are six groups under Physical (Table 3.3). The first group is crossings with four sub-groups underneath. Presence and types of crossings refers to the existence of crossings, the presence of different types of crossings and their number in the neighborhood. Presence of crossing aids means the existence of aids that make the crossing easier like signs and signals. Physical qualities of crossings is the overall physical condition and qualities of crossings. Easiness of crossings contains how pleasant or easy is to pass through the crossing. The second group is finding way and navigation with one sub-group. Presence of wayfinding aids refers to the existence of wayfinding aids which make the legibility and identification of the neighborhood easier. The third group is lighting with four sub-groups. Presence of outdoor lighting covers the existence of urban lighting equipment in the neighborhood. Coverage of lighting means the area which the urban lighting covers in the streets of the neighborhood. Lighting at night contains the presence and level of night lighting in the neighborhood. Quality of lighting discusses the overall quality of urban lighting features and how safe and pleasant that residents feel as a result. The fourth group is obstruction with four sub-groups. Presence of permanent obstructions comprises the existence of constant obstructions like some urban furniture which block walking or make the movement difficult. Presence of temporary obstructions refers to the existence of provisional obstructions like parked cars that block walking or make the movement difficult. Physical difficulties while walking and cycling discusses the level or degree how easy or difficult it is to walk or bicycle due to the obstructions in the neighborhood. Presence of temporary and permanent obstructions includes the existence of both temporary and permanent obstructions that make pedestrian movement difficult. The fifth group is pavement/sidewalk with six sub-groups underneath. Physical dimensions of pavement and sidewalks covers the physical dimensions of sidewalks (especially width). Presence of kerb (curb-driveway cut) and qualities discusses the existence, types, numbers, and overall physical conditions of curb cuts. Maintenance of sidewalks refers to the overall cleanliness and maintenance of sidewalks and pavements. Presence of sidewalks means the existence of sidewalks and pavements in the neighborhood. Overall condition and physical quality of sidewalks contains the general physical condition and infrastructure of sidewalks and pavements. Presence of buffer and qualities discusses the existence and physical dimensions of buffers in sidewalks. The sixth group is walking paths with two sub-groups. Availability of walking paths is the presence of walking paths and their types in the neighborhood. Quality of walking paths handles the overall condition of walking paths in the neighborhood. There are two groups under Function (Table 3.3). The first group is facilities and amenities with three sub-groups. Presence and quality of different amenities covers the existence of different amenities and facilities within the walking distance and their overall quality. Presence and quality of urban amenities refers to the existence of different urban facilities, amenities and furniture, either natural or man-made. Distance to amenities means the walking distance to facilities and amenities from home or work. The second group is land use and diversity with five sub-groups in its scope. Land use diversity refers to the variety of functions in land use and the ratio or balance in between these various functions. Dominant land use means the dominant function in the land use (either residential or commercial; if commercial, the specific type). Residential density and type of residential buildings discusses the density of residential buildings in land use, the different type of units and their numbers in the neighborhood. Condition of lands covers the overall condition of land use and presence of abandoned or vacant land use in the neighborhood. Vertical land use is the difference of functions in vertical land use (the function difference in each story of the buildings).

There are four groups under Network (Table 3.3). The first group is public transportation that covers five sub-groups. Availability of public transportation refers to the presence of public transportation in the neighborhood. Public transport facilities (presence, type, and properties) cover the existence, the different types, and quality of public transportation in the neighborhood. Walking distance to transit stops is the distance to transit stops by walking from homes, schools or works. Number of motor vehicles to be used discusses the available number of motor vehicles that is used while using the public transportation. Quality of public transportation includes the comfort and pleasure level of public transportation and public transportation waiting areas. The second group is speed comprised of four sub-groups. Posted speed indicates the posted speed of motor vehicles in the neighborhood. Posted speed limit is the posted speed limits for motor vehicles in the neighborhood. Designs for lowering speed refers to the aids and urban designs that aim to lower the speed of motor vehicles. Over-drive (exceeding speed) discusses the existence of over-driving (exceeding speed) by drivers. The third group is traffic consisting of seven sub-groups. Motorists' behavior covers the behavior of motorists towards pedestrians in the neighborhood like slowing down in the crossing to let them cross the street. Number of (thru) lanes refers to the number of existing lanes for motor vehicles. On and off street parking is the presence and number of parking facilities in the neighborhood and distance to them from homes, schools, or works. Level of traffic discusses the perceptual volume of traffic in the neighborhood. Traffic control devices and signs, and traffic calming features are the presence and location of traffic control devices like signals, signs, and bumpers. Either traffic is one way or two ways comprises the direction of traffic in the neighborhood. Road properties: location, type, condition, and number of driveways shows the properties, location, type, and condition of roads which is mainly used by motor vehicles. The fourth group is walking and cycling with four sub-groups. Presence of bicycle lanes covers the existence of bicycle tracks and routes in the neighborhood. Presence of bicycle facilities is the existence of physical bicycle-related facilities like overhead protection or areas in where bicycles can be locked. Quality of cycling paths is the overall physical condition of bicycling tracks. Easiness of bicycling and walking discusses the level of pleasure of bicycling and walking in the neighborhood. There is one group under Policy (Table 3.3). The one and only group is policy with one sub-group. General policy covers the presence of regulations, laws, and policies set for assessing and limiting the walkability in the neighborhood and the guidelines proposed for general urban planning.

In Table 3.3 which is the final version of Content Chart, it can be seen which groups are placed under each theme and the subgroups under each group with their symbols and scope definitions.

Table 3.2. Symbols of Content Analysis Chart

	MAIN SYMBOL	MAIN TITLE		SUB-TITLES	SCOPE OF SUB-TITLES
PERCEPTION & ABSTRACT	○	ACCESSIBILITY	1	OVERALL WALKABILITY	THE GENERAL WALKABILITY EVALUATION OF THE SEARCHED AREA (SEGMENT, NEIGHBORHOOD, STREET, ETC.)
			2	ACCESS TO SERVICES: DISTANCE & EASINESS	THE OVERALL ACCESSIBILITY REVIEW TO THE FACILITIES IN TERMS OF THEIR DISTANCE (HOW LONG IT TAKES) & SIMPLICITY (HOW DIFFICULT OR EASY TO ARRIVE) INCLUDING INFRASTRUCTURE & CHOICE OF DIFFERENT MODES OF TRANSPORTATION
	α	CONNECTIVITY	1	COMPLETE STREETS & CONNECTEDNESS	THE QUALITY OF HOW MUCH STREETS ARE CONNECTED & COMPLETE FOR WALKING & CYCLING
			2	CUL-DE-SACS	THE EXISTENCE OF CUL-DE-SACS (DEAD-END STREETS) IN THE AREA
			3	NO OF INTERSECTIONS	THE PHYSICAL QUALITIES OF INTERSECTIONS (DENSITY, NUMBER & IN-BETWEEN DISTANCE) & PRESENCE OF TRAFFIC CALMING FEATURES AT INTERSECTIONS
			4	SIDEWALK CONTINUITY	THE CONNECTEDNESS & COMPLETENESS QUALITY OF SIDEWALKS
	✤	FINDING WAY & NAVIGATION	1	EASINESS OF WAYFINDING (GENERAL LEGIBILITY)	THE EASINESS OF WAYFINDING & OVERALL LEGIBILITY OF SEARCHED AREA FOR DIFFERENT USERS
	☑	SAFETY	1	SURVEILLANCE	THE PRESENCE OF SURVEILLANCE IN THE SEARCHED AREA
			2	PRESENCE OF STRAY DOGS	THE PRESENCE OF STRAY DOGS
			3	TRIP HAZARD	THE RISK OF FALLING WHILE WALKING
			4	SAFETY FROM CRIME	THE SAFETY FROM CRIME
			5	SAFETY FROM TRAFFIC	THE SAFETY FROM TRAFFIC
			6	OVERALL FEELING OF SAFETY	THE OVERALL FEELING OF SAFETY
			7	HEDGE HEIGHT	THE DIMENSIONS OF FENCES

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Table 3.2 (cont.)

	MAIN SYMBOL	MAIN TITLE	SUB-TITLES		SCOPE OF SUB-TITLES
USER	❖	DISABILITY	1	DISABLED ACCESS & INFRASTRUCTURE	THE PRESENCE & QUALITY OF DESIGNS & AIDS WHICH ARE FOR DISABLED USERS
	¶	PEDESTRIAN	1	PRESENCE OF PEOPLE	THE NUMBER OF PEOPLE IN THE SEARCHED AREA
			2	PHYSICAL ACTIVITY LEVEL OF PEOPLE	THE PHYSICAL ACTIVITY LEVEL OF PEOPLE IN THE SEARCHED AREA
			3	PRESENCE OF PEDESTRIAN AIDS	THE PRESENCE OF AIDS & DESIGNS THAT INCREASES PEDESTRIAN ACCESSIBILITY
			4	OVERALL PEDESTRIAN FRIENDLINESS	THE OVERALL PEDESTRIAN FRIENDLINESS LEVEL

(cont. on next page)

Table 3.2 (cont.)

	MAIN SYMBOL	MAIN TITLE		SUB-TITLES	SCOPE OF SUB-TITLES
ENVIRONMENT-BASED	⊙	AESTHETICS	1	OVERALL ATTRACTIVENESS & QUALITY (FOR WALKING & CYCLING)	THE GENERAL ATTRACTIVENESS LEVEL OF THE SEARCHED AREA ESPECIALLY FOR WALKING & CYCLING LIKE SMARTNESS, BEAUTIFULNESS, OVERALL VISUAL ATTRACTIVENESS & HOW PLEASE THE AREA IS TO BE USED
			2	FREENESS FROM NEGATIVE THINGS & EXISTENCE OF ABANDONED BUILDINGS	THE OVERALL CLEANLINESS OF THE SEARCHED AREA & HOW MUCH THE AREA IS FREE FROM NON-AESTEHTIC QUALITIES LIKE VISUAL ITEMS (GRAFFITI, BROKEN WINDIWS, LITTER, ABANDONED BUILDINGS, RUBBISH, EXHAUST FUMES, ETC.) & NON-VISUAL ITEMS (ODOR, AIR POLLUTION, TRAFFIC NOISE, ETC.)
			3	PRESENCE OF POSITIVE ASPECTS	THE EXISTENCE OF PHYSICAL ITEMS THAT CONTRIBUTES TO OVERALL AESTHETIC QUALITY INCLUDING VISUAL AIDS IN BUILDINGS (PORCHE, DECORATION & BORDER), URBAN FEATURES (PUBLIC ART, BILLBOARD) & OTHERS LIKE STREET VENDORS
			4	GENERAL MAINTENANCE	THE OVERALL MAINTENANCE OF GARDENING ITEMS & VERGES
			5	PRESENCE OF VIEW TYPES & SIGHTS	THE PRESENCE OF NATURAL SIGHTS & THEIR GENERAL PROPERTIES LIKE OPENNESS & ATTRACTIVENESS IN TERMS OF AESTHETICS
			6	INTERESTING THINGS TO DO	THE PRESENCE OF FACILITIES & ITEMS THAT ATTRACT & TAKE ATTENTION OF PEOPLE WHILE WALKING (INTERESTING THINGS TO DO)
			7	ATTRACTIVENESS OF BUILDINGS	THE GENERAL ATTRACTIVENESS & CLEANLINESS LEVEL OF BUILDINGS EXISTING IN THE AREA
	■	BUILDINGS	1	SETBACK FROM STREET OR SIDEWALK	THE DISTANCE IN-BETWEEN SIDEWALK & BUILDINGS
			2	PHYSICAL ASPECTS OF BUILDINGS	THE VISUAL & PHYSICAL PROPERTIES OF BUILDINGS LIKE THEIR DENSITY IN THE SEARCHED AREA, HEIGHT & NUMBER OF STORIES
			3	OVERALL QUALITY OF BUILDINGS	THE GENERAL ATTRACTIVENESS & MAINTENANCE OF BUILDINGS
			4	SIMILARITY OF BUILDINGS	HOW SIMILAR & ALIKE THE BUILDINGS IN THE AREA

(cont. on next page)

Table 3.2 (cont.)

	MAIN SYMBOL	MAIN TITLE		SUB-TITLES	SCOPE OF SUB-TITLES
ENVIRONMENT-BASED	⏏	NEIGHBORHOOD CHARACTERISTICS	1	NEIGHBORHOOD IDENTIFIERS	THE PRESENCE OF NEIGHBORHOOD IDENTIFIERS INCLUDING LANDMARKS, MONUMENTS & BANNERS
			2	OVERALL NEIGHBORHOOD SATISFACTION	THE OVERALL NEIGHBORHOOD SATISFACTION FOR USERS
	✖	PUBLIC SPACE	1	PRESENCE & QUALITY OF PARKS	THE PRESENCE & OVERALL QUALITY OF PUBLIC PARKS & PLAYGROUNDS
			2	HAVING A CENTER	THE PRESENCE OF CENTER IN THE SEARCHED AREA
			3	OVERALL CONDITION OF PUBLIC SPACES	THE OVERALL CONDITION OF PUBLIC SPACES
			4	PRESENCE OF PUBLIC SPACES	THE DIFFERENT TYPES OF PUBLIC SPACES
			5	USABILITY OF PUBLIC SPACE FOR ACTIVITY BY USERS	THE OVERALL USABILITY OF PUBLIC SPACES FOR ACTIVITIES BY PUBLIC
	✔	STREET CHARACTERISTICS	1	CONDITION & QUALITY OF ROADS	THE OVERALL CONDITION & QUALITY OF ROADS
			2	TYPE OF ROADS	THE TYPE & DENSITY OF ROADS
	Θ	TOPOGRAPHIC QUALITIES	1	HILLINESS	THE HILLINESS QUALITY OF THE SEARCHED AREA
			2	SLOPE	THE SLOPE PRESENCE & QUALITY OF THE SEARCHED AREA & CROSSINGS

(cont. on next page)

Table 3.2 (cont.)

	MAIN SYMBOL	MAIN TITLE		SUB-TITLES	SCOPE OF SUB-TITLES
PHYSICAL	◆	CROSSINGS	1	PRESENCE & TYPE OF CROSSINGS	THE EXISTENCE, TYPE & NO OF CROSSINGS
			2	PRESENCE OF CROSSING AIDS	THE PRESENCE OF CROSSING AIDS FOR PEDESTRIANS (SIGNS & SIGNALS)
			3	PHYSICAL QUALITIES OF CROSSINGS	THE GENERAL PHYSICAL CONDITIONS OF CROSSINGS
			4	EASINESS OF CROSSINGS	HOW EASY & CONVENIENT IS TO USE CROSSINGS
	✜	FINDING WAY & NAVIGATION	2	PRESENCE OF WAYFINDING AIDS	THE EXISTENCE OF AIDS & EQUIPMENTS WHICH INCREASES THE WAYFINDING & IDENTIFICATION WHERE THE ONE SHOULD GO (BOTH WITHIN A SINGLE SPACE & IN-BETWEEN DIFFERENT SPACES)
	✪	LIGHTING	1	PRESENCE OF OUTDOOR LIGHTING	THE EXISTENCE OF OUTDOOR LIGHTING
			2	COVERAGE OF LIGHTING	THE EXTENT WHICH THE URBAN LIGHTING COVERS
			3	LIGHTING AT NIGHT	THE QUALITY OF LIGHTING AT NIGHT
			4	QUALITY OF LIGHTING	THE OVERALL QUALITY OF EXISTING URBAN LIGHTING

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Table 3.2 (cont.)

	MAIN SYMBOL	MAIN TITLE		SUB-TITLES	SCOPE OF SUB-TITLES
PHYSICAL	⌘	OBSTRUCTION	1	PRESENCE OF PERMANENT OBSTRUCTIONS	THE EXISTENCE OF PERMANENT OBSTRUCTIONS WHICH BLOCK WALKING
			2	PRESENCE OF TEMPORARY OBSTRUCTIONS	THE PRESENCE OF TEMPORARY OBSTRUCTIONS WHICH BLOCK WALKING
			3	PHYSICAL DIFFICULTIES WHILE WALKING & CYCLING	THE LEVEL OF PHYSICAL EASINESS OR HARDSHIP WHILE WALKING
			4	PRESENCE OF TEMPORARY &/OR PERMANENT OBSTRUCTIONS	THE PRESENCE OF BOTH PERMANENT & TEMPORARY OBSTRUCTIONS THAT MAKE PEDESTRIAN MOVEMENT DIFFICULT
	⌥	PAVEMENT / SIDEWALK	1	PHYSICAL DIMENSIONS OF PAVEMENT & SIDEWALKS	THE OVERALL PHYSICAL DIMENSIONS OF PAVEMENTS & SIDEWALKS
			2	PRESENCE OF KERB (CURB-DRIVEWAY CUT) & QUALITIES	THE PRESENCE, TYPE, NUMBER & OVERALL QUALITY OF KERB (CURB OR DRIVEWAY CUT)
			3	MAINTENANCE OF SIDEWALKS	THE GENERAL MAINTENANCE OF SIDEWALKS
			4	PRESENCE OF SIDEWALKS	THE PRESENCE OF SIDEWALKS
			5	OVERALL CONDITION & PHYSICAL QUALITY OF SIDEWALKS	THE OVERALL CONDITION & PHYSICAL QUALITY OF SIDEWALKS & PAVEMENTS
			6	PRESENCE OF BUFFER & QUALITIES	THE PRESENCE & DIMENSIONS OF BUFFERS
	ψ	WALKING PATHS	1	AVAILABILITY OF WALKING PATHS	THE PRESENCE & TYPE OF WALKING PATHS & THEOR DISTANCE FROM CURBS
			2	QUALITY OF WALKING PATHS	THE OVERALL PHYSICAL QUALITIES & PROPERTIES OF WALKING PATHS

(cont. on next page)

Table 3.2 (cont.)

	MAIN SYMBOL	MAIN TITLE		SUB-TITLES	SCOPE OF SUB-TITLES
FUNCTION	✚	FACILITIES & AMENITIES	1	PRESENCE & QUALITY OF DIFFERENT AMENITIES	THE EXISTENCE & QUALITY OF DIFFERENT AMENITIES & FACILITIES WITHIN WALKING DISTANCE WHICH HAVE DIFFERENT FUNCTIONS
			2	PRESENCE & QUALITY OF URBAN AMENITIES	THE EXISTENCE OF URBAN AMENITIES INCLUDING URBAN FURNITURES, FACILITIES & NATURAL ITEMS
			3	DISTANCE TO AMENITIES	THE WALKING DISTANCE TO DIFFERENT AMENITIES FROM HOME
	★	LAND USE & DENSITY	1	LAND USE DIVERSITY	THE PRESENCE OF DIFFERENT FUNCTIONS & DIVERSITY IN TERMS OF LAND USE IN SEARCHED AREA & DENSITY (BALANCE) BETWEEN DIFFERENT LAND-USES
			2	DOMINANT LAND USE	THE DOMINANT LAND USE TYPE
			3	RESIDENTIAL DENSITY & TYPE OF RESIDENTIAL BUILDINGS	THE (MAIN) TYPE OF RESIDENTIAL UNITS, THEIR NUMBER & DENSITY WITHIN THE SEARCHED AREA
			4	CONDITION OF LAND USES	THE OVERALL QUALITY OF DIFFERENT LAND USAGES & PRESENCE OF VACANT LANDS
			5	VERTICAL LAND USE	THE VERTICAL USAGE OF LAND

(cont. on next page)

Table 3.2 (cont.)

	MAIN SYMBOL	MAIN TITLE	SUB-TITLES		SCOPE OF SUB-TITLES
NETWORK	✕	PUBLIC TRANSPORTATION	1	AVAILABILITY OF PUBLIC TRANSPORTATION	THE AVAILABILITY OF PUBLIC TRANSPORTATION
			2	PUBLIC TRANSPORT FACILITIES (PRESENCE, TYPE & PROPERTIES)	THE PRESENCE, TYPE & PROPERTIES OF PUBLIC TRANSPORTATION FACILITIES
			3	WALKING DISTANCE TO TRANSIT STOPS	THE WALKING DISTANCE TO TRANSIT STOPS
			4	NO OF MOTOR VEHICLES TO BE USED	THE NUMBER OF MOTOR VEHCILES THAT CAN BE USED AS PUBLIC TRANSPORTATION
			5	QUALITY OF PUBLIC TRANSPORTATION	THE OVERALL COMFORT LEVEL OF PUBLIC TRANSPORT WAITING AREAS
	☒	SPEED	1	POSTED SPEED	THE POSTED SPEED OF MOTOR VEHICLES
			2	POSTED SPEED LIMIT	THE POSTED SPEED LIMIT FOR MOTOR VEHICLES
			3	DESIGNS FOR LOWERING SPEED	THE AIDS & URBAN FEATURES THAT LOWERS SPEED
			4	OVER-DRIVE (EXCEEDING SPEED)	OVER-DRIVE (EXCEEDING SPEED) BY DRIVERS

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Table 3.2 (cont.)

	MAIN SYMBOL	MAIN TITLE		SUB-TITLES	SCOPE OF SUB-TITLES
NETWORK	Δ	TRAFFIC	1	MOTORISTS' BEHAVIOUR	MOTORISTS' BEHAVIOUR TOWARDS PEDESTRIANS
			2	NO OF (THRU) LANES	NO OF LANES EXISTING
			3	ON & OFF STREET PARKING	PRESENCE & NO OF ON & OFF STREET PARKING & DISTANCE FROM HOME TO PARKING FACILITIES
			4	LEVEL OF TRAFFIC	THE LEVEL OF TRAFFIC
			5	TRAFFIC CONTROL DEVICES & SIGNS + TRAFFIC CALMING FEATURES	THE PRESENCE OF TRAFFIC CONTROL DEVICES, SIGNS & TRAFFIC CALMING FEATURES
			6	EITHER TRAFFIC IS ONE WAY OR TWO WAYS	EITHER THE TRAFFIC IS ONE WAY OR TWO WAY IN THE SEARCHED AREA
			7	ROAD PROPERTIES: LOCATION, TYPE, CONDITION & NO OF DRIVEWAYS	THE GENERAL ROAD PROPERTIES: LOCATION, TYPE, CONDITION & NO OF DRIVEWAYS
	Ω	WALKING & CYCLING	1	PRESENCE OF BICYCLE LANES	THE PRESENCE OF BICYCLE LANES WITHIN THE SEARCHED AREA
			2	PRESENCE OF BICYCLE FACILITIES	THE PRESENCE OF PHYSICAL BICYCLE FACILITIES
			3	QUALITY OF CYCLING PATHS	THE OVERALL PHYSICAL QUALITIES OF CYCLING PATHS
			4	EASINESS OF BICYCLING & WALKING	HOW EASY & PLEASANT IS TO BICYCLE & WALK IN THE SEARCHED AREA

(cont. on next page)

Table 3.2 (cont.)

	MAIN SYMBOL	MAIN TITLE	SUB-TITLES		SCOPE OF SUB-TITLES
POLICY	⊘	POLICY	1	GENERAL POLICY	THE EXISTING POLICIES, LAWS, REGULATIONS & GUIDELINES FOR URBAN PLAN

Table 3.3. Content Analysis Chart

TYPE OF THE TOOL	#	NAME OF THE TOOL	PERCEPTION / ABSTRACT			
			ACCESSIBILITY	CONNECTIVITY	FINDING WAY & NAVIGATION	SAFETY
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	-	2α	-	-
	2	GLOBAL WALKABILITY INDEX	-	-	-	4☑ / 5☑ / 6☑
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	-	2α	-	2☑ / 5☑ / 6☑
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	2O	α / 2α / 3α	-	4☑ / 5☑
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	-	3α / 4α	2❖	6☑
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	2O	-	❖ / 2❖	4☑ / 6☑
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	O	3α	-	6☑
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	-	3α	-	4☑
	9	PIN 3 NEIGHBORHOOD AUDIT TOOL	O	-	-	2☑
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	2O	3α	-	☑ / 2☑ / 5☑ / 6☑ / 7☑
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	-	α	❖	☑
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	-	-	-	-
WEB-BASED	1	MAPONICS	-	-	-	4☑
	2	RATE MY STREET	-	-	❖	3☑ / 4☑ / 5☑
	3	WALK SCORE	-	α	-	-
	4	WALKABILITY ASIA	-	-	-	5☑
	5	WALKONOMICS	-	-	❖ / 2❖	5☑ / 6☑
	6	WALKSHED	-	-	-	4☑

(cont. on next page)

Table 3.3 (cont.)

PERCEPTION / ABSTRACT			
OVERALL WALKABILITY (O): THE GENERAL WALKABILITY EVALUATION OF THE SEARCHED AREA (SEGMENT, NEIGHBORHOOD, STREET, ETC.)	**COMPLETE STREETS & CONNECTEDNESS (α)**: THE QUALITY OF HOW MUCH STREETS ARE CONNECTED & COMPLETE FOR WALKING & CYCLING	**EASINESS OF WAYFINDING (GENERAL LEGIBILITY) (✤)**: THE EASINESS OF WAYFINDING & OVERALL LEGIBILITY OF SEARCHED AREA FOR DIFFERENT USERS	**SURVEILLANCE (☑)**: THE PRESENCE OF SURVEILLANCE IN THE SEARCHED AREA
ACCESS TO SERVICES: DISTANCE & EASINESS (2O): THE OVERALL ACCESSIBILITY REVIEW TO THE FACILITIES IN TERMS OF THEIR DISTANCE (HOW LONG IT TAKES) & SIMPLICITY (HOW DIFFICULT OR EASY TO ARRIVE) INCLUDING INFRASTRUCTURE & CHOICE OF DIFFERENT MODES OF TRANSPORTATION	**CUL-DE-SACS (2α)**: THE PRESENCE OF CUL-DE-SACS (DEAD-END STREETS) IN THE AREA	**PRESENCE OF WAYFINDING AIDS (2✤)**: THE PRESENCE OF AIDS & EQUIPMENTS WHICH INCREASES THE WAYFINDING & IDENTIFICATION WHERE THE ONE SHOULD GO (BOTH WITHIN A SINGLE SPACE & IN-BETWEEN DIFFERENT SPACES)	**PRESENCE OF STRAY (2☑)**: THE PRESENCE OF STRAY DOGS
	NO OF INTERSECTIONS (3α): THE PHYSICAL QUALITIES OF INTERSECTIONS (DENSITY, NUMBER & IN-BETWEEN DISTANCE) & PRESENCE OF TRAFFIC CALMING FEATURES AT INTERSECTIONS		**TRIP HAZARD (3☑)**: THE RISK OF FALLING WHILE WALKING
	SIDEWALK CONTINUITY (4α): THE CONNECTEDNESS & COMPLETENESS QUALITY OF SIDEWALKS		**SAFETY FROM CRIME (4☑)**: THE SAFETY FROM CRIME
			SAFETY FROM TRAFFIC (5☑): THE SAFETY FROM TRAFFIC
			OVERALL FEELING OF SAFETY (6☑): THE OVERALL FEELING OF SAFETY
			HEDGE HEIGHT (7☑): THE DIMENSIONS OF FENCES

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Table 3.3 (cont.)

TYPE OF THE TOOL	#	NAME OF THE TOOL	USER	
			DISABILITY	PEDESTRIAN
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	-	-
	2	GLOBAL WALKABILITY INDEX	❖	-
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	-	3¶
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	-	¶
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	-	-
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	❖	-
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	-	-
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	-	2¶
	9	PIN 3 NEIGHBORHOOD AUDIT TOOL	-	¶ /2¶
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	-	-
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	-	-
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	-	-
WEB-BASED	1	MAPONICS	-	4¶
	2	RATE MY STREET	❖	-
	3	WALK SCORE	-	¶ / 3¶
	4	WALKABILITY ASIA	❖	-
	5	WALKONOMICS	-	-
	6	WALKSHED	-	-

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Table 3.3 (cont.)

USER	
DISABLED ACCESS & INFRASTRUCTURE (❖): THE PRESENCE & QUALITY OF DESIGNS & AIDS WHICH ARE FOR DISABLED USERS	**PRESENCE OF PEOPLE (¶):** THE NUMBER OF PEOPLE IN THE SEARCHED AREA
	PHYSICAL ACTIVITY LEVEL OF PEOPLE (2¶): THE PHYSICAL ACTIVITY LEVEL OF PEOPLE IN THE SEARCHED AREA
	PRESENCE OF PEDESTRIAN AIDS (3¶): THE PRESENCE OF AIDS & DESIGNS THAT INCREASES PEDESTRIAN ACCESSIBILITY
	OVERALL PEDESTRIAN FRIENDLINESS (4¶): THE OVERALL PEDESTRIAN FRIENDLINESS LEVEL

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Table 3.3 (cont.)

TYPE OF THE TOOL	#	NAME OF THE TOOL	ENVIRONMENT-BASED		
			AESTHETICS	BUILDINGS	NEIGHBORHOOD CHARACTERISTICS
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	2⊙ / 3⊙	■	-
	2	GLOBAL WALKABILITY INDEX	-	-	-
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	⊙ / 2⊙ / 3⊙ / 5⊙ / 7⊙	2■ / 3■	⏏
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	2⊙ / 5⊙ / 6⊙ / 7⊙	-	2⏏
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	⊙/ 2⊙	■ / 2■	-
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	⊙/ 2⊙	-	-
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	⊙/ 2⊙	-	-
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	6⊙	-	-
	9	PIN 3 NEIGHBORHOOD AUDIT TOOL	2⊙ / 3⊙ / 7⊙	3■	-
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	⊙ / 2⊙ / 4⊙ / 5⊙	3■ / 4■	-
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	⊙ / 2⊙ / 4⊙ / 5⊙	4■	-
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	2⊙	-	-
WEB-BASED	1	MAPONICS	-	-	-
	2	RATE MY STREET	⊙/ 2⊙	-	-
	3	WALK SCORE	-	-	-
	4	WALKABILITY ASIA	-	-	-
	5	WALKONOMICS	⊙ / 2⊙ / 6⊙	-	-
	6	WALKSHED	-	-	-

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Table 3.3 (cont.)

TYPE OF THE TOOL	#	NAME OF THE TOOL	ENVIRONMENT-BASED		
			PUBLIC SPACE	STREET CHARACTERISTICS	TOPOGRAPHIC QUALITIES
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	-	-	2Θ
	2	GLOBAL WALKABILITY INDEX	-	-	-
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	4✖ / 5✖	✔	Θ
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	-	-	-
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	-	2✔	2Θ
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	5✖	-	2Θ
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	-	-	-
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	-	-	-
	9	PIN 3 NEIGHBORHOOD AUDIT TOOL	✖ / 3✖	✔	-
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	✖	✔	2Θ
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	-	-	2Θ
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	-	-	-
WEB-BASED	1	MAPONICS	-	✔ / 2✔	-
	2	RATE MY STREET	-	-	-
	3	WALK SCORE	✖ / 2✖	-	-
	4	WALKABILITY ASIA	-	-	-
	5	WALKONOMICS	-	-	Θ
	6	WALKSHED	-	-	-

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Table 3.3 (cont.)

ENVIRONMENT-BASED					
OVERALL ATTRACTIVENESS & QUALITY (FOR WALKING & CYLING) (⦿): THE GENERAL ATTRACTIVENESS LEVEL OF THE SEARCHED AREA ESPECIALLY FOR WALKING & CYCLING LIKE SMARTNESS, BEAUTIFULNESS, OVERALL VISUAL ATTRACTIVENESS & HOW PLEASE THE AREA IS TO BE USED	**SETBACK FROM STREET OR SIDEWALK (■):** THE DISTANCE IN-BETWEEN SIDEWALK & BUILDINGS	**NEIGHBORHOOD IDENTIFIERS (⏏):** THE PRESENCE OF NEIGHBORHOOD IDENTIFIERS INCLUDING LANDMARKS, MONUMENTS & BANNERS	**PRESENCE & QUALITY OF PARKS (✖):** THE PRESENCE & OVERALL QUALITY OF PUBLIC PARKS & PLAYGROUNDS	**CONDITION & QUALITY OF ROADS (✔):** THE OVERALL CONDITION & QUALITY OF ROADS	**HILLINESS (ʘ):** THE HILLINESS QUALITY OF THE SEARCHED AREA
FREENESS FROM NEGATIVE THINGS & PRESENCE OF ABANDONED BUILDINGS (2⦿): THE OVERALL CLEANLINESS OF THE SEARCHED AREA & HOW MUCH THE AREA IS FREE FROM NON-AESTEHTIC QUALITIES LIKE VISUAL ITEMS (GRAFFITI, BROKEN WINDIWS, LITTER, ABANDONED BUILDINGS, RUBBISH, EXHAUST FUMES, ETC.) & NON-VISUAL ITEMS (ODOR, AIR POLLUTION, TRAFFIC NOISE, ETC.)	**PHYSICAL ASPECTS OF BUILDINGS (2■):** THE VISUAL & PHYSICAL PROPERTIES OF BUILDINGS LIKE THEIR DENSITY IN THE SEARCHED AREA, HEIGHT & NUMBER OF STORIES	**OVERALL NEIGHBORHOOD SATISFACTION (2⏏):** THE OVERALL NEIGHBORHOOD SATISFACTION FOR USERS	**HAVING A CENTER (2✖):** THE PRESENCE OF CENTER IN THE SEARCHED AREA	**TYPE OF ROADS (2✔):** THE TYPE & DENSITY OF ROADS	**SLOPE (2ʘ):** THE SLOPE PRESENCE & QUALITY OF THE SEARCHED AREA & CROSSINGS
PRESENCE OF POSITIVE ASPECTS (3⦿): THE PRESENCE OF PHYSICAL ITEMS THAT CONTRIBUTES TO OVERALL AESTHETIC QUALITY INCLUDING VISUAL AIDS IN BUILDINGS (PORCHE, DECORATION & BORDER), URBAN FEATURES (PUBLIC ART, BILLBOARD) & OTHERS LIKE STREET VENDORS	**OVERALL QUALITY OF BUILDINGS (3■):** THE GENERAL ATTRACTIVENESS & MAINTENANCE OF BUILDINGS		**OVERALL CONDITION OF PUBLIC SPACES (3✖):** THE OVERALL CONDITION OF PUBLIC SPACES		
GENERAL MAINTENANCE (4⦿): THE OVERALL MAINTENANCE OF GARDENING ITEMS & VERGES	**SIMILARITY OF BUILDINGS (4■):** HOW SIMILAR & ALIKE THE BUILDINGS IN THE AREA		**PRESENCE OF PUBLIC SPACES (4✖):** THE DIFFERENT TYPES OF PUBLIC SPACES		
PRESENCE OF VIEW TYPES & SIGHTS (5⦿): THE PRESENCE OF NATURAL SIGHTS & THEIR GENERAL PROPERTIES LIKE OPENNESS & ATTRACTIVENESS IN TERMS OF AESTHETICS			**USABILITY OF PUBLIC SPACE FOR ACTIVITY BY USERS (5✖):** THE OVERALL USABILITY OF PUBLIC SPACES FOR ACTIVITIES BY PUBLIC		
INTERESTING THINGS TO DO (6⦿): THE PRESENCE OF FACILITIES & ITEMS THAT ATTRACT & TAKE ATTENTION OF PEOPLE WHILE WALKING (INTERESTING THINGS TO DO)					
ATTTRACTIVENESS OF BUILDINGS (7⦿): THE GENERAL ATTRACTIVENESS & CLEANLINESS LEVEL OF BUILDINGS EXISTING IN THE AREA					

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Table 3.3 (cont.)

TYPE OF THE TOOL	#	NAME OF THE TOOL	PHYSICAL		
			CROSSINGS	FINDING WAY & NAVIGATION	LIGHTING
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	◆ / 2◆	-	-
	2	GLOBAL WALKABILITY INDEX	◆	-	-
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	◆ / 2◆ / 3◆ / 4◆	-	✪
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	◆	-	3✪
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	◆ / 2◆	2✜	✪
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	◆ / 3◆ / 4◆	✜ / 2✜	✪ / 4✪
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	◆ / 2◆ / 4◆	-	✪
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	-	-	-
	9	PIN 3 NEIGHBORHOOD AUDIT TOOL	2◆	-	✪
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	◆ / 2◆	-	✪
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	◆ / 2◆	✜	✪ / 2✪
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	-	-	4✪
WEB-BASED	1	MAPONICS	-	-	-
	2	RATE MY STREET	◆	✜	-
	3	WALK SCORE	-	-	-
	4	WALKABILITY ASIA	◆ / 3◆ / 4◆	-	-
	5	WALKONOMICS	4◆	✜ / 2✜	-
	6	WALKSHED	-	-	-

(cont. on next page)

Table 3.3 (cont.)

TYPE OF THE TOOL	#	NAME OF THE TOOL	PHYSICAL		
			OBSTRUCTION	PAVEMENT/SIDEWALK	WALKING PATHS
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	⌘	⌥ / 2⌥ / 4⌥ / 5⌥ / 6⌥	-
	2	GLOBAL WALKABILITY INDEX	2⌘	-	2ψ
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	4⌘	2⌥ / 4⌥ / 5⌥ / 6⌥	-
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	-	4⌥ / 5⌥	-
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	⌘ / 3⌘	⌥ / 2⌥ / 5⌥	ψ / 2ψ
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	⌘ / 2⌘ / 4⌘	⌥ / 2⌥ / 5⌥	2ψ
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	4⌘	⌥ / 2⌥ / 5⌥ / 6⌥	-
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	-	3⌥ / 4⌥	-
	9	PIN 3 NEIGHBORHOOD AUDIT TOOL	-	4⌥ / 5⌥ / 6⌥	-
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	⌘	2⌥	ψ / 2ψ
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	⌘ / 3⌘	2⌥	2ψ
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	-	⌥ / 2⌥ / 5⌥ / 6⌥	-
WEB-BASED	1	MAPONICS	-	-	-
	2	RATE MY STREET	-	⌥	-
	3	WALK SCORE	-	-	-
	4	WALKABILITY ASIA	4⌘	-	ψ / 2ψ
	5	WALKONOMICS	-	⌥ / 4⌥ / 5⌥	-
	6	WALKSHED	-	-	-

(cont. on next page)

Table 3.3 (cont.)

PHYSICAL					
PRESENCE & TYPE OF CROSSINGS (◆): THE PRESENCE, TYPE & NO OF CROSSINGS	**EASINESS OF WAYFINDING (GENERAL LEGIBILITY) (✤)**: THE EASINESS OF WAYFINDING & OVERALL LEGIBILITY OF SEARCHED AREA FOR DIFFERENT USERS	**PRESENCE OF OUTDOOR LIGHTING (✪)**: THE PRESENCE OF OUTDOOR LIGHTING	**PRESENCE OF PERMANENT OBSTRUCTIONS (⌘)**: THE PRESENCE OF PERMANENT OBSTRUCTIONS WHICH BLOCK WALKING	**PHYSICAL DIMENSIONS OF PAVEMENT & SIDEWALKS (⌥)**: THE OVERALL PHYSICAL DIMENSIONS OF PAVEMENTS & SIDEWALKS	**AVAILABILITY OF WALKING PATHS (ψ)**: THE PRESENCE & TYPE OF WALKING PATHS & OR THE DISTANCE FROM CURBS
PRESENCE OF CROSSING AIDS (2◆): THE PRESENCE OF CROSSING AIDS FOR PEDESTRIANS (SIGNS & SIGNALS)	**PRESENCE OF WAYFINDING AIDS (2✤)**: THE PRESENCE OF AIDS & EQUIPMENTS WHICH INCREASES THE WAYFINDING & IDENTIFICATION WHERE THE ONE SHOULD GO (BOTH WITHIN A SINGLE SPACE & IN-BETWEEN DIFFERENT SPACES)	**COVERAGE OF LIGHTING (2✪)**: THE EXTENT WHICH THE URBAN LIGHTING COVERS	**PRESENCE OF TEMPORARY OBSTRUCTIONS (2⌘)**: THE PRESENCE OF TEMPORARY OBSTRUCTIONS WHICH BLOCK WALKING	**PRESENCE OF KERB (CURB - DRIVEWAY CUT)) & QUALITIES (2⌥)**: THE PRESENCE, TYPE, NUMBER & OVERALL QUALITY OF KERB (CURB OR DRIVEWAY CUT)	**QUALITY OF WALKING PATHS (2ψ)**: THE OVERALL PHYSICAL QUALITIES & PROPERTIES OF WALKING PATHS
PHYSICAL QUALITIES OF CROSSINGS (3◆): THE GENERAL PHYSICAL CONDITIONS OF CROSSINGS		**LIGHTING AT NIGHT (3✪)**: THE QUALITY OF LIGHTING AT NIGHT	**PHYSICAL DIFFICULTIES WHILE WALKING & CYCLING (3⌘)**: THE LEVEL OF PHYSICAL EASINESS OR HARDSHIP WHILE WALKING	**MAINTENANCE OF SIDEWALKS (3⌥)**: THE GENERAL MAINTENANCE OF SIDEWALKS	
EASINESS OF CROSSINGS (4◆): HOW EASY & CONVENIENT IS TO USE CROSSINGS		**QUALITY OF LIGHTING (4✪)**: THE OVERALL QUALITY OF EXISTING URBAN LIGHTING	**PRESENCE OF TEMPORARY &/OR PERMANENT OBSTRUCTIONS (4⌘)**: THE PRESENCE OF BOTH PERMANENT & TEMPORARY OBSTRUCTIONS THAT MAKE PEDESTRIAN MOVEMENT DIFFICULT	**PRESENCE OF SIDEWALKS (4⌥)**: THE PRESENCE OF SIDEWALKS	
				OVERALL CONDITION & PHYSICAL QUALITY OF SIDEWALKS (5⌥): THE OVERALL CONDITION & PHYSICAL QUALITY OF SIDEWALKS & PAVEMENTS	
				PRESENCE OF BUFFER & QUALITIES (6⌥): THE PRESENCE & DIMENSIONS OF BUFFERS	

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Table 3.3 (cont.)

