THE MEASUREMENT OF WALKABILITY IN VILLA-TYPE NEIGHBORHOODS: USING HPE'S WALKABILITY INDEX. CASE OF JEDDAH CITY, SAUDI ARABIA

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Abstract

One of the main elements that make open spaces livable, friendly, and healthy is walkability. Walkability has attracted much attention from urban designers and architects in recent decades. Cities that did not take into consideration the walkability key principals during the planning process are now facing several urban issues such as the lack of safety, friendliness, and a sense of freedom for the public. Therefore, applying walkability in urban design has now become more crucial than ever before. Saudi Arabia, being an Islamic state, requires mosques in the neighborhood to be at the center of the residential blocks within the walkable distance that can be used five times a day for the prayers. Since the demolition of the city walls of old Jeddah, Jeddah City has become the second-largest city of the Kingdom of Saudi Arabia, and as a gate to the holy city of Makkah. With the rapid expansion, several issues related to pedestrianization have risen, such as the increase in the ratio of fatal car accidents along with some cases of residential violations. This has led the municipality to set up a strategy to determine the priority of amenities, infrastructure development, and advancement of the built environment of planned neighborhoods (Jeddah Magazine, 1st April 2016). Thus, responding to the needs for the development of planned neighborhoods, and the built environment, this study aims to 1) Make arrangements for the development of planned neighborhoods in Jeddah, 2) Clarify to what extent Al-Andalus district and Al-Naeem District villa-type neighborhoods are walkable in Jeddah City using Hall Planning & Engineering's Inc. (HPE) Walkability Index, and 3) Identify the existing issues in villa-type neighborhoods and come up with a method so that such issues can be avoided in the prospective neighborhood planning.

The methodology of this study is 1) Survey villa-type neighborhoods combined with the chronological growth of Jeddah City. This survey was carried out by using data such as city land use map from the Jeddah Municipality, occupancy of each neighborhood from the General Authority for Statics, and other related studies. After achieving this, the author then sorted them into different categories (establishment date of each district). The districts selected for this research area) Al-Andalus District. as an old district. which was established in 1979, b) Al-Naeem District. as a new district. which was established in 2007. These sites were selected to represent the old villa-type neighborhood and a new villa-type neighborhood to be tested in this study. 2) Apply the measurement tool of HPE's Walkability Index to these two districts. A pilot survey for 25 days during April 2019 was also carried out. The measurement consists of evaluating all factors of HPE's walkability Index, such as vehicle's flow speed during non-peak hours (measured with a speed gun, using Pocket Radar Personal Speed Radar with an accuracy of +/- 1 MPH (+/- 2 KPH) ISIN: B003IM6YAM), width of pavement at each pedestrian crossing, availability of parking on-street, width of sidewalk, pedestrian connectivity, availability of different facilities and features for pedestrian features, street enclosure, use of available land, design of façade, and finally the availability of transit and/or bicycle features. 3) Analyze the results of the survey to identify the current issue of the built environment for each category. This study concluded that there is a remarkable correlation between the total score of HPE's and the establishment date of each neighborhood and in each category of the neighborhoods. Based on the results, the walkability level in Al-Naeem District. is moderately walkable whereas in the Al-Andalus District. it has basic walkability. The results also show that the municipality must revise and develop the existing regulation and standards of the neighborhood development to enhance the principle of walkability by studying the factor of vehicle's flow speed, width of pavement, availability of parking on-street, width of sidewalk, pedestrian connectivity, presence and quality of pedestrian features, and enclosure of the street.

Key words: Pedestrian Environment; Audit Tool; Public Space; Residential Building Type

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1. Introduction

1.1   Research Background

Saudi Arabia is an important Islamic country. Most Muslims intent to visit Saudi Arabia due to the presence of holy places such as the holy mosque Al-Haram. Muslims pray five times a day and perform all other activities such as shopping, schooling, jogging, business, etc. Muslims preferably perform prayers in mosques, and this is why mosques are the basic and necessary part of residential districts of Saudi Arabia. At the time of prayer or Azan, there is an increase in the pedestrian environment. With the rise in the pedestrian environment, the risk of pedestrian accidents has risen significantly. Most of these cities have a higher ratio of motorbikes and cars as compared to other cities in the country. Saudi Arabia currently has a car ownership ratio of 0.349 which is lower than some other countries such as Spain which has a car ownership ratio of 0.504 (List of countries by vehicles per capita, 2019). As suggested by the Jeddah strategic plan of 2010, it is expected that this ratio will increase for Saudi Arabia due to an increase in population and economic growth (Jeddah Strategic Plan,2010).

From the cultural and economic perspectives, Jeddah is an important city in the Makkah region as well as for all Saudi Arabia being the second biggest city in the country. Jeddah is the hub for the pilgrims coming from all over the world to Makkah and Medina and is also renowned for being the region of the oldest fishing settlement of as long as 2500 years ago. The historical value and area of this city distinguish it from other Saudi Arabian cities (Al-Balad; Figure. 1, left map). This area comprises of different elements such as walkable and urban fabric, its unique buildings, fulfillment of the needs of the society, and other different key elements.