TYPE OF THE TOOL	#	NAME OF THE TOOL	FUNCTION	
			FACILITIES & AMENITIES	LAND USE & DENSITY
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	✚ / 2✚	★
	2	GLOBAL WALKABILITY INDEX	2✚	-
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	✚ / 2✚	★ / 5★
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	✚ / 3✚	3★
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	2✚	★
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	-	-
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	2✚	★
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	✚	3★
	9	PIN 3 NEIGHBORHOOD AUDIT TOOL	2✚	★ / 3★ / 4★ / 5★
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	✚ / 2✚	3★
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	✚ / 2✚	★ / 2★
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	-	-
WEB-BASED	1	MAPONICS	✚	-
	2	RATE MY STREET	-	-
	3	WALK SCORE	3✚	★
	4	WALKABILITY ASIA	2✚	-
	5	WALKONOMICS	-	-
	6	WALKSHED	✚	-

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Table 3.3 (cont.)

FUNCTION	
PRESENCE & QUALITY OF DIFFERENT AMENITIES (✚): THE PRESENCE & QUALITY OF DIFFERENT AMENITIES & FACILITIES WITHIN WALKING DISTANCE WHICH HAVE DIFFERENT FUNCTIONS	**LAND USE DIVERSITY (★):** THE PRESENCE OF DIFFERENT FUNCTIONS & DIVERSITY IN TERMS OF LAND USE IN SEARCHED AREA & DENSITY (BALANCE) BETWEEN DIFFERENT LAND-USES
PRESENCE & QUALITY OF URBAN AMENITIES (2✚): THE PRESENCE OF URBAN AMENITIES INCLUDING URBAN FURNITURES, FACILITIES & NATURAL ITEMS	**DOMINANT LAND USE (2★):** THE DOMINANT LAND USE TYPE
DISTANCE TO AMENITIES (3✚): THE WALKING DISTANCE TO DIFFERENT AMENITIES FROM HOME	**RSIDENTIAL DENSITY & TYPE OF RESIDENTIAL BUILDINGS (3★):** THE (MAIN) TYPE OF RESIDENTIAL UNITS, THEIR NUMBER & DENSITY WITHIN THE SEARCHED AREA
	CONDITION OF LAND USES (4★): THE OVERALL QUALITY OF DIFFERENT LAND USAGES & PRESENCE OF VACANT LANDS
	VERTICAL LAND USE (5★): THE VERTICAL USAGE OF LAND

(cont. on next page)

Table 3.3 (cont.)

TYPE OF THE TOOL	#	NAME OF THE TOOL	NETWORK			
			PUBLIC TRANSPORTATION	SPEED	TRAFFIC	WALKING & CYCLING
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	2✕	⊠	2Δ / 3Δ / 5Δ	Ω / 2Ω
	2	GLOBAL WALKABILITY INDEX	-	-	Δ	-
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	-	2⊠ / 3⊠	2Δ / 3Δ / 6Δ / 7Δ	Ω / 3Ω
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	-	⊠ / 4⊠	4Δ	Ω / 4Ω
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	2✕	2⊠	2Δ / 3Δ / 4Δ / 5Δ / 7Δ	2Ω
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	2✕ / 5✕	-	-	-
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	-	2⊠	2Δ / 5Δ / 6Δ	2Ω
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	3✕ / 4✕	-	4Δ	Ω / 3Ω
	9	PIN 3 NEIGHBORHOOD AUDIT TOOL	2✕	2⊠	2Δ / 3Δ / 5Δ	Ω
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	2✕	-	2Δ / 3Δ / 5Δ / 7Δ	Ω / 2Ω
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	-	-	2Δ / 5Δ / 7Δ	2Ω / 3Ω
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	-	⊠	2Δ / 4Δ	-
WEB-BASED	1	MAPONICS	-	2⊠	-	-
	2	RATE MY STREET	-	-	-	-
	3	WALK SCORE	-	-	-	-
	4	WALKABILITY ASIA	-	-	Δ	-
	5	WALKONOMICS	-	-	-	-
	6	WALKSHED	-	-	-	-

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Table 3.3 (cont.)

NETWORK			
AVAILABILITY OF PUBLIC TRANSPORTATION (✕): THE AVAILABILITY OF PUBLIC TRANSPORTATION	**POSTED SPEED (⊠):** THE POSTED SPEED OF MOTOR VEHICLES	**MOTORISTS' BEHAVIOUR (Δ):** MOTORISTS' BEHAVIOUR TOWARDS PEDESTRIANS	**PRESENCE OF BICYCLE LANES (Ω):** THE PRESENCE OF BICYCLE LANES WITHIN THE SEARCHED AREA
PUBLIC TRANSPORT FACILITIES (PRESENCE, TYPE & PROPERTIES) (2✕): THE PRESENCE, TYPE & PROPERTIES OF PUBLIC TRANSPORTATION FACILITIES	**POSTED SPEED LIMIT (2⊠):** THE POSTED SPEED LIMIT FOR MOTOR VEHICLES	**NO OF (THRU) LANES (2Δ):** NO OF LANES EXISTING	**PRESENCE OF BICYCLE FACILITIES (2Ω):** THE PRESENCE OF PHYSICAL BICYCLE FACILITIES
WALKING DISTANCE TO TRANSIT STOPS (3✕): THE WALKING DISTANCE TO TRANSIT STOPS	**DESIGNS FOR LOWERING SPEED (3⊠):** THE AIDS & URBAN FEATURES THAT LOWERS SPEED	**ON & OFF STREET PARKING (3Δ):** PRESENCE & NO OF ON & OFF STREET PARKING & DISTANCE FROM HOME TO PARKING FACILITIES	**QUALITY OF CYCLING PATHS (3Ω):** THE OVERALL PHYSICAL QUALITIES OF CYCLING PATHS
NO OF MOTOR VEHICLES TO BE USED (4✕): THE NUMBER OF MOTOR VEHCILES THAT CAN BE USED AS PUBLIC TRANSPORTATION	**OVER-DRIVE (EXCEEDING SPEED) (4⊠):** OVER-DRIVE (EXCEEDING SPEED) BY DRIVERS	**LEVEL OF TRAFFIC (4Δ):** THE LEVEL OF TRAFFIC	**EASINESS OF BICYCLING & WALKING (4Ω):** HOW EASY & PLEASANT IS TO BICYCLE & WALK IN THE SEARCHED AREA
QUALITY OF PUBLIC TRANSPORTATION (5✕): THE OVERALL COMFORT LEVEL OF PUBLIC TRANSPORT WAITING AREAS		**TRAFFIC CONTROL DEVICES & SIGNS + TRAFFIC CALMING FEATURES (5Δ):** THE PRESENCE OF TRAFFIC CONTROL DEVICES, SIGNS & TRAFFIC CALMING FEATURES	
		EITHER TRAFFIC IS ONE WAY OR TWO WAYS (6Δ): EITHER THE TRAFFIC IS ONE WAY OR TWO WAY IN THE SEARCHED AREA	
		ROAD PROPERTIES: LOCATION, TYPE, CONDITION & NO OF DRIVEWAYS (7Δ): THE GENERAL ROAD PROPERTIES: LOCATION, TYPE, CONDITION & NO OF DRIVEWAYS	

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Table 3.3 (cont.)

TYPE OF THE TOOL	#	NAME OF THE TOOL	POLICY
			POLICY
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	-
	2	GLOBAL WALKABILITY INDEX	⊘
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	-
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	-
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	-
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	-
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	-
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	-
	9	PIN 3 NEIGHBORHOOD AUDIT TOOL	-
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	-
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	-
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	-
WEB-BASED	1	MAPONICS	-
	2	RATE MY STREET	-
	3	WALK SCORE	-
	4	WALKABILITY ASIA	-
	5	WALKONOMICS	-
	6	WALKSHED	-

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Table 3.3 (cont.)

POLICY
<u>GENERAL POLICY</u> (⊘): THE EXISTING POLICIES, LAWS, REGULATIONS & GUIDELINES FOR URBAN PLAN

CHAPTER 4

FINDINGS

In this chapter, the findings of both Comprehensive Data Chart and Content Analysis Chart are presented and analyzed. The analysis for both are conducted in two separate stages as numeric analysis and descriptive analysis. In other words, the analysis mainly covers both the numeric description and verbal interpretation.

It is important to re-specify that Comprehensive Data Chart is an extensive table which is composed of through concrete data from the literature review without any critical lens (except the groupings and themings), but in Content Analysis Data, the elements or criteria of the each tool is given in the final phase after clustering, symbolization, and analysis.

4.1. Comprehensive Data Chart

Comprehensive Data Chart is a chart that is composed to make a comparison between both web-based and hard-copy walkability measurement tools. Under defined upper-titles, the collected data are clustered as sub-titles. While chart has been created, all data is collected from references. The chart covers the following information: the developer of the tool, the aim and interest of the tool and the tool's developer, the target profile of the tool, the methodology of the tool, the question formations of the tool, and the presence of guides under the tool.

4.1.1. Numeric Analysis of Comprehensive Data Chart

The aim of making numeric analysis of Comprehensive Data Chart is to make a detailed comparison between the web-based and the hard-copy tools in numeric format. For checking the numeric distribution of the chart, a table is composed (Table 4.1). This quantitative analysis chart enables a direct comparison to be made and analysis between each sub-title and to see which of the parameters are more dominant.

4.1.2. Descriptive Analysis of Comprehensive Data Chart

For the descriptive analysis of Comprehensive Data Chart, previously given Comprehensive Data Chart (Table 3.1) and Numeric Distribution of Comprehensive Data Chart (Table 4.1) are put together for making an in-depth interpretation and analysis. The numeric analysis is reviewed and put into words. For the details, the main chart is used. While doing analysis, each title is analyzed in detail and separately in the below part. In that extensive commenting process, web-based tools and hard-copy tools are firstly analyzed by themselves. Afterwards, they are analyzed as a whole under each title.

4.1.2.1. Developer: Type and Details

In web-based walkability measurement tools, the greatest percentage of the tools are developed by private firms. The second greatest percentage is individual researchers. Although there are other tool developer types – *research team, government facility, research project outcome* –none of the web-based tools are developed by these. In hard-copy walkability measurement tools, most of the tools are developed by individual researchers. Between the remaining tool developer types, it can be said that there is an equal distribution for hard-copy tools. When web-based and hard-copy walkability measurement tools are analyzed as a whole, individual researchers are ahead by small difference which are followed by firms. As the hard-copy tools, there is an evenness between other tool developer types.

The first thing that should be questioned is if this dominancy in web-based tools as a result of their aim. As being a private firm, they have a great economic support behind them by its very nature. In other words, there is a specific budget of the firm in which a part of it can be divided for the tool. Depending upon this economic support, one of the greatest aim they follow might be economic. Although most of the tools say that their main aim is to measure walkability, this economic concern may be a bit front. Due to their economic focus, the tools developed by firms are web-based through which they can reach more individuals, and when people visit the tool's website or download the app from the store, the firms earn money. However, assume that if they develop a hard-copy tool, this financial gain cannot be obtained.

The second question is about the dominancy of individual researchers in hard-copy tools. As an individual researcher, they can reach more limited people. Also, hard-copy tools are actually print-out versions because they have an access to fewer people compared to web-based tools in which they can access more people through social media. On the other hand, they do nott have a great economic support at their back like the web-based tools have from the firms. Because that they do nott spend money for developing the tool, their main aim and concern might not be economic. In other words, their main aim can be more research-based or academic in comparison with web-based tools. In short, the dominancy of individual researchers can be an evidence that their main target is to measure walkability.

The third question is to examine why the other developer types are at the back in terms of percentage in the web-based, hard-copy, and total. There can be several reasons behind. The first thing can be that it might be harder for them to develop a walkability measurement tool perhaps that they do nott have specialized teams on the issue of walkability. The second thing might be that they are afraid to loss-making if they especially develop a web-based tool.

The fourth and last thing to question is to examine the geographic dominancy of the tool developers. When the web-based tools are analyzed, the following results are obtained: United States – three tools (Maponics – Walk Score – Walkshed); – United Kingdom – two tools (Rate My Street – Walkonomics); Asia – 1 tool (Walkability Asia).

Table 4.1. Numeric Distribution of Comprehensive Data Chart

NUMERIC DISTRIBUTION OF COMPREHENSIVE ANALYSIS CHART

	DEVELOPER				
	FIRM	INDIVIDUAL RESEARCHERS	RESEARCH TEAM	GOVERNMENT FACILITY	RESEARCH PROJECT OUTCOME
HARD-COPY (12)	1	6	2	1	2
WEB BASED (6)	5	1	0	0	0
IN TOTAL (18)	6	7	2	1	2

	TARGET PROFILE				
	USERS				
	ASIA	AFRICA	ANTARCTICA	EUROPE	AUSTRALIA
HARD-COPY (12)	2	1	1	2	2
WEB BASED (6)	2	1	1	3	2
IN TOTAL (18)	4	2	2	5	4

	TARGET PROFILE		
	USERS		
	NORTH AMERICA	SOUTH AMERICA	NO INFO
HARD-COPY (12)	5	3	4
WEB BASED (6)	5	4	0
IN TOTAL (18)	10	7	4

(cont. on next page)

Table 4.1 (cont.)

NUMERIC DISTRIBUTION OF COMPREHENSIVE ANALYSIS CHART

	TARGET PROFILE					
	TECHNOLOGICAL & LOCATION-BASED ADAPTATION			GEOGRAPHIC ADAPTATION		
	YES	NO	NO INFO	LOCAL	GLOBAL	NO INFO
HARD-COPY (12)	3	0	9	0	1	11
WEB BASED (6)	0	0	6	1	5	0
IN TOTAL (18)	3	0	15	1	6	11

	QUESTION FORMATIONS					
	OPEN-ENDED	CLOSE-ENDED				
		TWO-OPTION RESPONSES	ONE BEST ANSWER	RATING SCALE	ORDERED CHOICE	"OTHER, PLEASE SPECIFY"
HARD-COPY (12)	4	7	6	7	4	1
WEB BASED (6)	2	0	1	5	0	0
IN TOTAL (18)	6	7	7	12	4	1

	QUESTION FORMATIONS					
	CLOSE-ENDED					
	ITEMS IN SERIES	PAIRED COMPARISONS	MATCHING	CHECK ALL THAT APPLY	LISTS	RANKING
HARD-COPY (12)	2	0	0	5	0	0
WEB BASED (6)	0	0	0	0	0	0
IN TOTAL (18)	2	0	0	5	0	0

(cont. on next page)

Table 4.1 (cont.)

NUMERIC DISTRIBUTION OF COMPREHENSIVE ANALYSIS CHART

	METHODOLOGY					
	DATA COLLECTION					
	METHODS					
	NUMERIC DATA	DIRECT SAMPLING	OPEN SOURCE (OPEN DATA)	CROWD-SOURCING	SOFTWARE	PRIORIZATION
HARD-COPY (12)	0	0	0	0	0	0
WEB BASED (6)	3	1	2	2	1	1
IN TOTAL (18)	3	1	2	2	1	1

	METHODOLOGY					
	DATA COLLECTION					
	METHODS					
	OBSERVATION	QUESTIONNAIRE	GIS DATA	SELF-REPORT	ON-STREET	NO INFO
HARD-COPY (12)	5	3	2	2	1	1
WEB BASED (6)	0	0	0	0	0	0
IN TOTAL (18)	5	3	2	2	1	1

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Table 4.1 (cont.)

NUMERIC DISTRIBUTION OF COMPREHENSIVE ANALYSIS CHART

	METHODOLOGY					
	DATA COLLECTION					
	USAGE OF NUMERIC DATA			NO OF TEAM MEMBERS		
	YES	NO	NO INFO	INDIVIDUAL	TEAM OF 2	NO AUDITORS
HARD-COPY (12)	3	3	6	6	3	0
WEB BASED (6)	4	2	0	4	0	2
IN TOTAL (18)	7	5	6	10	3	2

	METHODOLOGY					
	DATA COLLECTION					
	NO OF TEAM MEMBERS	AUDITOR PRIVACY		MAPS BEING USED		
	NO INFO	ANONYMOUS	NOT ANONYMOUS	UPDATEABLE ONLINE MAP	PRINTOUT MAP	NO INFO
HARD-COPY (12)	3	8	4	2	3	7
WEB BASED (6)	0	4	2	5	0	1
IN TOTAL (18)	3	12	6	7	3	8

(cont. on next page)

Table 4.1 (cont.)

NUMERIC DISTRIBUTION OF COMPREHENSIVE ANALYSIS CHART

	METHODOLOGY					
	IN PROCESS					
	CRITERIA WEIGHT			ENGINES & ALGORITHMS BEING USED		
	SAME	DIFFERENT	NO INFO	USED	NOT USED	NO INFO
HARD-COPY (12)	2	2	8	3	5	4
WEB BASED (6)	1	1	4	4	0	2
IN TOTAL (18)	3	3	12	7	5	6

	METHODOLOGY			
	IN PROCESS			
	IN PROCESS SCORING			
	ORDINAL	NOMINAL		
	LIKERT	MULTIPLE CHOICE	YES/NO	CHECKING
HARD-COPY (12)	7	2	5	7
WEB BASED (6)	4	1	0	0
IN TOTAL (18)	11	3	5	7

(cont. on next page)

Table 4.1 (cont.)

NUMERIC DISTRIBUTION OF COMPREHENSIVE ANALYSIS CHART

	METHODOLOGY		
	IN PROCESS		
	IN PROCESS SCORING		
	REVIEW	ALGORITHMIC SCORING	NO INFO
HARD-COPY (12)	0	0	1
WEB BASED (6)	1	1	0
IN TOTAL (18)	1	1	1

	METHODOLOGY					
	EVALUATION					
	DEFINITIONS OF SCORING				FINAL SCORING	
	TOOL		DEVELOPER		ORDINAL	
	USED	NOT USED	USED	NOT USED	LIKERT	RANGING
HARD-COPY (12)	9	3	8	4	0	2
WEB BASED (6)	5	1	4	2	3	3
IN TOTAL (18)	14	4	12	6	3	5

(cont. on next page)

Table 4.1 (cont.)

NUMERIC DISTRIBUTION OF COMPREHENSIVE ANALYSIS CHART

	METHODOLOGY				
	EVALUATION				
	FINAL SCORING		RANGING FINAL SCORE		
	REVIEW	NO INFO	YES	NO	NO INFO
HARD-COPY (12)	0	10	1	0	11
WEB BASED (6)	2	0	4	1	1
IN TOTAL (18)	2	10	5	1	12

	METHODOLOGY		
	EVALUATION		
	VISUALIZATION		
	YES	NO	NO INFO
HARD-COPY (12)	0	0	12
WEB BASED (6)	3	2	1
IN TOTAL (18)	3	2	13

(cont. on next page)

Table 4.1 (cont.)

NUMERIC DISTRIBUTION OF COMPREHENSIVE ANALYSIS CHART

	PRESENCE OF GUIDES			
	USER GUIDE / MANUAL		SCORING GUIDE	
	EXISTING	NOT EXISTING	EXISTING	NOT EXISTING
HARD-COPY (12)	5	7	1	11
WEB BASED (6)	0	6	1	5
IN TOTAL (18)	5	13	2	16

It can be summarized that web-based tools are mainly developed by the firms who are from already developed countries. Only one tool is developed by a firm from still-developing country. If the really aim of the developers is to only measure and quantify the results, it can be understandable that the dominancy are in developed countries. However, if their aim is to measure and develop the country accordingly, it should be mostly developed by still-developing countries.

4.1.2.2. Aim and Interest: Interest Area

The interest area of the tool developers – *either as a private firm, an individual researcher, or a research team* – has a direct impact upon their understanding of walkability, why they want to do analysis on walkability, how that define it, and the aim of the tool. In short, their interest area can affect the tool directly or indirectly from several different aspects.

Especially the firms as tool developers can give an idea and clue about the really main aim of the tools. In addition to this, the developer's main interest area can directly affect the scope, questions, and criteria of the tools. Also, they may only look to the issue of walkability from the perspective of 'their main interest'. Accordingly, even all the web-based and hard-copy tools claims that they measure walkability, it can be said that they all look from different perspectives. However, this difference point of views can result from and espouse the multidisciplinarity aspect of the walking act and walkability. At the same time, it makes people to think that the act of walking – *even as the very basic act and movement of people* –has a large number of dimensions.

For conducting a more detailed analysis, each hard-copy and web-based tool is analyzed from their developers' interest area point of view as follows.

Active Neighborhood Checklist (ANC): The tool was developed by individual researchers whose main research and interest area are epidemiology, public health, and disease prevention. Based on their main interest area, the tool's content is shaped accordingly. The developers claim that the act of walking prevents most of the diseases. That's why the tool's criteria mainly covers the physical aspects of walking from pedestrians' point of view, while the developers actual concern is seeking to find the items that encourage or discourage the act of walking and physical activity.

Global Walkability Index (GWI): This tool was developed by an individual researcher for the World Bank, which means that they have financial worries in their mind while analyzing walkability. The content of the tool is mostly dealing with the physical aspects of walking for making urban renovations in the researched area, which will also have economic output at the end. Because that there are two surveys in this tool, public agency survey and field survey, it can be understood that they mainly look for the areas that need improvement for enhancement applications.

Irvine Minnesota Inventory (IMI): IMI was developed by a research team whose main interest area is active living and well-being. Also, they are conducting researches about the urban environment. Because their focus is on both living actively and the quality of the environment, they try to make the tool's content such comprehensive that it covers almost all related aspects from unwanted smell to existence of features that provide weather protection. Although they try to cover and sum up both health and built environment-related aspects in one tool, the greatest percentage is on the built environment and it's physical aspects; that's why the tool's criteria is mostly shaped around the physical items rather than perceptual ones.

Neighborhood Environment Walkability Scale (NEWS): NEWS is a tool that is developed by two individual researchers. Their main interest area is about human behavior and psychology of health, which means that they are mainly interested in perceptual things. Although the tool's criteria is mainly shaped around the existence of physical facilities and their physical qualities, they should be evaluated from more subjective and perceptual point of view by the auditors like somewhat agree, strongly disagree, how common, neither satisfied nor dissatisfied.

Pedestrian Environment Data Scan (PEDS): PEDS is a tool that was developed by individual researchers whose main interest area is more concrete and physical dimensions of the walking like urban environment, land development, and transportation systems. Due to their research area, the tool mainly covers the physical and objective aspects of walkability like existence of pedestrian facilities, objective road and traffic qualities, the physical dimensions or qualities of the immediate surroundings. For increasing this objectiveness of walkability from their point of view, they also use different checking and likert scales, rather than letting auditors make comments with their own words. Also, the presence of an audit-training guide helps to make criteria and questions' meaning and scope the same for all by defining and explaining each criterion in the guide.

Pedestrian Environment Review System (PERS): PERS was developed by Transportation Research Laboratory (TRL), Transport for London (TfL), and London Borough of Bromley, which means that the developer of Rate My Street and PERS are the same with same concerns. As Rate My Street, PERS also deals with walking as a mode of transportation and how the searched area promotes walking as transportation or with a target.

Pedestrian Environment Quality Index (PEQI): PEQI was developed by the San Francisco Department of Public Health. As it is obvious from both the developer's name and from the content, their main concern is to understand the walkability–health relation and how walkability can affect pedestrians' behavior. Because the developer has governmental support, they also want to identify which areas need improvements for enhancement of the urban area.

Physical Activity Neighborhood Environment Scale (PANES): The tool is developed by individual researchers who have a research interest in the physical activity of individuals. Rather than directly trying to measure the physical qualities that have impact upon the level of physical activity, they try to set the tool's scope around the perceptual aspects of physical activity. With their aim to collect data from multiple countries to increase environmental variability, they shaped their questions around the physical items through perceptual lens of the auditors.

PIN 3 Neighborhood Audit Tool: PIN 3 is a tool that is developed by a team of researchers with several different research areas like physical activity, statistical science, regional planning, and women's health. Due to their multidisciplinary research areas, the tool's content is comprehensive, covering all aspects of walking and walkability. In addition to the broad scope of the tool, the tool tries to measure both the physical and the perceptual dimensions of walkability. However, for somehow limiting and controlling the tool, they use checking in the evaluation process in between the given choices. With this evaluation, this comprehensive scope can be a bit controlled.

Scottish Walkability Assessment Form (SWAF): The tool is an outcome of a research project named Well-Being in the West (WWW), which was designed to evaluate whether pedometer based walking combined with physical activity advisory can increase and have a positive impact upon walking behavior in the long term. In short, the tool's main scope can be described as focusing on the physical activity level and health. Because walking behavior is subjective and may change from one to another, the tool tries to measure more perceptual aspects. While trying to get the perceptual evaluation, the questions are shaped around the physical dimensions for increasing the comparability and reapplication of the tool.

Systematic Pedestrian and Cycling Environmental Scan (SPACES): SPACES is a research project outcome that evaluates the physical environment that may have a relation with the level and behavior of physical activity. The research project mainly covers the built environment and physical activity interaction. Due to the focus of built environment, the tool tries to cover several different physical and objective aspects of the physical world like dimensions or materials. Whereas the built environment is more dominant in the tool, there are no visible clues that they are trying to measure their effect on walkability and physical activity. However, mostly the health related questions are asked more implicitly. For also assessing the subjective evaluation, there is a small part of the tool in which the attractiveness level of the searched area is evaluated by the auditors.

Walking Suitability Assessment Form (WSAF): WSAF is a tool developed by individual researchers. Their research and interest area covers transportation systems, land development, and urban environment which have a focus on more physical items. Due to their research focus, the content is shaped accordingly – *more objective and concrete aspects of walkability*. For increasing this objectivity level, the evaluation is made by assigning scores to each criterion from the given choices or selecting either yes or no. Therefore, this tool disregards the perceptual aspects of walking by focusing on the more physical aspects, which may not change from one to another.

Maponics: It was developed by the firm Maponics LLS, which specializes in location-based data provision. They also set geographic limitations and boundaries for neighborhoods, like shopping, school, and ZIP code. As the working procedure of the tool, polygons are used for boundary setting and all data is transferred into these boundaries or geographic limits. While collecting data about walkability, they refer to some statistical data about boundaries. Within the tool, no crowd-sourcing is used, but only statistical data is implemented. It can be commented that they analyze the act of walking within some limits or within a specific area in contrast to flaneur like idea. Also collecting related statistical data gives idea about how they interpret walkability quantitatively. Referring to their real-estate aims, it can be the simplest way to define areas by referring some variables. In addition to this, analyzing the issue of walkability of either having or not having some amenities within this zone directly associates the act of walking into facilities.

Rate My Street: The tool was developed by Transport Research Laboratory (TRL), which focuses on transportation and transportation-related issues like safety, engineering, simulation, intelligent transport systems, infrastructure, and human factors. It is obvious that the developer deals with such concrete and physical aspects of going from one point to another. As a reflection of this understanding to the tool's general idea, they handle walkability or the act of walking not as a leisurely activity but as a mode of transportation and having a target while walking. The criteria of this tool also make reference to transportation-related aspects like trip and safety.

Walk Score: This tool was developed by Front Seat Management Company, which was directly established to measure walkability with its financial supporters RWJF and the Rockfeller Foundation. As mentioned by themselves, Walk Score was developed for real estate purposes in which they sell their analysis outcomes to real estate firms like Redfin. Rather than making use of crowd-sourcing, the tool uses statistical data. Also, they only evaluate walkability as having amenities within the searched area. Both using only statistical data and only understanding the criteria of walkability as having amenities, they only related to the physical aspect of walking act rather than perceptual act.

Walkability Asia: This tool is an initiative of Clean Air Asia (CAI-Asia) Organization. It is actually an organization whose main aim is to improve air quality in Asian countries. It was developed by the partnership of World Bank, Asian Development Bank and USIAD. This partnership actually shows that this organization has economic support from several different institutions, and based on this, the innovations made by CAI-Asia seek profit. In addition to air quality, CAI-Asia's other focuses are transportation, infrastructure, traffic and security, industry, and energy. Actually, the reason behind the tool is developed is to analyze which part of cities need improvement in terms of walkability infrastructure. The research attempt to analyze infrastructure can also be seen from the content of the tool like walking paths, crossing points, and obstructions. Rather than having relation with the experimental side of the act of walking, they are much more related to transportation and the infrastructure of walking. In other words, they are much concerned with the physical part of walkability rather than perceptual or socio-spatial aspects. This physical consideration of the tool is directly linked to the urban physical renovations which are concrete and also can have economic outcomes at the end to the renovations made like higher house prices in renovated areas or reduction in the number of cars used.

Walkonomics: This tool was developed by two individual researchers whose focus is on transportation, planning, geography, and computer science. With their main aim for analyzing both the subjective experience of walking and how walking affects house prices, they set their criteria accordingly. Referring to their background, they include more transportation-related and physical, concrete variables into their criteria such as safety, existence of sidewalks, and pavements. For focusing on their geography background, they include hilliness as one of their criterion. Fear of crime, smart and beautiful, and fun and relaxing are the variables that emphasize subjectivity of walking experience, which is one of their main focuses. The slider that they developed also an attempt to analyze which areas are more beautiful while searching for real estate.

Walkshed: This tool is the great development of Aaron Ogle, who is a software developer. It was developed by the firm Avencia whose general interest is geographic analysis and related software development. They specialize in developing innovative location-based software tools. As the most distinguishable quality of Walkshed, friction-based procedure is used. Based on this, they define walkability as the ease of walking without any obstacles within a 1-mile-radius. Also, the usage of a grid plan is a clue that how limited or engineering related issue Walkshed see walking rather than as liberatory act. It is actually their way of defining zones and boundaries.

4.1.2.3. Aim and Interest: General Aim

The general aim covers the quotes that are said about specific tools or said by the tool developers. These quotes might be retrieved from one of several different sources: webpage of the tool developer, other webpages, interview with the developer, or academic articles. Not only the quotes about the tools but also the quotes that are not directly about the tool but said by the tool developer, give an idea especially about the tool's aim. The quotes retrieved from other academic or webpage sources are also valuable data for giving idea about the tool's general understanding of walkability. These quotes are indeed as important as the content of the tools. From the quotes, for example, it can be searched if there is a word about quantification or if the tool directly looks at the physical environment. For better understanding the tool developer's real comprehension of walkability, these quotes are analyzed and commented on as below.

Active Neighborhood Checklist (ANC): Via the tool created, it tries to evaluate not only walkability, but also other physical activities that take place in urban areas. By focusing on the street level features, they set their main aspect as the physical dimensions of walkability.

Global Walkability Index (GWI): Rather than focusing on the quantifiable part of the walking act, they create a focus on the qualitative and perceptual aspects of walkability, which are harder to measure and analyze. In other words, rather than focusing on the built environment, the focus is on the perceived dimensions by individuals.

Irvine Minnesota Inventory (IMI): They aim to comprehensively collect the most detailed data via in-street observation by focusing on the activity level–walkability relation. Their other aim is to compose an objective criteria at the end. The property which differentiates this tool from others is that they divide act of walking into two, intentional and recreational, which means that they do nott see walking only as physical activity. Whereas they try to comprehend two modes of walking, again they try to quantify it as a result.

Neighborhood Environment Walkability Scale (NEWS): The main aim of the tool is to analyze the subjective and perceptual aspects of walking that may have a relation to level of physical activity by residents. In addition to these subjective dimensions of walkability, they try to evaluate how the physical environment may have an impact upon this perception.

Pedestrian Environment Data Scan (PEDS): The main aim of the tool is to analyze the built environment that directly or indirectly has relation to walkability while creating a focus on the health–walkability relation. As their second aim, which is the minimization of the cost and time, it tries to measure the physical environment factors.

Pedestrian Environment Review System (PERS): Rather than focusing on the objective and physical properties of walkability, the tool's aim is to conduct research on the subjective and perceptual aspects of walkability, but at the end trying to create an objective measure. With their target profile as authorized people, they try to provide data to authorities. While doing analysis, the other aim is to minimize the cost for increasing the applicability of the tool.

Pedestrian Environment Quality Index (PEQI): Analyzing the parameters of built environment, either advantageous or disadvantageous is the main aim of the tool. In other words, they try to identify the built environment elements that encourage or demotivate for the walking act, which means that their main aim is to create awareness about residents' immediate surrounding. As a result of the analysis, composing a plan for the future improvements is another aim of the tool.

Physical Activity Neighborhood Environment Scale (PANES): Collecting data that has impact on the regional or national scale of walkability to provide internationally valuable data at the end is the aim of the tool by putting physical activity–walkability relation at the front.

PIN 3 Neighborhood Audit Tool: Rather than focusing on the improvement of walkable environments, that only focus on the assessment of the built environment and the physical dimensions of the immediate surroundings from the point of walkability in a regional scale.

Scottish Walkability Assessment Form (SWAF): Because the tool was developed for a specific location, they try to assess this area's physical qualities regarding walkability. Also, they try to create an emphasis to the relation between walkability and level of physical activity.

Systematic Pedestrian and Cycling Environmental Scan (SPACES): Rather than directly analyzing walkability, they try to measure physical activity level and its relation to walkability. While analyzing the act of walking, they also include cycling as both two are non-motorized physical activities.

Walking Suitability Assessment Form (WSAF): As perceptual and subjective aspect of walkability, they try to create a focus on safety while walking. Rather than directly analyzing the physical environment, the focus is kept in the invisible aspects of walkability which can also have a relation with physical entities given by the built environment.

Maponics: When the direct quotes of the tool developer is analyzed, several important points can be listed. The first thing is that rather than making a walkability analysis and trying to enhance the built environment into a better and more walking friendly environment, they try to achieve a walkability score via data provision and ranking at the end for providing these scores to real estate professionals. In other words, they want to provide economic profit rather than research through selling this data to real estate professionals. They also want to give scores to the homebuyers and renters, which makes their focus more property related. Also, their focus is younger generation that uses mobile applications more and decide accordingly. By making younger generation their target profile, they mainly disregard other users. With their data, they want to direct them into neighborhoods which have more walkable friendly qualities. In addition to these, it can be also obtained from their quotes that they only and directly relate the act of walking with house and renting prices, which means that it is their one and only consideration for developing tool. Lastly, as they told in their quotes; through walkability, they want to assign a geo-spatial meaning into the neighborhoods that can also be interpreted as only focusing on the physical side of walking and setting boundaries.

Rate My Street: According to the words of the tool developer, the tool makes the users as the center of the tool – both by data providers and auditors. Through letting them to give feedbacks, the tool makes users to feel valuable. In other words, they turn this evaluation process into participatory one via crowd-sourcing. However, with the scoring method the tool uses, this subjectivity turns into a more numeric and quantifiable thing.

Walk Score: Through the words of Walk Score's developer, it can be easily understood that they do nott actually perceive the act of walking as an urban activity and an act towards space production. Rather, they address the issue of walkability that has a direct relation with built environment in architecture scale rather than urban. In other words, they take walkability into consideration as built environment aspect that has direct relation to economics – as a value of real estate like the number of rooms in a house. As they added, their main concern is to add value to real-estate related issues by promoting some neighborhoods while not promoting the others. In addition to the economics, the tool creates a direct relation between walking and transportation. Put differently, they melt these two in the same pot. Also, it can be understood that each and every person like low-income people cannot live in a walkable environment because there is a direct interaction between walkability and house prices; so it is the right of only high-income people to live in a walkable neighborhood. As an addition, they claim that walkability is such a numeric value that people consider it while choosing where to live.

Walkability Asia: With their focus on the infrastructure development and advancement in Asian countries and cities that can be obtained from the content of the tool and the background idea of the developer, the words they use also make reference to the same idea. When the words they use are considered, it can be easily understood that by providing infrastructure for walking to all Asia, they tend to accomplish the act of walking for all. At first sight it can be understood that they are dealing with the physical aspect of walkability, which is infrastructure, but by improving that infrastructure; they want to emphasize that walking is the very basic right of each and every human, which is actually the social aspect of walking act. Also, their first and main aim is to improve the current walking infrastructure in Asian cities. The tool also aims to increase the level of mindfulness about walking and the benefits of it as a sustainable mode of transportation.

Walkonomics: One of the properties that differentiate this tool from others is that it focuses on the subjective experience of the pedestrian. It puts the aesthetic quality of walking into center by letting users choose the route that they walk according to their own preferences. While conducting analysis through the tool via using slider, users can evaluate the most aesthetic route (beautiful, safest, tree lined, and fun). Even though they are focusing on the subjective experience, they also evaluate the act of walking not as leisurely, but as a mode of transportation. Although they are focusing on the subjective and the most beautiful aspect of walking, they also relate walkability with economic aspects and the activity level performed by the residents. They think that walkability is such a thing that is not directly related with the urban environment, but something that adds value to house prices. In other words, the ones who live in a walkable neighborhood should pay more. As vice versa; if the ones is not rich enough, should not live in not walkable neighborhood. At the end, they finalize the evaluation of walkability through doing quantification. Due to this, it can be summed up that at the end, they put subjective experience to one side while assigning more importance to the numeric value of walkability.

Walkshed: The very first thing that can be understood from the quote about Walkshed is that they see the issue of walkability as both a numeric and a quantitative issue that can be digitized into a single number at the end. However, rather than improving the searched neighborhoods, they try to quantify walkability via mapping it. In other words, their main aim can be interpreted as creating a database as final result. Also, they rely on the subjective choices of each individual, which makes the act of walking a personal thing that may change from one to another.

As a more general comment, it can also be analyzed why some of the tools have more quote about themselves, whereas others have significantly less. When the hard-copy walkability measurement tools are analyzed, only four of them (Irvine Minnesota Inventory, Neighborhood Environment Walkability Scale, Pedestrian Environment Data Scan, and Pedestrian Environment Review System) have many quotations about them. The other eight hard-copy walkability measurement tools have fewer quotes about them.

When web-based walkability measurement tools are analyzed, it can be seen that only Maponics and Walkonomics have great number of quotes about them, whereas the other four have fewer in number. The main reason behind the great number of quotations in a tool can be due to having a good public relations. It can be reasonable for web-based ones in which they are more accessible by users, but in hard-copy walkability measurement tools, it can show that they are much preferred and easily applicable compared to others. Another reason behind this can be that other hard-copy tools are more research focused, and they are actually not concerned about how much they are mentioned. Also, even Walk Score is accepted as one of the great tools that measure walkability in the literature and in the sector, it has fewer quotations. However, Walkonomics and Maponics has great number compared to Walk Score. Currently, Maponics is only accessible if the one buys them. Perhaps, Maponics tries to give many quotations and words about it to make itself more visible. In Walkonomics, because that it has a great relation with economic aspects of walkability, it might try to advertise itself. Like the hard-copy ones, the remaining web-based tools might have a concentration on actual assessment of walkability. In short, the number of quotations of each tool can also give an idea about their background.

4.1.2.4. Target Profile: Users

Under the target profile of the tools, there are two parameters to be discussed: user profiles and the specific geographic area for which the tool is specifically developed (as city and/or country).

The first parameter, users, can be listed according to their different age and physical requirements and difficulties as follows: adult, children, parent, elderly, and disabled (including pregnant). When both the web-based and the hard-copy tools are analyzed, no specific user profile can be found as a specific target audience. In other words, as an interpretation, each and every tool aims at every user profile. If the tool is developed for different user types, it can be concluded that this tool is more comprehensive in terms of the data collected. From other point of view, if the tool focuses on a single user profile while disregarding the others, it might only collect data about one’s needs, however, all different types of users can give different ideas. Therefore, all the tools can be interpreted as comprehensive referring to their user profile. When the other side of the coin is reviewed, all user profiles have different requirements in terms of walkability analysis. That is why it might be good to develop tools with different scope and criteria in terms of walkability.

The second parameter is the geographic target, which is the specific location for the tool is developed for. Generally, hard-copy tools are developed for a single location due to its main aim, which is actually data collection and improving urban environment accordingly. Also, it can be hard to reach people from other geographic areas and reapply it. When the web-based tools are considered, they are generally developed for several different locations at the same time which can access more people via technological devices and internet access.

When the numeric distribution is checked, for web-based, hard-copy and whole tools, the greatest percentage is for North America. After North America, it is followed by South America for web-based, hard-copy and whole tools. The third greatest percentage for web-based, hard-copy and whole tools is taken by Europe. The remaining continents – *Asia, Africa, Antarctica and Australia* – have nearly equal distribution for each type of tools. Therefore, it can be understood that the first three places are taken by the developed countries and continents, whereas the remaining places are taken by still-developing continents. It can be seen from the numeric and percentage distribution that the main target of the tools as geographic location are developed areas. However, it might be better to develop tools for still-developing continents or areas to increase the level of walkability.

4.1.2.5. Target Profile: Technological and Location-Based Adaptation

By their very nature, there are no technological and location-based adaptations for web-based walkability measurement tools. If users have technological devices and internet access, they can be reached from almost all over the world. When hard-copy walkability measurement tools are checked, only three of twelve tools are technologically adapted. It is a great difference that should be questioned in detail only to have technological adaptation in quarter of the hard-copy tools. The reason behind so little technological adaptation in hard-copy tools can be originated from the idea that hard-copy tool developers might think that they cannot compete with web-based tools. In other words, the hard-copy developers might come up with the idea that their adapted tools from printout to digital cannot have the same properties and quality as web-based tools. The technologically adapted hard-copy tools can also be interpreted that their developers might also accept that the hard-copy tools are replaced by web-based one; that's why they try to keep tabs on them.

4.1.2.6. Target Profile: Geographic Adaptation

Whether the tool has global adaptation or not can be described as follows: if the tool is adapted for a different location than its original target location, it became a geographically adapted tool. When the tool is adapted for a different geographic location, the same criteria can be used for both locations or the content can be adapted for the place that the tool is adapted. In the adaptation process, if the criteria remains the same, it means that the same criteria is applied to each and every place and it can be described that the content is global. However, if the content changes from the original place to adapted place, it can be described that the content is local – *which changes from place to place*.

When the numeric distribution is analyzed, only one web-based tool is adapted for a different geographic location – Walkshed. In other words, Walkshed has a local content. It uses different criteria for different locations. Actually, it can be the logical attitude. Because for example, in one city there can be a boat for public transportation whereas in other city, there is not. If all areas are evaluated according to the same criteria, there can be some problems. So, it can be better to change the criteria according to the geographic differences. In addition to this, walking is a location-based act, which may change from one place to another. From a philosophical point of view, it is an act that liberates us and it has no limits, but again it can be questioned if using same criteria for all regions is true or not.

For the other web-based tools, they are all global because they use the same criteria and content for all locations. It is logical for web-based tools to have greatest percentage of global content because individuals who have mobile phones and internet access can reach these tools. Also, all web-based tools use English as a language. So, by being English in language and being accessible through the technological devices and internet, web-based tools go beyond the limits.

When hard-copy tools are analyzed, there is no such information in most of them (eleven of twelve). There is information about only one hard-copy tool which is NEWS that keeps its content global. Although there is no information about most of the hard-copy tools, they can be accepted as local.

When both hard-copy and web-based tools are evaluated numerically in terms of the localness or globalness in their content, there is no such information for most of them, which is continued with the global ones. The local tools have the lowest percentage in all WMTs. Maybe the reason behind keeping all criteria the same might results in getting statistical data more easily (with the same questions), saving them, and comparing all data with each other.

4.1.2.7. Methodology – Data Collection: Methods and Details

The data collection methods and details cover mainly the procedures and ways that the tools collect input from data providers. While the data collection methods and their details are being analyzed, there are three important things to discuss. The first thing is the interpretation of the data collection methods between web-based tools, hard-copy tools, and whole. After commenting on the general statistical distribution, the details should be discussed as the second thing to obtain further detail about each tool. The third thing to discuss is the details that cover whether the data is directly collected from the users or from other sources, and what this difference means.

Firstly, when the numeric and percentage distribution are analyzed in terms of data collection methods, the numeric data has the greatest percentage in web-based tools, which is followed by both open source and crowd-sourcing with the same numeric importance. Referring to this statistical data, it can be said for web-based tools that rather than using people or users as a source, they mainly rely on statistical databases like the number of schools around the neighborhood, the crime rate in that area, or the public transportation facilities in that immediate surrounding. Because the statistical databases generally cover issues about more physical and/or objective aspects, the tool's content or walkability assessment start to focus on the more concrete perspectives of walkability. Open-source (open-data) has almost same logic with numeric data; that is why they can be interpreted similarly. Crowd-sourcing is a method in which data is collected from numerous of people, which creates a valid and logical result but in numeric format. So, whereas the data source is different than the numeric data or open-data, crowd-sourcing also has a tendency to quantify the analyzed issues. Direct sampling, software, and priorization are the other methods used in web-based tools with lower importance, whereas the following are disregarded: observation, questionnaire, GIS data, self-report, and on-street. When the hard-copy tools are analyzed from the same point of view, the greatest percentage is observation which is followed first by questionnaire, and second, by GIS data and self-report. On-street method is also used in hard-copy tools but rarely. The methods mainly covered in web-based tools are not used in hard-copy tools, which are numeric data, direct-sampling, open-source, crowd-sourcing, software, and priorization. The most commonly used method in hard-copy tools sets the people and users in their center. Also, they conduct a real environment analysis like in the street or in the neighborhood, which is totally different than the web-based ones in which users evaluate the walkability from far away and also from a digital medium. When the whole tools are analyzed, the greatest number is taken by observation, which is followed by numeric data and questionnaire with the same numbers. The remaining methods have nearly the same in the holistic distribution. The important thing to discuss from this numeric distribution and comparison is that the data collection methods are divided into two parts in which one part is used by web-based tools and the other part is by hard-copy tools. In other words, the methods are like split into half by a knife. This separation shows that web-based and hard-copy tools are totally different from each other in terms of data collection methods without having any intersections. Via the methods of the web-based tools, they can reach more people; at the meantime, hard-copy tools can reach only a limited number of people with their methods. As another perspective, the methods that hard-copy tools use are mainly real-life methods that aim to collect real data from urban everyday life with the target of analyzing and enhancing the physical surrounding. However, the methods used by web-based tools always result in numeric data at the end. In other words, rather than analyzing and measuring walkability, they also act as data providers to bigger or greater statistical databases as becoming a slave to this routine.

A second thing to question, some of the tools have also details about their data collection methods. They are discussed as follows to provide more detailed information.

Irvine Minnesota Inventory (IMI): In addition to the observation made by users, IMI uses GIS data for some concrete statistical data like density and street pattern. Using statistical data in accordance with real environment user feedbacks can give a good review as an end result.

Systematic Pedestrian and Cycling Environmental Scan (SPACES): Same with IMI, SPACES also uses observation and GIS data at the same time. Different than IMI, SPACES also obtains some data about traffic and existing amenities which may serve beneficially to walkability evaluation.

Maponics: As their one and only data source, numeric data, Maponics retrieves walkability data about the following: administrative, industry, and community. Although it gets these statistical and numeric data from several different resources, it doesn't change Maponics' understanding of walkability – which is quantifiable for them.

Rate My Street: In addition to using open-source statistical data, Rate My Street also uses user data as rating and comment. Through rating, the users are asked to evaluate the given items according to their preferences. Also, the users can add their comments with their own words, which may soften that quantification approach of the tool.

Walk Score: As its only data source, Walk Score uses numeric data from different data providers. The users can not be a part of this data collection process, which is against walkability's nature.

Walkability Asia: This is the tool that only uses users as a data source. While making them the only data source, the tool lets them to make different evaluations like rating and multiple choices. Although users are directly active at the data collection process, they can only choose from the given choices, which makes users' comments numeric also.

Walkonomics: Walkonomics collects the physical data about the dimensions and some statistical rating like crime from several resources. In addition, users are active at the data collection process as crowd-sourcing. Validating the statistical data with users' feedbacks or vice versa can be good for obtaining a valid and logical result.

Walkshed: The only data used by Walkshed is numeric data. They use different data sources, but there is no detail about these sources.

Thirdly, the main source of the data, either directly from the user or statistical data, may create a big difference. It needs to be discussed that if the data is only and directly collected from a statistical database or a specific data source by totally disregarding human beings as a data source, it can be interpreted as it is totally conflicting with the idea that walking is such personally changed and perceptual act to make. It can be okay to provide the data from human beings with data from other sources, but it can be a bit problematic to only use data source by externalizing the main element of the walking act – ‘human being’.

4.1.2.8. Methodology – Data Collection: Usage of Numeric Data

As one of the sources and methods, during data collection, numeric data usage should better be discussed separately because it tells much about the tool’s understanding of walkability and developer’s point of view about the issue.

When the numeric distribution of statistical data usage is checked for the tools, the following can be told. In web-based tools, two-thirds of the tools use numeric data in their data collection process. In other words, there is dominancy of numeric data usage in web-based tools. However, contrarily, only three hard-copy tools use numeric data in their data collection process, which means that there is no dominancy by statistical data users. When both web-based and hard-copy tools are analyzed, the greatest percentage is covered by the tools that use numeric data. Although there is not a big difference in between, the tools that do not use numeric data comes in as second.

In that case, the web-based tools can be commented as the ones who quantifies walkability more. Also, it can be presupposed that their numeric data usage is the result of their economic concerns. If they use numeric data more, they will also digitize and make the final evaluation quantified at the end which may turn out into an economic value also. The most effective and influential consideration may be defined as the tool developer, which are mainly private firms.

The usage of numeric data is also a trace that the tool interprets walkability as an objective issue through focusing on its physical dimensions more. If the numeric data is collected as a way of validation, it can be a good source to affirm the crowd-sourcing method, but if the statistics is the only data source, it is a bit of a questionable issue.

4.1.2.9. Methodology – Data Collection: Number of Team Members

One of the factors that have a great impact upon the data collection process and that has a direct relation with tool users are how many people that the tool is used for data collection. To put it differently, the number of team members can create a great difference in the analysis of walkability.

When the web-based tools are analyzed, two-thirds of the tools are practiced or used individually. The other one-third of the tools totally disregard the users from their data collection process – *no auditors*, they use only statistical and GIS data from other ready-made resources. In hard-copy tools, only a quarter of them are proposed to be conducted as team of two, whereas others are proposed to be conducted individually. When all tools are analyzed, more than half are conducted individually which is followed by the team of two with great difference between them.

The reason behind the dominancy of individual auditors may result from the individuality of the technological world. The web-based tools are generally conducted from the mobile phones and personal computers, which are all personal belongings logged in with personal emails or IDs. By its very nature, the technology may force the developers to design their tools as individually. Although there is no such limitation in hard-copy tools, there is again a dominancy of individual usage.

As an individual act, walking can be analyzed for each and every single person from point of view of the web-based tools. Also, it can be described as an act that may change from person to person perceptually. Although it is an individual act, the walkability analysis conducted by web-based tools may increase the level of subjectivity.

In addition to being an individual act, walking is also a social and communal act and movement which helps space production or feeling as a part of community. Even it can be harder to conduct analysis in team of two for web-based tools, it should be questioned why most of the hard-copy tools do not conduct the analysis as groups. In the case in which the tool is conducted in groups, there will be one result or comment at the end in which all the team members should have reached consensus. This consensus and final result may not reflect all individual ideas but it can be more objective. Also, there can be a concern about the background of the hard-copy tools that the final output may not give clear data at the end. Another concern which can be valid for both web-based and hard-copy tools is to have a maximum number of data at the end. This concern may be a result of the idea that each individual is seen as “single data” rather than being “person” or “user”.

4.1.2.10. Methodology – Data Collection: Auditor Privacy

The issue of privacy can be considered as one of the biggest problems in our technological world, including walkability measurement tools. In tools, there are three main problems in terms of auditor privacy at the data collection process.

The first problem is the data that is collected and questions asked openly to the users for data collection or before the data collection process starts that aims to collect data rather than walkability-related issues. Both the web-based and hard-copy tools aim that their main target is to collect data and conduct analysis about walkability but most of them, actually web-based ones, ask other questions like the frequency of using public transportation. If the questions are openly asked to the users, it seems it is not okay to collect other data from the users as a requirement to follow and complete the questions.

The second problem is the data that is collected without the awareness of users like their daily habits. In addition to the openly asked questions, some tools also collect data in an under-handed way. While collecting data about walkability via walkability measurement tools, some other data is also collected like facilities that respondents use, the frequency of going to amenities, the facilities that they prefer, and users’ daily habits and preferences such as their daily routines. This ‘un-related’ data is sometimes collected with the permission of the users but mostly without their permission and creating direct awareness. Whereas some of the tools collect ‘un-related’ data in addition to walkability, they are doing it without hiding it, but straightforwardly, which is more ethical and acceptable. While collecting data about walkability analysis, like data collection about respondents’ everyday routines and daily habits as mentioned before, one of the web-based walkability measurement tools – *Walkonomics* – developed a search tab called “Slider” in which they collect data about most beautiful and greenest route in the searched area. The slogan of this slider is “Finding a Beautiful Route”. The left side of the slider is the value of beauty and the right side of this slider is the speed of the route.

In addition to walkability data collection, the tool also collects data about respondents' "beautiful" concept and understanding. Like personal preferences and daily habits data collection, it collects other data more than walkability. Although aesthetics can be one aspect of walkability in terms of its environmental features; the beauty understanding is another piece of detailed data. Respondents think that they are only evaluating the aesthetic value of the route, whereas they are data providers at the same time. Behind this issue, there can be some economic concerns like increasing rents and prices of the buildings that are located on that route.

The third and the last problem about the tools is either the auditors are anonymous during the data collection or not. When the numeric distribution is checked, there is a double dominancy in web-based, hard-copy and both tools. This anonymity problem is tried to be solved more in hard-copy tools through giving each individual or team an ID, and they are asked to write down their ID numbers on the tool. But, it is the issue that should be questioned; if they are given an ID for each and they only note down their ID's on the tool, what is done with their names. In other words, whether the names are kept as a list somewhere else and used for 'other purposes'. When the web-based ones are analyzed, they also ask for users' e-mail or address as a required step to fill in for skipping to the tool.

If the common aim of web-based, hard-copy and both is to measure and analyze walkability, it should be scrutinized more deeply why this personal data is collected either publicly or not.

4.1.2.11. Methodology – Data Collection: Maps Being Used

As to their characteristic properties, maps have limits in themselves like presenting three-dimensional environment which has heights and are hubbly into two-dimensional medium. This limitations and abstraction are directly opposite to general idea of walking.

There are two types of mapping that are used in walkability measurement tools: printout and digital (online). In all web-based tools, there is usage of online maps from several different databases like Google Map, Open Street Map. In hard-copy tools, there is equal balance in between printout and digital maps. For most of them, there is no information about what type of maps they use. When all tools are analyzed, there is a great dominancy of online map usage.

For analyzing walkability, tools use maps as a base either as hard-copy or in digital format. In hard-copy walkability measurement tools, either the map of the selected site is given as print out or respondents are asked to draw the route that they walk from their mind and identify the landmarks. Different than hard-copy walkability measurement tools, in web-based tools, each tool uses an online mapping system that may differ in terms of its visual qualities and interface. The usage of online mapping can both have advantageous and disadvantageous aspects. As a positive aspect, as online mapping systems are updated to changing urban areas; the tool's map will be up-to-date, but for this, there should be a full access to the map provider in that geographic location. As negative part, the tools that uses digital mapping can only do walkability analysis in the limits in where only mapping has access or data. In other words, through referring to online mapping; the data collection about walkability can only be limited to the areas that the mapping platform includes.

Some of the hard-copy tools also use digital maps in tablet computers. This approach can be interpreted as a way of orienting hard-copy tools into web-based ones. With maps, walkability is analyzed on maps, which are actually abstractions of the real environment. For a more comprehensive and valid analysis, it can be proposed not to use maps as base for the tools, but observation in real-life and real-environment.

4.1.2.12. Methodology – In Process: Criteria Weight

In each tool, there are several different criteria which are ended with the final result through a specific calculation or application of an algorithm. There are only two tools that assign different criteria weights: one from web-based, 'Rate My Street' and one hard-copy, 'Pedestrian Environment Review System (PERS)'.

It should be analyzed whether giving different weight to each criteria is for the benefit of the tool or not. In one aspect, each criteria can have the same importance regarding their quality, but only as a criteria towards analyzing walkability; on the other hand, each parameter can be given different weight due to the reason for users' preferences. For example, user who doesn't use educational amenities may weight this criteria as zero or disregard it totally, whereas other user who have children may weight is as ten out of ten. Having a different weight in criteria is both beneficial and not. It can be described as beneficial from the perspective that it emancipates users in a way that they can prioritize or disregard some criteria totally while analyzing walkability, which is actually an individual act to evaluate. In other words, because that walking is an individual experience that changes from one to another, it can be better that users have the right to weight the criteria. It should also be kept in mind that the criteria of the tools are also developed by individuals according to their individual preferences. Having the same weight for all criteria in a single tool is also suitable from the viewpoint that all aspects are important for walkability and have same importance for all. That may make the result more objective, whereas the tools that set different weight for each criteria may result in more individual assessment so that it can be objective.

4.1.2.13. Methodology – In Process: Engines and Algorithms Being Used

Not generally in hard-copy ones, but in most of the web-based tools; there is a usage of specifically developed algorithm to finalize the collected data. When numeric distribution is analyzed, there is a great dominancy of algorithm and engine usage in web-based ones, whereas in hard-copy ones, specific calculation methods or software are not used that much. When all types of tools are analyzed, the greatest percentage is covered by the usage of engines during the process.

It can be the easiest way to calculate and keep all collected data by defining each variable's weight and percentage. Behind this, the main aim can be to speed up the data analysis process and compose a database at the end rather than only collecting and analyzing data about walkability. However, it should be questioned how true is to put such a social act – walking – into a mathematical process. It also gives clue about the understanding of walkability that it is evaluated as a numeric and quantifiable issue.

For processing the collected data, some engines are being used to apply a specific calculation or for creating a database at the end. This engines also have the same role with specific algorithms developed for the tools with specific mathematical formulas inside. This engines actually effect the way the data collected – in a more quantified way – and also the tools that are developed by the engine firms put a question mark in the minds about their main concern or aim, which cannot be data collection at first, but can be economic concerns.

Although there are some tools in both web-based and hard-copy ones which use engines and algorithms, the main aim of hard-copy tools can be described as not integrating this calculation into the process, but only simplifying the procedure to keep the data collected at the end. From other perspective, it can be thought that the algorithm is the one that makes these web-based walkability measurement tools because that the ones who collect data regarding the algorithms' variables can do walkability analysis.

4.1.2.14. Methodology – In Process: In Process Scoring

As the in-process scoring of the tools, whether web-based or hard-copy, there are four main types as follows: ordinal, nominal, review, and algorithmic scoring. Ordinal scoring covers likert scaling, whereas nominal scale covers three methods: multiple choice, yes/no, and checking. In likert scale, the users are asked to rank the question like from good to bad, or totally agree and totally disagree. In multiple choice option, users are asked a question and expected to choose the answer from the given choices. In yes/no answer type, auditors should answer the question as yes or no. In checking, the auditors should select all the appropriate answers from the given ones. In review, the users are asked to write down their comments and ideas with their own words. In algorithmic scoring, the questions are evaluated by a specific engine or digital program without the interaction of the user or auditor.

When the numeric distribution is analyzed for web-based tools, the likert scale is the dominant type of in-process scoring. The multiple choice, review, and algorithmic scoring are used by only one tool, whereas other nominal scoring – *yes/no and checking* - types are not used. When the hard-copy tools are checked, likert scale and checking has the same importance as the most dominant type of in-process scoring. The second place is taken by yes/no, and the third place is taken by multiple choice. Although there is imbalance, all in-process scoring types are used by hard-copy walkability measurement tools except review and algorithmic scoring. When all tools are taken as a whole, the great dominancy is in likert scale, which is followed by checking. Like hard-copy tools, the second place is taken by yes/no, and the third place is taken by multiple choice in all tools. The last place is taken by the same numeric by review and algorithmic scoring.

These in-process scoring actually tell much about understanding of walkability of the tools and the tool developers. When the ordinal (likert) and nominal (multiple choice, yes/no, and checking) in-process scoring methods are analyzed, they give some choices to the user and want them to conduct evaluation via the given options. In other words, the options are given by the developer, and the user can only choose between them, either as validating or disclaiming them. In that way, there is no place for users to claim their ideas. Even if they do nott share the same idea or want to choose even one of the choices, they are obliged to do it. Also, these nominal and ordinal scoring types are much more inclined to make a quantitative evaluation at the end, like obtaining a 'final walkability score'. It can be described as the methods that can be evaluated most easily at the end by getting numeric results. Because that users cannot describe their ideas in these two main types of in-process scoring subjectively, the given choices mainly cover the physical and objective dimensions of walkability. More comprehensively, the tools that use nominal or ordinal in-process scoring can be described as the ones who try to direct the auditors or users even subconsciously.

When the review is analyzed as an in-process scoring method, it is the only method that gives users the chance to write down their own ideas and feedbacks. If this method is used on its own, the answers or analysis obtained at the end may be subjective, but if this method is used simultaneously with one of the other tools, it can work better and give better results. Although this method is the most subjective one, it is also the only method of in-process scoring which gives users the floor.

Although it is the least used in-process scoring method, algorithmic scoring says much about the walkability understanding of a tool. It totally disregards the users whether giving them several options or asking their comments more openly. Through algorithmic scoring, the analysis of walkability was exposed to mechanization, which means that walkability is only a physical and quantitative issue where users are not needed.

4.1.2.15. Methodology – Evaluation-Definition of Scoring: Tool and Developer

Rather than analyzing the scoring procedure of each tool or checking whether the tool uses statistical data, quantification can also be understood from the developer's own words or in the tool directly. The definitions of scoring give an idea about the aims of the tools and how they see the act of walking and walkability.

When the numeric distribution is analyzed, there is a dominancy of words that are related to quantification in web-based tools either by the tool directly or by the tool developers. This dominancy is repeated in hard-copy tools also. When all the tools are analyzed, again there is a dominancy of words about quantification and measuring walkability more numerically.

Each and every walkability measurement tool uses such quantification words (calculate, rate, measure, scale, value) through which they give clue about their understanding of walkability and their aim towards quantification. Although all tools use such words in their discourse – directly in the tool, in the questions, or by the tool developers' speech – some tools contain these words less than the others (for details, Table 3.1 can be seen). When the number of the words increases, it can be interpreted that the understanding of the tools towards walkability get more numeric and quantifiable.

4.1.2.16. Methodology – Evaluation: Final Scoring

Different than the in-process scoring, final scoring is much more related to the result that the tools want to receive at the end about walkability. Also, the final scoring type can be decided upon the following: either the tool uses open-ended or close-ended questions, makes subjective or objective analysis, or focuses on the physical, psychological (perceptual), or socio-spatial aspects of walkability. For example, if the tool wants to sell or send the final outcome of the tool to somewhere, it may try to obtain a more numeric data at the end. However, if a tool wants to enhance the urban environment and the city according to the results, the final output might be more verbal which depends on words. It can also be described as the 'final words' of the tool about its walkability analysis.

In final-scoring, there are three methods: likert, ranging, and review. In likert, the final score is put as a single score at the end, which is represented in a likert scale. In ranging, the final score is put in a range and evaluated as walkable or not according to the assigned range. In review, the final product is the comment of the auditors.

When, the numeric distribution of final scoring is analyzed, the following comments can be made. In web-based tools, likert and ranging has the same numbers as the first place, and review follows them with a slight difference as second. When the hard-copy tools are looked at, there is only information about the final scoring of two tools, which two both makes ranging as final scoring. There is no information about the final scoring procedure of ten hard-copy walkability measurement tools. When all tools are analyzed comprehensively, the first place is taken by ranging. It is continued with likert scale as second place and review as third. Again, there is no information about the final scoring methods of ten tools.

When they are analyzed verbally, it can be said that both web-based and hard-copy tools mostly try to complete with a score at the end, rather than having an individual comment. It can be understood that most tools use final scoring method with a quantification approach method to conduct analysis more easily, more quickly and to compose databases/datasets more easily. For easily directing the process, quantification may make a great contribution but it should be criticized if it is true to finalize the result only as a final score rather than comment or more qualitative analysis. In addition to this, it should be mentioned that walking as a liberatory and qualitative act is quantified that much. The very main aim of quantification with scoring process can serve the final results to other databases, real estate professionals, or policy makers, but then there is a contradiction with the idea of conducting research and analysis.

4.1.2.17. Methodology – Evaluation: Ranging the Final Score

In addition to finalizing analysis and converting the outputs into final scores and results, some tools also develop a range for their scores in which they define some areas as highly walkable, low walkable.

When it is analyzed numerically, two-thirds of web-based tools use ranging in their final score, whereas only one of them does not use ranging. Contrarily, there is ranging in final score in only one hard-copy tool. However, there is no information about the final score ranging of the other eleven hard-copy tools.

Ranging the final score is grading and ranking the neighborhoods according to walkability analysis scores. For instance, if a tool uses three different ranges, it means that they evaluate and grade urban areas into three. It is actually the direct grouping or grading of urban environment. Also through this range setting, actually the tools may melt some neighborhoods with different qualities in the same spot. In other words, having a center but not having a school as amenity is evaluated similarly with having a school as amenity but not having a center. Put differently, neighborhoods having different values and properties in terms of walkability can be evaluated as same range definition.

Although ranging may be seen smoother in terms of quantification, there is no difference in between setting a final score and setting a range at the end. In short, it can be said that the ones that use ranging as final scoring is more final oriented, whereas the ones that does not set a final range the same as the final score can be described as more process and analysis oriented.

4.1.2.18. Methodology – Evaluation: Visualization

In most of the tools as mentioned before, direct quantification via in-process or final-scoring is used. This can be the most easily readable way to see either the tool makes quantification or not. However, there are also several ways of reconsidering or representing this quantification, which is not very clear as scores but have the same logic in its background theoretical framework. Visualizing the final score or final result of the walkability analysis is also a representation of the quantification or the numeric value. The visualization method can be interpreted as a way of making the final result user-friendly and joyful. It is also a method of ranging the final result not over hundred, but with the help of color because it does not give each score separately but coloring each range.

With different visualization techniques like heat map or colored pins, they may try to mask or reconsider the final scores. By setting a range to final scores and giving each range a different color-coding, they obtain their final results. Although there is no information about the visualization preferences of hard-copy tools, most of the web-based tools visualize the final result with different techniques and methods like heat maps in Walkshed or colored pins in Walkonomics and Walkability Asia. It should be examined that through using different techniques, their aim can be to minimize the effects of quantification and make it more pleasant for users. Another thing to be examined in further studies is why developers want to use visualization techniques in their final result. It might result from the concern that the users want to see their analysis result at the end in such a colored format which is more readable. Although they try to readapt the quantification they make, it is still a method of reinterpretation of final scores in a more "colored-way".

4.1.2.19. Question Formations: Open-Ended and Close-Ended

The form of the questions is directly related to the data that want to be collected by the tool. In close-ended questions, the respondents may chose in between several answers or give such answers like yes/no, numeric responses. In open-ended ones, the respondent can explain what they want without any word count limit. It can be seen that most of the tools use only close-ended questions. The numeric distribution of the tools that only uses close-ended questions are the following: four of six web-based tools, seven of twenty hard-copy tools and eleven of eighteen all tools. It can be said that the tools that only use close-ended questions are not open to comments and focus on more physical and objective aspects of walkability. Only six of all tools use both close-ended and open-ended questions together, which can be evaluated as the ones that try to be comprehensive in terms of combining both objective and subjective aspects of walking analysis. Contrarily, there is no such tool that only uses open-ended question.

The problematic concern behind using close-ended questions is that act of walking is a liberatory act; however, close-ended question forms may limit respondents, which is in contrast to the idea of walkability. The tools that combine both open and close-ended questions may be the most comprehensive ones to analyze both objective and subjective measures of walkability in research.

The reason behind using close-ended questions can be one of the two following. The first reason might be that they try to avoid abusive content or responses in comments. The second reason might be that through more detailed, expressive, real-life stories, and subjective experiences of respondents, the tool authorities may not want other respondents to be affected by previous answers. Contrarily to comment-like responses, in close-ended question forms, most of the thing is like under control in terms of possible answers can be given. Referring to this, respondents can only select among the given choices. If the choices are the given by the tool, again respondents can only give short answers like numeric data, yes/no, or high-medium-low. Only through the formation of questions and possible answers, the respondents are limited. Through close-ended questions, tool developers also might tend to minimize data collection duration. Also, the responses of close-ended questions are more easily compared with other answers. However, there is a concrete and visible direction of users although the question types are different, which makes all different users standardized. Contrarily, in open-ended questions, there should be a coding process after data collection that needs qualification and needs more time. But, these will be the ones that give more detailed information about the one’s understanding and ideas about the analysis.

4.1.2.20. Presence of Guides: User Guide/Manual and Scoring Guide

The guides are the general informative documents that can be about the methodology, process or final scoring of the tool.

In none of the web-based walkability measurement tools, there is user guide or manual and there is scoring guide in only one of the web-based tools. User guides and manuals are included in five of the hard-copy tools and scoring guide is included in one of the hard-copy tools.

Having a users' guide and manual can be either beneficial or not. It might guide users and respondents who have never conducted such a research before or might direct respondents in the light of ideas and theoretical framework for the process of the tools. For obtaining proper and comprehensive results at the end, they can direct users and auditors in appropriate ways. However, it might have a direct impact upon standardizing people if they read this before auditing the tool.

The thing that should be questioned is the small number of guides both in web-based and hard-copy tools. When all web-based and hard-copy tools are analyzed, only two of the tools include scoring manual which can be resulted because they do nott want to conceal themselves, especially about the final result. But it should also be thought that if they make themselves visible to all, the users may believe them more and give their answers in a more open way.

4.2. Content Analysis Chart

Content Analysis Chart mainly covers the questions, parameters, or elements of each web-based and hard-copy walkability measurement tool in which they are symbolized and grouped into a single holistic table. This table consists of main themes, titles under each theme, and sub-titles under each title. As an analysis of this chart, both the numeric distribution and verbal interpretation are made in the following parts of this chapter.

4.2.1. Numeric Analysis of Content Analysis Chart

The aim of making numeric analysis of Content Analysis Chart is to see which criteria, parameters, or elements are predominant or minority in terms of numeric distribution. These charts can also work as a guide to make a further comment on if there is consistency between web-based and hard-copy walkability measurement tools in terms of their criteria.

To see this numeric distribution, five different tables are organized (Table 4.2, Table 4.3, Table 4.4, Table 4.5 and Table 4.6). In this five tables, the analysis are done with three different methods: the predominant and minority elements in web-based walkability measurement tools, the predominant and minority elements in hard-copy walkability measurement tools and the predominant and minority elements in both web-based and hard-copy walkability measurement tools (total).

Actually, these tables are composed and ordered from more detailed point of view to a broader one – *from smaller scale to bigger scale*. The details of the tables are as follows. In Table 4.2 (Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Titles and Subtitles)), all titles are listed in alphabetical order with their sub-titles underneath. At the composition phase, the themes are disregarded. The main aim is to see which of the existing sub-titles have a significant difference or take a backseat when the themes are not considered. Also, this table helps to see which sub-titles are more dominant or more recessive under each title. In Table 4.3 (Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Titles)), the titles are listed in alphabetical order while disregarding the themes and sub-titles. The aim of composing this table is to see which titles are more in number or less in number. Table 4.4 (Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes, Titles and Subtitles)) is relatively similar to Table 4.2. However, in Table 4.2, the themes are added so that it aims to analyze which sub-titles have a significant difference or few in number under each theme. Table 4.5 (Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes and Titles)) has similarities with Table 4.3, but the important difference between them is this table have themes also. The main aim of developing this table is to conduct an analysis about how titles are numerically distributed under each theme. Table 4.6 (Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes)) provides the widest point of view in between five tables. Table 4.6 lists the number of sub-titles under each theme while disregarding the titles. The main aim of this table is to see the numeric distribution of sub items under each theme.

Table 4.2. Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Titles and Subtitles)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
MAIN SYMBOL	MAIN TITLE	NO OF SUB-TITLES	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
○	ACCESSIBILITY	2	1	OVERALL WALKABILITY	2	0	2
			2	ACCESS TO SERVICES: DISTANCE & EASINESS	3	0	3
⊙	AESTHETICS	7	1	OVERALL ATTRACTIVENESS & QUALITY (FOR WALKING & CYCLING)	6	2	8
			2	FREENESS FROM NEGATIVE THINGS & EXISTENCE OF ABANDONED BUILDINGS	10	2	12
			3	PRESENCE OF POSITIVE ASPECTS	3	0	3
			4	GENERAL MAINTENANCE	2	0	2
			5	PRESENCE OF VIEW TYPES & SIGHTS	3	0	3
			6	INTERESTING THINGS TO DO	2	1	3
			7	ATTRACTIVENESS OF BUILDINGS	3	0	3
■	BUILDINGS	4	1	SETBACK FROM STREET OR SIDEWALK	2	0	2
			2	PHYSICAL ASPECTS OF BUILDINGS	2	0	2
			3	OVERALL QUALITY OF BUILDINGS	3	0	3
			4	SIMILARITY OF BUILDINGS	2	0	2

(cont. on next page)

Table 4.2 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
MAIN SYMBOL	MAIN TITLE	NO OF SUB-TITLES	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
α	CONNECTIVITY	4	1	COMPLETE STREETS & CONNECTEDNESS	2	1	3
			2	CUL-DE-SACS	3	0	3
			3	NO OF INTERSECTIONS	5	0	5
			4	SIDEWALK CONTINUITY	1	0	1
◆	CROSSINGS	4	1	PRESENCE & TYPE OF CROSSINGS	9	2	11
			2	PRESENCE OF CROSSING AIDS	7	0	7
			3	PHYSICAL QUALITIES OF CROSSINGS	2	1	3
			4	EASINESS OF CROSSINGS	3	2	5
❖	DISABILITY	1	1	DISABLED ACCESS & INFRASTRUCTURE	2	2	4
✚	FACILITIES & AMENITIES	3	1	PRESENCE & QUALITY OF DIFFERENT AMENITIES	6	2	8
			2	PRESENCE & QUALITY OF URBAN AMENITIES	8	1	9
			3	DISTANCE TO AMENITIES	1	1	2
✜	FINDING WAY & NAVIGATION	2	1	EASINESS OF WAYFINDING (GENERAL LEGIBILITY)	2	2	4
			2	PRESENCE OF WAYFINDING AIDS	2	1	3

(cont. on next page)

Table 4.2 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
MAIN SYMBOL	**MAIN TITLE**	**NO OF SUB-TITLES**	**SUB-TITLES**		**HARD-COPY (12)**	**WEB-BASED (6)**	**IN TOTAL (18)**
★	LAND USE & DENSITY	5	1	LAND USE DIVERSITY	6	1	7
			2	DOMINANT LAND USE	1	0	1
			3	RESIDENTIAL DENSITY & TYPE OF RESIDENTIAL BUILDINGS	4	0	4
			4	CONDITION OF LAND USES	1	0	1
			5	VERTICAL LAND USE	2	0	2
✪	LIGHTING	4	1	PRESENCE OF OUTDOOR LIGHTING	7	0	7
			2	COVERAGE OF LIGHTING	1	0	1
			3	LIGHTING AT NIGHT	1	0	1
			4	QUALITY OF LIGHTING	2	0	2
⏏	NEIGHBORHOOD CHARACTERISTICS	2	1	NEIGHBORHOOD IDENTIFIERS	1	0	1
			2	OVERALL NEIGHBORHOOD SATISFACTION	1	0	1

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Table 4.2 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
MAIN SYMBOL	**MAIN TITLE**	**NO OF SUB-TITLES**	**SUB-TITLES**		**HARD-COPY (12)**	**WEB-BASED (6)**	**IN TOTAL (18)**
⌘	OBSTRUCTION	4	1	PRESENCE OF PERMANENT OBSTRUCTIONS	5	0	5
			2	PRESENCE OF TEMPORARY OBSTRUCTIONS	2	0	2
			3	PHYSICAL DIFFICULTIES WHILE WALKING & CYCLING	2	0	2
			4	PRESENCE OF TEMPORARY &/OR PERMANENT OBSTRUCTIONS	3	1	4
⌥	PAVEMENT / SIDEWALK	6	1	PHYSICAL DIMENSIONS OF PAVEMENT & SIDEWALKS	5	2	7
			2	PRESENCE OF KERB (CURB-DRIVEWAY CUT) & QUALITIES	8	0	8
			3	MAINTENANCE OF SIDEWALKS	1	0	1
			4	PRESENCE OF SIDEWALKS	5	1	6
			5	OVERALL CONDITION & PHYSICAL QUALITY OF SIDEWALKS	8	1	9
			6	PRESENCE OF BUFFER & QUALITIES	5	0	5
¶	PEDESTRIAN	4	1	PRESENCE OF PEOPLE	2	1	3
			2	PHYSICAL ACTIVITY LEVEL OF PEOPLE	2	0	2
			3	PRESENCE OF PEDESTRIAN AIDS	1	1	2
			4	OVERALL PEDESTRIAN FRIENDLINESS	0	1	1

(cont. on next page)

Table 4.2 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
MAIN SYMBOL	MAIN TITLE	NO OF SUB-TITLES	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
⃠	POLICY	1	1	GENERAL POLICY	1	0	1
✖	PUBLIC SPACE	5	1	PRESENCE & QUALITY OF PARKS	2	1	3
			2	HAVING A CENTER	0	1	1
			3	OVERALL CONDITION OF PUBLIC SPACES	1	0	1
			4	PRESENCE OF PUBLIC SPACES	1	0	1
			5	USABILITY OF PUBLIC SPACE FOR ACTIVITY BY USERS	2	0	2
×	PUBLIC TRANSPORTATION	5	1	AVAILABILITY OF PUBLIC TRANSPORTATION	0	0	0
			2	PUBLIC TRANSPORT FACILITIES (PRESENCE, TYPE & PROPERTIES)	5	0	5
			3	WALKING DISTANCE TO TRANSIT STOPS	1	0	1
			4	NO OF MOTOR VEHICLES TO BE USED	1	0	1
			5	QUALITY OF PUBLIC TRANSPORTATION	1	0	1

(cont. on next page)

Table 4.2 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
MAIN SYMBOL	MAIN TITLE	NO OF SUB-TITLES	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
☑	SAFETY	7	1	SURVEILLANCE	1	0	1
			2	PRESENCE OF STRAY DOGS	3	0	3
			3	TRIP HAZARD	0	1	1
			4	SAFETY FROM CRIME	4	3	7
			5	SAFETY FROM TRAFFIC	4	3	7
			6	OVERALL FEELING OF SAFETY	6	1	7
			7	HEDGE HEIGHT	1	0	1
☒	SPEED	4	1	POSTED SPEED	3	0	3
			2	POSTED SPEED LIMIT	4	1	5
			3	DESIGNS FOR LOWERING SPEED	1	0	1
			4	OVER-DRIVE (EXCEEDING SPEED)	1	0	1
✔	STREET CHARACTERISTICS	2	1	CONDITION & QUALITY OF ROADS	3	1	4
			2	TYPE OF ROADS	1	1	2
⊖	TOPOGRAPHIC QUALITIES	2	1	HILLINESS	1	1	2
			2	SLOPE	5	0	5

(cont. on next page)

Table 4.2 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
MAIN SYMBOL	MAIN TITLE	NO OF SUB-TITLES	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
Δ	TRAFFIC	7	1	MOTORISTS' BEHAVIOUR	1	1	2
			2	NO OF (THRU) LANES	8	0	8
			3	ON & OFF STREET PARKING	5	0	5
			4	LEVEL OF TRAFFIC	4	0	4
			5	TRAFFIC CONTROL DEVICES & SIGNS + TRAFFIC CALMING FEATURES	6	0	6
			6	EITHER TRAFFIC IS ONE WAY OR TWO WAYS	2	0	2
			7	ROAD PROPERTIES: LOCATION, TYPE, CONDITION & NO OF DRIVEWAYS	4	0	4
Ω	WALKING & CYCLING	4	1	PRESENCE OF BICYCLE LANES	6	0	6
			2	PRESENCE OF BICYCLE FACILITIES	5	0	5
			3	QUALITY OF CYCLING PATHS	3	0	3
			4	EASINESS OF BICYCLING & WALKING	1	0	1
Ψ	WALKING PATHS	2	1	AVAILABILITY OF WALKING PATHS	2	1	3
			2	QUALITY OF WALKING PATHS	5	1	6

Table 4.3. Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Titles)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART

MAIN SYMBOL	MAIN TITLE	HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
○	ACCESSIBILITY	5	0	5
⊙	AESTHETICS	29	5	34
■	BUILDINGS	9	0	9
α	CONNECTIVITY	11	1	12
◆	CROSSINGS	21	5	26
❖	DISABILITY	2	2	4
✚	FACILITIES & AMENITIES	15	4	19
✜	FINDING WAY & NAVIGATION	4	3	7
★	LAND USE & DENSITY	14	1	15
✪	LIGHTING	11	0	11
⏏	NEIGHBORHOOD CHARACTERISTICS	2	0	2

(cont. on next page)