Figure 1. **Map of Saudi Arabia (right) & Jeddah Governorate area (left)**

Source: (Maddah, Song and Deguchi, 2016)

1.2   Urban Development of Jeddah City

From 1509-1947, Al-Balad had a boundary wall all around it (Historical Place); however, in 1947, the Saudi Arabia government removed this wall for the expansion of Jeddah city. Due to some geographical constraints, Jeddah city is restricted to growth towards the northern and south-eastern areas. Al-Sarwat mountain is in the east of the city while the Red Sea is in the west. To the south of the city, there is presence of the country's naval base. Due to the removal of the wall, the population of the city has grown rapidly. In 1947, Jeddah city population was only 35,000, but in 2010 its population was 3.3 million, and it is expected that in 2029 Jeddah's population will

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reach a staggering 5 million. In 1947, the urbanized area of Jeddah was just 300 hectares however, by 2009, this region has expanded to over 176,500 hectares (Jeddah Strategic Plan,2010).

Due to all the growth and development, Jeddah city has turned into a modern car-oriented city from a pedestrian and walkable city. Now Jeddah municipality has started to impose many different strategies to make this city a pedestrian-oriented city. However, to implement such changes in the city in an effective way, there are many different issues faced by the municipality (Jeddah Strategic Plan,2010*)*. According to the Jeddah municipality, some of the existing pedestrian environment of the city is not safe enough for the people because of the increase in pedestrian casualties in the city. In 2006, Jeddah city faced almost 1,165 pedestrian casualties in which 139 were serious. In 2007, Jeddah city faced almost 170 such casualties (Jeddah Strategic Plan,2010*)*. Illegal parking is also increasing in the city due to the shortage of parking spaces. Illegal parking is also known to lower the walkability score of a region as people may park their cars in locations where people were supposed to walk such as on sidewalks.

1.3 Research Objectives

Due to the changing trends of increase in population, car accidents due to rise in pedestrians and motorists and increase in the ratio of car ownership makes it important to improve the following issues: 1) Lack of walkability, and 2) Defining better use of streets such as addition of parking and proper sidewalks.

The research objectives for this study are: 1) Make arrangement of the chronological growth of planned neighborhoods in Jeddah city (section 2), 2) Clarify to what extent Al-Andalus district (established in 1979) and Al-Naeem District (established in 2007) villa-type neighborhoods are walkable in Jeddah City based on HPE's walkability index (Section 3).

1.4 Research Methods

To accomplish the aforementioned objectives, data was collected from several competent authorities and past researches on the topic. A pilot survey was conducted in both old and recent villa-type neighborhoods. A pilot study helped us better analyze our research techniques before carrying out comprehensive research. The methodology was carried out using the following procedure.

1.4.1 Previous Studies

Different studies on the selected research have been conducted in different locations such as Al-Balad (Abu-Ghazzeh,1994) and (Soliman, 2010), commercial areas (A Murad, 2007), planned neighborhoods (Maddah and Deguchi, 2015) and waterfront (Soliman and Amin,2007). Some surveys and studies are about the urban process of Jeddah city such as city planning (Daghistani,1993) and urban growth (Abdu, Salagoor and Al-Harigi, 2002); (Al-Shafie,2010) and (Mandeli, 2008). Some studies also have been conducted on housing-related issues such as housing shortage crisis (Al-Otaibi, 2004), residential locations (Mousalli, 1999), and affordable housing (Salama,2006). Researches have also worked on environmental problems (Vincent, 2004) and flooding (Momani and Fadil, 2010). Many types of researches about pedestrian and motorization issues have also been conducted in planned neighborhoods (Maddah, Song, and Deguchi, 2016). Though quite some researches regarding Jeddah city problems such as housing

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problems and urban processes have been carried out, none have focused on the walkability index in planned apartment-type and villa-type neighborhoods of Saudi Arabia. Hence, it is important that in-depth research is carried out on different villa types of neighborhood walkability and whether this neighborhood meets the needs of its residents.

1.4.2 Pilot Survey

The pilot survey was done for 25 days in April 2019. The pilot survey helps us better understand whether our mode of data collection and the selected variables are capable of producing reliable and accurate results. The pilot survey also saves the researchers with time and resources as an issue with the study variables or methods that can be easily identified earlier rather than being identified at the end of the research. A pilot survey also helps us to better structure out the survey models and yield good results. The measurements in the pilot survey consist of evaluating all factors of HPE's walkability Index (out of 100 as total), which are divided into four main categories. These four categories are urban design, street design, transit/bicycle feature and urban design. These four main categories are then divided into ten sub-categories. All these categories are discussed below.

1.4.2.1 Street Design (30 Points)

1) Non-peak hour vehicle's flow speed. The data is measured with a speed gun, using Pocket Radar Personal Speed Radar with an accuracy of +/- 1 MPH (+/- 2 KPH) ISIN: B003IM6YAM -10 Points.
2) Pavement width at each pedestrian crossing (measured curb face to curb face) -10 Points, this was done by measuring the distance by Bosch Bluetooth Enabled 330-Foot Lithium-Ion Laser Distance and Angle Measurer GLM 100 C, ASIN: B00K1XL7Y4.
3) Presence of on-street parking (percentage of block face where on-street parking is provided and is in effective use) -10 Points; this was done by an observation and pilot survey.