Table 4.3 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART

MAIN SYMBOL	MAIN TITLE	HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
⌘	OBSTRUCTION	12	1	13
⌥	PAVEMENT / SIDEWALK	32	4	36
¶	PEDESTRIAN	5	3	8
⃠	POLICY	1	0	1
✖	PUBLIC SPACE	6	2	8
✕	PUBLIC TRANSPORTATION	8	0	8
☑	SAFETY	19	8	27
☒	SPEED	9	1	10
✔	STREET CHARACTERISTICS	4	2	6
Θ	TOPOGRAPHIC QUALITIES	6	1	7
Δ	TRAFFIC	30	1	31
Ω	WALKING & CYCLING	15	0	15
Ψ	WALKING PATHS	7	2	9

Table 4.4. Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes, Titles and Subtitles)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
THEME	MAIN SYMBOL	MAIN TITLE	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
PERCEPTION & ABSTRACT	○	ACCESSIBILITY	1	OVERALL WALKABILITY	2	0	2
			2	ACCESS TO SERVICES: DISTANCE & EASINESS	3	0	3
	α	CONNECTIVITY	1	COMPLETE STREETS & CONNECTEDNESS	2	1	3
			2	CUL-DE-SACS	3	0	3
			3	NO OF INTERSECTIONS	5	0	5
			4	SIDEWALK CONTINUITY	1	0	1
	✤	FINDING WAY & NAVIGATION	1	EASINESS OF WAYFINDING (GENERAL LEGIBILITY)	2	2	4
	☑	SAFETY	1	SURVEILLANCE	1	0	1
			2	PRESENCE OF STRAY DOGS	3	0	3
			3	TRIP HAZARD	0	1	1
			4	SAFETY FROM CRIME	4	3	7
			5	SAFETY FROM TRAFFIC	4	3	7
			6	OVERALL FEELING OF SAFETY	6	1	7
			7	HEDGE HEIGHT	1	0	1

(cont. on next page)

Table 4.4 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
THEME	MAIN SYMBOL	MAIN TITLE	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
USER	❖	DISABILITY	1	DISABLED ACCESS & INFRASTRUCTURE	2	2	4
	¶	PEDESTRIAN	1	PRESENCE OF PEOPLE	2	1	3
			2	PHYSICAL ACTIVITY LEVEL OF PEOPLE	2	0	2
			3	PRESENCE OF PEDESTRIAN AIDS	1	1	2
			4	OVERALL PEDESTRIAN FRIENDLINESS	0	1	1

(cont. on next page)

Table 4.4 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
THEME	**MAIN SYMBOL**	**MAIN TITLE**	**SUB-TITLES**		**HARD-COPY (12)**	**WEB-BASED (6)**	**IN TOTAL (18)**
ENVIRONMENT-BASED	⊙	AESTHETICS	1	OVERALL ATTRACTIVENESS & QUALITY (FOR WALKING & CYCLING)	6	2	8
			2	FREENESS FROM NEGATIVE THINGS & EXISTENCE OF ABANDONED BUILDINGS	10	2	12
			3	PRESENCE OF POSITIVE ASPECTS	3	0	3
			4	GENERAL MAINTENANCE	2	0	2
			5	PRESENCE OF VIEW TYPES & SIGHTS	3	0	3
			6	INTERESTING THINGS TO DO	2	1	3
			7	ATTRACTIVENESS OF BUILDINGS	3	0	3
	■	BUILDINGS	1	SETBACK FROM STREET OR SIDEWALK	2	0	2
			2	PHYSICAL ASPECTS OF BUILDINGS	2	0	2
			3	OVERALL QUALITY OF BUILDINGS	3	0	3
			4	SIMILARITY OF BUILDINGS	2	0	2
	⏏	NEIGHBORHOOD CHARACTERISTICS	1	NEIGHBORHOOD IDENTIFIERS	1	0	1
			2	OVERALL NEIGHBORHOOD SATISFACTION	1	0	1

(cont. on next page)

Table 4.4 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
THEME	MAIN SYMBOL	MAIN TITLE	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
ENVIRONMENT-BASED	✖	PUBLIC SPACE	1	PRESENCE & QUALITY OF PARKS	2	1	3
			2	HAVING A CENTER	0	1	1
			3	OVERALL CONDITION OF PUBLIC SPACES	1	0	1
			4	PRESENCE OF PUBLIC SPACES	1	0	1
			5	USABILITY OF PUBLIC SPACE FOR ACTIVITY BY USERS	2	0	2
	✔	STREET CHARACTERISTICS	1	CONDITION & QUALITY OF ROADS	3	1	4
			2	TYPE OF ROADS	1	1	2
	⊝	TOPOGRAPHIC QUALITIES	1	HILLINESS	1	1	2
			2	SLOPE	5	0	5

(cont. on next page)

Table 4.4 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
THEME	**MAIN SYMBOL**	**MAIN TITLE**	**SUB-TITLES**		**HARD-COPY (12)**	**WEB-BASED (6)**	**IN TOTAL (18)**
PHYSICAL	◆	CROSSINGS	1	PRESENCE & TYPE OF CROSSINGS	9	2	11
			2	PRESENCE OF CROSSING AIDS	7	0	7
			3	PHYSICAL QUALITIES OF CROSSINGS	2	1	3
			4	EASINESS OF CROSSINGS	3	2	5
	✜	FINDING WAY & NAVIGATION	2	PRESENCE OF WAYFINDING AIDS	2	1	3
	✪	LIGHTING	1	PRESENCE OF OUTDOOR LIGHTING	7	0	7
			2	COVERAGE OF LIGHTING	1	0	1
			3	LIGHTING AT NIGHT	1	0	1
			4	QUALITY OF LIGHTING	2	0	2

(cont. on next page)

Table 4.4 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
THEME	MAIN SYMBOL	MAIN TITLE	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
PHYSICAL	⌘	OBSTRUCTION	1	PRESENCE OF PERMANENT OBSTRUCTIONS	5	0	5
			2	PRESENCE OF TEMPORARY OBSTRUCTIONS	2	0	2
			3	PHYSICAL DIFFICULTIES WHILE WALKING & CYCLING	2	0	2
			4	PRESENCE OF TEMPORARY &/OR PERMANENT OBSTRUCTIONS	3	1	4
	⌥	PAVEMENT / SIDEWALK	1	PHYSICAL DIMENSIONS OF PAVEMENT & SIDEWALKS	5	2	7
			2	PRESENCE OF KERB (CURB-DRIVEWAY CUT) & QUALITIES	8	0	8
			3	MAINTENANCE OF SIDEWALKS	1	0	1
			4	PRESENCE OF SIDEWALKS	5	1	6
			5	OVERALL CONDITION & PHYSICAL QUALITY OF SIDEWALKS	8	1	9
			6	PRESENCE OF BUFFER & QUALITIES	5	0	5
	Ψ	WALKING PATHS	1	AVAILABILITY OF WALKING PATHS	2	1	3
			2	QUALITY OF WALKING PATHS	5	1	6

(cont. on next page)

Table 4.4 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
THEME	**MAIN SYMBOL**	**MAIN TITLE**	**SUB-TITLES**		**HARD-COPY (12)**	**WEB-BASED (6)**	**IN TOTAL (18)**
FUNCTION	✚	FACILITIES & AMENITIES	1	PRESENCE & QUALITY OF DIFFERENT AMENITIES	6	2	8
			2	PRESENCE & QUALITY OF URBAN AMENITIES	8	1	9
			3	DISTANCE TO AMENITIES	1	1	2
	★	LAND USE & DENSITY	1	LAND USE DIVERSITY	6	1	7
			2	DOMINANT LAND USE	1	0	1
			3	RESIDENTIAL DENSITY & TYPE OF RESIDENTIAL BUILDINGS	4	0	4
			4	CONDITION OF LAND USES	1	0	1
			5	VERTICAL LAND USE	2	0	2

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Table 4.4 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
THEME	MAIN SYMBOL	MAIN TITLE	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
NETWORK	×	PUBLIC TRANSPORTATION	1	AVAILABILITY OF PUBLIC TRANSPORTATION	0	0	0
			2	PUBLIC TRANSPORT FACILITIES (PRESENCE, TYPE & PROPERTIES)	5	0	5
			3	WALKING DISTANCE TO TRANSIT STOPS	1	0	1
			4	NO OF MOTOR VEHICLES TO BE USED	1	0	1
			5	QUALITY OF PUBLIC TRANSPORTATION	1	0	1
	☒	SPEED	1	POSTED SPEED	3	0	3
			2	POSTED SPEED LIMIT	4	1	5
			3	DESIGNS FOR LOWERING SPEED	1	0	1
			4	OVER-DRIVE (EXCEEDING SPEED)	1	0	1

(cont. on next page)

Table 4.4 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
THEME	MAIN SYMBOL	MAIN TITLE	SUB-TITLES		HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
NETWORK	Δ	TRAFFIC	1	MOTORISTS' BEHAVIOUR	1	1	2
			2	NO OF (THRU) LANES	8	0	8
			3	ON & OFF STREET PARKING	5	0	5
			4	LEVEL OF TRAFFIC	4	0	4
			5	TRAFFIC CONTROL DEVICES & SIGNS + TRAFFIC CALMING FEATURES	6	0	6
			6	EITHER TRAFFIC IS ONE WAY OR TWO WAYS	2	0	2
			7	ROAD PROPERTIES: LOCATION, TYPE, CONDITION & NO OF DRIVEWAYS	4	0	4
	Ω	WALKING & CYCLING	1	PRESENCE OF BICYCLE LANES	6	0	6
			2	PRESENCE OF BICYCLE FACILITIES	5	0	5
			3	QUALITY OF CYCLING PATHS	3	0	3
			4	EASINESS OF BICYCLING & WALKING	1	0	1

(cont. on next page)

Table 4.4 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART							
THEME	**MAIN SYMBOL**	**MAIN TITLE**	**SUB-TITLES**		**HARD-COPY (12)**	**WEB-BASED (6)**	**IN TOTAL (18)**
POLICY	⃠	POLICY	1	GENERAL POLICY	1	0	1

Table 4.5. Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes and Titles)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART					
THEME	MAIN SYMBOL	MAIN TITLE	HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
PERCEPTION & ABSTRACT	O	ACCESSIBILITY	5	0	5
	α	CONNECTIVITY	11	1	12
	✜	FINDING WAY & NAVIGATION	2	2	4
	☑	SAFETY	19	8	27
USER	❖	DISABILITY	2	2	4
	¶	PEDESTRIAN	5	3	8

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Table 4.5 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART					
THEME	**MAIN SYMBOL**	**MAIN TITLE**	**HARD-COPY (12)**	**WEB-BASED (6)**	**IN TOTAL (18)**
ENVIRONMENT-BASED	⊙	AESTHETICS	29	5	34
	■	BUILDINGS	9	0	9
	⏏	NEIGHBORHOOD CHARACTERISTICS	2	0	2
	✖	PUBLIC SPACE	6	2	8
	✔	STREET CHARACTERISTICS	4	2	6
	⊝	TOPOGRAPHIC QUALITIES	6	1	7

(cont. on next page)

Table 4.5 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART					
THEME	MAIN SYMBOL	MAIN TITLE	HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
PHYSICAL	◆	CROSSINGS	21	5	26
	✜	FINDING WAY & NAVIGATION	2	1	3
	✪	LIGHTING	11	0	11
	⌘	OBSTRUCTION	12	1	13
	⌥	PAVEMENT / SIDEWALK	29	4	33
	ψ	WALKING PATHS	7	2	9
FUNCTION	✚	FACILITIES & AMENITIES	15	4	19
	★	LAND USE & DENSITY	14	1	15

(cont. on next page)

Table 4.5 (cont.)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART					
THEME	**MAIN SYMBOL**	**MAIN TITLE**	**HARD-COPY (12)**	**WEB-BASED (6)**	**IN TOTAL (18)**
NETWORK	×	PUBLIC TRANSPORTATION	8	0	8
	☒	SPEED	9	1	10
	Δ	TRAFFIC	30	1	31
	Ω	WALKING & CYCLING	15	0	15
POLICY	⃠	POLICY	1	0	1

Table 4.6. Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes)

NUMERIC DISTRIBUTION OF CONTENT ANALYSIS CHART

THEME	NO OF SUB-TITLES	SCOPE OF SUB-TITLES	HARD-COPY (12)	WEB-BASED (6)	IN TOTAL (18)
PERCEPTION & ABSTRACT	2	THE GENERAL WALKABILITY EVALUATION OF THE SEARCHED AREA (SEGMENT, NEIGHBORHOOD, STREET, ETC.)	37	11	48
USER	1	THE PRESENCE & QUALITY OF DESIGNS & AIDS WHICH ARE FOR DISABLED USERS	7	5	12
ENVIRONMENT-BASED	7	THE GENERAL ATTRACTIVENESS LEVEL OF THE SEARCHED AREA ESPECIALLY FOR WALKING & CYCLING LIKE SMARTNESS, BEAUTIFULNESS, OVERALL VISUAL ATTRACTIVENESS & HOW PLEASE THE AREA IS TO BE USED	56	10	66
PHYSICAL	4	THE EXISTENCE, TYPE & NO OF CROSSINGS	82	13	95
FUNCTION	3	THE EXISTENCE & QUALITY OF DIFFERENT AMENITIES & FACILITIES WITHIN WALKING DISTANCE WHICH HAVE DIFFERENT FUNCTIONS	29	5	34
NETWORK	5	THE AVAILABILITY OF PUBLIC TRANSPORTATION	62	2	64
POLICY	1	THE EXISTING POLICIES, LAWS, REGULATIONS & GUIDELINES FOR URBAN PLAN	1	0	1

4.2.2. Descriptive Analysis of Content Analysis Chart

In descriptive analysis of Content Analysis Chart, previously given Symbols of Content Analysis Chart (Table 3.2), Content Analysis Chart (Table 3.3), Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Titles and Subtitles) (Table 4.2), Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Titles) (Table 4.3), Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes, Titles and Subtitles) (Table 4.4), Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes and Titles) (Table 4.5) and Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes) (Table 4.6) are analyzed and studied together for giving a further thought. While doing interpretation, all numeric analysis charts are tackled as a whole.

Each of these five tables in which numeric analysis is made are analyzed separately as below. Under each table, web-based tools, hard-copy tools, and all tools are analyzed separately and as a whole.

While commenting on the numeric analysis charts, the analysis is made through the lens of dimensions of walking and walkability: physical, perceptual and socio-spatial. *The physical aspects* of walking mainly covers the objective issues which are covered in urban areas like the presence of specific amenities, the dimensions of kerbs, the material types used in the searched area, the presence of lighting equipment in the area, and the speed limits set for the area. *The perceptual aspects* of walking primarily involve more subjective elements like how good or how bad the area is, how long it takes for walking, how easy it is to across the street from the pedestrian crossing, or feeling of safety in the neighborhood. *The socio-spatial aspects* of walking can be either objective or subjective, which substantially contains creating of space while walking, sensing the urban area, and preventing segregation in urban environments.

Descriptive analysis of content chart is made to understand the reason behind which criteria is dominant or recessive for each table and type of tool. Also, the distribution of criteria in terms of the aspects of walking is analyzed.

The first analysis is made based upon Table 4.2 Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Titles and Subtitles) as follows. In hard-copy tools, there are several different sub-titles that are dominant as criteria. Although the dominant sub-titles are numerous and listed under different themes and titles, the common point of all is that they only cover and related to the physical aspects of walking (like presence or non-presence of amenities and qualities and number of them). Unlike the dominant sub-titles, there is no common point in recessive criteria in hard-copy tools. The criteria which are fewer in number cover more perceptual items like the availability of some qualities, friendliness level of urban areas and trip hazards. There is only one physical quality that is recessive in hard-copy tools which is directly related with urban areas; having a center in neighborhood. When the web-based tools are analyzed, there is a great dominancy of more perceptual aspects of walking, which are mostly related to safety from external factors like traffic and crime. These factors are actually not directly related with the act of walking or walkability, but generally relate with urban life and everyday routines. Whereas there is a great dominancy of perceptual items, none of the sub-titles are fewer in number with a great difference. When all tools are analyzed, the greatest percentage is taken only by physical aspects related to walkability. This physical aspect includes the presence, physical quality, and freeness of some amenities. Although there are different items which are dominant, there is no recessive sub-title in all tools. As general analysis of sub-titles disregarding themes and titles, the physical aspects are both dominant for hard-copy tools and all tools whereas perceptual items are more dominant in web-based tools. This difference of greatest percentage from hard-copy tools to web-based ones should be questioned. It can result from the concern that hard-copy tools are more research-oriented and mainly conducted in real-environment; that is why they may focus on the physical aspects. Different than hard-copy tools, web-based tools are mainly more final-process oriented and they are conducted in digital medium. Also, rather than really analyzing walkability, their main concern can be identified as individuals' ideas about their living environment.

The second analysis is made based upon Table 4.3 Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Titles) as follows. In hard-copy tools, the greatest percentage is taken by both physical and perceptual items like web-based tools. However, what is different from web-based tools that in hard-copy tools, physical items (presence and physical qualities of sidewalks and traffic related items) are more than perceptual criteria (the aesthetic quality of the neighborhood). Different than web-based tools, the most recessive titles are only physical aspects of walking related to users' abilities, the qualities of the neighborhood, and wayfinding aids' presence in that area. As with the hard-copy tools, the dominancy is in both physical and perceptual aspects of walking, and the distribution of these aspects are similar. In other words, the greatest percentage in all tools is firstly taken by physical aspects that are followed by perceptual aspects of walkability. Identical with hard-copy tools, the only recessive aspects in all tools are physical aspects of walkability, which covers urban features, user related aspects, and more regulative elements. In web-based tools, the most recessive aspects of walkability are both physical and perceptual items. As titles of web-based tools, the dominant ones are both perceptual and physical items. The most dominant two titles are perceptual, which are related to security feeling and design-related items in neighborhood, whereas the one title is physical, which has direct relation to amenity of crossing the street. When the lowest percentage is analyzed in web-based tools, there are again both physical and perceptual titles. Although they are both covered as few in number, physical titles are more than perceptual items. There are six physical titles that are recessive, whereas there is only one perceptual title. Different than the web-based tools, hard-copy tools and all tools has same fewer in number aspects, which are only physical. From this inference from both quantitative and qualitative analysis, it can be said that all tools have same percentage with hard-copy tools, whereas web-based ones are diverged from them in terms of title based distribution.

The third analysis is made based upon Table 4.4 Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes, Titles and Subtitles) as below. In hard-copy tools to analyze the dominant sub-titles under each theme, in perception and abstract, and environment-based themes, both physical and perceptual aspects are covered with similar percentages. However, in themes of physical, function, network and policy, only physical aspects of walkability has dominancy over other themes. When the least dominant sub-titles under each theme is analyzed in hard-copy tools, in three of them, the criteria covered are all physical in which no perceptual aspects are included because they are few in number. The themes that have least dominant sub-titles are as follows: perception and abstract, environment-based, and physical. There is only one theme that is less in perceptual aspects of walking which is the user. In function and network themes, there are no such sub-titles that are less in number under themes. In web-based, when the dominant or numerous sub-titles are analyzed under each theme disregarding the titles, only perceptual aspects of walkability are covered in perception and abstract with three subtitles. In environment-based and physical themes, the issues mostly covered are both perceptual and physical aspects of walking. In function, network, and user, the most covered criteria are only physical dimensions of walkability. When the most used aspects are analyzed in web-based tools, physical aspects have the same distribution as perceptual aspects with twelve tools. In the sub-titles that are few in number in each theme for web-based tools, mostly, there are no sub-titles that are significantly lower than the others. This recessive number of sub-titles under each theme is only covered in user with physical aspects. When both web-based and hard-copy tools are analyzed as the numeric distribution of sub-titles under themes, in perception and abstract, there is a great dominancy of more perceptual sub-titles. In environment-based theme, both physical and perceptual aspects are covered as the most with the numeric dominancy of physical properties. In all other themes, physical, function, network, user, and policy, the dominant aspects related to walkability are only physical features. As the lowest number of sub-titles under themes in all tools (hard-copy and web-based), in perception and abstract, and physical themes, the sub-titles that are few in number are all physical aspects of walkability. In environment-based theme, the sub-titles with lower number are both physical and perceptual dimensions of walking act. In user theme, perceptual aspects only are covered, whereas in function, network, and policy, there are no sub-titles which are significantly recessive. For analyzing the sub-titles under themes for each type of tools in terms of their dominant and recessive numeric distributions, mainly physical sub-titles are dominant in each type. As greatest recessive aspects, there is an equal distribution of both physical and perceptual dimensions. As the smallest scale of the analysis, which is sub-titles, it gives the more detailed information about the covering of dimensions of walkability in tools.

The fourth analysis is made based upon Table 4.5 Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes and Titles) as below. When the hard-copy tools are analyzed in terms of title distribution under themes, the titles that can be listed under physical aspects are more than the titles that can be grouped under perceptual aspects of walkability. When the numeric distribution under each title is analyzed, the greatest numeric distribution is also at the physical dimensions. The lowest numbers of titles that are covered in hard-copy tools are mainly covered under themes that can be clustered as physical dimensions of walkability. The physical aspects of walkability are covered by one theme of perceptual dimensions. When the numeric distribution under each theme is analyzed, the greatest numbers are covered with physical aspects. In all tools, the greatest number of titles are taken by the themes which can be clustered under physical dimensions of walkability. This greatest number of titles are followed by the themes of perceptual aspects. The fewer number of titles listed under each theme only covers the physical aspects of walkability. Different than the hard-copy and the web-based tools, there is no fewer number of tools covered under perceptual dimensions of walkability in all tools. In web-based tools, when each dominant title is analyzed under each theme, the greatest percentage is physical aspects of walkability. Although the greatest percentage of dominant titles are covered by physical aspects, only two titles are covered under perceptual aspects. However, when the numeric distribution of this dominant titles is covered, perceptual titles are covered in thirteen web-based tools under themes whereas fourteen titles are covered under physical dimensions of walkability. As the lowest percentage of titles under each theme for web-based tools, there are several main titles that are actually not covered with zero tools. There are eight titles under themes that are not covered in web-based tools that are related to physical aspects of walkability whereas only one title is covered under perceptual aspect of walking. When web-based, hard-copy, and all tools are analyzed, both the greatest number of titles and the fewest number of titles are the physical aspects of walkability, which may not be seen as logical. Although the greatest and lowest number of titles are taken by the same dimension of walkability, they both cover different physical aspects of walkability like the presence of amenities, traffic-related aspects, and land use. While doing a detailed analysis, the number of subtitles covered under each title should also be paid attention. Whereas all tools cover physical aspects, the number under each title also gives idea about the themes' general scope.

The fifth analysis is made based upon Table 4.6 Numeric Distribution of Content Analysis Chart (In Alphabetical Order Arranged in Themes) as follows. In hard-copy tools, the same as with the web-based tools; the greatest percentage is taken by the theme physical, in which physical aspects of walkability are covered. Again same as with web-based tools, the lowest percentage is taken by the theme policy. The difference between web-based and hard-copy tools is that there is only one hard-copy tool that includes policy in its content. In web-based tools, the greatest number of tools are covered under physical theme, which includes the presence and physical qualities of crossings, presence of aids that increase the level of wayfinding, the existence of lighting equipment in the neighborhood, the presence of obstructions which make the act of walking more difficult, the presence, physical qualities and dimensions of sidewalks, and the availability of walking paths. The lowest number of web-based tools is covered in policy theme, which covers the regulation related aspects of walkability. There are no web-based tools under policy which can be described under physical dimensions of walkability. Like web-based and hard-copy tools, physical theme is the most dominant theme on all tools with a significant difference with the other themes. Similarly, policy takes the lowest number of tools with one of all tools which can be described under physical aspect of walkability. As the most comprehensive analysis about the numeric distribution and which theme is mostly covered as the content of walkability measurement tools, this part of qualitative analysis gives the detailed idea about each type of tools' scope. There is a great consistency between web-based, hard-copy, and all tools that the greatest percentage and number of distribution are physical aspects of walkability, whereas policy is the theme that covered lowest of all which actually serves for the physical dimensions of the walking act. The dominance of physical aspects of walkability and lack of policy settings in each and every tool is a concern that should be discussed more in detail in the conclusion.

As an additional comment, it can also be said that when hard-copy and web-based walkability measurement tools are compared in terms of their content or scope, there are great differences in terms of their numeric distribution (as themes). When all themes are covered, it can be easily seen that Physical theme is the most dominant one in other tools but during the transition process from hard-copy to web-based walkability measurement tools, lighting and presence of obstructions are totally disregarded. In other words, although the dominant theme is the same in both types of tools, they are changed in their details.

Another thing that should also be analyzed as themes that Network is the second dominant theme in the hard-copy ones but when it comes to web-based ones, it totally disregarded. In three other themes, they are decreased from hard-copy to web-based ones in relation to the number of tools under each type: Perception and Abstract, Environment-Based, and Function. The other critical theme is User, in which they are like in half of hard-copy tool, whereas it can be found in all of the web-based walkability measurement tools. To put it differently, during the transition from hard-copy to web-based walkability measurement tools, the theme User is the one that gains the most importance. The theme Policy is also an important theme which is covered in only one hard-copy tool, and it is totally disregarded in web-based tools.

CHAPTER 5

CONCLUSION

This chapter summarizes the general findings of the research, the contribution to the literature, and suggestions for the future works. It covers the general comments deduced from the study. The results that are given in this chapter take part in the first section of the chapter, analysis and discussion. While giving the overall consequences, it is divided into two as follows. Firstly, the results and general comments for each research question are given in detail. Secondly, more implications derived from the analysis are given. After discussion and general comments, the contribution of the thesis to the related literature is mentioned. In the last part of this chapter, the proposals for future work are listed.

5.1. Analysis and Discussion

In discussion and general comments, the comprehensive findings from the analysis of WMTs are given in two parts. The first part covers the summary of the research questions' answers to each research question. The first research question is "What is the underlying idea of each walkability measurement tool – understanding of walkability, expressions, aim and strategy, publications and other studies, scientific algorithms, data sources, evaluation criteria, scoring procedure, operating methods, final result presentation, user profile, and locations the tool is available?". The second research question is "What are the aspects generally covered in WMTs – physical, psychological, and socio-spatial? Are there any missing aspects in WMTs?". The first research question tries to bring the existing or covered aspects into light, whereas the second research question aims to reveal the missing sides. Following the first part, the second part covers the findings that are related to the comparative analysis with more detailed point of view.

Under the first part, which is the recapitulation of the research questions, to make it more readable and apparent; the findings that are directly related to each of two research questions are given separately. For carrying out a productive analysis, two separate charts are developed for each research question. The Comprehensive Data Chart (Table 3.1) is developed as a way of understanding the first research question to analyze the overall understanding about walkability of each tool. The Content Analysis Chart (Table 3.2 and Table 3.3) is created as a response to the second research question, which seeks to analyze the dominant or recessive criteria in each tool. Although the detailed analysis is made in Chapter 4 for each table separately, the recapitulation of the research questions is made to provide a more comprehensive understanding about walkability measurement tools.

As a reminder, the research questions with comments are as follows. The first research question seeks to understand the underlying idea of each walkability measurement tools with the focus on developers, aim and interest areas, target user profiles, the adaptations of the tool, the methodological details about data collection; in process and final scoring, the question types and the presence of guides in the tool. To follow the comprehensive comments about the general understanding of WMTs, it would be better to continue term by term in accordance with the same order of Comprehensive Data Chart.

The developer type of the tool has a direct impact upon the understanding of WMTs from the perspective of their aim, the content and their methodological process. The important difference between the web-based and the hard-copy tools is that there is a firm dominancy in web-based tools. However, the dominant developer type in hard-copy tools is individual researchers. Because that the main concern of the firms are more market, the web-based tools can be described as the tools that are developed with these considerations which also have impact upon the content and methodology of WMTs. The dominancy of individual researchers in hard-copy tools can be identified as the main concern of hard-copy tools are much more “real research oriented” to improve the level of walkability in the searched area. In short, the type of developer both in web-based tools and hard-copy tools may affect their understanding, interpretation and addressing the issue of walkability. As a sample, Walkability Asia can be given in which the focus of the content is shaped around the infrastructure related aspects of walking act.

When the interest area of the tool developers and the general aims of them are analyzed from their own discourses, it can be told that each developer develops the tool through their own lens. In other words, the content or criteria of the tool is shaped in accordance with the main interest area. It both limits the criteria within the boundaries of interest area and restricts getting walkability analysis or results from this perspective. To say it differently, the interest area of developer directly changes their walkability understanding. In addition to their main interest area, their general aim have the similar effect upon the tools general understanding of walkability in which both aims shape the tools' content, scoring process, target profile, and methodological process details accordingly. For example, because that Walk Score's aim is to provide data to real estates, they give a single numeric result at the end and as a methodological process, only statistical data is used rather than personal ideas.

The target user profile of the each tool is also effective when the tool is in its development process. Due to the reason that the user profile covers both the user profile typology and the geographic area for which area the tool is developed, these two parameters should be analyzed in detail. When the user profile is discussed, there is no such tool that is developed for a type of user like children, women, disabled and adults. However, there is a great difference in geographic target. The important thing which is valid for both web-based and hard-copy walkability measurement tools is that they are dominantly developed for developed countries like U.S. or U.K. but not for developing countries like African countries. If their aim is to develop the level of walkability of country by WMTs, they should change their target geographic area. However, if they keep their geographic target the same, it means that rather than making developments accordingly, their main aim is to obtain a result from the developed areas with a different aim in the background. When the technological and location-based adaptation of the tools is checked, it can be said that there is no dominancy of technological adaptations in hard-copy tools, which may be interpreted as one of the following: they want to keep their format same or they think that they cannot compete with the web-based tools. Whatever the reason is, it can be said that if the hard-copy tools do not make technological adaptations to themselves, they will be exposed to be replaced or totally eliminated by the web-based tools in the near future. As the last aspect of the target profile, geographic adaptation does not appear much in both web-based and hard-copy tools. In other words, they do not adapt their criteria from a place to another through which they keep their criteria global. This "globalness in criteria" gives the idea that they think that the act of walking is the same in each and every single place in the world; however it is actually an act that may change from a single geographic location to another depending on both the geographic properties and the social dynamics of the area.

Similar like the developers and the target profile of the tools, methodology of the tools also gives information about the understanding of WMTs. In the first stage of methodology, data collection has several different aspects to analyze how the developer comprehend the issue of walkability. When the data collection methods are analyzed, there is a great dominancy of numeric data usage in web-based tools, which can be interpreted as follows: that they mainly focus on the statistics rather than the idea of individuals like in Maponics. However, when the hard-copy tools are analyzed, there is a great dominancy of observation that can be commented from the point of view that their main concern is real life analysis of individuals rather than ready-made concrete data. More specifically, as data collection details, numeric data also tell many things about their understanding of walkability. According to the analysis, most of the web-based tools use numeric data in their process whereas there is a balance in hard-copy tools in which the tools that use numeric data and the tools that do not numeric data are the same. The usage of numeric data can be a result of their point of view about the issue of walkability that focuses on the physical aspects of walkability and urban areas which can be digitized; in the meantime the personal ideas cannot be digitized. The number of team members also has an impact upon the understanding of walkability, which is also discussed in the following part of the conclusion as a separate issue. It can be seen that most of the tools are conducted individually rather than being a group of two or more. Whereas this individuality in web-based tools can be as a result of the usage of technological devices, there is no valid and logical reason behind this dominancy. The auditor privacy is also important for the tools to understand whether the developers see the auditors as anonymous individuals or not. If the tools keep the auditors anonymous, it can be interpreted as that they are seen only as data sources disregarding their personal information details. Another issue about auditor privacy is the questions asked to the users openly or without their awareness. Whether openly or not, if information other than walkability is collected, it means that the tools' main concern is not walkability but collecting personal data from each auditor. This issue is also discussed as a separate topic in the following.

The maps used in each tool are also a clue as to how the tool analyzed the issue of walkability. Whether the map is online or not, it is directly opposite to the liberatory aspect of walking with their limits or geographic boundaries. If the tool uses online-maps, it means that they try to keep their data up-to-date to obtain current walkability analysis at the end. In other words, they try to keep their walkability analysis current. However, if there is usage of printout maps, it can be interpreted that the maps are only used as base, but the real environment is much more important in walkability.

As the second part of methodology, in-process properties (criteria weighting, engines and algorithms being used and in-process scoring methods) also gives information about how the developers define walkability. The first parameter of the in-process property is weighting the criteria. There is an equal balance in-between the tools that weights each criteria same or differently. This can be interpreted as the tools which see each criterion has the same importance as others and vice versa. In other words, the tools that think some criteria are more important in the assessment in walkability are numerically same with the tools which think that all criteria have same importance in the assessment process. When the engines and algorithms being used in the process are evaluated, there is a great dominancy of usage in web-based tools, whereas most of the hard-copy tools do not use these specific methods during the process. It can be interpreted that web-based tools are more concerned with the data processing rather than the final analysis result. Also, they think that walking is an act that can be quantifiable with specific calculation methods. However, the hard-copy tools can be defined as more research oriented than the final analysis through not quantifying walkability. As the last aspect of in-process evaluation and assessment, the scoring methods also tells much about the understanding of WMTs. When both web-based tools and hard-copy tools are analyzed, it can be seen that likert scale is the method that is used most. Also, checking method has the same importance as likert scale only in hard-copy tools. Likert scale is a method in which auditors are asked to answer question by assigning same value from the given scale. In checking, the auditor is asked to choose all the appropriate answers from the listed given ones. In both methods, it can be commented that the great dominancy of the tools comprehend walkability analysis as giving the possible answers to the auditors and asking them to evaluate the given ones either by assigning scores or making selection. In other words, for the tools, walkability should be analyzed not wondering about the personal ideas or comments of the auditors, but it should be a process that the auditors should choose from the given options “as a must”. Also, both likert scale and checking are the methods that are most easily quantifiable at the end or which can be turned into numeric results at the end. When these scoring methods are analyzed from different perspective, using objective or subjective criteria more, the methods both used by the web-based and hard-copy tools are the ones that gives the objective options to be evaluated by the auditors. So, web-based tools can be expressed as the ones which quantifies walkability by using specific algorithms and likert scale, whereas the hard-copy tools are caught in the middle through not using specific calculation methods that much, but using scoring methods that can be most quantifiable at the end. In short, it can be said that web-based tools think that walkability is an issue that can be quantifiable in its all aspects during the process, but hard-copy tools do not disagree them totally. The thing that they all have in common is that walkability is much more related with the physical aspects through assessing them via objective answer options.

The last dimension of the methodology is the evaluation step. The first aspect that tells about the understanding of WMTs is the words that make reference to the quantification – definitions of scoring. Both in web-based and hard-copy tools, there is a great dominancy of using different terms and words about numeric assessment of walkability used in the tools and by the developers. The words that are used in two different mediums can be interferred that their main aim is to measure walkability. With these words, they actually state that their main aim is to quantify walkability at the end which is supported by the other quantification attempts in methodological process. When the final scoring methods are analyzed, as with in-process scoring, the likert scale and ranking are outnumbered by web-based tools and there is dominancy of ranking in hard-copy tools. Since final scoring is much more related to the final result obtain at the end, it tells more than the in-process evaluation. Like likert scale, ranging procedure is a method in which auditors assign some weights to the given options. The extraction made from the final scoring can be that both types of tools' aim is to obtain a numeric result at the end rather than the opinions of the auditors. In other words, the greatest aim is to quantify the issue of walkability rather than obtaining comments at the end. In addition to the dominant ones, it can also be questioned why comments are the least in number method of final scoring at the end. In addition to obtaining a single numeric result at the end, there is also a method in which some tools range these final scores. There is a great dominancy of setting a range for the final scores like Walk Score, whereas hard-copy tools do not use ranging the final output. The ranging can be interpreted as also ranging the urban into different parts through the walkability results. In short, it can be commented that the web-based tools' attempt is to classify the neighborhoods according to the walkability results, which make the walkability analysis a method that assigns value to urban areas. From the perspective of the understanding of walkability, the web-based tools can be clustered that walkability analysis is not a final result but a tool to cluster the neighborhoods; however, for hard-copy tools, the real aim is to analyze walkability. As a different way to interpret the final score, there is a visualization in some tools. In web-based ones, there is an equal balance between the tools that use visualization and not, like Walkshed and Maponics. When hard-copy tools are analyzed, there is no information about the usage of visualization as a final scoring representation technique. Based on this, when the visualization in web-based tools are analyzed, this technique can be interpreted as an attempt to minimize the visible effect of quantification and put it in a more 'colored-way'. It can be a more readable way for the auditors. But when the all tools are analyzed, it can be seen that there is no dominancy of visualization. In other words, there is not much concern to certain quantification but the usage of quantification is still a more common way.

The question formations are also directly related to the understanding of WMTs. The greatest percentage for both web-based and hard-copy tools are taken by the ones that only use close-ended questions. It is followed by the tools that use both open-ended and close-ended questions together. It can be commented that the ones that only use close-ended questions like Maponics interpret the issue of walkability as a theme that can be quantifiable with the answers. However, the ones that uses both close-ended and open-ended questions together like Rate My Street can be classified as the ones that try to make the most comprehensive analysis via using numeric data and opinions together. Another thing to be questioned is why none of the tools only use open-ended, which can be more related to the liberatory dimension of walking act.

The last aspect that gives information about the general walkability understanding of tools is the existence of guides as supplementary documents of the tool – *scoring guide or user guide*. When the tools are analyzed, there is no usage of guides in most of the tools. Although these guides can give information to the auditors, they may also direct them according to the way that the tool wants and may standardize people. Relating to the understanding of walkability, it can be interpreted that the tools generally do not want to openly guide and direct auditors, but they make guiding with 'invisible methods' like question formations or scoring procedures.

The second research question aims to criticize the aspects of walkability covered in walkability measurement tool (WMTs). To understand the aspects of walkability and act of walking, it is proper to first analyze the dimensions of the walking act. Then, the

Content Analysis Chart is discussed from the dimensions of walking to see which aspects are covered and missing.

As cited by Richardson, Faulkner, McDevitt, Skrinar, Hutchinson, and Piette (2005), walking is one of the basic act conducted by human and also it is one of the easiest, safest, and cheapest mode of activity. It can be practiced like anywhere and by anyone so that it can be easily included in everyday routines (Richardson, Faulkner, McDevitt, Skrinar, Hutchinson, and Piette, 2005; Department of Health, 2011). As well as being simple activity, it also celebrates the heritage of human evolutionary, and it is both a biomechanical and aesthetic victory as well as being a form of political expression. Moreover, it amplifies the understanding of humanity and is a way of admiration of the natural and built worlds, which also complies with the spirituality of humans (Manning, 2012).

Walking, with its multi-dimensions, has several different benefits like physical, psychological, and social. There are increasing evidence showing that walking improves both physical health and psychological wellbeing (McDevitt, Wilbur, Kogan, Briler, 2005; Richardson, Faulkner, McDevitt, Skrinar, Hutchinson, and Piette, 2005; Dawson, Boller, Foster, and Hillsdon, 2006; Mind: For Better Mental Health, 2007; Roe and Aspinall, 2011).There are also some other studies on the effect and benefits of walking as follows: the positive impacts of walking on both physical and mental well-being (Darker, Larkin, and French, 2007; Hanson and Jones, 2015; Morgan, Tobar, and Snyder, 2010; Song, Ikei, Takagaki, and Miyazaki, 2015; Wolf and Wohlfart, 2014). Moreover, there are other studies that proves that there is a direct link in between walking and individual well-being (Doughty, 2013; Ettema and Smajic, 2015; Gatrell, 2013; Marselle, Irvine, and Warber, 2013; Middleton, 2010; Ziegler and Schwanen, 2011). It is found by the evaluation of the WHI (Walking the Way to Heath Initiative) scheme that walking makes people feel better, more alive and more socially connected (Wensley and Slade, 2012). As walking is also a community-based activity, it also develops social networks and social support between people (Reger-Nash, Bauman, Cooper, Chey, and Simon, 2006). More generally, urban walking has several benefits like consuming less energy, taking up less space than transportation, a healthy activity and helps to sustain social links (Thomas, 2009). As the primary practice, walking also helps to retrieve the sense of self and to counter materialism back (Veith, 2012). As being an act with multiple dimensions, walking was conducted by important historical figures – Nietzsche, Rimbaud, Rousseau, Thoreau, Nerval, Kant, and Gandhi, who were actually ambitious walkers who cogently advocated for the benefits of walking (Sioli, 2015).

In addition to being a mode of transportation, walking is also a way of experiencing place and the urban environment (Wunderlich, N.D.). As being an everyday practice in our everyday lives, walking has four significant sides as follows: it is an experience with individual qualities, it is one of the most important mode towards experiencing the urban area that provide a sense of place, it is an aesthetic and 'critical spatial practice' in which a double sided relationship between humans and urban place and meaning is obtained (Careri, 2002; Rendell, 2006), and it is an experience of temporal and rhythmic properties with several different practices and events (Wunderlich, N.D.). In addition to experiencing the urban space, it also connects individuals to their living environment. As cited by Rybraten, Skar, and Nordh (2019), through their feet, people can move in the world rather than on the world. Also while walking, "landscapes are woven into life, and lives are woven into the landscape, in a process continuous and never-ending". In other words, with their bodies, minds, backgrounds, and experiences, people can actively take part in the world (Ingold, 2011, p. 47.). More than the experiential aspect of walking, it also makes people more liberated. As cited by Sioli (2015): "You are doing nothing when you walk, nothing but walking. But having nothing to do but walk makes it possible to recover the pure sensation of being, to rediscover the simple joy of existing, the joy that permeates the whole of childhood." Also, it is a way of providing individual freedom: "Walking means resigning yourself to being an ambulant, forward-leaning body.". While some of these chapters deal with short urban strolls, the majority focus on long walks in nature, which may last for hours or even days. Under these circumstances walking "means living a life scoured bare (social varnish burned off), unburdened, divested of social skills, purged of futility and masks". Walking is understood as a means of personal freedom that leads to states of joy, happiness, or serenity (Sioli, 2015).

Like other things, walking is also effected by both external and internal factors. In other words, the act of walking is shaped by the physical and social environment including social norms (the standards of behavior that are considered acceptable or appealing in a group or society), social networks (people around us), family bounds, and our communities and neighborhoods that we live in (Hunter, Ball, and Sarmiento, 2018). It is also affected from some internal variables like personal motivations and individual needs (Köseoğlu, 2016). Although walking has several different aspects and is affected from different variables, it is mentioned that geographers and town planners generally restrict themselves to assess walking as only affected by the built environment (Thomas, 2009).

Although walking is affected from the internal individual parameters, some academicians suggest evaluating the act of walking as group. For Gilbert (1990), walking together helps to compose the plural object of a common aim. In other words, when walking as a group, they have a "joint", "collective", or "shared" goal when they are the plural subject of an aim. This plural subject – being a group – is the concept of the human social and everyday life.

For developing a better understanding the content of the tools from a general point of view, it is better to refer to the quantitative and qualitative results of the Content Analysis Chart.

At the composition stage of the Content Analysis Chart, the all criteria of each tool are listed and both sub-titles, titles, and themes are constituted accordingly. The themes that can be listed under physical dimensions of walking can be as follows: Physical – Function – Network – User –Policy.

The themes that can be listed under perceptual dimensions of walking can be as follows: Perception and Abstract – Environment-Based.

The first thing that draws attention is that all the themes either reply to the physical or perceptual aspects of walking. There are no themes that match with the social or socio-spatial dimensions of walking and walkability. Although walking also has social dimensions, it should also be covered in the tools while analyzing walkability. The reason behind not including social aspects of walking in the walkability measurement tools can be that they can be harder to measure and conduct analysis on. From other point of view, it may tell some important things about the walkability measurement tools' aims that their main target is to measure either physical or perceptual dimensions of walkability.

Both for web-based and hard-copy tools, the great dominancy is in physical aspects of walking with the theme "Physical". The web-based tools' other dominant themes are "Perception and Abstract" and "Environment-Based" with order that shows that web-based tools try to balance both physical and perceptual aspects together, while totally disregarding the social dimensions. When the hard-copy tools' other dominant themes are analyzed, the second place is taken by "Network" and the third place is taken by "Environment-Based". Although hard-copy tools also try to scrutinize both physical and perceptual aspects, the majority is in the physical themes. Contrarily, in web-based tools, the majority is in perceptual aspects. Even though the distribution of physical and perceptual aspects are not equal, the one thing that is common is that there are no social and socio-spatial aspects covered in the tools.

Under part two, the detailed implications, findings, and interferences from the analysis are given. There are several different details that are deduced from the analysis charts and the overall research as follows. The first detail is analysis scale of WMTs. The second deduction is the process covered by each tool after data collection completed. The third point that is deduced is whether the tools are objective or subjective in data collection and scoring process. The fourth subject that is covered is whether the tools are qualitative or quantitative in their criteria, question types, and formations, data collection procedures, and scoring. The fifth thing to be analyzed is the general analysis issue of the tools – the main focus of each tool. The sixth detail is the issue of "privacy" in both data collection (for users of the tool) and after the data collection process. The seventh deduction is whether the tool measures the "real" walking or the final result obtained at the end is only the "measured" aspects of walking activity. The eighth point is in process details of the tools - the time spent, the supplementary equipment required in the process, the technological devices needed. The ninth subject that is analyzed is being a "flaneur" vs. walkability measurement tools. The tenth deduction is either there is a class-difference between the web-based and the hard-copy tools. The eleventh item that is deduced is "quantification" in walkability measurement tools. The twelfth detail covered is why most of the tools are conducted individually but not as teams. The thirteenth and the last topic is why only Global Walkability Index (GWI) contains "policy" as its criteria.

5.1.1. Research Details of WMTs

As research and analysis details of walkability measurement tools, three issues are covered. The first issue is the analysis scale of walkability measurement tools with making reference to the existing scale clustering in the literature as micro and macro. The second issue to be analyzed is the research methods of each WMT. As research methods, the qualitativeness or the quantitativeness characteristics of each walkability measurement tool are discussed based on their question types, scoring methods and so on. As the latest and the third, general analysis focus and interest area of each WMT are discussed from a point of view that how the main interest area of each developer shapes each WMTs content accordingly.

5.1.1.1. Scale: Micro and Macro in WMTs

Although there is difference in terms of scale in urban design as macro and micro, there is no scaling difference in walkability measurement tools on the size of specific research.

The scaling used in urban is either macro scale or micro scale. Macro scale is basically the region or neighborhood level in which it mostly deals with urban forms and variables like density, and street network patterns (Neto, 2015). These properties are the characteristics of urban areas that are actually hard to change. Micro scale is much more related to street level which are easier to handle and control (Neto, 2015). Although most of the papers and research classify urban and built environment into two as macro and micro, there are also some papers that divide built environment into three dimensions: land development patterns (*which can be interpreted as macro scale*), microscale urban design, and transportation systems (Weiss, Maantay, and Fahs, 2010). In this reference, microscale refers to the organization and order of the city and its micro elements like sidewalks, crosswalks, and streetlights. (Weiss, Maantay, and Fahs, 2010). Also, there is a research study that list the details of macro scale characteristics for a better understanding in Figure 5.1 (Pentella, 2009). There are a list of papers which focus on the techniques of different scales in urban areas from neighborhood to street (Moura, Cambra, and Gonçalves, 2017).

Scale of analysis is one of the issues that is not addressed in walkability measurement studies. In addition to scaling, dispersion of concept and methodologies, urban context and origin of studies, multiplicity of indicators being used in the evaluation process, and the validation of the model are other issues that are not discussed in walkability (Moura, Cambra, and Gonçalves, 2017). Whereas the issue of scaling still remains unaddressed, most of the literature about walkability research uses macro scale indicators and criteria like density, connectivity, and mixed-land use. When the focus is

Environmental attributes	Implied relationship with walkability
Residential density	• High-density neighborhoods encourages mixed-use development (improves accessibility to variety of interests and increases utility) • Associated with increase in retail/services variety (results in shorter, more walkable distances between interests)
Street connectivity	• High intersection densities provide more potential routes for walking and greater accessibility • Greater neighborhood connectivity, shorter distances to destinations
Public transit density	• High public transit density provides shorter, more walkable distances to alternate modes of transportation (buses, etc) • Use of more accessible bus stops encourages walking between leisure, work, and home
Crime density	• High-density crime discourages walking in neighborhood • Sense of lack of pedestrian safety encourages more protected automobile use and alternate transportation methods
Land use mix	• Multiple and diverse retail/services opportunities encourage more specialized, frequent, and shorter shopping trips by foot • More land use mix means more varied and interesting built environment, creating neighborhoods conducive to walking

Figure 5.1. Elements of Neighborhood-Scale Environmental Characteristics Relationships to Walkability (Source: Pentella, 2009)

in macro scale, the micro scale which covers the street level characteristics and details are somehow ignored (Neto, 2015). Focusing on the macro scale features, concentrating on the micro scales while analyzing walkability, and using smaller scale while measuring it has two benefits (Park, 2008). The first benefit is that it enables researchers to analyze more individual characteristics of the walking environment. In other words, researchers can assess the specific trip of an individual in a definite street level rather than conducting analysis on a bigger environment – neighborhood. The second benefit is micro scale aspects that are easier to be improved in urban areas. It is beneficial to focus and work on a smaller scale to make necessary improvements in street design.

In the table below, scale of each WMT can be found, which is conducted with reference to their scope, criteria, and discourse. While proposing the below table, two scaling types in urban environment is used as a reference (Table 5.1).

The scale that is used in walkability measurement tools also gives an idea about the details in their scope. In other words, it can be understood whether the tool does a detailed analysis or conducting a more superficial research. When the below table is analyzed, in web-based tools, the most used scale is macro scale, which can be interpreted that web-based tools aim to conduct a less detailed analysis. Put differently, web-based tools can be described as the tool type which focus on the neighborhood and tackles the issue of walkability with broad brush strokes. In hard-copy tools, the numeric distribution of findings of the thesis between the tools which are either using macro scale or using both macro-scale and micro-scale together is the same. The common point between the web-based and the hard-copy tools is that there are only few tools that only use micro-scale for analysis. When all tools are taken as a whole, again the greatest percentage is taken by macro-scale analysis which means that walkability measurement tools do not make a smaller scale analysis – micro-scale but they are mostly concerned with the general characteristics of walkability.

Table 5.1. Analysis Scale of Walkability Measurement Tools (WMTs)

TOOL TYPE	#	TOOL NAME	ANALYSIS SCALE
WEB-BASED	1	MAPONICS	MACRO-SCALE
	2	RATE MY STREET	MICRO-SCALE
	3	WALK SCORE	MACRO-SCALE
	4	WALKABILITY ASIA	MICRO-SCALE & MACRO-SCALE
	5	WALKONOMICS	MICRO-SCALE
	6	WALKSHED	MACRO-SCALE
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	MICRO-SCALE & MACRO-SCALE
	2	GLOBAL WALKABILITY INDEX	MACRO-SCALE
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	MICRO-SCALE & MACRO-SCALE
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	MICRO-SCALE & MACRO-SCALE
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	MICRO-SCALE & MACRO-SCALE
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	MACRO-SCALE
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	MICRO-SCALE
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	MACRO-SCALE
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	MACRO-SCALE
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	MACRO-SCALE
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	MICRO-SCALE & MACRO-SCALE
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	MICRO-SCALE

5.1.1.2. Qualitativeness vs. Quantitativeness of WMTs

Being qualitative or quantitative while analyzing walkability is important for the understanding of walkability and to understand at which side the tool stands. Before describing which tool is more qualitative or quantitative in their walkability understanding, it is better to define the properties and difference between them.

Firstly, qualitative research is a type of research in which data is not in numeric form (McLeod, 2017). By its own nature, its focus is multi-methods but it has an interpretive and naturalistic approach in topic (McLeod, 2017). The main aim of qualitative research is to analyze the social reality of either individual subjects or groups and cultures. It is a research types that searches to answer the questions "how" and "why" in a defined context (McLeod, 2017). With more detailed point of view, it tries to read between the lines of causes, ideas, and motivations (De Franzo, 2011). The methods used in qualitative research can be several as follows in which all try to develop a better understanding in a specific context: diary accounts, open-ended questionnaires, documents, participant observation, and ethnography. (McLeod, 2017). In data analysis part which is held after data collection, content analysis, grounded theory (McLeod, 2017), thematic analysis (McLeod, 2017), discourse analysis, and some other methods can be used which are all explicative and creative (McLeod, 2017). Like other methods, qualitative method has both some limitations and strengths as follows (McLeod, 2017).

The first strength of qualitative research is that because that researcher get inside the issue or topic, he gains a detailed insider view about the issue and it allows the researcher to be informed about the issues that are not mostly covered. The second benefit is that it puts forward probable causal relations and effects. The third benefit is acting as a mirror and reflection of social life, it shows discrepancies in data. The fourth and last benefit of qualitative research is that researcher can be given a new point of view due to the reason that qualitative research uses a narrative style for analyzing different types of data.

The first limitation of qualitative research is when both time and cost are thought as limitations, it is hard to work with large data sets. The second limitation is because qualitative research is subjective in its very nature and the context are generally not multiple but single, one of the major criticisms is the problem of validity and reliability.

The third and the last limitation is that for data collection, analysis, and commenting, a long time is required.

Secondly, quantitative research is a method which aims to set general rules and regulations about an issue that can be held in different settings or mediums. Mostly, research is mainly used either to validate or reject a theory (McLeod, 2017). It also quantifies a research problem via composing digitized data that can be turned into statistics at the end. The results from quantitative data can also be used as generalization (De Franzo, 2011). As methods, there are several different methods for data collection as experiments, controlled observation, questionnaires with a rating scale, or closed questions (McLeod, 2017). While analyzing the collected data, inferential statistics or descriptive statistics let researcher to turn that quantitative data into a final comment which mainly covers the significant difference between different groups (McLeod, 2017).

Like qualitative method, quantitative method also has some strengths and limitations as its main characteristics as listed below (McLeod, 2017).

The first strength of quantitative research is that due to having reference to statistics and it can be analyzed via statistical analysis which are actually based on mathematical principles, it is described as objective and rational (Carr, 1994). This objectivity makes quantitative data appropriate for testing and validating. The second strength is that it can be rapidly analyzed by using sophisticated software, which is especially used in large volumes of data. The third and the last strength is the base on measured data and can be checked by others via re-application, the data obtained at the end is less open to critiques and hypothesis can also be retested for its validity which shows the re-applicable characteristic of quantitative data.

The first limitation of quantitative research is that mostly, quantitative research is not conducted in natural settings and also, the research participants can not define their preferences (Carr, 1994). The second limitation is that for making statistical analysis, it requires comprehensive knowledge about the issue. In other words, the researcher should be an expert about the research topic. The third limitation of making quantitative research is that for providing a detailed, comprehensive, and accurate analysis, it requires large and more samples, which also increases the validity and generalization quality of the findings. The fourth and the last limitation of quantitative research is because that its first aim is to test the validity of a theory and hypothesis, it sometimes miss to generate a new hypothesis.

TABLE 1

Comparison and critical evaluation of three international pedestrian environment assessment tools for application in South Africa

	SPACES, Australia[15,18]	SWAT, Scotland[16]	PEQI, USA[17]
Purpose	Improve the environment for cycling and walking, for recreational, health and transport purposes	Encourage people to walk more so more people meet the Scottish exercise guidelines	Assess pedestrian environment, to inform better planning for pedestrian safety and recreational purposes
Tool administration	Segments of road were rated Inter-rater and intra-rater reliability considered	Sides of street assessed separately Inter-rater and intra-rater reliability considered	Site selected and administered
Qualitative/Quantitative	Quantitative with qualitative aspects such as rating a segment in terms of difficulty for walking	Qualitative with some quantitative, e.g. fieldworkers rate their perception of some variables	Quantitative
Intersection safety factors	Types of crossings, crossing aids	Type of pedestrian crossings, crossing aids, pedestrian signage	Crosswalks, ladder crosswalks, countdown signals, signal at intersection, crossing speed, crosswalk scramble, no turn on red, traffic calming features, signs for pedestrians
Traffic element factors	Number of lanes, traffic-control devices	On-road cycle lane, number of car lanes, traffic control devices, intersection density	Number of vehicle lanes, two-way traffic, vehicle speed, traffic volume, traffic calming features
Street design factors	Path*, type of path, path location, path slope, path material, path condition and smoothness, permanent path obstructions, on-road cycle lane, curb type, driveway cuts, garden maintenance, verge maintenance, number of verge trees, average height of trees, bike-parking facilities, number of car-parking facilities, vehicle-parking restriction signs, street lighting, path lighting, condition of road, other routes available, destinations present in segment, difficulty of segment for walking or cycling, continuity of path, neighbourhood legibility (ease of navigation)	Path* location, type of path, path material, path width, path slope, path condition, path obstructions, dropped curb, raised curb, driveway cuts, presence of trees, tree height, presence of hedges, hedge height, types of public transport facilities, on- and off-street parking, street lighting, bike-parking facilities, road slope if no path, road condition if no path, directness of path, other access points	Width of sidewalk, sidewalk impediments, large sidewalk obstructions, presence of curb, driveway cuts, trees, planters/gardens, public seating, presence of buffer
Perceived safety factors	Surveillance, cleanliness, attractiveness of segment, types of views, building similarity	Surveillance, graffiti and vandalism, litter, derelict land, feelings of safety, garden and verge maintenance, dog fouling, overall attractiveness, air pollution, noise pollution, building attractiveness, type of views, building similarity	Graffiti, litter, lighting, construction sites, abandoned buildings
Land use factors	Type of building features, prominent building features (includes public transport infrastructure), predominant building features same on both sides	Residential density, types of commercial destinations, types of public or government services, types of recreation facilities, access to services, types of residential buildings	Public art or historic sites, restaurant and retail use
Key important factors identified	Appropriate walking surface, presence of destinations	Public transport, services, parks, personal safety, traffic safety, streetscape and views	No applied evidence available
Limitations	Limited variation among factors evaluated because of poor variability in study sites Difficulty in defining what constitutes a neighbourhood Quantitative study design limited results for more subjective factors such as safety and aesthetics	Lack of variability in results because of limited study area Recreation (health) focus	No applied evidence available Relatively narrow scope

*Note: path refers to sidewalk, pavement or pathway.
SPACES, Systematic Pedestrian and Cycling Environmental Scan; SWAT, Scottish Walkability Assessment Tool; PEQI, Pedestrian Environmental Quality Index.

Figure 5.2. Comparison and Critical Evaluation of Three International Pedestrian Environment Assessment Tools for Application in South Africa (Source: Albers, Wright, and Olwoch, 2010, p. 3)

For describing whether the tools are qualitative or quantitative in terms of understanding of walkability, their criteria, form and type of questions, data sources, and scoring can be interpreted. There is an existing table developed by Albers, Wright and Olwoch (2010, p.3) that gives information about SPACES, SWAF and PEQI tools' qualitativeness and quantitativeness characteristics (Figure 5.2). After the overall interpretation, the Table 5.2 is composed for all tools. Tools which are quantitative may use criteria which is more related to physical aspects with close-ended question types, statistical and numeric data as data sources, and more digitized scoring methods. Contrarily, the tools that are qualitative use more opinion-related criteria in their scope with open ended question forms, comments as data sources, and reviews as final scoring.

From Table 5.2, it can be easily seen that all tools either make quantitative analysis or combine quantitative and qualitative analysis, which is defined as both. The first thing that should be questioned is why there is no tool that only makes qualitative analysis. In other words, the reason behind might be that a comment or interpretation cannot be made or cannot be enough for improving urban areas accordingly. The second comment to this table is that tools that combine quantitative and qualitative both in the process and final scoring can make a more comprehensive analysis by both collecting numerical and comment-like answers. In the tools which only use quantitative analysis can also be reviewed that these tools may create a more mechanic understanding of walking or walkability from respondents' point of view.

Table 5.2. Qualitativeness / Quantitativeness of Walkability Measurement Tools (WMTs)

TOOL TYPE	#	TOOL NAME	QUALITATIVE / QUANTITATIVE	
			PROCESS	FINAL
WEB-BASED	1	MAPONICS	QUANTITATIVE	QUANTITATIVE
	2	RATE MY STREET	BOTH	BOTH
	3	WALK SCORE	QUANTITATIVE	QUANTITATIVE
	4	WALKABILITY ASIA	QUANTITATIVE	QUANTITATIVE
	5	WALKONOMICS	QUANTITATIVE	BOTH
	6	WALKSHED	QUANTITATIVE	QUANTITATIVE
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	QUANTITATIVE	-
	2	GLOBAL WALKABILITY INDEX	QUANTITATIVE	-
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	QUANTITATIVE	-
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	QUANTITATIVE	-
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	QUANTITATIVE	-
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	QUANTITATIVE	QUANTITATIVE
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	QUANTITATIVE	QUANTITATIVE
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	QUANTITATIVE	-
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	QUANTITATIVE	-
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	-	-
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	QUANTITATIVE	-
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	QUANTITATIVE	-

5.1.1.3. Focus of the General Analysis

In walkability measurement tools, there is an issue in which if the developer is a specialist. Either with awareness or not, this issue they specialize in have impact upon the scope of the tool like their general understanding of point of view, criteria they set, the aspect to be searched, target profile, the target geographic location of the tool, and other methodological details. In Comprehensive Data Chart (Table 3.1) under Aim and Interest - Interest Area, each interest area can be seen.

These traces of the main interest area may not always be seen directly in the tool but walkability measurement tools are always designed and shaped accordingly. In other words, the developers constitute their tools by creating a focus on their main interest area which may cause the other aspect of walking to be disregarded. This focus and disregarded aspects of walking and walkability is also a reference to how each tool comprehensively understands walkability and at which side they stand in walking-related issues.

5.1.2. Details of Data Collection

Under the data collection details of walkability measurement tools, both in-process and after data collection are covered. What is done after data collection completed by each WMT is discussed as the first notion. As second notion, the ways of data collection are covered as either objective or subjective by making reference to question formations and scoring methods of each WMT. Data processing details is the third notion to be discussed under data collection details that contains the equipments needed while collecting data, the time spent for auditing the tool and other operational details.

5.1.2.1. After the Data Collection Process

When the information about walkability measurement tools is analyzed, there is no such information about after the data collection period of the tools. In other words, there is no information about what the tools do with the analysis outcomes. None of the tools say what they do with the outputs, but some of them can be interpreted as more innocent, whereas others are not. By analyzing the question and criteria types, final scoring methods, and tool's own discourse, some comments can be made. In addition to the methodological details, the developer or aim of the tool can also give clue about the after data collection process.

It can also give an idea about the general understanding of WMTs, which is actually under the scope of the research question. With the outcomes of the tool, it can make the collected results as open-source data, use them to increase the awareness of society, enhance the urban areas or provide the final results to other services. About these details, the below interpretation or comments can be made.

What is done with the outcomes of the tool is as important as the process of the tool for understanding the main concern of developers or reason for developing the tool. With the outcomes of the tool, two main things can be done as following: the one can be only doing research and keeping to itself, whereas the other is serving others. With the collected data, either a database or a dataset can be composed. When it is analyzed, all main aim of web-based tools while doing research is to create a database that has the possibility to be served for others for several purposes. Because their main concern is economics in one hand, they also use their outcomes for financial reasons. For example, Walk Score shares their outcomes with real estate firms.

Different than web-based ones, the actual aim of hard-copy tools is conducting analysis in defined specific area and improving this area according to the obtained results. With hard-copy tools, related improvements can be made rather than databases, which means that the real consideration of hard-copy ones are assessing walkability, whereas web-based ones have also a dominant economic consideration in their background.

Related to their aims, the tools might be developed accordingly and might use quantification as a method also. Quantification might be one of the very parameters that have direct relation with the aim. In web-based ones in which their main concern is economic, their main aim can be to create a database. The collected data and created database can be served to other organizations with this economic concerns rather than data sharing. In other words, while their main aim seems to be doing walkability research analysis, the tools might make quantification for database composition and sharing this numeric data to other firms like real estate companies and urban designers. Hard-copy walkability measurement tools aim to analyze and research about walkability so that the quantification level might not be as much as web-based walkability measurement tools.

5.1.2.2. The Ways of Data Collection and Scoring

For better understanding their point of view, it is important to analyze whether the objective or subjective analysis is made through the tool in both their data collection process and scoring process. The easiest way to understand if objective or subjective analysis is the tools' criteria and questions. In addition to their criteria, data sources that they use also makes a reference to the issue.

To put it broadly, objective information can be described as facts, whereas subjective information can be thought as opinions (Buzzle Staff, 2018). Although they are totally different from each other, both subjective and objective data collection methods are two outstanding ways which depends on the type of data collected (Buzzle Staff, 2018).

To start with, objective data is the data type that is collected through and from facts and sources (Buzzle Staff, 2018). In other words, it can be described as the physical data that can be observed through the five senses (TestPrepNerds, N.D.). Different than subjective data, this data type does not depend on the individual. It reflects the truth without adding any personal ideas or opinions (Buzzle Staff, 2018). The aim of objective data is validating the assumptions and to collect confidential information which can be felt with five senses (Buzzle Staff, 2018).The sources of objective data can be a measurement, direct observation (TestPrepNerds, N.D.), or from other accurate multiple sources (Buzzle Staff, 2018). The main property of objective data is that it does not change from person to person and it does not depend on a situation (Buzzle Staff, 2018). Because it remains unchanged although many data sources are included, it can be described as true data (Buzzle Staff, 2018). In other words, there is no gray area because that it is obtained and observed via tests and exams (TestPrepNerds, N.D.). The examples of objective data findings can be listed as following: height, weight, temperature, and pressure (TestPrepNerds, N.D.).

Different than the objective data, subjective data is collected via individual and personal relations (Buzzle Staff, 2018). In other words, it comes from the perspective in which he expresses his own experiences (TestPrepNerds, N.D.). It aims to make an assumption about the possible facts, what might have happened (Buzzle Staff, 2018). Subjective data can be collected through judgement, suspicion or rumors (Buzzle Staff, 2018). By its own nature, subjective data depends on an individual that's why it can change from one to another, with each and every case and every time (Buzzle Staff, 2018). Unlike objective data, it cannot be accepted as truth or concrete fact (Buzzle Staff, 2018). Some examples which can be described as subjective data are as follows: pain, itching, easy, and hard (TestPrepNerds, N.D.).

To summarize, the below comparison can be made between objective and subjective data (Managing with Measures, N.D.). Firstly, objective data are collected via controlled experiments or polling, whereas subjective data contains individual opinions and experiences. Secondly, objective data is based on facts and numeric realities, whereas subjective data is more thought-based. Thirdly, objective data is a type of data that can be observed, but subjective data are 'subject' to comments. Lastly, the way of perceiving objective data is senses, whereas the source of subjective data are individuals.

The content of walkability measurement tools can be classified as either objective or subjective, depending on their analysis perspective. Through the questions or criteria they set or with the questions they form, they can do either subjective or objective analysis. In subjective analysis, the tool tries to obtain more personal data, which may change from one to another like perception and feelings. In objective analysis, the tool tries to collect more concrete data which does not change from one to another, like the dimensions of a pavement, materials used in the sidewalk surface, population density in neighborhood, speed limits, and crime level information.

Each analysis aspect is examine to see whether they do either subjective or objective analysis in Table 5.3 Most of the tools combine both subjective and objective methods. Also, there are plenty of tools that only conduct objective analysis, whereas subjective analysis is only conducted by plenty of web-based tools. It can be said that for a comprehensive analysis, generally both methods are used. The tools that only use objective analysis mainly focus on only physical data generally referring to statistical data. The reason behind why there is no tool that only makes subjective analysis is that it can be hard to create a database/dataset and make improvements in urban planning and design due to subjective answers. Also because subjective means changing from one to another, the data collected that way cannot be as dependable and trustworthy as much as in the objective one.

From their understanding, the tools that combine both subjective and objective analysis can be named as the ones that try to tackle walkability as holistic understanding, whereas the tools that use either objective or subjective analysis separately can be described as disregarding some aspects of walking while disregarding other dimensions. The tools which only uses objective analysis have a focus on physical aspects of walking, but the tools that only uses subjective analysis have a focus on more perceptual dimensions. For obtaining a comprehensive analysis via tools, it is better to combine them with a balanced distribution because that walking has both objective and subjective dimensions as complex activity.

Table 5.3. Objectiveness / Subjectiveness of Walkability Measurement Tools (WMTs)

TOOL TYPE	#	TOOL NAME	OBJECTIVE / SUBJECTIVE
WEB-BASED	1	MAPONICS	OBJECTIVE
	2	RATE MY STREET	SUBJECTIVE
	3	WALK SCORE	OBJECTIVE
	4	WALKABILITY ASIA	BOTH
	5	WALKONOMICS	SUBJECTIVE
	6	WALKSHED	OBJECTIVE
HARD-COPY	1	ACTIVE NEIGHBORHOOD CHECKLIST	OBJECTIVE
	2	GLOBAL WALKABILITY INDEX	BOTH
	3	IRVINE MINNESOTA INVENTORY TOOL (IMI)	BOTH
	4	NEIGHBORHOOD ENVIRONMENT WALKABILITY SCALE (NEWS)	BOTH
	5	PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)	BOTH
	6	PEDESTRIAN ENVIRONMENT REVIEW SYSTEM (PERS)	BOTH
	7	PEDESTRIAN ENVIRONMENTAL QUALITY INDEX (PEQI)	BOTH
	8	PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (PANES)	BOTH
	9	PIN3 NEIGHBORHOOD AUDIT TOOL	BOTH
	10	SCOTTISH WALKABILITY ASSESSMENT FORM (SWAF)	BOTH
	11	SYSTEMATIC PEDESTRIAN & CYCLING ENVIRONMENTAL SCAN (SPACES)	BOTH
	12	WALKING SUITABILITY ASSESSMENT FORM (WSAF)	BOTH

5.1.2.3. The Details of Data Processing

The methodological details of the walkability measurement tools are also important for their understanding of walkability. To put it differently, the supplementary items to be used for conducting the tool or application details can also give information about their walkability analysis point of view that makes reference to second research question.

The details of the tools can be interpreted as follows.

The duration of data collection: In today's world, people want to minimize time spent for each activity they recognize either as a must or a leisurely activity. Due to this reason, web-based tools can be better because that they are easier to apply, can be applied in a shorter time compared to hard-copy ones, and respondents' can conduct walkability analysis with web-based tools whenever they want, even at 2 a.m. at night. However, because hard-copy ones are generally conducted in real environments with observation, it takes longer time. In addition to this, in web-based ones, respondents evaluate walkability according to previous walking experiences or imagining from the mind that one is walking again; however, in most of the hard-copy tools, there is a real-life walking action simultaneously conducted with the tool.

Devices that are used to make analysis and collect data: While collecting data, only internet connection and electronic device (mobile phone, tablet and personal computer) can be enough for data collection; however, for doing analysis with hard-copy ones, there are generally some items needed like pen, pencil, camera, map, and equipment for weather conditions (sunglasses, suntan cream, umbrella, gloves, scarf). Because hard-copy tools require more equipment compared to web-based ones, and most people in the world have technological devices and internet access, web-based tools are preferable. As a sample in which MAPS, RALA, PIN 3 and PEDS are compared, the support materials required can be seen in detail (Figure 5.3).

Either technological devices are needed or not for data collection process:

Although most of the people have access to technological devices and internet, which make the usage of web-based walkability measurement tools easier, it might alienate the group who have not access to web-based ones.

AUDIT TOOL ELEMENTS	AUDIT TOOLS			
	MAPS-Mini	RALA	PIN3	PEDS
Training preparation	Extensive- Manual, Class/Field Training, Certificate, Photo examples[52,53]	Sufficient- Manual, Webinar training, Photo examples[7,54]	None- Only available for original research project[43,55]	Extensive- Manual, Class/Field Training, Certificate, Video practice, Photo examples[56-59]
Literacy level of scoring & instructions	8.4	*Segment* - 12.3 *Policy* - 12.4 *Townwide* – 13.8	12.3	10.2
Literacy level of audit tool	4.6	*Segment* – 15.3 *Policy* – 10.0 *Townwide* – 20.9	15.5	10.4
Languages	English	English	English	English, Spanish
Audit preparation	Create Map of segments targeted for audit	*Townwide* -Map town *Policy* - Contact people with policy knowledge (town board/school) *Segment* - Partner with informed member of community, Create Map of segments targeted for audit	Create Map of segments targeted for audit	Create Map of segments targeted for audit Walk segments once without marking on sheet
Labor assistance needed for audit?	Teammate to conduct audit with and to check answers against	*Townwide* - Contact town officials *Policy* - Need policy knowledge to answer questions *Segment* -Audit with informed community member to check answers against	Teammate to conduct audit with and to check answers against	Teammate to conduct audit with and to check answers against
Extra equipment or tools needed	None needed	None needed. Can use GPS for segment audit tool.	None needed. Can use handheld device	None needed. Adapted for use with GIS/GPS and personal digital assistants (PDAs)
Technical knowledge need	Ability to print aerial maps of area	Ability to print aerial maps of area	Ability to print aerial maps of area. Option to use handheld device.	Ability to print aerial maps of area. Option to use GIS/PDA

Figure 5.3. Support Materials Provided by and Capacity Needed for Audit Tool Process (Source: Stushek, 2017, p. 13-14)

(cont. on next page)

AUDIT TOOL ELEMENTS	AUDIT TOOLS			
	MAPS- Mini	RALA	PIN3	PEDS
Scoring procedure	Clear, numerical breakdown on audit worksheet, and further explanation in scoring guideline	*Segments* - not scored *Townwide and Policy* - numerical scoring in codebook, but not on the audit worksheet	Scores not explained. Checkboxes are used with no numerical value applied to them	No numerical scoring measures available, just questions answered
Reliability and validity of audit tool	Moderate to excellent inter-rater item reliability[47] Total microscale environment scores were significantly related to active transportation[48]	*Townwide and Policy* - evaluated for their feasibility and not reliability or validity *Segments* - found to have substantial agreement in inter-rater reliability[49] More research needed to test reliability for rural towns specifically	Two-week test-retest reliability had substantial to near perfect reliability in urban and rural segments for most categories of audit tool. "Decoration" had moderate reliability in urban segments, and lower reliability in rural segments.[43]	Has measures of reliability in rural areas,[50] Rated as reliable when assessing rater reliability[44]

Figure 5.3. (cont.).

5.1.3. Understanding of Walkability

Under the part of each WMTs walkability understanding, four details are discussed. First detail is the privacy issue in walkability measurement tools which covers both in-process and after data collection periods. The second detail is the contemplating of walkability that contains either WMTs can measure only measurable aspects of walking or they can measure walking with it's all aspects. As the third detail, the idea of free walker – *flaneur* – and WMT opposition is discussed. The forth detail to be discussed is the quantification approaches that are held in walkability measurement tools.

5.1.3.1. Privacy and Free Walker

The issue of privacy is one of the topics that is problematic in today's capitalist world including walkability measurement tools. One of the greatest examples of that data privacy can be given as Cambridge Analytics and Facebook. Rather than broadly call them privacy, it can be better called as information privacy. As Westin (1967) defined it as follows: Privacy is the proof that individuals, groups or institutions determine for themselves in which place, in which aspects and to what limits the information collected about them is given, communicated or shared with others (Mai, 2016).

There are four challenges in the concept of "information" (Mai, 2016). The first challenge is that the concept of information in information privacy is still not clear. The second weakness of information is that informational privacy's focus is much more about individual access, whereas the social scale is totally disregarded. The third limitation is it is only taken into consideration as the issue of individuals to protect themselves, but it is more than this. The fourth and the last challenge is the unclearness about the difference between what is private and what is public.

For preventing or decreasing these challenges in information privacy, some solutions are proposed. Some technical approaches include privacy warning, notification or warning system (Shilton, Burke, Estrin, Hansen, and Srivastava, 2008), some methods for the identification of privacy vulnerability in information systems (Shilton, Burke, Estrin, Hansen, and Srivastava, 2008), systems which let users to make preference about the data sharing (Shilton, Burke, Estrin, Hansen, and Srivastava, 2008), identity management systems (Shilton, Burke, Estrin, Hansen, and Srivastava, 2008) and selective retention systems (Shilton, Burke, Estrin, Hansen, and Srivastava, 2008). There are also many complex data protection methods such as encryption, privacy-enhancing technologies (PETs) and statistical data anonymization (Shilton, Burke, Estrin, Hansen, and Srivastava, 2008). In short, these data protection methods can be generalized into two approaches: restricted access (Mai, 2016) and the control theory (Mai, 2016). The most important method is restricted access, which is valid in today's social and digital world. Restricted access is a method in which a single individual can limit or set boundaries for others to reach information about himself or herself (Mai, 2016). In other words, an individual can define his or her private zone in which personal information is located (Mai, 2016). With the increasing number and new shift in mobile devices, these 'personal information sharing tools' offer a new dimension both in trust and information privacy challenges (Krontiris, Langheinrich, and Shilton, 2014).

Associated with mobile tools, data turned out into 'big data' actually for data providers or pioneers of social media or technology related improvements. Big data is defined as large and complex datasets that can only be processed by nonconventional software programs (Ahmed, Yaqoob, Hashem, Khan, Ahmed, Imran, and Vasilakos, 2017). In addition to the complexity characteristic, big data is also varied in terms of what it covers (Günther, Mehrizi, Huysman, and Feldberg, 2017). Rather than defining it with a sentence, starting from 2000s; it has been discussed with 5V rules (Gupta, Mateu, Degbelo, and Pebesma, 2018): volume (the size of the data), velocity (the kind of outcomes it can be developed from data sources), variety (the heterogeneity of data covered), veracity (the realness of data) and value (the quality of results and easiness level for public usage).

Big data is mainly used by organizations or institutions for developing innovative insights, products, or services (Günther, Mehrizi, Huysman, and Feldberg, 2017). There are several different types of big data (Oussous, Benjelloun, Lahcen, and Belfkih, 2018): smart grid case, e-health, internet of things (IoT), public utilities, transportation and logistics, and political services and government monitoring.

The importance of big data can be analyzed from the aspect that extensive data is produced each and every single day in many varied forms and from several different resources. In every sixty seconds, the following data is created: in Twitter, more than ninety eight thousand tweets are posted, six hundred ninety five thousand statuses are updated in Facebook, eleven million instant messages are sent, nearly six hundred thousand Google searches are made, more than one hundred sixty nine millions-mails are sent, greater than one thousand and eight hundred TB of digital data is created and two hundred seventeen mobile users just begin to use social media (Ragueseo, 2018).

This greatest data produced is actually a new opportunity for organizations. Through the adaptation of data technologies, organizations try to receive benefits in many different domains like e-commerce, e-government, science, health and security (Günther, Mehrizi, Huysman, and Feldberg, 2017). From the 5V rules, the greatest benefit that organizations gain is “Value” depending on their strategic goals for accepting and using big data (Günther, Mehrizi, Huysman, and Feldberg, 2017).

There are different numerous challenges of big data, which includes scalability, data availability, data integrity, data transformation, data quality, data provenance, management of huge data volumes, data heterogeneity, integration of data from several different sources, data matching, bias, availability of tools for conducting appropriate analysis in such data, the complexity level in process, privacy and legal issues, and data governance (Blazquez and Domenech, 2018). To put it more concisely, these challenges can be divided into two. The first challenge is how to collect, integrate, and keep this big data with more simple and less hardware and software equipment (Oussous, Benjelloun, Lahcen, and Belfkih, 2018). The second challenge is the efficient management of big data to provide a reliable point of view and optimize the expenses.

Big data is also commonly used in urban scale, especially in geographic tools that mainly work with geo-coded software. By using big data in online geographic tools, the health research in neighborhood scale became possible in which effects of neighborhood properties on health and individual well-being are studied. The big data usage in online geographic tools can be exemplified as: obtaining crime statistics from New York Times and EveryBlock, walkability scores from WalkScore.com, and location and ratings of restaurants from Yelp. As a new approach, Google Maps also started to work as geocoding service (Bader, Mooney, and Rundle, 2016). Also, another great source of big data is Google Street View in which street level images along the streets in the United States and other developed countries around the world are provided. It is all available through the internet access and via Google Earth software (Yin and Wang, 2016).

There are some ideas that big data can be beneficial to handle the city and urban related issues. As Zhen (2014) mentioned, this rich knowledge embedded in big data can be helpful to solve major issues if it is used properly (Petit, Stimson, Nino-Ruiz, Morandini, Widjaja, Delaney, Tomko, Sinnott, Randolph, and Kvan, 2014). He defines this as "urban computing":

> *... a process of acquisition, integration, and analysis of big and heterogeneous data generated by a diversity of sources in urban spaces, such as sensors, devices, vehicles, building, and human, to tackle the major issues that cities face" ... it ... "connects unobtrusive and ubiquitous sensing technologies, advanced data management and analytics models, and novel visualization methods, to create win-win-win solutions that improve urban environment, human life quality, and city operation systems.*

Like other big data, the geo-coded big data also has some problems and challenges. These negative issues emerged when the researchers or developers share individually identified information like their addresses to online service providers. If a researcher uses online geo-coding like converting the ones address to latitude and longitude or obtaining information about the ones neighborhood via his residential or work address, the developer gives this information to the superior service. Unfortunately, most web sites allow these geo-code providers to use such data freely rather than protecting personal data of individuals (Bader, Mooney, and Rundle, 2016).

As the increasing distribution and usage of social media and technology in our everyday routines and habits, privacy becomes a crucial issue to be discussed. Either with awareness or not, we sometimes share our personal information from social media accounts. In a similar manner, walkability measurement tools also collect data apart from walkability related questions with or without awareness of the ones who use the tool. If the auditor becomes aware that data is collected apart from walkability, he can make a selection – either continuing to use the tool or not. However, if the tool makes it without the awareness of the auditor; like collecting information about everyday routines, it is so problematic issue. Some tools also give ID for each auditor with the aim of keeping each auditor anonymous but it can also be interpreted as masking the data collected. More than the privacy-related challenges and problems during data collection, it is also important what is done with the outcomes of the tool at the end.