1.4.2.2 Sidewalk Design (30 Points)

4) Sidewalk width (transect sensitive) -10 Points, this was done by measuring the distance by Bosch Bluetooth Enabled 330-Foot Lithium-Ion Laser Distance and Angle Measurer GLM 100 C, ASIN: B00K1XL7Y4.
5) Pedestrian connectivity (distance between street intersections or mid-block crossing) -10 Points, this was calculated through google map.
6) Presence of pedestrian features and their quality (high quality versus low quality) -10 Points, this was done by an observation and pilot survey.

1.4.2.3 Urban Design (30 Points)

7) Street enclosure (ratio of building height to street width) -10 Points, measuring the distance was done by Bosch Bluetooth Enabled 330-Foot Lithium-Ion Laser Distance and Angle Measurer GLM 100 C, ASIN: B00K1XL7Y4.
8) Use of land mix (presence of different land-use types that are attractive to pedestrians; also transect sensitive) -10 Points; this was done by an observation and pilot survey.
9) Façade design (number of doors and façade character per block face), this was done by an observation and pilot survey.

1.4.2.4 Transit/ Bicycle Feature (10 Points)

10) Transit and/or bicycle features (presence of bus stop shelters, bicycle lockers and bicycle racks). This was done by an observation and pilot survey.

Figure 2. **Empty HPE's Walkability Index Data Sheet**

	Street Name		Cross Street			
Date:		Street Segment:			Street Name	
Begin Time:	A.M. P.M. (Circle One)			Side A		Side B
Completed by:						
Representing:						
Posted Speed of Street/Road:			Cross Street			

Transect Zone (Circle One):

T3   T4   T5   T6

WALKABILITY MEASURE

Criterion	Value	Score Side A	Score Side B	Total Score

STREET DESIGN (MAXIMUM SCORE 30 POINTS)

1 Non-peak hour Free Flow Speed (Vehicles not hindered by stop signal or other slowing/stopping vehicles)
[Note for this measure: If possible, take a minimum of 10 samples; if not possible, take at least 3 samples in 10 minutes]

	Value			Total Score
≤15 mph	10			0
20 mph	8			0
25 mph	6			0
30 mph	4			0
Over 30 mph	0			0
			Segment Total	0

2 Pavement Width---curb face to curb face--at Pedestrian Crossing

	Value			Total Score
32' or less	10			0
33' - 42'	8			0
43' to 54'	6			0
55' to 66'	4			0
Over 66'	0			0
			Segment Total	0

3 Presence of On-Street Parking (Parallel or Angle Parking)

	Value			Total Score
76% - 100% of Block Face	5			0
51% - 75% of Block Face	4			0
26% - 50% of Block Face	3			0
10% - 25% of Block Face	2			0
No on-street parking	0			0
			Segment Total	0

SIDEWALK DESIGN (MAXIMUM SCORE 30 POINTS)

4 Sidewalk Width: Sidewalk width should be appropriate to the built environment (Score for appropriate transect)

T3	T4	T5	T6	Value			Total Score
>5'	>6'	>12'	>20'	5			0
>4' to 5'	>5' to 6'	>8' to 12'	>12' to 20'	3			0
>3' to 4'	>4' to 5'	>5' to 8'	>8' to 12'	2			0
≤3'	≤4'	≤5'	≤8'	0			0
						Segment Total	0

5 Pedestrian Connectivity: Distance between intersections or mid-block crossings

	Value			Total Score
300' or less	5			0
301' to 400'	4			0
401' to 500'	3			0
501' to 600'	2			0
Over 600'	0			0
			Segment Total	0

6 Presence and quality of pedestrian features (good sidewalk condition; lack of obstacles; ADA compliance; shade trees; street furniture)

	Value			Total Score
High quality	5			0
Moderate quality	3			0
Low quality	2			0
Poor quality or no features	0			0
			Segment Total	0

URBAN DESIGN (MAXIMUM SCORE 30 POINTS)

7 Street Enclosure: Ratio of building height to street width [building face to building face]*

	Value			Total Score
<1:1	10			0
1:1 to <1:3	8			0
1:3 to 1:6	6			0
>1:6	0			0
				0

* Blocks with center medians or parks should be scored by subtracting the median or park from the street width width. E.g., a street with an 8' parking lane and 12' travel lane on both sides of a 30' median would be calculated as a 40' wide street.

8 Land Use Mix: Presence of different land use types, e.g. retail, eating and drinking establishments, hotels and residential units
(Score for appropriate transect)

WITHIN 5 MIN WALK	ON BLOCK FACE			Value			Total Score
T3 -T4R	T4-O	T5	T6				
3+	3+	4+	4+	5			0
2	2	3	3	3			0
1	1	2	2	2			0
N/A	N/A	1	1	0			0
						Segment Total	0

9 Façade Design: Presence of façade arrangements and designs that are attractive to pedestrians*

	Value			Total Score	Alt Ratio**
Small units; many doors (15-20 doors/block face); lots of character	5			0	.03-.04
Small units; many doors (10-14 doors/block face), many details	4			0	.02-.028
Mix of large & small units; (6-9 doors/block face); few details	3			0	.12-.18
Large units; little variation (2-5 doors/block face); few or no details	1			0	.004-.01
Large units; few or no doors (0-1 doors/block face); uniform façade	0			0	0.0-.001
			Segment Total	0	

*Drawn from *Close Encounters With Buildings*; Jan Gehl, Lotte Johansen Kaefer and Solvejg Reigstad
** Dividing # doors by block length prevents penalizing smaller blocks for having a fewer number of doors.

TRANSIT/BICYCLE FEATURES (MAXIMUM SCORE 10 POINTS)

10 Transit and/or Bicycle Features

	Value			Total Score
Presence of special bus/bicycle features (e.g. bus shelters)	10			0
Presence of bus stops and bicycle racks	8			0
Presence of bus stops or bicycle racks only	6			0
No bus stops or bicycle racks	0			0
			Segment Total	0

Walkability Scoring		
90 - 100 points	High Walkability (*****)	
70 - 89 points	Very Walkable (****)	
50 - 69 points	Moderately Walkable (***)	
30 - 49 points	Basic Walkability (**)	
20 - 29 points	Minimal Walkability (*)	
19 points or less	Uncomfortable/hazardous for Walking (0)	

TOTAL SCORE, THIS STREET SEGMENT   **0**

Source: (HPE, 2012)

The walkability index data sheet (Figure 2), which was produced by Hall Planning & Engineering. HPE shows how scores are distributed along with the criteria. While conducting the pilot survey, each street has its own evaluation sheet as a raw material in addition to the raw picture to be in the archive. A number of students were helping in observation and pilot surveys. These observations and surveys enabled for better understanding of the variables as well for better data collection methods. With the assistance of other students, it was also made sure that human errors were kept to the minimal.

2. Chronological Growth of Jeddah City

2.1 Urbanization Process

Until 1947, Jeddah city was a walled settlement and was restricted in growth. Limited tax revenues and low income of the city government restricted the growth of the city in all major fields. The discovery of oil was a major boom for the city that changed its history. After world war II, the discovery of oil resulted in the growth of the city's revenue. This helped the government to remove the city wall and start its expansion. The government started to invest in different sectors, such as public hospitals, airports, roads, and other public sectors. Reports show that until 1964, Jeddah city did not have an effective plan for new settlements around the Al-Balad area. The unplanned settlement had different issues such as narrow public spaces between buildings, poor quality constructions, no flow or pattern in designing of buildings, the difference in floor numbers, and lack of land tiles (Figure 4).

In 1964, the government designed a master plan for Jeddah to make it more urbanized and a much more developed city. This plan included the architecture and planning of all new buildings, the location of the airport, and all the necessary infrastructure and facilities required for the effective running of a city. After the master plan implementation in 1971, many different unplanned settlements began to appear outside the urban area (Jeddah Strategic Plan,2010). All new settlements and construction did according to the master plan and removed or grounded all the illegal and unplanned settlements in specific districts, and this step made the city more urbanized. The development and urbanization of the city are illustrated in figure 4 of this research.

Jeddah is an important city and has several geographical restrictions that stop the city from growing towards the east, west, and south side. Al-Sarwat mountain range is in the east of the city, while in the west it has the Red Sea. The naval base is in the south of the city. Jeddah is a gateway for Pilgrims towards Makkah city. Makkah city is located towards the southeastern side of Jeddah that is why the government is expanding the city towards the northern and southeastern sides

Construction is a profitable business, and at the time of the urbanization of Jeddah city, many businessmen made investments to make villas. In Saudi Arabia, Villa's design is a popular choice, and most people constructed villa neighborhoods on the ruling land. That is why the number of villas neighborhood is very high in Jeddah city. Currently, Jeddah city comprises of 63% of villa neighborhoods of the planned neighborhoods. Launch of the bid-rigging scheme by the construction companies after the stock market crisis in 2006 and increased the prices and value of villa neighborhoods in Jeddah. This scheme changed the demand trend, and businessmen focused on making new apartment units in the urban area due to an increase in demand for apartments.

2.2   Villa-Type (VT) and Apartment-Type (AT) Neighborhoods

It is important to understand the different types of Villa types and apartment types of Jeddah city. Figure 3, and table 1 illustrate the detailed plans of the different types of planned neighborhoods. The first two layouts from the left are the Villa Type 1 (VT1) and Villa Type 2 (VT2). Followed by the villa types are the apartment types. The third image from left is Apartment Type 1 (AT1) followed by Apartment Type 2 (AT2), Apartment Type 3 (AT3), and Apartment Type 4 (AT4). From the layouts, it can be seen that the patterns and the designs have evolved over time owing to the demands of the public. It can also be seen that with the passage of time, the neighborhoods in the country are now also been made with multiple villa/apartment types. A single neighborhood can have a mix of Villa type and apartment type or one single type.