For understanding the detailed privacy view of the tools, the following can be discussed: seeing the comments or evaluations made by others – necessity of log-in or giving personal information for making comment and evaluation – not obtaining specific point data but giving more regional data – make the outcomes of the tool public or not – collecting data rather than walkability – with or without the permission of auditors.

Seeing other respondents' ratings and comments is one of the most important issues in walkability measurement tools which has a direct relation to privacy. From the literature analysis about walkability measurement tools, it can be easily seen that most of the tools do nott share their results with other respondents.

If the aim of these tools is to conduct research and researches can grow via getting feedback and with sharing, it is questionable why most of the tools do nott share their outputs. The reason behind that not-sharing can be due to two reasons: first, the tool developers can be afraid that some areas get low scores in walkability analysis or usage of abusive words in comments or second, the main aim can be to sell the outcomes to other organizations, regarding economic concerns.

While making comment or assessment, there are some tools that ask for log-in (only in web-based) or declaration of the respondent's name or city that is being evaluated. The necessity of log-in actually means from developer point of view is that "We do nott actually trust you and in case some bad situation happens, we are asking for an account we can validate or can contact.". However, looking from this perspective, the logged in account or given data can be fake. When it is analyzed from respondent's point of view, it is very understandable for them to criticize that why they have to share their personal information for making walkability assessment. This question marks in respondent's mind can decrease the number of assessments in web-based tools day by day.

Sharing of geographic information can be a requirement for doing analysis, but again respondents can give fake information again. This problem can be solved asking for the location while using the application either in mobile phones or personal computers. In one of the web-based walkability measurement tools, Maponics, the tool does not share for the specific point location due to respondents' privacy concerns, even though they are asking again like specific point for keeping themselves and creating a database but sharing it as more regional data. The reason behind this attitude can be interpreted as protecting respondents' individual information, but if it is really a well-intentioned approach, the tool should not ask for this information. Another proposal can be not even asking this information without the concern of creating a database at the end.

Some of the web-based tools also mention that for reaching the ratings and comments of walkability analysis, the only way is having a license through paying some money to the developer. More general, these type of tools say that if respondent wants to see the previous analysis, the one should pay money. It actually shows that the main concern is economic rather than data collection and doing walkability analysis. If their concern is protecting their collected data, other solutions can be proposed.

Another issue is utilizing the outcomes of the analysis, either keeping them or providing these to other services. If the data is kept by the developer and the area is developed according to the research results, it can be said that the tool achieves its objective. However, if the tool sells or provides the final results to other service or database, it is a thing that should be questioned from the point of view that the tool's main aim is not to do walkability analysis but it works like a subcontractor to provide data for others.

In web-based walkability measurement tools, some of them collect other data rather than walkability analysis regarding their everyday habits. There are privacy declaration either which emerges at the first time after downloading and activating the application or inside the application as embedded file for only as information, however, in both cases, respondents generally do no read the privacy policy and regulations. Also, in some of the web-based tools, there is no privacy document but they are collecting personal data with the asked questions in the content. Even if there is an approach for giving information, how ethical for walkability measurement tools to collect data about respondents' daily lives which are mainly developed for walkability analysis is a problematic issue.

This privacy issue actually gives general information about how the tools understand walkability. It can be said that if the tool is really private both in data collection and after data collection, the main aim can be said that the tool's main aim is assessing walkability so that the personal information of auditors is no important. From another perspective, if the tool does not attach importance to the issue of privacy, it can be said that the tool's aim is not really measuring walkability but collecting other information about everyday routines of auditors.

As being one of the most important concept which has its focus on the liberatory characteristic of walking, "flaneur" should be discussed from the perspective of walkability measurement tools. In more detail, it should be analyzed if the walkability measurement tools and flaneur concept are on the same sides or not for understanding walkability.

Flaneur is a concept that was originated in Paris in the early 19th century. During this time period, several arcades were built as enclosed spaces. The main idea behind this enclosed spaces was letting individuals to stroll, look, idle, and dawdle (Featherstone, 1998). It has also references to a new type of public character with the leisure to wander, watch, and browse (Wearing and Wearing, 1996). As an everyday activity, flaneur simply looks at urban spectacle, observes new inventions, and spends time in shopping or only window-shopping (Wearing and Wearing, 1996). His main is to search for the unfamiliar (Wearing and Wearing, 1996).

While going around, flaneur becomes a foreigner in urban areas (Featherstone, 1998). In other words, he tries to get lost in urban environment as stranger. As a liberatory act, on one side of the coin; flaneur is an idle person and on the other side; he is observer of urban everyday life (Wearing and Wearing, 1996). He tries to become lost in feelings and move according to his random desires without any target while walking (Wearing and Wearing, 1996).

However, this liberal movement and act of flaneur is re-evaluated in today's capitalist system that has turned into a tourist or a traveler with a backpack and started to explore the whole world rather than the arcades only. Today's flaneur is going around for telling whereas Walter Benjamin's flaneur walks only for going around. In more detail, flaneur of today's capitalist world seeks for the life, culture, and natural properties in where they go and aims to make information exchange (Featherstone, 1998).

Walter Benjamin sees photographers as the inheritor of flaneur. With internet and social media, YouTubers, vloggers, and bloggers can be described as the new inheritors of flaneur who both shoot photographs, save them, walk around, and share these photos via social media (Featherstone, 1998).

Although flaneur is a liberal act within its nature, walkability measurement tools limit this emancipation movement while making analysis from different aspects like the analysis area or region, or only focusing on some dimensions of walkability. The contradiction between the understanding of walkability for flaneur and walkability measurement tools is discussed as below.

As its libertarian characteristics, flaneur has no limits while walking. Flaneur is a concept that tries to free pedestrians and individuals in urban life. However, like in Walkshed, some tools use grid plan layout as base. In other words, this type of tools actually tries to set boundaries and limits for geographic areas or zones. If one walks outside the limits of the one specified area, this means he is out of space. In addition to this, these limits are also set by an individual, and the maps are also an abstraction and a type of visualization. However, flaneur is not such a thing to have zones, boundaries, or limits while walking. That's why Walkshed-like tools, which use a grid base for creating boundaries, are totally in contrast to understanding and general concept of flaneur.

As same theoretical framework with Walkshed's grid layout plan, Maponics also uses "intelligent polygons" to define some zones and geographic limits which are divided according to density of residential facilities in the area, number of facilities, school attendance zones, or number of streets in the area. This is also a type of limitation for the act of walking not physically, but as a base for walkability analysis. In addition to defining limits and boundaries, this approach is also an attempt to cluster neighborhood according to their characteristics. As being a flaneur, the exploration of urban life and neighborhoods, streets and city is one of the most important things. Through the limits set, like intelligent polygons, these types of tools directly go against liberal understanding of flaneur.

Again as contrast with the theoretical framework behind being a flaneur, some tools define the concept of walkability as the ability to walk to facilities within five minutes. Through these criteria, walkability is both described as walking with target and also in a limited time duration by the tools. However, it is questionable thing how these limitations, both having a target and having a limited time while walking, are related or similar with the flaneur concept. Referring to this information, it can be understood that walkability measurement tools analyze walkability as a planned act of walking, whereas flaneur is directly on the contrary. The first proposal that comes to mind is developing a tool that can also measure and analyze unplanned walking without any target and time limitation.

In addition to the geographical limitations defined by the tool and planned walking with a target and time limitation, some walkability measurement tools also define walkability as not having obstacles during the act of walking. In some tools it can be one of the criteria, where as some tools only define walkability according to obstacle-free walking. It can be the first criticism that walking in an obstacle-free environment is enough for walkability analysis. The tools that include obstacles into their criteria only consider physical and geographic obstacles rather than social obstructions. If the tools want to handle walkability with the same theoretical framework of flaneur, rather than physical obstacles, the social obstructions can be more meaningful that cause flaneur to change his path or experience. Through the social obstruction definition, the tools also come to consider the socio-spatial aspect of walkability analysis.

Because some tools measure walkability through having listed facilities and amenities within the searched area of neighborhood, it means that the ones who are walking only as flaneur or understanding the act of walking like flaneur cannot use walkability measurement tools. In other words, flaneur cannot analyze walkability. Also, the quantified approach used by walkability measurement tools is directly in contrast the general concept of flaneur.

As the general concept of flaneur, walking is not a type of transportation mode, but a leisurely activity like going around and being part of urban life. However, walkability measurement tools only include walking as a mode of transportation by totally eliminating leisurely walking. It can be concluded from the analysis of walkability measurement tools that walking can only be evaluated either a target or as mode of transportation.

5.1.3.2. Contemplating of Walking Activity

Although being the most basic act of humans or the basic mode of transport throughout history, walking has several different properties, types, and characteristics. In other words, whereas being a basic movement, it is complex in its features. Somehow, all humans can be described as pedestrians at least for a specific part of their lives either for transport, exercise, or just for fun (Lukenangula, 2017). This simplicity in its very nature, it allows humans to access everywhere via walking, even to places in which motor vehicles cannot access (Lukenangula, 2017).

Even though the act may seem the same from the outside, there are several different reasons for walking. For Lukenangula (2017), the reasons of walking can be listed as four: making short trips in neighborhoods (for visiting familiars or shopping) (Schmeidler, 2008), as leisure activities (jogging or hiking), for connecting to other modes of transportation (train or bus) and health reasons or recreational purposes (Ann, Ken, and Nicholas, 2013).

Although researchers are like minded that there is not only one type of walking, there are several reasons for walking for each researcher. In Figure 5.4, it can be seen that there are several different reasons of walking and also reasons not for walking. Actually, this begging to differ with others in reasons of walking shows how complex activity it is. As with the reasons of walking, there is also no consensus in the types of walking. For Hajna (2016), walking can be divided into two: utilitarian walking and leisure-time walking. Different than Hajna (2016), the act of walking can be categorized as three modes: transportation, recreation or leisure, and exercise (Takacks, 2017). In Carrapatoso (2015), it is mentioned that walking is important for several different reasons: active transportation, leisure domains, personal care, and work domains. As another research study that differentiates walking types, Riggs (2011) also takes walking for transportation and walking for leisurely into account as different modes of walking. It is addressed in Hajna (2016) that utilitarian walking is conducted in neighborhoods that have high density whereas leisurely walking is conducted in less walkable areas. Riggs (2011) also supports the idea given in Hajna (2016) that higher density areas have more walking for transportation, whereas lower density neighborhoods promote and offer more for leisurely type of walking.

Reason for Walking	Reasons for not Walking
Physical (especially fighting obesity) and emotional health	Distance
Accessibility/ close proximity to non-residential destinations/ land use mix	Carrying things
Pleasurability/ Aesthetics/ "streetscape"	Do not want to / Laziness / Prefer other transport
Safety form crime	Time limitations
Safety from traffic	Fear of crime
Freedom from congestion and parking	Weather conditions
Environmental impact	Fear of traffic
Economical (save gas and maintenance)	Disabilities
Recreation/ leisure	Too busy
	Inconvenient / Poor infrastructure

Sources: Compiled from DOTFHWA 2006, Belden Ressonello and Stewart 2003, James et al. 2001, Mackett 2003, Longdill and Associates Ltd 2003, Krizek and Johnson 2007, Royal and Miller-Steiger 2008, NHTSA and BTS 2003a and 2003b, Frank et al. 2004, Day et al. 2006, O'Reilly et al. 2011, Saelens and Handy 2008, Rattan 2012, Sehatzadeh et al. 2011, Handy et al. 2008, Saelens et al. 2003, Frank et al. 2005; Leslie et al. 2005, Rutt and Coleman 2005, Cleland and Walton 2004, Fleury 2013.

Figure 5.4. Common Reasons for Walking and Not for Walking
(Source: Biernecka-Lievestro, 2014, p. 23)

To state the difference between leisurely walking and recreational walking, the term "leisure" can be defined as follows: "a shared human experience engaged in for the purpose of amusement, relaxation or self-actualization" (Wensley and Slade, 2012).There are also some studies that take leisurely walking and recreational walking into account as totally different from each other (Carrapatoso, 2015). Starting from 20th century, walking is reframed as leisurely activity rather than a mode of transportation (Riggs, 2011). The same study also supports the idea that both recreational and utilitarian walking modes have decreased in cities (Riggs, 2011). Because leisurely walking is performed more, health related literature also directs its focus to walking as a leisurely activity (Wensley and Slade, 2012).

With its different types, its several numerous benefits and the different items that it is affected by, walking is a complex mode of activity, although it is the most basic act conducted by humans regularly in everyday lives. Despite its complicated properties, all walkability measurement tools handle the issue of walking without defining its type. In other words, while doing an analysis; there is no identification of which walking type they are conducting research on. It has also several different effects on physical, perceptual, and social features of humans, however, in walkability measurement tools, there is again no identification of which part it focuses on. The main and most problematic of walkability measurement tools that should be questioned is whether these tools really measure walking or give the results on only the measured aspects of it. Because that there is no identification in even a single tool, it can be said that tools actually measure the act of walking only from their own perspective, disregarding whether as leisurely or transportation activity. This non-identification of walking in the tools gives information about how the tools look towards the issue of walkability. Also, it can be stated that by only analyzing the measurable aspects of walking, the tools only create a focus on the physical and maybe even a little perceptual aspects totally disregarding the social dimensions of it.

5.1.3.3. Quantification of WMTs

In walkability measurement tools, there are two types of quantification approaches that tell about tool’s understanding of walkability. The first method of quantification is directly quantifying the final output walkability assessment in which the research shows how walkable the area is. In other words, after doing an analysis of walking; the final result is turned out into numeric value at the end. This is actually the quantification of the walking act. However, with its multiple dimensions, walking cannot be only interpreted as numbers or via digitization. It is actually the reduction of everyday activity into single number. Although it can be commented as the most understandable way, it is directly in contrast with the nature of walkability.

Another method of quantification is quantifying the auditors of the tool. Most of the tool developers see the auditors not only the ones who make comment about the research of walkability, but as data providers disregarding their personal characteristics and opinions as humans.

For some people, it can be the easiest and most easily understandable way of analyzing walkability; however, with its perceptual aspects and social dimension in its nature, it should not be quantified.

5.1.4. User Profile in WMTs

As the important dynamic of walkability measurement tools, users (or auditors) of WMTs are discussed with their two aspects. The first thing to focus is the inequalities between hard-copy and web-based WMT auditors and users. The second issue to analyze is the data collection methods either as by group or as individuals.

5.1.4.1. Inequality in WMTs

Due to their different nature, there is a difference in between web-based tools and hard-copy tools. These differences may be interpreted as class difference. This inequality may be in each type of tool.

The inequality can be analyzed through the following: technological devices used in web-based walkability measurement tools - validity in mostly big cities and metropolis - usage of Google Maps - log in to make comment and view the final result - adaptation to different languages - hard-copy: more locally applicable vs. web-based: more globally applicable - adaptation to different locations - background difference between users.

Walkability measurement tools can be classified into two as hard-copy and web-based. Hard-copy walkability measurement tools can be conducted by everyone, whereas for conducting web-based, one should have access to technological devices like mobile phone, tablets or computer and internet. In other words, web-based ones eliminate the group of residents who do nott have access to technology and internet. If one doesn't have access to these facilities, he cannot have a right to evaluate walkability through web-based tools. From their very beginning, web-based tool developers accept the fact that their target profile is internet and technology users. As a data collection method, crowd-sourcing is used by all web-based tools with the aim of collecting data from numerous people from various backgrounds, however, they totally disregard a crowd of people. From this point of view, hard-copy walkability measurement tools can be evaluated as more fair in terms of preventing class differences because it can be conducted by each resident via observation. It can also be added that technological devices can mainly be bought by those who have a certain level of economic income. Therefore, technological device usage can also be interpreted as that web-based tools are much more concerned with those with a large income. This might also give a clue about web-based tools which can be deduced that web-based tools have a direct relation between the level of walkability and economic income. The class difference that results due to the technological device usage can be interpreted as the first point between web-based and hard-copy walkability measurement tools.

It can be easily obtained from the previous tables (Table 3.1) that most of the tools take aim at metropolis or big cities. They are either developed or adapted for these areas. It is one of the greatest criticisms of walkability measurement tools. In metropolises or big cities, automobiles or public transportation are preferred rather than walking or bicycling. In other words, act of walking starting to be impoverished due to time limitations in people’s everyday lives or distances in-between facilities or targets (like school, jobs, cafe). Due to this, the reason why walkability measurement tools aim at metropolis or big cities can be reanimating this decrease in value. If the reason is increasing the value of walkability, it should be discussed if the goal can be obtained. These hard-copy walkability measurement tools can be used randomly in small cities or cities that are underdeveloped. Walkability Asia is the only web-based walkability measurement tool that aims at Asia and its infrastructure, which are actually underdeveloped, with the aim of developing the infrastructure and drawing attention to walkability. In addition to Walkability Asia, there are some existing tables that compare Maponics and Walk Score in terms of their geographic coverings as below (Tables 5.4-5.5-5.6). The one thing that should be questionable about these tables is why Maponics compare it with Walk Score rather than the other web-based or hard-copy walkability measurement tools. The main reason behind this comparison is that Maponics might see Walk Score as an opponent because it is one of the pioneers in the area of walkability measurement tools. The other thing to be discussed is whether it is enough to compete with Walk Score through their coverage like neighborhoods, cities, school zones, and ZIP codes. Rather than this numeric covering of each tool, this rivalry can be conducted on the general walkability understanding of Walk Score.

In almost all web-based tools that are digital and in majority of hard-copy tools that have a printout version, Google Maps is used as mapping. As one of the variables in mapping, the usage of Google Maps can make all tools more equal. From another point of view, it can be seen as a limitation which makes tools to analyze only the areas that are included in Google Maps so that areas that are not covered by Google Maps in detail are disregarded in walkability analysis. Another issue that should also be covered is that everyone cannot read map or the reading of map should not be a requirement to analyze

Table 5.4. Context Walkability vs. Walk Score
(Source: Maponics Surpasses Walk Score in Coverage, 2014)

	MAPONICS	WALKSCORE
Neighborhoods covered	154.000	10.000 +
Cities covered	4.000 + (only in USA)	3.000 -
School attendance zones covered	61.000 +	Not available
ZIP codes covered	35.000	Not available

Table 5.5. Context Bikeability vs. Walk Score's Bike Score
(Source: Maponics Surpasses Walk Score in Coverage, 2014)

	MAPONICS	WALKSCORE
Neighborhoods covered	154.000	1.000- (estimate based on Walk Score's published city-to-neighborhood ratio)
Cities covered	4.000+	100+
School attendance zones covered	61.000+	Not available
ZIP codes covered	35.000	Not available

Table 5.6. Context Public Transportation vs. Walk Score's Transit Score
(Source: Maponics Surpasses Walk Score in Coverage, 2014)

	MAPONICS	**WALKSCORE**
Neighborhoods covered	154.000	1.000- (estimate based on Walk Score's published city-to-neighborhood ratio)
Cities covered	2.000+	300+
School attendance zones covered	14.000+	Not available
ZIP codes covered	8.000	Not available

walkability. From this aspect, Google Maps can be both a positive and negative aspect for class differences.

Most of the tools, without making any classification as web-based or hard-copy, ask for personal information like the respondent's name, date, team member names, street, age, gender, and job or asks for log-in via e-mail or social media accounts. This requested data can be either for using the tool and making analysis or seeing others' comments and ratings. In web-based tools which asks for log-in actually disqualify people who do nott have social media or e-mail. While walking is everyone's right, it should be criticized why people only taking part in social media can assess and evaluate walkability. This requested data may be directly related to security for preventing abusive comments.

Fundamentally all tools – either web-based or hard-copy – are developed in English, but some tools are adapted for different regions and their languages may be adapted accordingly. Because that all are originally developed in English, it can be deduced that the target user profile of tools are English speaking respondents. On the other side of the coin, it can be interpreted that people who do not know English are disregarded. While walking is a mode of expression of individuals, the language of the tools can be a limitation. Rather than a written evaluation of walkability, visual expression or analysis can be provided in the tools to obtain more equal research outcomes. From other perspective, usage of English in all tools, it can be better to make comparison between all tools and data outcomes of a single tool. Also, it can be better to be understood by most people in terms of results.

Because hard-copy walkability measurement tools are resulted in a printout version, they can be applied more locally, whereas web-based tools are conducted via the Internet, which means that they can be more globally applied. From one aspect, hard-copy tools' local applicability can reduce the validity of the results because they can only be conducted in one neighborhood, whereas the next neighborhood is disregarded. However, in web-based tools, the analysis can be made by people from all around the world who have visited the searched area beforehand. This applicability by more people might increase the validity of results in web-based tools. On other aspect, this locality may increase the probability of detailed analysis, whereas with more globally applied tools, the scale may get larger with fewer details in the analysis.

In addition to their original locations of the tools, some of them are also adapted for other geographic location. The details of geographical adaptation of each tool can be seen in the Comprehensive Data Chart (Table 3.1). For including different users and respondents from different backgrounds, adaptation for different locations can be a beneficial attempt. However in an adaptation, if the content keeps the same, it may not totally address the related walkability analysis. For example, in İzmir where coast can be an important aspect of walkability, whereas in Ankara, it cannot even be a criteria. In contrast, from other perspective; if the content is also updated according to geography, the tool's main idea and main characteristics may change. More commonly, if the tools are adapted to several and numerous locations, the main aim can be changed and the aim can be converted into database collection.

Because that demographic characteristics of each individual change from one to another – age, gender, education, financial situation, disability, ethnicity, education level, job – personal preferences and perception also change accordingly. Even though it is not expressed in words, most of the tools do not attach importance to these demographic differences or clustering tool's results accordingly. While conducting analysis and data collection, not disregarding or alienation of people from different demographic backgrounds should be done but they should be kept in balance – for example equal number of women and men, equal number of people from twenty-forty five and forty five and more years old – to obtain more valid results.

5.1.4.2. Walking Research by Group or Individual

When the walkability measurement tools are analyzed, it can be seen from Comprehensive Data Chart (Table 3.1) that all web-based tools and most of the hard-copy walkability measurement tools are proposed to be conducted individually rather than by team or group of individuals. The hard-copy tools that are suggested to be conducted in group of two are as follows: Global Walkability Index (GWI), Pedestrian Environment Data Scan (PEDS) and Pedestrian Environmental Quality Index (PEQI). When all the tools are analyzed, it is seen that majority of the walkability analysis is designed to be conducted individually.

It is certain that analyzing the individual walking in today's capitalist and individualist world is needed, but it should be questioned why walking is mostly analyzed individually. When the tool is conducted individually, one can only assess the walkability according to his own experiences and individual ideas. But when the tool is conducted by two, there should be a consensus for assessing the walkability alone. Based on this, it can be interpreted that reaching this consensus is important for the validation of the analysis. Also, through making research in a team of two, the social aspects can also be covered, which is mostly missed when the tool is conducted individually. In addition to covering the social dimensions of walkability, the urban space can be created via the walking of crowd or groups of people. So rather than focusing on the individual, the groups of people should be considered as tool auditors for a comprehensive analysis.

5.1.5. Policy in Global Walkability Index (GWI)

Global Walkability Index (GWI) is the only tool between both web-based and hard-copy tools that includes policy as one of its criteria. Not directly and only focusing on the content, it can be deduced from the tool developer's understanding of walkability. Therefore, to understand why only Global Walkability Index uses policy in its content, it is better to analyze the developer, the World Bank.

The World Bank was founded in June 25, 1946 (Ruger, 2005). By developing Global Walkability Index, it started to be mentioned as the pioneer work in the field (Yusuf and Waheed, 2015). The World Bank has two main functions (Ugalde and Jackson, 1995): remain profitable and financially solvent by lending to Third World nations and ostensibly act as a development institution

The World Bank was actually established to finance reconstruction of Europe after World War II (Ruger, 2005). The World Bank has claimed its main aim is to 'reduce poverty' (McNamara, cited in Ricah 1994, p. 88) via promoting development and economic growth. In other words, it is a capital provider to large-scale infrastructure projects that are related with industrialization, productivity, and economic output (Ugalde and Jackson, 1995). Today; it is a respectable power in the following sectors: health, nutrition, and population (HNP) in developing countries. At it's first emergence, the World Bank was no related to global health but today it has become the world's largest financial supporter of the health-related projects (Ruger, 2005). Currently, the World Bank is working on governmental issues from the following perspective: managerial and institutional issues related to bureaucratic reforms, policy analysis, and improving coordination and 'efficiency of public services' (Williams and Young, 2015).

Although, the World Bank itself claims that it was established to provide the better conditions especially for developing countries, there are also some negative comments about it. The first comment is that, rather than focusing on development, it became a 'global loan shark' (Ugalde and Jackson, 1995). The World Bank also accepted that for the sake of its own interests, it works as 'Western capitalist institution' (Ugalde and Jackson, 1995). The second and the most comprehensive comment about the World Bank is that in theory, the World Bank tries to work for developing world (Ugalde and Jackson, 1995). However, when it comes to actual practice, the World Bank also tries to make profit from the developing countries and widens the gap between the rich and poor (Ugalde and Jackson, 1995). In short, the World Bank contributes to the growing problems, rather than helping to get rid of them (Ugalde and Jackson, 1995).

Having policy as a criteria only in Global Walkability Index can be a result of the effect of the tool developer. When the information about World Bank, which is the developer of the tool, is analyzed in depth, it is found that rather than doing a real analysis about walkability, it's main target is to improve the existing urban areas with providing the neighborhood a specific budget. As the World Bank's understanding of walkability, it can also be stated that in addition to developing the urban features, the main target can also state new policies to the searched areas and apply them accordingly. As the walking is a liberatory act, this is totally irrational to set policies – *limitations*, on this act.

5.2. Contribution to the Literature

This thesis contributes to the existing literature of both walkability and walkability measurement tools (WMTs) from four different aspects. The first aspect is that, both in international and national literature, it is the first study that covers most important web-based and hard-copy walkability measurement tools in one study by comparing them. For considering all types of tools that measure walkability in detail and comprehensively, this pioneer work is developed with a critical approach. The second contribution is that it brings a critical understanding to walkability measurement tools (WMTs). In other words, the existing studies in the literature take an approach where they accept each and every tool as it is and do different researches like trying to validate that tool in different cases, compare one tool with another, or measuring the level of walkability with that tool. Contrarily; rather than directly accepting the tools as they are, a critical lens is applied to each tool to comprehend their understanding of walkability and their other characteristics like developer, question types which have direct impact upon walkability. The third issue is that it develops a new method for comparing web-based walkability measurement tools (WMTs) and hard-copy walkability measurement tools (WMTs). There are several different types of research on the walkability issue but different than these, this thesis is the first that applies both comparative content analysis and more comprehensive comparative analysis to them. In short, it is the first time that analytical lens is applied to walkability measurement tools (WMTs). The fourth and the last contribution is that it is applied to the current literature of walkability and walkability measurement tools (WMTs) by making comparison and critical analysis. Rather than applying this method to previous walkability measurement tools, it is applied to existing and current walkability measurement tools (WMTs) in which especially web-based tools are updated day-by-day.

5.3. Future Works

For further studies, the followings can be conducted. Firstly, this thesis aims to understand the general background ideas about walkability of widely used walkability analysis tools. Also, it seeks to understand which aspects are missing in their scope. In other words, it tries to understand their general understanding of walkability from different aspects. As a further study, a detailed critical discourse analysis can also be conducted from the direct quotes of the tools and tool developers. Conducting an analysis about their quotes or words are a small part of the thesis but there can also be a study that will only focus the words being used by the tools and its developers. Secondly, if new tools are developed in future, the same method can also be applied to them. This thesis can work as a base for the future walkability measurement tools about seeing the missing or more focused aspects or to which parameters they should be careful while designing a tool. Thirdly, rather than only covering the most important or mostly cited tools, the other tools can also be covered to see why they are not chosen that much. In this thesis, small scaled or less used tools are not covered. In further studies, all the tools can be covered to see why they are not commonly used or what makes the tools covered in this thesis as widely used ones. Fourthly, the analysis method can also be checked in a real case to develop a new walkability measurement tool. Fifthly, the method that is applied to common walkability measurement tools can also be applied to the tools which both do analysis on bikeability and walkability in the built environment. The same comparison and critical analysis can be reapplied to bikeability measurement tools to make their critical analysis. Sixthly, a more detailed analysis or research can be made to see which is the reason that hard-copy walkability measurement tools are replaced by web-based walkability measurement tools today. Also, the changes from hard-copy walkability measurement tools tried to be listed. As seventh and the list further study, the relation between mass tourism which also includes Airbnb and walkability can be analyzed. Due to the reason that mass tourism is one of the most discussed issues in today's literature and sector, how walkability measurement tools can be a method to measure accessibility as a criteria of mass tourism can be argued.

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APPENDIX A

HARD-COPY WALKABILITY MEASUREMENT TOOLS (WMTs)

Active Neighborhood Checklist (ANC)

Development and Aim

The aim of Active Neighborhood Checklist is to be a short objective tool that assesses how much activity friendliness the streets have. For making the tool useful for numerous audiences and reaching the large masses, reducing the administration time, and for minimizing the training length, the audit was designed in a user-friendly format with ordinary language (Hoehner, Ivy, Brennan Ramirez, Handy, and Brownson, 2007). The target user profile of the audit are community members and public health practitioners (Hoehner, 2011).

Scope and Content

The content of Active Neighborhood Checklist is mainly composed of five general areas and upper titles: land use, public transit stops, street characteristics, quality of the environment for a pedestrian, and places to walk and bicycle (The Robert Wood Johnson Foundation and The Centers for Disease Control and Prevention, 2011). Each question under each upper title is answered as either yes or no and checklist.

Previous to the questions and the checklist of Active Neighborhood Checklist, there is some general information about purpose of the checklist, it's content, the instructions about how to use the checklist, and operational definitions of the terms/keywords being used in the checklist. The instrument consists of the General Information Part (Purpose – Content – Instructions for Use – Operational Definitions) and the Checklist itself (Hoehner, 2011).

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

The process of the checklist mainly consists of two main steps: choosing an area or route to audit and auditing the checklist. In addition to the checklist, there is also a labelling part beforehand. The labelling in the tool comprised of as following (Hoehner, 2011): date, segment ID (Team ID and number), auditor name, neighborhood ID (can be seen from the map), street name, starting time, and stopping time. After finishing the checklist, the data collected might be used to compose data for assessment or research needs for raising and increasing the awareness in the community about the role of the environment in supporting or discouraging physical activity or mobilizing the community members to support for change (The Robert Wood Johnson Foundation and The Centers for Disease Control and Prevention, 2011). There are several materials being used during the checklist. These are audit tool, map, clipboard, pencil or pen, comfortable shoes, watch, cell phone, sunscreen, umbrella, and camera (Hoehner, 2011).

Global Walkability Index (GWI)

Development and Aim

In its very first and original version, Global Walkability Index was composed of three main components which were subdivided into twenty two indicators and forty five variables (Krambeck, 2006). After Krambeck received feedback about Global Walkability Index at the Association of Bicycle and Pedestrian Professionals Annual Conference in Chicago, October 2005, the index was revised. The main critique received was that the original should be simplified. The revised and final version of Global Walkability Index is shown in Krambeck (2006, p. 18-19).

Scope and Content

Mainly, Global Walkability Index is comprised of two different surveys, which are public agency survey and field survey. Public agency survey is simple, in which public agencies are asked to provide the required data (Yusuf and Waheed, 2015). Also, public agency survey is to be administered to departments responsible for urban and transportation planning (Krambeck, 2006). The public agency survey is important to collect required data that cannot be collected through physical infrastructure surveys like pedestrian fatality statistics and pedestrian-related laws and regulations (Minhas and Podder, 2017). The other survey is field survey, which is used to evaluate pedestrian infrastructure in four areas: commercial, residential, educational, and public. In field survey, pedestrian preferences and government policies are also analyzed (Juremalani and Chauhan, 2017; Gota, Fabian, Mejia, and Punta, N.D.; Clean Air Asia, N.D.). Field survey is used to collect perception of pedestrians about the facilities and to suggest improvements if needed (Minhas and Podder, 2017). In total, Global Walkability Index (GWI) consists of six primary, twenty three secondary and forty four tertiary indices, which are seventy three indices in total (Juremalani and Chauhan, 2017).

The components are shaped around three main components, which are safety and security, convenience and attractiveness, and policy support (Regidor, Marcelo, and Salvador, 2016). The detailed description of each component is as follows (Krambeck, 2006). Safety and security are intended to determine the relative safety and security of the walking environment (Ex. What are the odds of a pedestrian will be hit by a motor vehicle? What safety measures are in place at major crossings and intersections? How safe from crime do pedestrian feel along walking paths?). Convenience and attractiveness reflect the relative convenience and attractiveness of pedestrian network (Ex. Do pedestrians have to walk a kilometer out of their way just to cross a major road? Is there sufficient coverage from weather elements along major walking paths? Are paths blocked with temporary and permanent obstructions such as parked cars or poorly placed telephone poles?). Policy support reflects the degree to which the government supports improvements in pedestrian infrastructure and related services (Ex. Is there a non-motorized planning program? Is there a budget for pedestrian planning? Are pedestrian networks included in the city master plan?).

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

In general terms, Global Walkability Index uses a qualitative method. In addition to this, it produces a better concept for the pedestrian environment and enables researchers to identify areas that need to be improved (Tanan, Hıdayat, and Supraygoga, 2015). Moreover, it compasses several key parameters, and it provides a good insight into the current situation of the walkability environment (Juremalani and Chauhan, 2017; Gota, Fabian, Mejia, and Punta, N.D.; Clean Air Asia, N.D.).

By Minhas and Poddar (2014), the auditing process by Global Walkability Index was described as follows. First of all, the survey area is selected so that nearly whole neighborhood and most important roads are covered. For conducting analysis, a single sheet for each survey is used. Within the scope of the survey area, only main public roads are covered. To obtain consistent results, all surveys should be conducted at the same times like local peak travel times. While conducting the survey, the number of individuals walking on the street and on the walking paths on one side of the street are written down with traffic counting method. The street length that is surveyed can vary between 0.2-0.4 kms. A public agency rating is attained based on the responses for each survey area. During the survey, each surveyor asks pedestrians to rate and evaluate the selected road on five likert scale in which one is for the lowest and five is for the highest. The average for each parameter is turned into a rating system in which zero is the lowest and hundred is the highest. Walkability rankings are calculated by taking the average of each individual's assessment for that area so that the sum of the public agency rating and filed survey rating gives the Global Walkability Index (GWI). This method is actually a system that enables auditors to describe the preferences of individuals and to conduct analysis about the policies of the government.

While conducting Global Walkability Index and collecting data through it, it is important to conduct the survey by local populations to prevent undue bias in final results (Krambeck, 2006). Also, it should be noted that in Global Walkability Index, most of the data is collected in the real environment which has some hardness like time, effort, and subjectivity (Krambeck, 2006).

There are two important aspects that need to be taken into consideration while choosing survey area for Global Walkability Index. The first one is selecting the survey area within cities which can provide comparable results. The second one is that the area that is surveyed should be representative of a large cross-section of cities' varied neighborhood and districts (Krambeck, 2006).

In Global Walkability Index, the rating method is used as scoring (Regidor, Marcelo, and Salvador, 2016). In evaluation process, equal weight to each variable is provided for avoiding issues related to determine which are relatively more important or less important (Dristi, N.D.). In the index, each variable is scored on a scale from one to five (Krambeck, 2006).

The results obtained from Global Walkability Index for comparing cities and afterwards, the results help to identify areas for improvement that are site-specific. The results can also raise awareness and generate interest between policy makers, authorities, and officials (Clean Air Asia, N.D.).

Global Walkability Index Survey Implementation Guidebook is comprised of the following: Survey Materials and Implementation Guide, Public Agency Survey, Field Surveys, Notes, Consultant Contact Information, Public Agency Data Collection, Field Data Collection, Public Agency Contact Information, Survey Materials Submission Checklist and Appendix D: Extended Survey Materials (Consultant Contact Information – Part I: Pilot Physical Infrastructure Survey – Physical Infrastructure Survey: Roads, Walking Paths, Amenities, Crossings –Part II: Public Agency Survey – Part III : Pedestrian Survey) (Krambeck, 2006, p. 81-126).

Irvine Minnesota Inventory (IMI)

Development and Aim

There are several goals and aims of developing Irvine Minnesota Inventory (IMI) as follows. The first aim is collecting data by in-person field observation, while also including both micro-scale and macro-scale properties of the physical and built environment. These micro-scale properties (segment-level observations) are street segments and detailed properties related to each segment like street trees. The macro-scale properties (setting-level observations) enable researchers and auditors to evaluate the characteristics of the whole study area like overall street pattern (Lee and Talen, 2014). Another aim is to respond to the need for reliable tools and methods for evaluating physical and built environment properties that might have relation with the activity of walking or bicycling (Day, Boarnet, Alfonzo, Forsyth, and Oakes, 2006). Also, it was developed to measure environmental-features that might have a relation with physical activity, mostly walking (Boarnet, Forsyth, Day, and Oakes, 2011). Moreover, it was improved to become comprehensive and extensive, including a large variety of questions that might have a relation with physical activity or walking for travel (Boarnet, Forsyth, Day, and Oakes, 2011). Another aim of IMI is to collect data on built environment characteristics that might be linked to physical activity, for research purposes on the relation between the physical environment and physical activity (Premier's Council for Active Living New South Wales and NSW Centre for Physical Activity and Health, 2007). Also, IMI is advanced to measure a great variety of built environment characteristics that may have potential to have a link to active living, mostly walking (Active Living Research, 2005; MIDSS Measurement Instrument Database for the Social Sciences, N.D.). The last aim is to create an objective measure of the physical environment characteristics that might have impact upon physical activity, including both intentional walking (walking to destinations) and recreational walking (walking as leisure activity or as exercise) (State of Place, N.D.)

Scope and Content

Irvine Minnesota Inventory (IMI) is a comprehensive tool of micro-scale and macro-scale physical environment properties that might have relation to physical activity (Schopflocher, VanSpronsen, and Nykiforuk, 2014). It examines the built environment characteristics at the street segment scale (Boarnet, Forsyth, Day, and Oakes, 2011). It comprises from hundred and sixty two micro-scale features (Active Center Strategic Investment Plan The Region Forward Implementation Tool, N.D.) and items in total under four following scales (Alfonzo, Wolch, and Dunton, 2011; Active Living Research, 2005): accessibility (sixty two items), perceived safety from crime (fifteen items), perceived safety from traffic (thirty one items) and pleasurability (fifty six items).

Within these four scales in hundred and sixty two items, both objective and subjective physical environment properties are assessed (Lee and Talen, 2014; Premier's Council for Active Living New South Wales and NSW Centre for Physical Activity and Health, 2007; MIDSS Measurement Instrument Database for the Social Sciences, N.D.; Jensen, Brown, Smith, Brewer, Amburgey, and Mcliff, 2017). During assessment, observers and auditors rate the characteristics of each road segment in the selected area (two-facing sides of one street block) (Schopflocher, VanSpronsen, and Nykiforuk, 2014; Schopflocher, VanSpronsen, Spence, Vallianatos, Raine, Plotnikoff, and Nykiforuk, 2012).

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

IMI is actually an observational audit tool (Premier's Council for Active Living New South Wales and NSW Centre for Physical Activity and Health, 2007). In other words, the data is collected mostly in-person observations (Alfonzo, Wolch, and Dunton, 2011). In addition to this, additional information is collected with using geographic information systems (GIS) technology. The data collected includes density, intersection patterns, street length, and street pattern (Premier's Council for Active Living New South Wales and NSW Centre for Physical Activity and Health, 2007). The collected data has both objective and quantitative measurements (Alfonzo, Wolch, and Dunton, 2011).

While auditing the tool, the auditors and the raters receive a full-day training. The data collection lasts seven-ten minutes/block and averages forty-fifty blocks/neighborhood (Active Center Strategic Investment Plan: The Region Forward Implementation Tool, N.D.).

The inventory has both a paper version (Irvine Minnesota Inventory Paper Version, N.D.) and a digital version, a version in Microsoft Access for enabling data to be input into computer directly (MIDSS Measurement Instrument Database for the Social Sciences, N.D.).

Three different code books are with following contents. The content of the Code Book 1: General Information (Day, Boarnet, and Alfonzo, 2005) is as follows: I: Introduction – II: Getting Started – III: Conducting Observations – IV: Segment Level Questions – V: Setting Level Questions – Appendix A: GIS Measures – Appendix B: Inventory for Observation of Non-Linear Settings. The content of Codebook 2: Area (Irvine Minnesota Inventory: Area Version – Codebook 2, N.D.) is the checklist itself. The Codebook 3: Scales for Analyzing Data (Irvine Minnesota Inventory: Appendix C (Scales for Analyzing Data) – Codebook 3, N.D.) includes Appendix C: Scales for Analyzing Data.

Neighborhood Environment Walkability Scale (NEWS)

Development and Aim

The Neighborhood Environment Walkability Survey (NEWS) was developed in December 2002 at the University of California, San Diego, by Brian E. Saelens and James Sallis for measuring the residents' perception about their neighborhood regarding the believed relation between urban and transportation aspects of the neighborhood and the walking and cycling habits of the residents (Martinez-Martinez and Ramirez-Lopez, 2018; Adlakha, Hipp, and Brownson, 2016; Sallis, N.D.; Active Living Research, 2002).

The aims and goals of Neighborhood Environment Walkability Survey (NEWS) defined by several different authors are as follows. The first aim that is described is to assess the environmental items that may influence physical activity (Rosenberg, Ding, Sallis, Kerr, Norman, Durant, Harris, and Sealens, 2009). Another defined target is measuring perception of residents about the environmental factors related to their local area (Martinez-Martinez and Ramirez-Lopez, 2018). It is also mentioned as an aim to assess several aspects of the perceived suitability of neighborhoods for the activity of walking (Starnes, McDonough, Tamura, James, Laden, and Troped, 2014). It is also developed to evaluate the characteristics from transportation and urban planning literatures and to assess the built environment properties that are believed to have a relation to physical activity (Adams, Ryan, Kerr, Sallis, Patrick, Frank, and Norman, 2009). To last defined aim is to obtain the perception of residents about how neighborhood characteristics found in the transportation and urban planning literature were related to a higher frequency of walking and cycling trips) (Cerin, Sealens, Sallis,and Frank, 2006).

Scope and Content

The current version of NEWS is comprised of sixty eight-items that measure the attributes that the resident perceives about the local environment which is thought to be related with physical activity and maybe to walking and transportation and walking as leisure activity (Cerin, Sealens, Sallis, and Frank, 2006).

The survey has nine main sections as follows (Martinez-Martinez and Ramirez-Lopez, 2018; Adams, Ryan, Kerr, Sallis, Patrick, Frank, and Norman, 2009; Cerin, Leslie, Owen, and Bauman, 2008; Adlakha, Hipp, and Brownson, 2016; Cerin, Sealens, Sallis, and Frank, 2006; Sallis, N.D.): Section A: Neighborhood Residential Density, Section B: Land-Use Mix Diversity, Section C: Land-Use Mix Access, Section D: Street Connectivity, Section E: Walking and Cycling Facilities, Section F: Aesthetics, Section G: Pedestrian and Traffic Safety, Section H: Crime Safety and Section I: General Neighborhood Satisfaction.

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

The original version of NEWS was actually developed for the United States. Its test-retest reliability of the subscales was reported and the interclass correlation coefficients (ICC) ranged from 0.58 to 0.80. It has actually ninety eight questions but it wasn't used widely (Martinez-Martinez and Ramirez-Lopez, 2018).

The original version of NEWS has the following content: Section A: Types of Residences in Your Neighborhood, Section B: Stores, Facilities and Other Things in your Neighborhood, Section C: Access to Services, Section D: Streets in My Neighborhood, Section E: Places for Walking and Cycling, Section F: Neighborhood Surroundings, Section G: Safety from Traffic, Section H: Section from Crime and Section I: Neighborhood Satisfaction (Neighborhood Environment Walkability Scale (NEWS), 2002).

Except from the residential density (Section A) and land-use mix-diversity (Section B) subscales, all the subscales are rated with a four-point likert scale from one (disagree) to four (strongly agree). In residential density (Section A), the frequency of various types of residences, from single-family detached homes to thirteen-story or higher apartments/condominiums are given the rating from one (none) to five (all). They are rated relative to the average density of single-family detached residences and the values that are weighted are summed up for obtaining the residential density subscale score. In land-use mix-diversity, the questions are evaluated according to the proximity of walking from home to different and various types of amenities and facilities in which the responses ranging from one to five minutes walking distance (coded as five) to nine to thirty minutes walking distance (coded as one). The higher scores on land-use mix-diversity shows closer average proximity (Cerin, Sealens, Sallis, and Frank, 2006).

Because NEWS was originally developed for the Unites States, its applicability for other regions is limited due to the cultural differences and some specific aspects of the physical built environment (Martinez-Martinez and Ramirez-Lopez, 2018).

There are some different adapted versions of NEWS for different regions such as Mexico, Saharan Africa, Republic of Korea, China, Australia, and India. Also, an adapted version for different target user profile group exists like youth, known as NEWS-Y. In addition to the adapted versions for different regions and for different target user groups, an abbreviated version of NEWS exists.

A shortened version of NEWS was developed with the name of The Neighborhood Environment Walkability Survey Abbreviated (NEWS-A). The abbreviated version was reproduced referring to a multi-level factor analysis conducted on the original NEWS using a subsample of participants in NQLS (Neighborhood Quality of Life Study) (Active Living Research, 2002; MIDSS Measurement Instrument Database for the Social Sciences, N.D.). NEWS-A was applied in several countries, including Australia, Belgium, Brazil, Colombia, Spain, the United Kingdom, and Korea because the shorter the version is more valid in determing the relation between the properties of the neighborhood and the variable of the amount of time people take to move around by foot. NEWS-A has eight subscales (Martinez-Martinez and Ramirez-Lopez, 2018): residential density – six likert type questions (never, rarely, sometimes, usually, always), proximity to stores and facilities – twenty three time-interval questions (one–five; six–ten; eleven–twenty; twenty one–thirty minutes; more than thirty minutes), perception of access to stores and facilities – four likert type questions (disagree strongly, disagree somewhat, agree somewhat, agree strongly), how connected the streets are – three likert type questions (disagree strongly, disagree somewhat, agree somewhat, agree strongly), pedestrian infrastructure – ten likert type questions (disagree strongly, disagree somewhat, agree somewhat, agree strongly), the image of neighborhood – six likert type questions (disagree strongly, disagree somewhat, agree somewhat, agree strongly), perception of traffic – six likert type questions (disagree strongly, disagree somewhat, agree somewhat, agree strongly) and the perception of neighborhood safety – four likert type questions (disagree strongly, disagree somewhat, agree somewhat, agree strongly).NEWS-A was also translated to Korean for evaluating the walking environment (Kim, Choi, Ma, Hyung, Miyashita, and Lee, 2016). There is also a modified version of NEWS-A for seniors consisted of seven subscales with thirty six items in total (Starnes, McDonough, Tamura, James, Laden, and Troped, 2014). The abbreviated version's instrument is with the content as follows: A: Types of Residences in Your Neighborhood – B: Stores, Facilities, and Other Things in Your Neighborhood –C: Access to Services – D: Streets in My Neighborhood – E: Places for Walking and Cycling –F: Neighborhood Surroundings/Aesthetics – G: Traffic Hazards – H: Crime – Single Items that Did Not Lead on Other Factors (Neighborhood Environment Walkability Scale (NEWS) – Abbreviated, N.D.). NEWS-AU was developed by Leslie and his colleagues in 2005 for adapting NEWS to linguistic and environmental idiosyncrasies of Australia. The changes and adaptations made are as follows (Cerin, Leslie, Owen, and Bauman, 2008): the replacement of U.S. English words with their Australian equivalent, the use of examples that are more relevant to the Australian environment, the addition of items describing features of the Australian environment that have been shown to be related to walking behavior, and length of the questionnaire.

NEWS-Y is the adapted version of NEWS-A specifically for youth, which consists of sixty seven questions which measures the perception of neighborhood design properties that might be related to physical activity. NEWS-Y has separate versions for parents and adolescents (aged eleven and above). The adaptations from NEWS-A to NEWS-Y were made referring to the interviews conducted with youth and parents (MIDSS Measurement Instrument Database for the Social Sciences, N.D.). NEWS-Y for Adolescent Instrument is with the following content: A: Stores and Other Public Places in Your Neighborhood – B: Recreation Places in Your Neighborhood – C: Types of Homes in Your Neighborhood – D: Access to Services – E: Streets in My Neighborhood – F: Places for Walking – G: Neighborhood Surroundings – H: Neighborhood Safety – I: Crime Safety (Neighborhood Environment Walkability Scale (NEWS-Y): Adolescent Version, N.D.). NEWS-Y for Parent Instrument has the following content: A: Stores and Other Public Places in the Neighborhood Where You and Your Child Live – B: Recreation Places in the Neighborhood Where You and Your Child Live – C: Types of Homes in Your Neighborhood – D: Access to Services – E: Streets in My Neighborhood – F: Places for Walking – G: Neighborhood Surroundings –H: Neighborhood Safety – I: Crime Safety (Neighborhood Environment Walkability Scale – Youth (NEWS-Y): Parent Version, N.D.). The scoring procedure being used in NEWS-Y has also a detailed description as follows: Subscale A: Land-Use Mix Diversity (Higher Score Denoting Higher Walkability) – Subscale B: Neighborhood Recreation Facilities (Higher Score Denoting Higher Walkability) – Subscale C: Residential Density (Higher Score Denoting Higher Walkability) – Subscale D: Land-Use Mix Access (Higher Score Denoting Higher Walkability) – Subscale E: Street Connectivity (Higher Score Denoting Higher Walkability) – Subscale F: Walking/Cycling Facilities (Higher Score Denoting Higher Walkability) – Subscale G: Neighborhood Aesthetics (Higher Score Denoting Higher Walkability) – Subscale H: Pedestrian and Automobile Traffic Safety (Higher Score Denoting Higher Walkability) – Subscale I: Crime Safety (Higher Score Denoting Higher Walkability) (Neighborhood Environment Walkability Scale – Youth (NEWS-Y), 2009).

The reliability and validity of NEWS and its several adapted versions are tested in several studies (Rosenberg, Ding, Sallis, Kerr, Norman, Durant, Harris, and Sealens, 2009; Cerin, Leslie, Owen, and Bauman, 2008; Cerin, Sealens, Sallis, and Frank, 2006; Sallis, N.D.).

Pedestrian Environment Data Scan (PEDS)

Development and Aim

Pedestrian Environment Data Scan (PEDS) was developed in January 2004 by Kelly Clifton from the University of Maryland, Andria Livi from the University of Maryland and Daniel Rodriguez from the University of North Carolina, who are three notable researchers of the urban planning field (Active Living Research, 2004; Pentella, 2009). PEDS was also supported with a grant from The Robert Wood Johnson Foundation Active Living Research Program (Clifton, N.D.).

PEDS was developed from the SPACES (Systematic Pedestrian and Cycling Environment Scan) audit and adapted for the specific conditions of the United States (Shay, Rodriguez, Cho, Klifton, and Evenson, 2009). In other words, PEDS draws mostly from SPACES (Fisher, Richardson, and Holster, 2010).

PEDS was developed to evaluate the physical environment factors that may affect the activity of walking (Fisher, Richardson, and Holster, 2010; Clifton, N.D.). It also aims to measure the environmental properties that may have a relation with the activity of walking in various environments in the United States. PEDS was specifically designed for addressing the pedestrian concerns, while also minimizing the cost and the time that PEDS required (Center TRT: Training and Research Translation, N.D.; Clifton, N.D., Clifton and Smith, 2010; Lopez-Bernal, N.D.). PEDS is also described as one of the audits that aims to provide information about the built environment (Stushek, 2017, p.10).

Scope and Content

This data scan includes and evaluates seventy eight measures of streetscape characteristics in which other studies show that they affect walkability (Pentella, 2009; Lopez-Bernal, N.D.).

The PEDS instrument data sheet can be found in Clifton (N.D.). All of the seventy eight measures are grouped into four main categories as following (Fisher, Richardson, and Holster, 2010; Clifton, N.D.): environment (which covers the types of housing, commercial uses of buildings, the slope of road, the streets' connectedness to other streets, and footpaths), pedestrian facility (which covers type, material, and condition of the pedestrian walking area), walking/cycling (which covers the surrounding environment as it supports these activities) and road attributes (which covers characteristics of the area of the road primarily designed for use by automobiles).

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

The data collection sources of PEDS are comprised of primary sources and detailed observation, rather than some secondary sources like census data (Pentella, 2009).

PEDS is mainly structured in a likert-scale format like poor, fair, good. However, the likert-scale of each question differs from each other (Pentella, 2009).

The main original format of PEDS is as paper/pencil instrument, but with the development of technology, it was adapted for use with handheld technology (Clifton, N.D.). The electronic version of PEDS (palmOS) is available like its comprehensive complementary materials (Hawaii's Complete Streets Policy, N.D., Clifton, N.D.; Clifton and Smith, 2010). In other words, there is an integration of hand held devices in PEDS (Shay, Rodriguez, Cho, Klifton, and Evenson, 2009).

There are some important points that auditors should be careful for. PEDS audit training takes four-eight hours to complete (Livi, N.D.) and it was designed to be conducted in pairs (Clifton, N.D.).

The Audit Training and Instructor Notes can be seen in Livi (N.D.) with the following content: Overview of the Audit – Detailed Description of Each Question – Practice Segments. The general directions, supplies, procedures at each segment and the question breakdown are also given by Livi (2004) in Audit Protocol. The following section of the protocol describes each question and response category to aid the administrators in dealing with variations in the environment. The administrators are encouraged to read through this section and use it as a reference while surveying the segments. For each question, the name and number are in **bold**, the answer options are in *italics* and the comments, definitions or directions in regular text. The Audit Protocol of PEDS is in Livi (2004) with the following content: General Directions and Procedures – Question Breakdown – Section 0: Segment Number and Type – Section A: Environment – Section B: Pedestrian Facility – Section C: Road Attributes – Section D: Walking/ Cycling Environment – Section SA: Subjective Assessment.

Reliability check of PEDS was conducted by Clifton and Livi in which they found a high reliability score for most of the questions despite PEDS has a great variety of street segment uses, conditions, and aesthetics (Schlossberg, Agrawal, and Irvin, 2007).

Pedestrian Environment Review System (PERS)

Development and Aim

Pedestrian Environment Review System (PERS) was developed by TRL (Transport Research Laboratory), TfL (Transport for London) and London Borough of Bromley (Allen and Clark, N.D.; Transport for London, N.D.; TRL The Future of Transport, 2003).

The aims of PERS are several. The first aim of PERS is to provide a comprehensive and holistic assessment and demands an appreciation of the qualitative aspects of good street design. Secondly, it aims to provide a framework for regarding the pedestrian environment design and also promotes the pedestrian considerations in the street environment (Gould, 2011). In addition to these, PERS attempts to provide an optimal pedestrian environment for all (TRL PERS Audit Team, 2008). It is also used to evaluate the level-of-service and the quality of the pedestrian environments (Transport for London, N.D.). Moreover, it aims to provide an efficient and objective tool to be used by local authorities for assessing the pedestrian provision (Allen and Clark, N.D.). PERS was also designed to allow cost effective evaluation of conditions leading to effective targeting of resources to deliver accessible and inclusive pedestrian networks (TRL The Future of Transport, 2003).

The PERS does not only focus on some specific variables and properties of the pedestrian environment but it also enables TfL to focus on the quality of walking environment as well. It can also be defined as the simplest method to compare the pedestrian environment across London (Allen and Clark, N.D.).

PERS was developed by referring to two following principles (TRL PERS Audit Team, 2008). First principle is that the quality of the pedestrian environment may be evaluated according to the degree to which it meets pedestrians' needs. Another principle is, that in evaluating the degree to which pedestrians' needs are met by the environment, the objective should be to satisfy as many people as possible, with the standard pedestrian being considered to be towards the vulnerable end of the spectrum.

It is beneficial to use PERS due to several reasons (TRL The Future of Transport, 2003). It identifies deficiencies in levels of service and provision of suitable pedestrian support. Also, it systematically assesses pedestrian needs and priorities improvements. Another reason is that PERS strengthens objectivity in the decision-making process. It also produces focused and transparent project proposals based on a clear and consistent evaluation framework. It is also a powerful software that is flexible enough to help quickly capture and structure traditional pedestrian issues. The last reason is it allows individual assessment of each parameter

Scope and Content

The PERS audit mainly comprised of two parts (WSP Development and Transportation, 2010): the audit sheets (accompanying guidance for use in the field to score environments and note comments) and the computer software (used to store results and produce presentational output).

It consists of on-street objective and quantitative assessment of different variables of the street environment which are grouped into six main categories (Gould, 2011; Aurecon Australia, 2010): link – any complete footway, footpath or highway or any section of one, crossing – at any significant crossing point, including crossing observed away from formal pedestrian facilities, route – considers how individual pedestrian facilities are serving pedestrian needs at a strategic level, public transport waiting area – designated space where people are required to wait in order to use public transport, public space – any space that allows the public to informally rest and enjoy and interchange space – any space that allows to change mode of transportation.

Whole parameters as in a comprehensive chart are as in Gould (2011, p.7). The detailed items under each category can be found in Aurecon Australia (2010, p. 4-15): Link Parameters – Crossing Parameters – Route Parameters – Public Transport Waiting Area Parameters – Public Space Parameters.

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

There are five main stages of conducting PERS as follows (TRL PERS Audit Team, 2008): definition of the study area, which is a step to ensure that the boundary of the study area is clearly defined with any key objectives for the review of the study area established, desktop identification of links, crossings, routes, and spaces which is a step to use mapping to initially indicate the links, crossings, routes, public transport waiting areas, interchange spaces and public spaces, the pre-audit process and to evaluate the resources required for the audit, optional collation of existing information, which is done for accurately assessing the walking environment and to provide a valuable foundation for the review – casualty statistics of the area, crime and disorder data of the area and land use info that may guide the auditor to focus upon particular areas of concern, on-street evaluation in which each form requires the auditor to score and comment on each parameter which will be summed to create an overall score for each upper title like link (scoring from -three to +three) (zero – average and N – not relevant) and also other information asked in the form: name, location, reference code, auditor, time of the day and date, data analysis in which all on-site audit scores and comments are entered into the PERS V.2. software for evaluation and display and review outputs which enables the user to automatically generate bar graphs to demonstrate results, and results can also be mapped on an image file to display the RAG (red: poor or very poor-amber: average-green: good or very good) ratings for all parameters.

The PERS scoring system is from -three to +three in which zero is the average score. Three, -two and -one are poor, 0 is average and +one, +two and +three are good (Transport for London, N.D.). In addition to this scoring, there is also a weighting system in PERS to prioritize the walking environment factors. For example, the footway width can be made a more important factor when assigning a PERS score than footway gradient. This allows for flexibility according to local circumstances and needs (Transport for London, N.D.). A detailed weighting table can be seen in TRL PERS Audit Team (2008, p.8).

After entering all the data obtained into software, it allows and bands performance scores into red, amber, or green and this information can be exported into data tables for inclusion in GIS packages, allowing performance maps to be created for rapid analysis and easy comprehension by non-technical audiences (TRLThe Future of Transport, 2003).

Pedestrian Environment Quality Index (PEQI)

Development and Aim

Pedestrian Environmental Quality Index (PEQI) was developed by San Francisco’s Department of Public Health (SFDPH) in 2008 as a paper form version (City of Austin Planning and Development Review Department, N.D.; Batteate, N.D.).

PEQI was developed to meet the needs for a practical method for assessing the existing barriers to the activity of walking and evaluating the quality of the built pedestrian environment (San Francisco Department of Public Health, Program on Health, Equity and Sustainability Environmental Health Section, 2008). It also aims to guide and help to familiarize the neighborhood characteristics, opportunities, and constraints in planning for the future improvements (Pedestrian Environmental Quality Index (Pedestrian Environmental Quality Index, 2011).

Scope and Content

As content, PEQI has thirty factors in total which is comprised of twenty one street segments and nine intersection factors. These thirty factors are grouped under five main domains: intersection safety, traffic, street design, land use and perceived safety (San Francisco Department of Public Health, Program on Health, Equity and Sustainability Environmental Health Section, 2008). The detailed indicators being used in PEQI are listed in San Francisco Department of Public Health, Program on Health, Equity and Sustainability Environmental Health Section (2008).

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

While conducting the data with the index, it is recommended to be in a team of two. Also, it is required to have clipboard, data collection forms, camera, and bottle of water with the team (City of Austin Planning and Development Review Department, N.D.). Before starting the index auditing, it can be beneficial to read the detailed user guide, which mentions the steps to do with photos and images (San Francisco Department of Public Health, Program on Health, Equity and Sustainability, 2012).

For collecting the data, first, the route should be planned and the segments of the planned route should be verified (City of Austin Planning and Development Review Department, N.D.). The data collection process is mainly comprised of observational study based upon the visual assessment of the street segments and intersections by trained observers. The survey form should be completed for each individual intersection and street segment. The index is composed of checklist with close ended questions. After collecting the data, all data should be entered into a database so that they can be converted into numeric value. There is a Microsoft Database specifically customized for this purpose (San Francisco Department of Public Health, Program on Health, Equity and Sustainability Environmental Health Section, 2008). Through the integration of the database, the geocoded information collected can be shared with larger datasets (Batteate, N. D.). The data collection form of PEQI can be found in Pedestrian Environment Quality Index (PEQI) – Data Collection Form (N.D.).

The detailed scoring procedure developed by San Francisco Department of Public Health, Program on Health, Equity and Sustainability Environmental Health Section (2008) is as follows. For each PEQI indicator, respondents are asked two questions. The first question is indicators in which overall importance for pedestrian quality is assessed. The response options included not important, somewhat important, important, very important, and essential, on a scale from one-five. The responses are re-scaled to a scale from one-three for the final indicator scoring, and each response is weighted by the median value of its survey response score. The second question is indicator response categories in which relative importance of indicator response categories for pedestrian quality are evaluated. Within each indicator, indicator response categories were assessed on a scale of -five to +five (from extremely detrimental to ideal for pedestrians). The responses were re-scaled to a scale from zero-ten for the final indicator response category scores, and the response categories weighted by the median value of their survey response scores. In a few cases, indicator response categories required further refinement after the survey responses were received, those scores were informed by survey responses as much as possible. Some indicators were also added to the survey after the expert scoring survey was completed. In those cases, the indicator is assigned with the median weight of all the indicators in its PEQI domain category. To create the overall Street Segment, Intersection and other Domain PEQI scores, it is aggregated the Indicator Response Category Weighted Scores and standardized those PEQI summary scores so that the maximum score is “hundred” by multiplying that summed total by the corresponding Domain or Street Segment (Overall) weight.

PEQI scores reflect the degree to which environmental factors supportive of walking and pedestrian safety have been incorporated into street segment and intersection design. The PEQI scores street segments and intersections separately, on a scale from zero to hundred. Currently using the following categories are used for scoring, a priori, with equal intervals of twenty points for all categories: hundred-eighty one (highest quality, many important pedestrian conditions present), eighty-sixty one (high quality, some important pedestrian conditions present), sixty-fourth one (average quality, pedestrian conditions present but room for improvement),forty-twenty one (low quality, minimal pedestrian conditions) and twenty and below (poor quality, pedestrian conditions absent).After final scoring, ArcGIS is used to create maps to visually display street and intersection findings.

The data collection manual of PEQI can be found in Pedestrian Environment Quality Index (PEQI) – Data Collection Manual (N.D.) which is comprised of the following content: Introduction – Data Collection (Intersection Data Collection Form - Street Segment Data Collection Form) – Appendix A: Measuring Your Stride Length: Step-by-Step Instructions – Appendix B: Photo Database: How to Save and Name Your Photographs – Appendix C: Traffic Calming Features: Definitions.

Physical Activity Neighborhood Environment Scale (PANES)

Development and Aim

It was developed for International Prevalence Study of Physical Activity (IPS) (Sallis, Kerr, Carlson, Norman, Saelens, Durant, and Ainsworth, 2010) and was previously referred to as the IPS Environmental Module (O’Connor, Leach, Mama, and Lee, 2015). This neighborhood environment scale was developed by Jamis F. Sallis and B.E. Ainsworth with the goal of using pooled data from multiple countries to increase and maximize environmental variability beyond what was possible in single-country studies (Sallis, Kerr, Carlson, Norman, Saelens, Durant, and Ainsworth, 2010).

The target of IPS is to collect nationally representative, internationally comparable and valid prevalence estimates on physical activity from a diverse set of countries (Sallis, Kerr, Carlson, Norman, Saelens, Durant, and Ainsworth, 2010).

Scope and Content

PANES consists of seventeen-items regarding attributes of local built environment with neighborhood specifically defined as ten-fifteen minutes distance from the home (Xu, Leslie, Wang, Zhou, and Owen, 2016; Sallis, Kerr, Carlson, Norman, Saelens, Durant, and Ainsworth, 2010). It reflects the ideas about environmental correlates of physical activity likely to be internationally consistent (Oyeyemi, Babatunde, Oyeyemi, and Sallis, 2011).

There are seventeen questions that are categorized under three main subtitles (Xu, Leslie, Wang, Zhou, and Owen, 2016): seven core items (residential density, access to destinations, neighborhood infrastructure, and neighborhood safety), four recommended items (neighborhood safety, social environment, aesthetic qualities, and household motor vehicle) and six optional items (access to destinations, neighborhood infrastructure, street connectivity, and neighborhood safety). The items included in PANES are shown in Sallis, Kerr, Carlson, Norman, Saelens, Durant and Ainsworth, (2010, p. 535).

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

PANES uses a four-point likert scale ranging as strongly disagree, somewhat disagree, somewhat agree, and strongly agree. There are also do nott know/not sure and refused to answer options (Sallis, Kerr, Carlson, Norman, Saelens, Durant, and Ainsworth, 2010). This likert scale is valid for fifteen questions. There are exceptions; the item one which asks about the main type of neighborhood housing (to assess residential density) and the other is item eleven regarding the number of household motor vehicles (numerical value; 'do nott know/not sure') (Xu, Leslie, Wang, Zhou,and Owen, 2016). The scoring guide of PANES as mentioned above can be seen in detailed in Carlson and Sallis (2014).

PANES was found reliable in Swedish, Nigerian, U.S. adult samples (Xu, Leslie, Wang, Zhou, and Owen, 2016) and some African populations (Oyeyemi, Babatunde, Oyeyemi, and Sallis, 2011). It was also found adaptable for use in international studies with single items (Xu, Leslie, Wang, Zhou, and Owen, 2016).

<u>PIN 3 Neighborhood Audit Tool</u>

Development and Aim

PIN3 was developed by Evenson, Sotres-Alvarez, Herring, Laraia and Rodriguez in 2009 (Evenson, Sotres-Alvarez, Herring, Messer, Laraia, and Rodriguez, 2009). It was developed to evaluate the built environment in urban and rural North Carolina. The researchers and developers are encouraged to conduct this instrument in other geographic areas to confirm their applicability to different locations (Active Living Research, 2009).

Scope and Content

The audit evaluates the street-level characteristics that may have relation between walking and bicycling. It objectively measures the following criteria: arterial road or thoroughfare, walkable neighborhood, physical incivilities, and decoration (Active Living Research, 2009; MIDSS Measurement Instrument Database for the Social Sciences, N.D.).

PIN3 consists of five main categories with different questions under each: residential land use, non-residential land use, public, residential and non-residential space/aesthetics, walking and bicycling amenities, and transit and road characteristics.

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

The data collection method of PIN3 tool is not biased self-reporting but uses the census data which represents environmental characteristics (Suminski, Wasserman, Mayfield, Thelen, and Egger, N.D.).

The original version of PIN3 Neighborhood Audit Tool is a paper-based one. But to be adaptable with electronic devices, the paper version was adapted for data collection using handheld devices (Evenson, Sotres-Alvarez, Herring, Messer, Laraia, and Rodriguez, 2009). The paper version of PIN3 is in Active Living Research (2009) with the following content: Residential Land Use – Non-Residential Land Use – Public, Residential and Non-Residential Space/Aesthetics – Walking and Bicycling Amenities – Transit and Road Characteristics.

Scottish Walkability Assessment Form (SWAT)

Development and Aim

Like Pedestrian Environment Data Scan (PEDS), SWAT was developed based on the SPACES instrument which was developed in Australia (Millington, Thompson, Rowe, Aspinall, Fitzsimons, Nelson, and Mutrie, 2009; Ahmad, Schubert and Bush, 2016).

The aim of developing Scottish Walkability Assessment Tool (SWAT) is to objectively assess and evaluate the walkability aspect of the physical environment in the west of Glasgow, Scotland (Millington, Thompson, Rowe, Aspinall, Fitzsimons, Nelson, and Mutrie, 2009; Belfast Healthy City: A World Health Organization, 2014). It also aims to promote public health and well-being by relating it with activity of walking (Albers, Wright, and Olwoch, 2010).

Scope and Content

Although SWAT was developed based on SPACE instrument, SWAT focuses on the activity of walking rather than both walking and cycling as in SPACE (Millington, Thompson, Rowe, Aspinall, Fitzsimons, Nelson and Mutrie, 2009). In addition to this, SWAT objectively evaluates the physical environment characteristics that may have relation with the activity of walking in Scotland (Albers, Wright, and Olwoch, 2010).

As items included in SWAT, there are four main themes: functional, safety, aesthetic, and destination. Under these themes, the elements exist as follows: (Millington, Thompson, Rowe, Aspinall, Fitzsimons, Nelson, and Mutrie, 2009): functional (walking surface, permeability), safety (personal, traffic), aesthetic (streetscape, architecture, views) and destination (parking, land use mix, services, public transport and parks). The items included in SWAT was divided into elements and themes as in Millington, Thompson, Rowe, Aspinall, Fitzsimons, Nelson and Mutrie (2009, p. 477).

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

While collecting data using with SWAT, self-reported perceptual characteristics from local residents are gathered. The data gathered from residents are subjective, whereas trained auditors gather objective measures (Belfast Healthy City: A World Health Organization, 2014).

<u>Systematic Pedestrian and Cycling Environmental Scan (SPACES)</u>

Development and Aim

SPACES was developed by the researchers of the University of Western Australia in 2000 (Calgary Regional Partnership, N.D.; A Guide to: Systematic Pedestrian and Cycling Environment Scan (SPACES), N.D.). It was developed based on a study in which data was collected in relation to the physical environment in a four hundred and eight km2 area in Perth. Approximately, two thousand km of roads were audited during February and March 2000 (MIDSS Measurement Instrument Database for the Social Sciences, N.D.). During the development of SPACES, a two-stage process is used that features stakeholder interviews and a Delphi study in which a controlled and systematic communication process is used to strike a balance (Badland, Opit, Witten, Keams, and Mavoa, 2010).

The general aim of SPACES is to measure the physical activity related aspects of built environment (Pikora, Bull, Jamrozik, Knuiman, Giles-Corti, and Donovan, N.D.; Lee and Talen, 2014; Pikora, Giles-Corti, Knuman, Bull, Jamrozik, and Donovan, 2006). In detail, it also aims to evaluate the physical environment in local neighborhoods for the activity of walking and cycling (Premier's Council for Active Living New South Wales and NSW Centre for Physical Activity and Health, 2007).

Scope and Content

SPACES was developed as an environmental audit tool that focuses on the urban context of Australia (Lee and Talen, 2014). In addition to this audit, some additional tools based on Geographical Information Systems (GIS) are used (MIDSS Measurement Instrument Database for the Social Sciences, N.D.).

SPACES contains thirty seven items in total grouped into main four as following (Calgary Regional Partnership, N.D.; Romanow, Couperwaite, McCormack, Nettel-Aguire, Rowe, and Hagel, 2013): types of buildings and features, a general assessment of paths that could be used for walking and/or cycling; e.g. type, location, material, slope, condition, a general street assessment; e.g. number of lanes on a road, kerb type, traffic control devices, crossing facilities, presence of street lights, presence of destinations, car and bike parking facilities, opportunities for natural surveillance, garden maintenance, cleanliness and views, and perceived attractiveness and difficulty for walking and cycling. The detailed content of SPACES in comparison with some other tools like WSAF, IMI and PEDS can also be found in Lee and Talen (2014, p. 372).

The whole audit as paper version is in Active Living Research (2000) with three main groupings: A. Path for Walkingand/or Cycling – B. On-Road – C. Overall Assessment.

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

While collecting data, street segment is the basis for conducting the observation which is a section of street or road between two intersections (Calgary Regional Partnership, N.D.). Each street segment assessment is conducted by a trained researcher (A Guide to: Systematic Pedestrian and Cycling Environment Scan (SPACES), N.D.). For collecting data, observers walk through neighborhoods for answering the questions (Transportation Research Board Institute of Medicine of the National Academies, 2005). In addition to this, street maps are developed with coded street segments and starting points identified. The information is recorded directly on audit. After completing the whole audit, the researcher rates the overall score. For decreasing the chance of subjectivity, audit is accompanied by a detailed observers' manual (A Guide to: Systematic Pedestrian and Cycling Environment Scan (SPACES), N.D.).

In addition to the audit form, other information is collected using desktop methods and geographic information systems (GIS) like traffic volume and speed, street and intersection design, the location of local destinations such as parks, shops, and public transport points (Calgary Regional Partnership, N.D.).

The SPACES tool has a detailed user manual accompanying the audit (The detailed observers' manual is in Pikora (N.D.) with the following content: The Study – Street Segments – Preparing for the Audit – The Audit – Guidelines for Completing the Audit Form – Detailed Information About Each Question – Appendix 1: Sample Audit Form – Appendix 2: Maps).

Validity and reliability of SPACSE audit is proved as cited in several different following studies: A Guide to: Systematic Pedestrian and Cycling Environment Scan (SPACES) (N.D.), Badland, Opit, Witten, Keams, and Mavoa (2010), Oliver, Witten, Biakely, Parker, Badland, Schofield, Ivory, Pearce, Mavoa, Hicnkson, Sweetsur, and Keams (2015), Pikora, Giles-Corti, Knuman, Bull, Jamrozik, and Donovan (2006), Romanow, Couperthwaite, McCormack, Nettel-Aguirre, Rowe, and Hagel (2012) and Transportation Research Board Institute of Medicine of the National Academies (2005).

SPACES was also modified for implementation in New Zealand (Oliver, Witten, Biakely, Parker, Badland, Schofield, Ivory, Pearce, Mavoa, Hicnkson, Sweetsur, and Keams, 2015; A Guide to: Systematic Pedestrian and Cycling Environment Scan (SPACES), N.D.; Badland, Opit, Witten, Keams, and Mavoa, 2010).

Walking Suitability Assessment Form (WSAF)

Development and Aim

As it was cited by Clifton, Smith, and Rodriguez (2007), Walking Suitability Assessment Form (WSAF) was developed by Emery, Crump and Bors in 2003 aiming to examine and evaluate the characteristics that may have relation with pedestrian safety (Clifton, Smith, and Rodriguez, 2007).

Scope and Content

As the scope of WSAF, the eleven variables that compose the audit are mainly related to the basic transportation environment characteristics and the aspects of the pedestrian facilities and the street crossings (Emery, Crump, and Bors, 2003; Clifton, Smith, and Rodriguez, 2007).

These eleven variables of WSAF are as following: annual average daily traffic (AADT), posted speed (mph), number of thru lanes, sidewalk / path, material, surface condition, sidewalk width, buffer width, curb ramps, adequate lighting, and isolated problem spots.

In addition to these eleven variables, there are also some dual questions about the characteristics of intersections that the auditor encountered while evaluating the sidewalk and providing space for recording isolated problem spots. Actually, the information about the intersection is not included in the final score but it aids in identifying the problems (Emery, Crump, and Bors, 2003). WSAF also does not evaluate or assess some important walkability qualities like land uses, aesthetics, and other non-safety aspects (Clifton, Smith, and Rodriguez, 2007).

The assessment form is as in Emery, Crump and Bors (2003, p. 45). WSAF is also identified as one of the tools that is used for identifying affordances in walkability with PEDS, IMI, SPACES and NEWS (Kari, 2016, p. 19).

Methodology: Data Collection, After Auditing Process, Scoring and Other Versions

There is not a specific and particular scoring system which may allow a rapid evaluation of the level of safety for auditors (Clifton, Smith, and Rodriguez, 2007). The values that are recorded are summed up for getting the final walking suitability score. Specifically, if no sidewalk exists for the segment, the instrument produces a minimum score of ninety nine to denote the lack of pedestrian facilities (Emery, Crump, and Bors, 2003).

APPENDIX B

WEB-BASED WALKABILITY MEASUREMENT TOOLS (WMTs)

Maponics

Data Model of the Tool: Sources

Maponics uses ‘Intelligent Polygons’ to rate the areas by applying boundaries to neighborhoods, subdivisions, school attendance zones, and other real-life geographies (or geographic coordinates). They use the term ‘Intelligent Polygons’ for the geographic units created by Maponics. The ‘Intelligent Polygons’ takes into account several factors like the concentration of homes in the area, number of local amenities, number and type of streets, and intersections in the zone (Hagey, 2013). The ‘Intelligent Polygons’ are synchronized with Maponics boundaries to make it more useful. The polygons makes some several applications and industries more easily used (Maponics Surpasses Walk Score in Coverage, 2014). These polygons can also be used by variety of web-based and mobile geofencing apps to define boundaries for themselves (Marlow, 2013).

School Ratings Data is a type of data that helps business owners and realtors, home-buyers, and home-sellers evaluate and compare the school quality with the data they provide. This comprehensive data includes statewide school performance rankings, standardized math and reading test scores, and detailed school profiles applied to predefined geofences by Maponics (Marlow, 2013).

There are two kinds of data being collected for the context or the insight. The first one is Polygons, which are the databases of the boundaries and the second one is the Maponics context, which is about the all information that is going on inside the boundaries. In the Pitney Bowes website, there is a catalogue related to boundaries of Maponics called “Boundary Data Portfolio”. The boundary data are as follows: administrative, industry, and community (Boundary Data, N.D.). Administrative data covers census data (World Boundaries Premium - Geographic demarcations of country, state, district, cities, towns, locality, neighborhood, postal, and land-use boundaries), ZIP code boundaries (geographic demarcations of spatial and postcode boundaries), parcel boundaries (documents, maps, and other information that depicy rights and interest in property) and cadastral plus (intelligent map of land parcels in Australia). The industry covers communications suite (comprehensive location-based coverage of telecommunications and wireless systems), U.S. carrier routes (geographic boundaries for USPS mail carrier routes), CRESTA zones (worldwide zones of natural disaster risk as determined by the CRESTA organization) and Risk Data Suite (extensive peril datasets for mission-critical insurance analysis). Community includes neighborhood boundaries (delineates the geographies that matter most to customers in the areas where people live, work, and socialize), residential boundaries (residential areas in and around metro areas with houses, condos and apartment complexes), social place boundaries (comprehensive geofence product consisting of destination and venue boundaries, shopping boundaries, and college campus boundaries), hospital boundaries (data and attributes for more than four thousand nine hundred acute and emergency care hospitals and VA medical centers in the United States and over six hundred emergency care facilities in Canada), school district boundaries (comprehensive dataset that includes school districts, school attendance zones (SAZ), as well as public and private school locations) and metro boundaries (map boundaries of the top metropolitan areas across the United States and Canada – urban areas in which population concentration is greater than fifty thousand and population density is greater than one thousand people per square mile).

All the above boundaries are the geographic areas in which massive amounts of people either live, work, or play, which means that boundaries are not drawn arbitrarily drawn around dense populations. For setting boundaries, there are hundreds of demographics that are projected into polygons on the context side (Aquino, 2013).

In the boundary setting process, forty three employees of Maponics team source, compile, and process the related data and then license them to the customers (including some real estate websites, location, and mapping web-sites). According to the percentages and data of Maponics, seventy percent of the top real estate websites, some search companies (Google, City Search, Yellowbook USA), some direct marketers who wants to reach the country's highest income neighborhoods, and some social media websites (like Twitter, Foursquare and MyLife) use Maponics' 'geofences' data. Also, ninety five percent of social media users somehow interact with Maponics Data (Resmer, 2013).

Criteria/Scaling/User Profile of the Tool

The two best-known products of Maponics are Context Walkability and Context Commuter Scores, in which they cover more cities and neighborhoods than Walk Score's data on walkability, public transit, and bikeability (Marlow, 2013). There are more products of Maponics under the new suite they offered: "New Transportation Data Suite". This new suite includes Context Walkability, Context Bikeability, Context Commuter Scores, and Context Public Transportation. With this new data set, Maponics started to do research and calculations on how easy it is to bike, drive, and take public transportation for city dwellers within one of the geographic units. For producing this transportation suite, Maponics reviewed more than one hundred fifty thousand neighborhoods. In the research process, lifestyle and behavioral data of the searched neighborhoods are synchronized with real-life location-based geographies (Hagey, 2013).

Context Walkability is a tool that rates the walkability of neighborhoods, school attendance boundary zones, subdivisions, and other geographical areas. This new tool was offered by Maponics LLC in 2013 (Daily Real Estate News, 2013). Compared to the others, it can be the most comprehensive and most customizable walk rating solution on the private market (RET Staff, 2014). They deliver pedestrian-friendliness ratings that also takes into account of the size and the type of the streets, the speed limits, and other features within the selected neighborhoods (Resmer, 2013). They also use detailed demographic information, crime level information, and school rankings for calculating the walkability score (Adrashminburg, 2013). With the help of these social-life related data, Context Walkability gets street-smart with the lifestyle and behavioral analytics relating to mobility in geographical area. Complicated modelling is applied to the volumes of big data, and this modelling is transmitted to the results within Maponics' 'intelligent polygons'. This data set not only gives the overall rating, but also a specific data about the amenities and leisure. With these three ratings, a more detailed picture about the walkability of the neighborhood can be obtained (Marlow, 2013). In the data they provide, walkability ratings mainly represents the accessibility to Point of Interests (POIs) by walking like coffee shops, parks, schools, and restaurants (RET Staff, 2014). Context Walkability is not available for public use because the customers are required to license it when they want to use it. However, some local results about the walkability of some geographic data are shared by the product manager. The firm thinks that Maponics is the tool that was created in response to the increasing demand from the customers for the information (Resmer, 2013). However, the data is increasingly relevant to the homebuyers (RET Staff, 2014). The Context Walkability ratings range from zero to five including three scores: amenity POIs (including schools, shopping centers), leisure of POIs (coffee shops, pizza places) and overall (the combination of amenity and leisure).