Figure 3. **Types of planned neighborhoods**
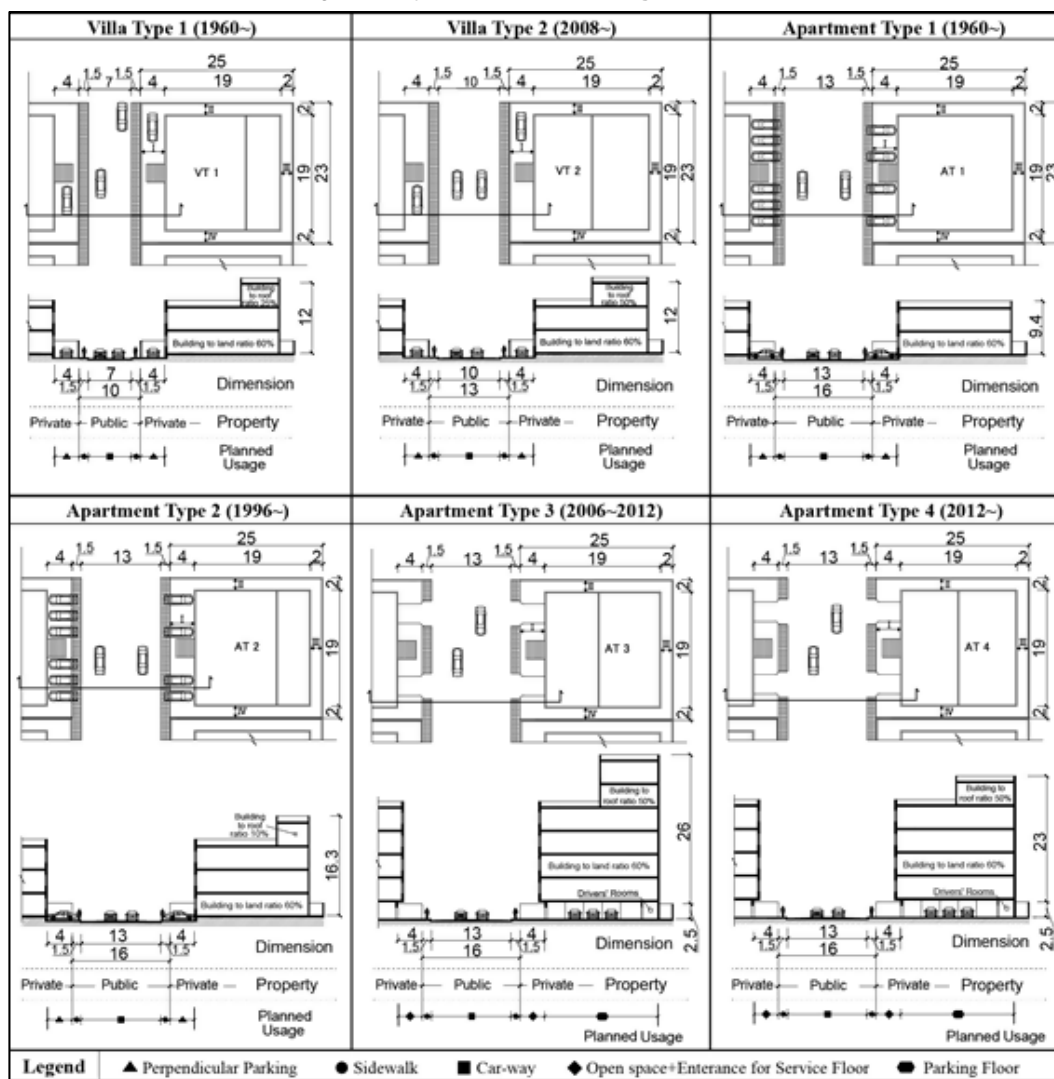
Source: (Maddah, Song, Deguchi, 2016)

Until 1964, there was no master plan for settlement in Jeddah city, and the growth was unpatterned and unplanned towards the southeast of the city (Figure 4). Following the construction of Al-Madinah road as one the major roads that connect the airport, the city is now

divided into two major parts; western and eastern parts. This road from south to north made different types of the neighborhood such as AT1, AT2, AT3, AT4, and the combination of these types of designed also made such as AT1+AT2, AT1+AT3, AT1+AT4, and AT2+AT3. New designs and combinations are introduced by the municipality and building regulation authority. New designs used when need the construction of new neighborhoods in vacant lots. Due to the lower prices of land in the eastern part of the city, most neighborhood apartments are located on this side of the city.

Table 1. **Elements of the spatial configuration of planned neighborhood streets**

Element / Type	Floor limitation (Maximum)	set-backs, minimum (m) One way land I	II	III	IV	Corner land I	II	III	IV	Concrete Fence I	II	III	IV	Parking location	Street (minimum) Side walk width	location	Car-way width(m)
VT1	2F+1F(25% of 2nd F)					2				O				Behind the villa fence at property		Beside the fence	7
VT2	2F+1F(50% of 2nd F)																10
AT1	2F	4	2		4									Perpendicular parking at set-back area	1.5mx2	Beside parking lot	
AT2	3F+1F(25% of 3rd F)					3	2			X	O						13
AT3	5F+2F(50% of 5th F)													Perpendicular parking at 60% of ground floor		Along the porperty line	
AT4	5F+1F(50% of 5th F)																

Source: (Maddah, Song, Deguchi, 2016)

Figure 4 shows that most of the apartments and villa neighborhoods are situated in the western region of Al-Madinah road due to a lack of land prices. Gathering places and entertainment things are the main factors for the popularity of the western part of the city. These factors have increased the prices in the western part; also, that is why now only mid or high-income earning people can afford villas in this area. The construction of villas in the northern side started in 2007.

Figure 4. Chronological Growth of Residential Areas in Jeddah City
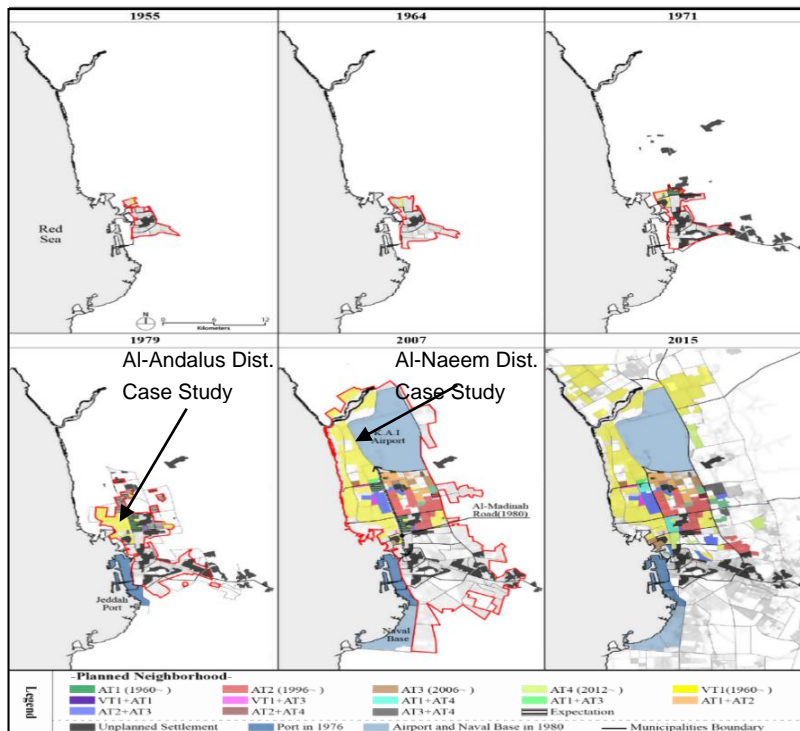
Source: (Maddah, Song, Deguchi, 2016)

3. Walkability Index in Villa-Type Neighborhoods

3.1 Walkability Index in Al-Naeem District

3.1.1 Introduction to Al-Naeem District

Al Naeem Dist. is located in the south-western part of King Abdulaziz Airport with an area of 5.91 km². The population of the district is 37,948 with a population density of 6.421 people/km². Aesha mosque was selected as a core with a 350m radius to cover our survey area. The study area consists of 22 streets that analyzed based on HPE's walkability Index. Table 2 shows the results of each street with a picture of the existing condition.

Figure 4. **Al-Naeem Dist. in Jeddah** Figure 5. **Survey Area boundary** Figure 6. **The Centered Mosque**

Source: Google, 2019; Google, 2019; Author, 2019

Table 2 has the walkability index for all the twenty-two streets of the Al-Naeem district. Each street is then given a score and then is being rated for its corresponding walkability index. As seen from table 2, Al-Naeem district twenty streets have a mediocre score of 52 out of 100. This score suggests that there is quite some room for the improvement of the walkability index of the region. If the walkability of the region is increased, people will favor this district more than others due to the presence of bigger and better mosques in this district.

Table 2. Walkability Index of Al-Naeem District
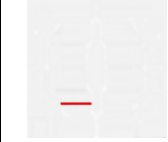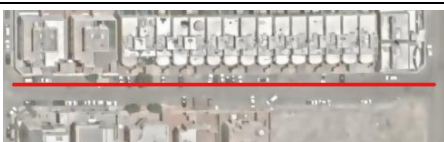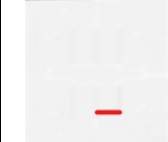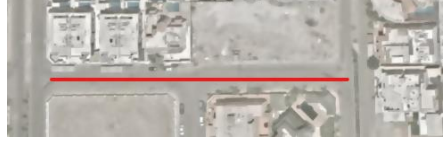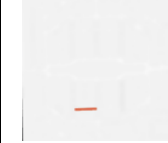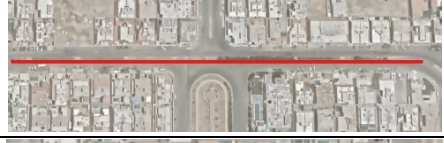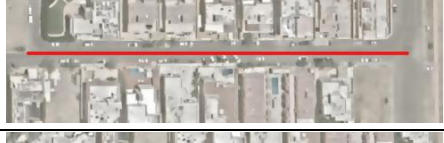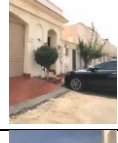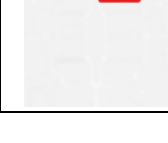
Street no.	Street Design			Sidewalk Design			Urban Design			Transit	Score	Street no.	Street Design			Sidewalk Design			Urban Design			Transit	Score
	1	2	3	4	5	6	7	8	9	10			1	2	3	4	5	6	7	8	9	10	
1	8	10	7	0	10	0	10	5	4	0	54	12	4	8	8	6	6	4	6	4	8	0	54
2	8	10	7	2	10	0	10	4	5	0	56	13	4	8	8	6	6	4	6	4	8	0	54
3	8	10	6	4	10	0	10	4	6	0	58	14	4	8	8	6	10	4	6	4	8	0	58
4	0	10	4	2	10	0	8	4	3	0	41	15	4	8	8	4	0	4	6	4	8	0	46
5	8	10	5	10	10	0	10	4	2	0	59	16	4	8	8	6	6	4	6	4	8	0	54
6	8	10	1	6	10	0	8	4	1	0	48	17	4	8	8	4	10	4	6	4	8	0	56
7	0	8	7	3	10	5	8	0	8	0	49	18	4	8	8	4	10	4	6	4	8	0	56
8	8	10	7	4	10	2	8	0	6	0	55	19	4	8	8	4	10	4	6	4	8	0	56
9	0	10	5	5	10	0	10	0	7	0	47	20	4	8	8	4	10	4	6	4	8	0	56
10	8	10	6	3	10	0	10	0	7	0	54	21	0	8	6	7	10	0	6	2	3	0	42
11	8	10	8	4	10	0	8	0	7	0	55	22	0	8	6	7	10	0	6	2	3	0	42
																					Average Score of Al-Naeem Dist.		52/100
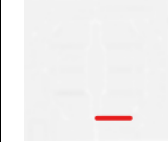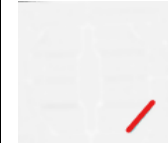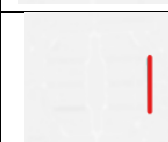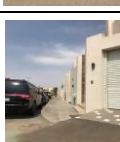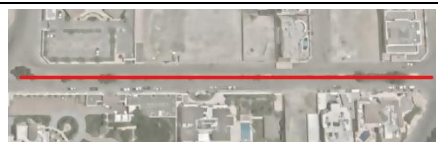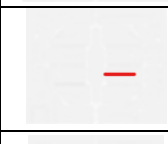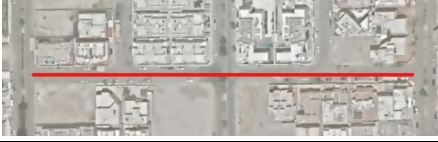
Notes: Walkability Scoring