Context Bikeability score summarizes the level of accessibility – both to leisure, amenities, and POIs available within the Maponics boundaries by biking. Bikeability scores are calculated with the usage of complex algorithms which covers the complexity of street intersections, speed limits, elevations, types of roads, length of time to bike to POIs, and the availability of POIs within the intelligent polygons (Marlow, 2013).

Context Public Transportation scores the level of accessibility to leisure, amenities, and overall point of interests by using the public transportation (like subways, buses, and trains). Each score is calculated using complex algorithms that consider how long it takes to walk to public transportation and the time spent in the public transportation travel to reach POIs. The data being used in Context Public Transportation is based on General Transit Feed Specification (GTFS) Data provided by public transit agencies **(**Maponics Surpasses Walk Score in Coverage, 2014).

In Context Commuter Scores, there are three ratings included – drivability, bikeability, and public transportation – in which the navigability of the area by multiple modes of transportation are rated (Marlow, 2013). The aim of this score is to determine the level of public transit access in the defined area. Context Commuter Score can be used by appraisers to choose the best neighborhood for buying houses (How Does Public Transportation Affect Residential Valuation and Appraisals?, N.D.).

Rather than having a crowd-sourced process, the company relies on the data obtained from data providers. A company runs simulations through the road patterns and networks to show and see how walkers and pedestrians reach where they want to go. Maponics tool mainly focuses on real estate purposes because the perceptions of people about the modes of transportation and access to the amenities affect where they want to live (Rival Metrics: Walkability vs. Walk Score, 2013).

One of the feathers in the cap of Maponics is how it addresses privacy concerns. In most of the marketing solutions, especially in mobile advertising, the tools, the websites, or the apps asks for the users definite or the precise location. For example, in Twitter, while the user is tweeting, the website uses the user's exact location "point" with the definite latitude and longitude, which is a bit terrifying case what a firm should not actually do. After being aware of this creepy situation, Twitter started to be employed by Maponics. With this this cooperation, the use of Maponics data allows users to disclose their exact point location as latitude and longitude, but lets the other know the user neighborhood they are in. Because the location data became more anonymous, some other companies may also start to use this data type for promoting the individuals who are actually at that point or location but do nott want to cough up their private data (Aquino, 2013).

Maponics' Context Walkability data rating either can be broken out from Maponics Context Suite or can be used together with the firm's other boundary-data related products. The smaller companies pay thousands for licensing the product whereas the larger companies pay in the tens of thousands per year for licensing and using the product (Hagey, 2013).

Countries/Locations Available in the Tool

Maponics is now available in several locations, neighborhoods, and regions of the United States (Maponics Surpasses Walk Score in Coverage, 2014).

Rate My Street

Data Model of the Tool: Sources

All the data of the tool comes from the users. In other words, the tool tries to create a crowd-sourcing data system based on the feedbacks and ratings received from the public users. The location data is also received from the Google Maps.

Criteria/Scaling/User Profile of the Tool

When the criteria of Rate My Street is checked, there are eight criteria and key factors of the tool (Neto, 2015): crossing the street, pavement width, trip hazard, finding your way, safety from crime, safety from traffic, clean/attractive, and disabled access.

All criteria can be evaluated with using a five-star rating system. Afterwards, the average of all criteria is taken than the average is summed up to the final walkability score of the street.

The tool Rate My Street is a very easy and user friendly interface that strikes everybody's fancy. Each and every user can get involved the tool to search for the walkability level of a street. In the homepage of the website, there is a large Google Map view. One can directly choose the location they want to look for with a marker or search for the wanted street from the search bar directly above the map and click 'Go'.

Figure B.1. Home Page of Rate My Street (Source: Rate My Street, N.D.)

If any earlier comments or ratings available in the system, user can see all these average ratings and comments made my other users.

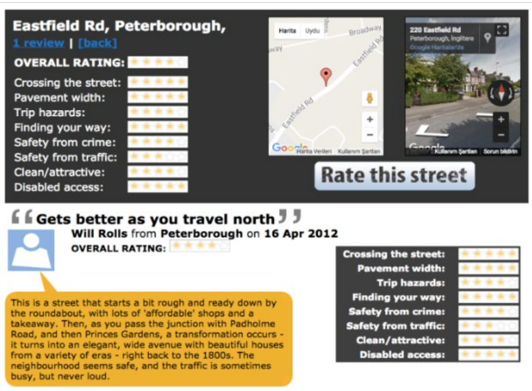

Figure B.2. Streets with Ratings and Comments of Rate My Street
(Source: Rate My Street, N.D.)

If there are no earlier comments or ratings for the searched location, the tool pops up with a new page offering the user to rate this street according to the set criteria with adding his name, the city he lives in. If he has a comment in addition to the rating, he can add his comment with giving it a title, then submit it.

Figure B.3. Streets without Ratings and Comments of Rate My Street
(Source: Rate My Street, N.D.)

Even though the users need to write down their names in order to add new ratings or comments, there is no need to login either for reviewing or adding ratings or comments. This "no log-in" requirement makes Rate My Street tool the ideal public consultation app that allows users to view quickly and easily. If enough ratings are submitted for a street and they are consistent, they are saved as the final walkability result of this street by the authority of the tool (Rate My Street, N.D.).

Because Rate My Street is still in Beta, it has some problems. For example, if the user tries to add a new comment and rating, but his sign-in name had already been used, there will be an error (Clarke, 2013).

Countries/Locations Available in the Tool

There are already more than ten thousand ratings submitted across worldwide locations including Hawaii, Chicago, Los Angeles, London, and Australia. Actually, Rate My Street can be available wherever Google Maps has a place's location and geographical information data (Retrieved from https://trlsoftware.co.uk/products/street_auditing/ratemystreet - Rate My Street, N.D.).

Walk Score

Data Model of the Tool: Sources

There are several different data sources of Walk Score for obtaining data and information according to the criteria they set as follows (Duncan, Aldstadt, Whalen, Melly, and Gortmaker, 2011; El-Geneidy, Lierop, and Wasfi, 2016; Langlois, Wasfi, Ross, and El-Geneidy, 2016; Xu and Wang, 2015): Google AJAX Search Application Program Interface (API), Localeze and Census, Open Street Map, Education.com, and

Transit Agencies. Google AJAX Search Application Program Interface (API) is an interface which is used to search the Walk Score database with URL calls. For using this interface, the researcher should first obtain a key number that can only be requested from Walk Score Website. This key number can be used for all API calls but only can be used for twenty four hours (Duncan, Aldstadt, Whalen, Melly, and Gortmaker, 2011). It can also be used for retrieving information about local amenities within a given distance of the location (i.e. 0.4 km) (Paez, Moniruzzaman, Bourbonnais, and Morency, 2013). Also, it can rapidly identify amenities in close proximity to an entered address and calculate a score of 'neighborhood walkability' on a continuous scale (Carr, Dunsinger, and Marcus, 2010). With the help of geography-based algorithm, it can identify nearby areas and calculate a score of walkability (Carr, Dunsinger, and Marcus, 2011). Front Seat also provides an application programming interface (API), which can be used to query the Walk Score database through URL calls, eliminating the need to use the website interface (Front Seat, 2011). In Localeze and Census, Localeze is used for obtaining the business and stores list according to the location (Chudyk, Winters, Moniruzzaman, Ashe, Gould, and McKay, 2015; Hirsch, Moore, Evenson, Rodriguez, and Diez Roux, 2013), whereas Census is used for gathering data about the United States density (Gilderbloom, Riggs, and Meares, 2015). Open Street Maps is used for obtaining data about the road network and the parks (Chudyk, Winters, Moniruzzaman, Ashe, Gould, and McKay, 2015; Hirsch, Moore, Evenson, Rodriguez, and Diez Roux, 2013). For gathering data about the number and location of the schools, Education.com can be used (Chudyk, Winters, Moniruzzaman, Ashe, Gould, and McKay, 2015; Hirsch, Moore, Evenson, Rodriguez, and Diez Roux, 2013). Lastly, to gather information about the public transportation, Transit Agencies (over two hundred transit agencies are data provider) are used (Chudyk, Winters, Moniruzzaman, Ashe, Gould, and McKay, 2015; Hirsch, Moore, Evenson, Rodriguez, and Diez Roux, 2013).

There is also an algorithm developed specifically for Walk Score for calculating the distance-walkability relation. Google Search Algorithm is used to find the amenities within a one-mile radius of an entered address (Brewster, Hurtado, Olson, and Yen, 2009). The algorithm uses a distance-decay function which grades each amenity based on its distance to the searched location (Brown, Pantin, Lombard, Toro, Huang, Plater-Zyberk, Perrino, Perez-Gomez, Barrera-Allen, and Szapocznik, 2013). In other words, this distance-decay algorithm evaluates how a searched location's immediate surrounding provides an opportunity for the activity of walking (Cole, Dunn, Hunter, Owen, and Sugiyama, 2015).

In the process of this algorithm, it calculates a linear combination of the Euclidean distance from the given location to the amenities (Xu and Wang, 2015). This algorithm is mainly based on the as-the-crow-flies distance of a given location to the amenities in the neighborhood (Kok and Jennen, 2012).

In addition to the distance from a given location to the amenities, Walk Score methodology also takes some other factors into consideration while evaluating a point's/street's/neighborhood's/city's walkability. "Pedestrian friendliness" is one of these parameters in which population density, average block length, intersection density, link/node ratio, and route directedness in the analyzed area are analyzed under this heading (El-Geneidy, Lierop, and Wasfi, 2016). "Land use mix" is also one of the leading predictors of walking behavior, which is placed by the highest priority in this methodology (Gilderbloom, Riggs, and Meares, 2015). "Other street network characteristics" like intersection density, roadway/street connectivity, block lengths (Sandt, Marshall, Rodriguez, Evenson, Ennett, and Robinson, 2016; Thielman, Rosella, Copes, Lebenbaum, and Manson, 2015; Winters, Sims-Gould, Franke, and McKay, 2015), and accessibility are also considered in the grading process (Yin, Cheng, Wang, and Shao, 2015). However, these variables were removed from the final model because the available Walk Score data is more comprehensive as a local accessibility measure (Manaugh and El-Geneidy, 2012).

Different types of amenities are graded according to their distances referring to the algorithm. Thirteen types of amenities under five evaluated categories are as follows: (Brown, Pantin, Lombard, Toro, Huang, Plater-Zyberk, Perrino, Perez-Gomez, Barrera-Allen, and Szapocznik, 2013; El-Geneidy, Lierop, and Wasfi, 2016; Lin, Xia, Robinson, Olaru, Smith, Taplin, and Cao, 2016; Kok and Jennen, 2012): education (schools and libraries), recreational areas (parks, and greenery areas), retail (bookstore, grocery store, and clothing shops), food (restaurant, coffee shops, and bars) and entertainment and leisure (cinema, and theatre). Banking, post offices, fitness areas and hospitals can also be added to the above list (Paez, Moniruzzaman, Bourbonnais, and Morency, 2013).

Walk Score can be easily used by manually entering the location that is searched from the main web page or through manually entering latitude and longitude coordinates for each image site into the search tool at the Walk Score Website (Harvey, Aultman-Hall, Hurley, and Troy, 2015).

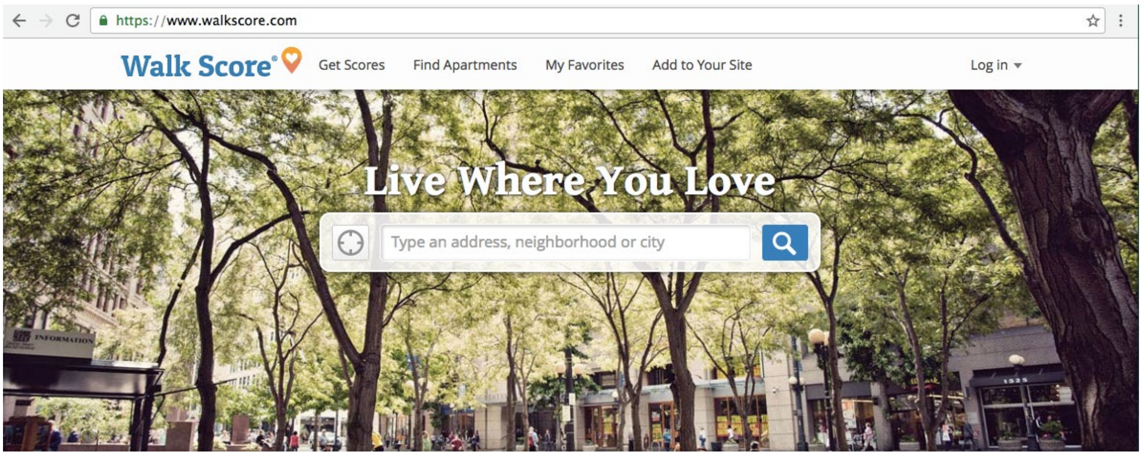

Figure B.4. Walk Score Main Page and Search (Source: Walk Score, 2019)

Criteria/Scaling/User Profile of the Tool

In Walk Score ©, there are seven criteria of walkable neighborhood as follows (Walk Score, 2016): a center (walkable neighborhoods have a center, whether it's a main street or a public space), people (enough people for businesses to flourish and for public transit to run frequently), mixed income/mixed use (affordable housing located near businesses), parks and public space (plenty of public places to gather and play), pedestrian design (buildings are close to the street, parking lots relegated to the back), schools and workplaces (close enough that most residents can walk from their homes), and complete streets (streets designed for bicyclists, pedestrians and transit).

For the grading, each amenity at a different distance gets different walkability score. If the amenity is located within a 0.25 miles (0.4 km) radius from the searched point/location, this amenity is assigned a full score. Fewer points are assigned where the amenity distance is 1.6 km. If the destination to the amenity from the given location is more than 1.5 miles (thirty minutes walk), these addresses are not taken into account while finalizing the Walk Score © (Chudyk, Winters, Moniruzzaman, Ashe, Gould, and McKay, 2015; Cole, Dunn, Hunter, Owen, and Sugiyama, 2015).

Each category of amenities was weighted equally and the scores will be normalized to the score scale starting from zero (the lowest) to hundred (the highest) (Lin, Xia, Robinson, Olaru, Smith, Taplin, and Cao, 2016). The whole scale of the Walk Score is as below (Figure B.5):

Walk Score®	Description
90–100	**Walker's Paradise** Daily errands do not require a car.
70–89	**Very Walkable** Most errands can be accomplished on foot.
50–69	**Somewhat Walkable** Some errands can be accomplished on foot.
25–49	**Car-Dependent** Most errands require a car.
0–24	**Car-Dependent** Almost all errands require a car.

Figure B.5. Walk Score Methodology (Source: Walk Score, 2019)

Actually for now, Walk Score is mostly used by real estate brokers and realtors for materializing and capitalizing the value of walkability (Arribas-Bel, 2014). It is an important value for them while selling or renting houses for residents. In addition to its monetary value, Walk Score was started to be searched and discussed both empirically and theoretically in academic field.

Countries/Locations Available in the Tool

Walk Score is now available in all of the United States and several addresses in Canada, Australia, New Zealand, England (United Kingdom), and Ireland (Barnes, Winters, Ste-Marie, McKay, and Ashe, 2016; Duncan, 2013). However, no maps for Asian cities or developing countries have not been produced (Çubukçu, Hepgüzel, Önder, and Tümer, 2015).

Walkability Asia

Data Model of the Tool: Sources

The main source of Walkability Asia is users' feedbacks or reviews. In other words, Walkability Asia uses crowd-sourcing in which pedestrians review the audit questions in the area or street they walked. Afterwards, all the reviews provide an overview of the current infrastructure and policies in this area which can be used to develop and propose pedestrian-focused solution. The rating system used is from zero (lowest) and hundred (highest) (Figure B6): lowest walkability – red (zero-fifty), average walkability – yellow (fifty one-seventy), highest walkability – green (seventy one-hundred) and unsafe street – black. The audit tool can be only used and reviewed as mobile app. In the website, these reviews can be only seen, but no any new reviews can be added.

Figure B.6. The Interface of Walkability Asia Website (Source: Clean Air Asia, N.D.)

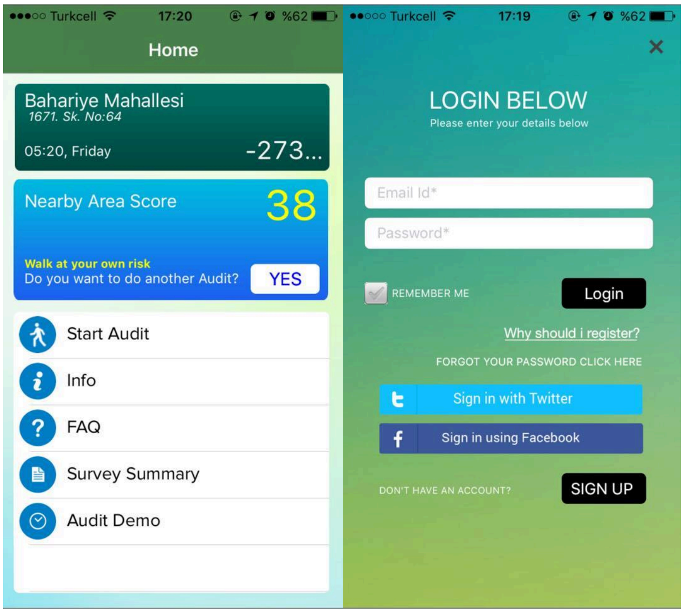

Figure B.7. The Homepage and the Login Interface of Walkability Asia Mobile App (Source: Walkability - Walkability Asia, 2015)

As the working procedure of the mobile app, there are nine questions to review the selected area with six possible answers each. After answering all questions, the user submits his review. For submitting the review, login is required either with e-mail, Facebook, or Twitter.

Criteria/Scaling/User Profile of the Tool

As criteria for rating the walkability by mobile app, there are nine questions with six given answers for each. In other words, while answering the questions, the auditor is asked choose between the given multiple choices. The first question is the level of conflict that one faces while walking along the street or road. The second question is the availability of the walking paths, and their overall condition and quality. The third question is the availability of the crossing paths, and their overall usability level, and overall quality. The fourth question is the overall quality of the crossing points. The fifth question is the availability and variety of the amenities along the walk, which can be either natural (trees) or man-made (signboards, benches). The sixth question is the presence of disability infrastructure and its overall condition. The seventh question is safety from crime due to some physical precautions like the height of the walls, the lighting quality, and presence of vendors. The eighth question is the motorists' behavior towards pedestrians. The ninth question is the presence of obstructions like the physical dimensions of the walkway, permanent obstructions like dustbins, and parked vehicles.

Each questions' screenshot can be found in Appendix P with their six given choices. As a sample, Figure B.8 can be checked.

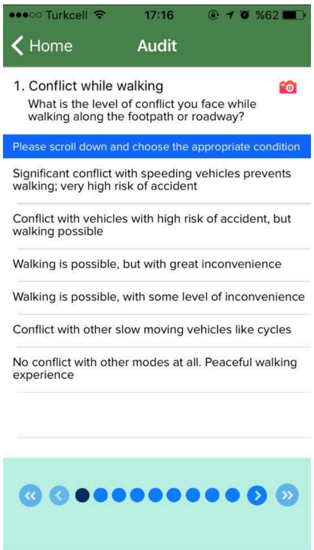

Figure B.8. Sample Question Screenshot of Walkability Asia Mobile App
(Source: Walkability - Walkability Asia, 2015)

Countries/Locations Available in the Tool

Walkability Asia Mobile App can be used for the walkability reviews of the users only in the following cities: Lanzhou, Bangalore, Bhaktapur, Bhubaneswar, Cebu, Colombo; Sri Lanka, Davao, Hanoi, Ho Chi Minh City; Vietnam, Hong Kong, Indore, Chennai, Islamabad; Pakistan, Jakarta; Indonesia, Karachi, Kathmandu, Kota; India, Male; Maldives, Manila; Philippines, Pokhara; Nepal, Pune, Rajkot, SAR; China, Surat, Ulaanbaatar; Mongolia, and Vientiane.

Walkonomics

Data Model of the Tool: Sources

There are three main data sources of Walkonomics: open-source data (Open-Data), crowd-sourcing, and WalkoBot. In Open-Data, there are thousands of datasets for public use. The related ratings generated from Open-Data are as follows: street widths, traffic levels, three hundred and eleven cleanliness reports, gradients, crime statistics, pedestrian accidents, and how many on each street (Vivion, 2013). In crowd-sourcing, users can add their own ratings and reviews. Rather than only relying on statistical information, Walkonomics also benefited from crowd-sourcing information (Friedlander, 2012). Users can add their ratings to each rating and also can add geo-referenced photos for these streets (Camuti, 2015). In WalkoBot, a computer model is used for modelling the walkability analysis of the streets and neighborhoods (Graham Richard, 2013).

Criteria/Scaling/User Profile of the Tool

There are eight different factors for Walkonomics' criteria (Walkonomics – About, 2011): road safety (How safe do you feel from traffic on this street? It is influenced by actual road accident statistics (where available), street type, traffic speeds and activity.), easy to cross (How easy it is to cross the street at regular points along the street? It is influenced by the traffic activity on the street, street width, physical barriers and provision of pedestrian crossings.), pavements/sidewalks (Are pavements/sidewalks provided along the street? Are they high quality? Are they wide enough? Do they have a lot of unnecessary clutter/furniture on them? Are they overcrowded?), hilliness (Is the street flat or on a hill? How steep is any slope? If the street is steep, then are any hand-rails or seats provided?), navigation (How easy is it to find your way around in this street and area? Is it easy to become lost here? Are any street names, pedestrian signs or maps provided?), fear of crime (How safe do you feel from crime on this street? It is influenced by actual crime statistics (where available) as well as perceived fear or crime. Other factors include lighting, vandalism, graffiti and presence of police.), smart and beautiful (How clean is the street? Is there much litter or vandalism? Is it regularly cleaned? Does the street have any trees or other green vegetation? Are the buildings attractive and in good condition?), and fun and relaxing (Is this a fun, interesting and popular place to be? Are there things to do in this street? Would you choose to spend time and hang-out here? Does the street have a relaxing atmosphere? Is it noisy or stressful? Can you play in this street?).

These categories are based on the findings of Methorst, Hector, Risser, Tight, and Walker (2010) and Ramirez, Hoehner, Brownson, Cook, Orleans, Hollander, Barker, Bors, Ewing, Killingsworth, Schmid, and Wilkinson (2006) who identified potential indicators associated with walkable and bikeable locations (Biernecka-Lievestro, 2014).

With its own rating system, there is a five-star-based rating system for each of the eight factors (Goodyear, 2013). In cases of non-existing data like pavements or sidewalks, an average score, which is two point five, is assigned (De Cambra, 2012).

Different than other walkability measurement tools that are mostly based on the shortest route with many amenities, Walkonomics also added a slider feature itself which chooses the most beautiful one filled with streets and parks (Walkonomics – About, 2011). In other words, the tool lets the users to choose also the most scenic route and lets the users balance the beauty and the speed by mapping the routes (Rudgard, 2015). For now, the "beauty" metrics only searches for the route filled with trees and parks. For future improvements, Adam Davies has an idea to make the "beauty" metric more nuanced, incorporating the locations of the historic monuments and buildings, supported with user comments and ratings (Peterson, N.D.).

As the working procedure of Walkonomics, there are some differences in web tool or mobile application. In the website, you can search for the specific location or the street with its place name or postcode. Afterwards, the kilometers around the specific location for search zone is selected as one of them: one km, five km, ten km, fifteen km or twenty km. Then, the five-star ratings, comments, and color-coded map is pop up in the new page. In the mobile app, there are three different search options. In the first one, "Nearby", the one can check for the walkability ratings of his immediate surrounding or neighborhood. In the second one, "WalkHood", the user can search for the closest amenities to his specific current location within five-minutes' walk. The one can change the amenities that he is looking for between these options: drink, food (in. Grocery), shopping, fun/attractions, education, health/pharmacy, bank/ATM, transport and hotel. In the third one, "Routes", the one first enters the route he wants to walk with "from" location and "to" location. Afterwards with the slider one fast on one side and the beautiful on another, he should decide between how beautiful or fast route he is looking for, then searches. As the result, the app gives him the best route that meets with his demands or needs.

The walkability analysis results are first turned out into five-star rating for each criteria and then, the overall walkability score (Davies, 2012). Also, the walkability ranking of each street is presented on a Google Map with a little pin like in Google or Apple maps (presents the results on Google Map) (Clarke, 2013). The colors being used in color-coded pins are green (for highest walkability rating), yellow (for average walkability rating), and red (for lowest walkability rating) based on how good they are on walking (Kachler and Walker, 2014). This color-coded presentation helps users to understand the overall walkability of the area and guide them to choose the best route they want (Treacy, 2012). As mentioned by Adam Davies, for future versions, they will change the walkability map presentation into a map in which each street is painted with different colors according to their walkability ratings rather than only pins (Mott, 2012).

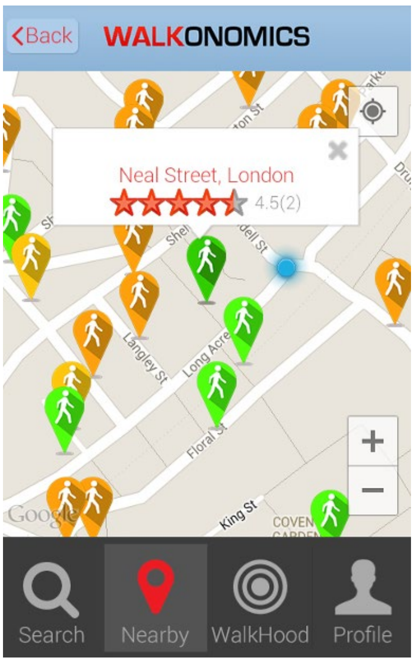

Figure B.9. Mobile App Screenshot of Walkonomics – Nearby
(Source: Walkonomics Navigation and Maps, 2016)

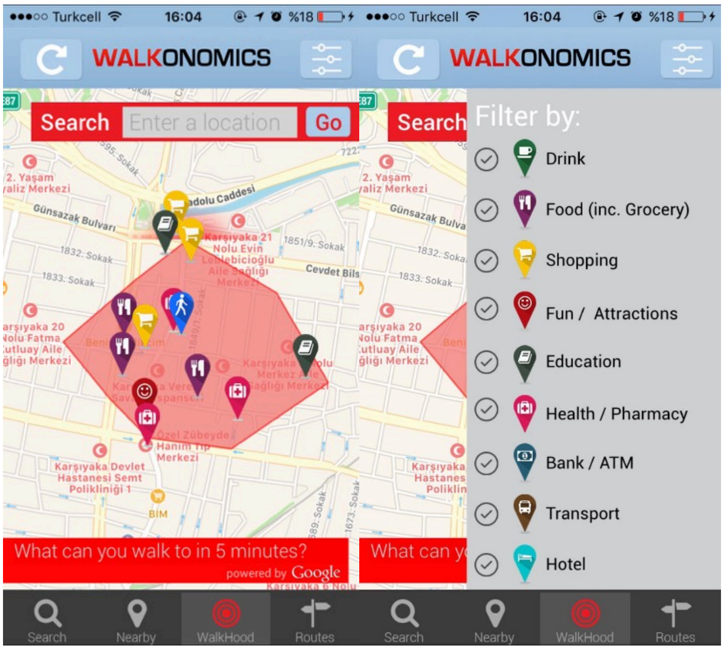

Figure B.10. Mobile App Screenshot of Walkonomics – WalkHood

(Source: Walkonomics Navigation and Maps, 2016)

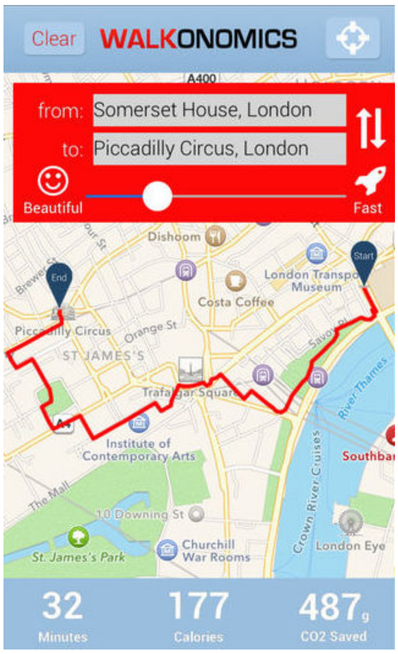

Figure B.11. Mobile App Screenshot of Walkonomics– Routes

(Source: Walkonomics Navigation and Maps, 2016)

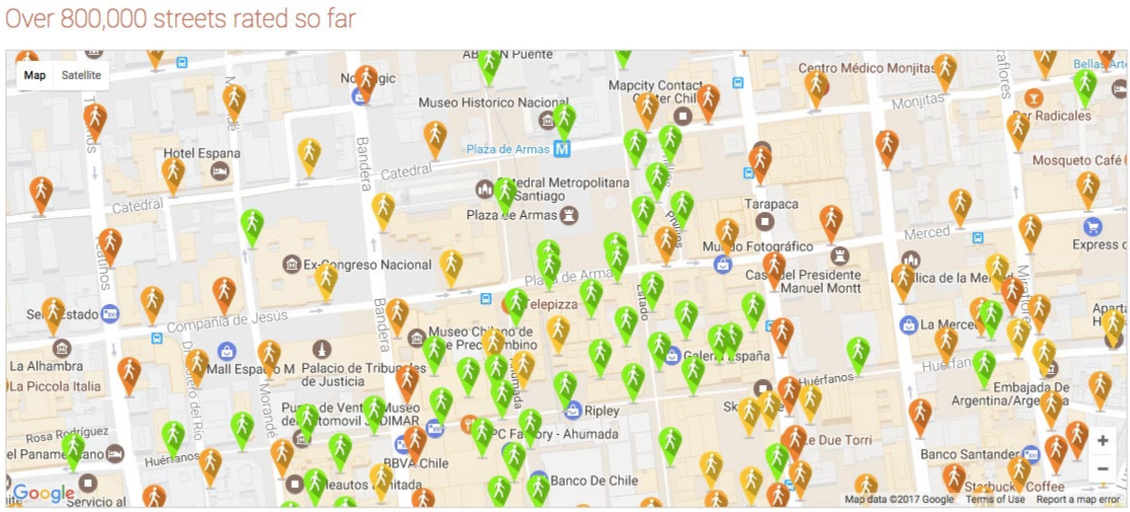

Figure B.12. Color-Coded Markers of Walkonomics (Source: Walkonomics, 2019)

Countries/Locations Available in the Tool

Walkonomics can be used in these following ten cities: Buenos Aires, Central London, Glasgow, Hamburg, New York, Paris, San Francisco, Santiago, Toronto, and Washington DC (Davies, N.D.).

<u>Walkshed</u>

Data Model of the Tool: Sources

For the mapping and GIS data obtained in Walkshed, the main data sources are Google Maps and OpenStreetMap (Clarke, 2013).

According to the seventeen criteria of Walkshed-New York and nineteen criteria of Walkshed-Philadelphia, there are different data sources for each item as follows. For New York, the data sources used are: Bing, NYC Data Mine, NewYorkOnTop.com, NYTurf.com, Azavea, and Littleviews Travel. For Philadelphia, the data sources used are: InfoUSA, Azavea, the City of Philadelphia, PhillyCarShare, USGS, the Philadelphia Police Department, and Bing.

Criteria/Scaling/User Profile of the Tool

The scope and meaning of walkability can differ from one to another. That is why Walkshed made it possible to dynamically account and take into consideration each individual's preferences by giving relative weights to each factor before finalizing the data through using Azavea's Decision Tree calculation engine (About Walkshed, 2010). By using Decision Tree (Avencia's geographic planning and priorization software), users can assign different and personal weights to each amenity in the system. With the help of Decision Tree, Walkshed lets people to calculate the locations that best meet with their preferences – weighted criteria and turning out into a personal heat map which reflects their scenarios (Avencia Launches Walkshed.org to Calculate and Map Walkability Based on Individual Preferences*,* 2016).

While evaluating the walkability of neighborhoods by users, for New York; there are seventeen criteria and for Philadelphia; there are nineteen different criteria from the scale minus five to plus five. The criteria set for New York and it's data sources are the following: grocery stores (Bing), farmers' markets (NYC Data Mine), restaurants (NYC Data Mine), bars (NewYorkOnTop.com), coffee shops (restaurant, Wi-Fi hotspots and sidewalk cafe data from NYC Data Mine), MTA subway stops (NYTurf.com), PATH shops (NYC Data Mine), Zipcar (as manually entered by Azavea), parks and recreation (NYC Data Mine), playgrounds (NYC Data Mine), cultural centers (NYC Data Mine), Wi-Fi hotspots (NYC Data Mine), bookstores (Littleviews Travel), libraries (NYC Data Mine), post offices (NYC Data Mine), pharmacies (Bing), and hardware stores (Bing). The criteria set for Philadelphia and it's data sources are as the following: grocery stores (InfoUSA), farmers' markets (as manually entered by Azavea), restaurants (InfoUSA), coffee shops (InfoUSA), bars (InfoUSA), rail stops (SEPTA rail stops from the City of Philadelphia), bus stops (SEPTA bus stops from the City of Philadelphia), PhillyCarShare Pods (PhillyCarShare), Zipcar (as manually entered by Azavea), parks (City of

Philadelphia), tree cover (density from USGS), violent crimes (density of violent crimes – including homicides, aggravated assaults, rapes and robbery – from the Philadelphia Police Department), illicit activities (density of illicit activities – including narcotics arrests and prostitution – from the Philadelphia Police Department), libraries (City of Philadelphia), bookstores (InfoUSA), pharmacies (Bing), hardware stores (Bing), fitness centers (InfoUSA), and clothing retails (InfoUSA).

The most distinguishing aspect of Walkshed that differs it from other apps is the term "friction-based". Walkshed incorporates this concept for reflecting the relative ease or difficulty of walking in urban environment (Avencia Launches Walkshed.org to Calculate and Map Walkability Based on Individual Preferences, 2016). For the best accuracy, they are using "friction-based" (*or cost-based)* distance calculations in lieu of straight distances. While making calculations, Walkshed is worked by laying a grid plan of thousands of cells over the entire city and the 'friction' is decided with the pedestrian encounter for each cell. For Walkshed, the 'friction' has important effects on the issue of walkability. Barriers have negative impact on walking distances because pedestrians typically and normally do nott walk through highways or on water. Street connectivity is also some other important issue for 'friction'. Winding, disconnected and sprawling streets - *like cul-de-saces* - surely have longer walking distances than grid urban patterns.

After all the walking frictions for pedestrians are decided for the entire city, optimal and actual walking distance can be calculated from each and every point in the city to the closest amenities in every category (About Walkshed, 2010). In other words, instead of using "as-the-crow-flies" distance for distance calculation, actual walking distance can be calculated via "friction-based" understanding. In many cases, while calculating the actual walking distances, "as-the-crow-flies" distances cannot be accurate enough because of the presence of barriers (rivers, highways), disjointed street networks, and extreme topography. When it was calculated via "as-the-crow-flies" distance, an amenity can be seen within a quarter mile, but being bound to the street grid can considerably increase the walking distance and duration. Each friction in the walking path is different than each other. Buildings, highways, rivers, or other physical barriers have higher friction values, while parks and sidewalks have lower friction values (Avencia Launches Walkshed.org to Calculate and Map Walkability Based on Individual Preferences, 2016).

When it comes to the user step, Walkshed lets users select and prioritize within a number of indices. After the user select their priorities with grading them, a heat map that highlights the walkable neighborhoods comes into view (Steiniger, Poorazizi, and Hunter, 2012). Within these interactive and personal heat maps, the amenities are also graded according to their distances within the selected area (Moura, Cambra, and Gonçalves, 2017).

During the working process, user should first decide in which city he wants to make a walkability analysis. After the decision-making process, the user should click either on New York or Philadelphia on the main webpage. Subsequently, a new page will be opened with a big Google Maps view of the selected city. There is also a search tab above the map for a detailed location search; for example, a specific location in New York. When the user searches for this location, the map switches to this point. Then, the walkability searching process starts. On the righthandside, there are a set of criteria that can be changed according to the priorities of the user. The user should set priorities for the each criteria than click 'Calculate Walkshed'. As the final result, the program shows the walkability score that results from the meat map. In this score part, one means the lowest and hundred means the highest walkability score. Also, the lowest scores are symbolized with red, whereas the highest scores are visualized with green color.

Walkshed uses the same concept with Walk Score, and users can set their priorities in terms of amenities that are important for them. After the location is chosen and the priorities are set by the user, a heat map is generated as the final result of the walkability analysis that meets the needs of the user most (Top 10 Websites – 2010, N.D.).

2.2.6.3. Countries/Locations Available in the Tool

Until today, there is only one country and two cities covered in Walkshed: New York and Philadelphia (Clarke, 2013).

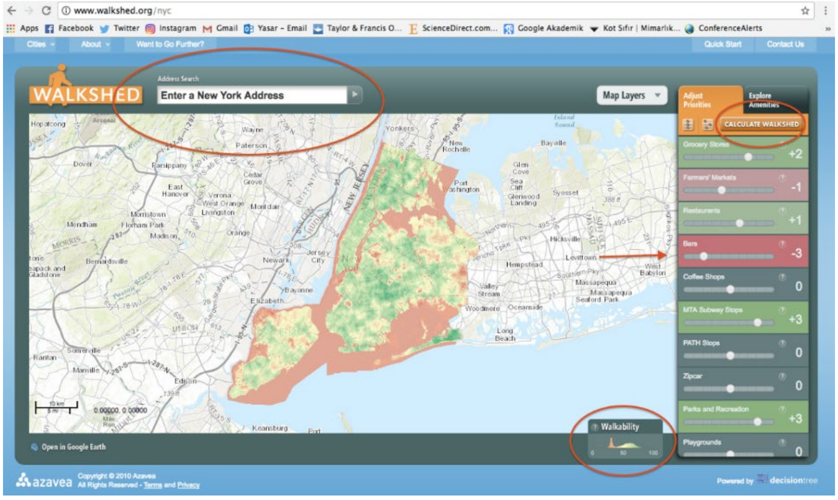

Figure B.13. Walkability Searching and Calculation Interface of Walkshed (Source: About Walkshed, 2010)

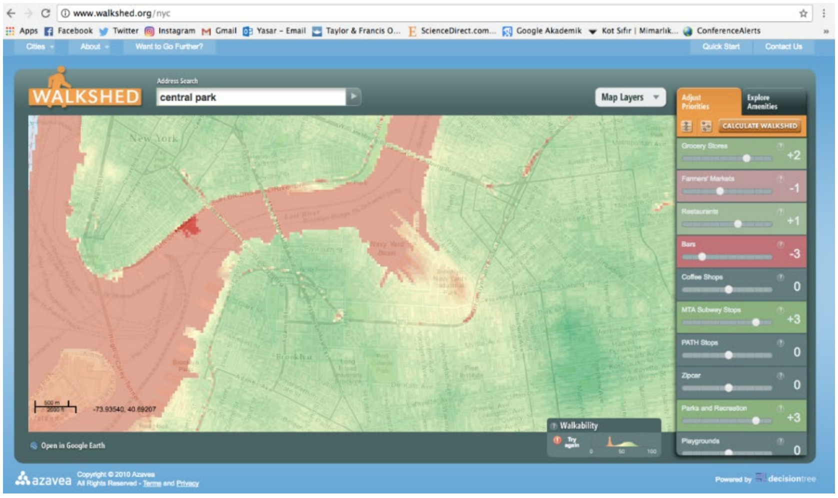

Figure B.14. Example of the Final Result of Walkshed – Heat Map (Source: About Walkshed, 2010)

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JOURNAL PUBLICATIONS

- Altay, B., Ballice, G., Bengisu, E., Alkan-Korkmaz, S., and Paykoç, E. (2016). Embracing User Experience in Inclusive Design Education through Learner-Centered Instruction. *International Journal of Inclusive Education, 20*(11), 1123-1141. http://dx.doi.org/10.1080/13603116.2016.1155662 (SSCI, Scopus)
- Ballice, G., and Paykoç, E. (2014). Re-Architecture of Existing Building Stock with Sustainable Approach: The Analysis of the City of İzmir. *Journal of Environmental Protection and Ecology, 15*(4), 1610-1618. (SCI Expanded, Web of Science, Scopus)