90-100	Points	High Walkability	(A)	30-49	Points	Basic Walkability	(D)
70-89	Points	Very Walkable	(B)	20-29	Points	Minimal Walkability	(E)
50-69	Points	Moderately walkable	(C)	19	Points or less	Uncomfortable for walkability	(F)

Source: own elaboration

Table 3. **Aerial Maps and Existing Condition of Al-Naeem District**

Street No.	Street Aerial Pic	Street Map	Existing Condition	Length (m)	Wide (m)
1				204	14
2				242	18
3				180	14
4				250	18
5				180	14
6				140	14
7				460	28
8				240	18
9				280	18
10				240	18

11				240	18
12				180	26
13				180	26
14				350	26
15				240	16
16				260	18
17				180	16
18				250	18
19				180	16
20				300	16
21				650	18

| 22 | | | | 650 | 18 |

Source: own elaboration

3.1.2   Walkability Index of Al-Naeem District

By analyzing table 2, and 3 in-depth, *street design section,* the street width has a direct correlation with the car speed (criteria no.1), The third criterion, which is the presence of parking, it was clear that some people park paralleled, and some angle parking. This was due to the unclearness of parking regulations. *Sidewalk design section* reflects a clear image regarding the existing condition, where the average score of sidewalk width is between four and five that are based on the pedestrian, is unwalkable. The average score of the sixth criteria (the presence and quality of sidewalk feature) is between two and three. In the real world, this is due to the presence of vegetation. Presence of unwanted vegetations on the sidewalks eventually results in the walkability score to be lower as it makes walking on the streets to be uncomfortable and unpleasant. Vegetations also degrade the quality of the sidewalks faster and thus require frequent repairs. This, in turn, results in problems for the locals and also for the government as maintenance is then more frequent, and people have to walk on roads due to bad sidewalks.

The urban design section illustrates that the street enclosure has an average to good score (between 6-8), so the presence of openness helps pedestrians to walk, instead of the feeling of fear which is resulted from the closeness. The lack of variety in land use resulted in a low score in the eighth criteria, with an average of 3. Regarding the ninth criteria of the façade design criteria, Al-Naeem dist. has an average score of 7, which means it has a variety in façade design, so the pedestrian will have the interest to walk. Unfortunately, due to the lack of transit such as bus stop, and bicycle racks, the score of the last criteria is zero.

3.2   Walkability Index in Al-Andalus District

3.2.1   Introduction to Al-Andalus District

The Survey area of Al-Andalus Dist. is in the south-western part of the intersection of the Almadinah Al-Munawarah Rd. and Prince Mohammed Bin Abdulaziz St. with a total area of 12.96 km^2. The total population of the district is 19,684 with a population density of 1.518 people/km^2. Al-Noor Mosque was selected as the core of the study area. The study area consists of 7 streets that analyzed based on HPE's walkability Index.
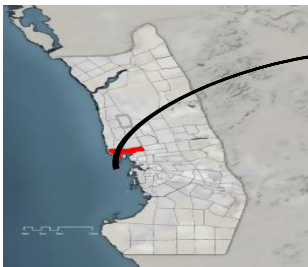
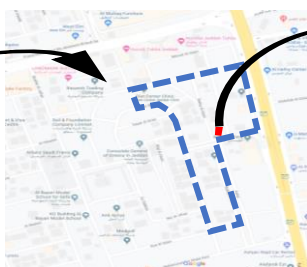Figure 7. **Al-Andalus Dist.**　　Figure 8. **Survey Area boundary**　　Figure 9. **Centered Mosque**

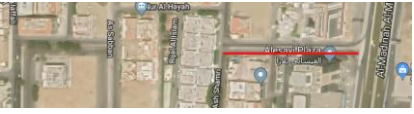Source: Google, 2019; Google, 2019; Author, 2019
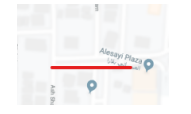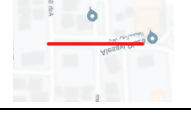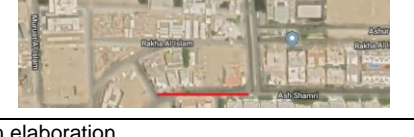
Table 4 shows the results of each street with a picture of the existing condition. Table 4 comprises of the 7 streets of the Al-Andalus District. Each street has been given a walkability score. After all the scores for each street are tabulated, they are then averaged. This gives the overall score for the Al-Andalus street. From table 4, it can be seen that Al-Andalus street has a very low walkability score of just 30.8. This poor score indicates that this district has a huge room for improvement.

Table 4. **Walkability Index of Al-Andalus District**

Street no.	HPE's Criteria										Score	Street no.	HPE's Criteria										Score
	Street Design			Sidewalk Design			Urban Design			Transit			Street Design			Sidewalk Design			Urban Design			Transit	
	1	2	3	4	5	6	7	8	9	10			1	2	3	4	5	6	7	8	9	10	
1	0	10	10	4	10	0	0	5	2	0	31	5	8	10	2	0	5	0	8	2	1	0	36
2	0	10	10	0	4	0	0	4	2	0	30	6	0	10	4	0	10	0	0	7	3	0	34
3	0	10	8	0	4	0	8	4	2	0	26	7	0	10	0	0	9	0	4	5	2	0	30
4	8	10	2	0	5	0	0	3	1	0	29												
																	Average Score of Al-Andalus Dist.						30.8/100

Source: own elaboration

Table 5. **Aerial Maps and Existing Condition of Al-Andalus District**

Street No.	Street Aerial Pic	Street Map	Existing Condition	Length (m)	Wide (m)
1				170	18
2				170	18
3				350	12
4				350	12
5				350	12
6				220	14
7				170	14

Source: own elaboration

3.2.2 Walkability Index of Al- Andalus District

By analyzing tables 4, and 5 in-depth, in the *street design section,* it is remarkable that there is a lack of parking space which has led to illegal parking taking place in almost all the locations. *The sidewalk design section* reflects a clear image regarding the good condition of the distance between street intersections and pedestrian linkage; however, the poor quality of the sidewalk makes the place not interested to the pedestrian, and dangerous to walk. This is the reason that made the pedestrian walk on the roadway. A high rate of W/H, which results in a high rate of closeness in the area made the walkability index low. Additionally, due to lack of bus stops, all streets have a zero score for the transit criteria. Zero scores of transit suggests that either the people are driving or walking. With the ratio of cars and people on the road to be higher, the chances of accidents are also higher. It is crucial for the government to come with different policies and changes so that the HPE score of the district increases. The increase in the HPE index will be beneficial to both the locals as well as the government.

4. Conclusions

Based on the survey and the results of the walkability index, it is concluded that there is a need to revise current neighborhood regulation in order to raise the walkability index. Especially, the parking regulation and standards, sidewalk width in relation to street furniture. It was also found that it is important to enhance the neighborhoods by using the existing land in different ways to make the area more interesting in walking. A committee in Jeddah Municipality should be established to create a Saudi Arabian culture-oriented walkability index.

This research also concluded that HPE's walkability index gives a result based on physical features, without taking into consideration the social and behavioral factors. Although Al-Naeem Dist. has the walkability level of moderately walkable but due to the vegetation on the sidewalk, all pedestrians walk on the road which makes them in danger from a car accident. The ratio of streets in lowly populated regions such as villa-type neighborhood is significantly higher, and this results in very wide and unnecessary streets.

The study also concluded that semi-public spaces, semi-private spaces, and private spaces are not well defined in the city's regulation. Overtime sidewalks have become a private space for some villa owners, which makes these sidewalks difficult to walk. With sidewalks becoming a semi-private space in some regions, more and more people prefer to walk off these sidewalks as the adjacent owners of the villas/apartments cause problems for the people on sidewalks. Along with this, when the sidewalks are being considered as part of one's property, then the owners try to alter the sidewalks to their own benefits. This greatly affects the walkability of the streets and the district in which those streets are.

For future studies, it is recommended to define the factors that play the main role in walkability in a hot-arid region — for instance, the shade devices, and so on. Socio-cultural environmental factors should also be taken into consideration in determining the factors that help in defining the meaning of walkability in Saudi Arabia. Due to time constraints, the current research was limited to just two districts in Saudi Arabia. In order to have a clearer picture of the country and how well the selected districts of this study compare with other districts, it is important at many other districts of the country should be selected and compared. This way, we can better understand the walkability of Saudi Arabia as a whole.

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