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Comparative assessment of pedestrian crossing behavior at Baghdad and Nasiriya

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General Note

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ABSTRACT

To design safe pedestrian facilities, much work is required to evaluate the pedestrian characteristics and behavior regarding age group, clothes tradition and gender while crossing the roadway. Little attention have been paid on such researches in Iraq and the published work on this subject was scares and scattered. This research work will consider the crossing speed of pedestrian at various land use locations. Baghdad and Nasiriya have been selected for comparative evaluation of pedestrian characteristics. This study dealt with the factors affecting the crossing speed as well as the behavior of acceptance of the lag. The crossing speed was 1.31 and 1.13 meters per second for Baghdad and Nasiriya, respectively. On the other hand, it was found that the minimum acceptance of the lag is 3.50 and 2.85 seconds in Baghdad and Nasiriya, respectively. It was found that significant factors affect the speed of pedestrians such as gender, age and clothing tradition. The walking speed of males are faster than females, and pedestrian aged

between 18-50 are the fastest, Male pedestrians wearing western style are walking faster than those with Arabic style, while the cloth style was not significant for female pedestrian.

Keywords –Age group, Clothing traditions, Crossing speed, Gender, Modeling, Pedestrian characteristics.

1. INTRODUCTION

Pedestrian crossing speed is an important traffic engineering design parameter. The level of exposure of pedestrians to vehicle traffic depends on their walking speeds. The literature suggests certain pedestrian speed values that may be used as a guide in the design and operation of traffic signals. Proper planning of pedestrian facilities is crucial to allow optimum performance. In New Zealand Government's Pedestrian Planning and Design Guide [1], adopted 1.5m/s as the mean walking speed of a "fit, healthy" adult, this is around 25% faster than that of United States. For aged and those with mobility impairments, their mean walking speed is specified as 1.2m/s. The Federal Highway Administration, [2] recommends a pedestrian crossing speed of 1.22 m/s for traffic signal timing in designing crosswalks, it was concluded that nearly one-third of pedestrians walk slower than 1.22 m/s and nearly 15% of pedestrians walk at or below 1.06 m/second. However, this value was questioned in a number of occasions. [3] indicated that many pedestrians, especially older pedestrians, do not walk that fast. It was recommends that 0.91 to 0.99 m/s be used for traffic signal timing. [4] Modeled the pedestrian crossing behavior at Mosul, a series of logistic regressions were used to reduce the large body of results to a compact form which could be used in planning and design for safer pedestrian facilities. Safety assessments can profitably be linked with the model measures to detect the degree of exposure to risk in this vulnerable travel mode. It was concluded that the crossing speed of 0.83 m/sec is almost lower than that found by other researchers. Pedestrian were unaware of the danger of lengthy exposure to traffic movement, the tendency of the pedestrian is to take the shortest course even if it involves a certain amount of risk when crossing. Such behavior may also indicate lower traffic educational level. [5] Stated that the contributing factors of the walking speed for male and female pedestrian are clothing tradition, gender, and age group. The literature also suggests that different locations have different effects on pedestrian movements. Video capture has been widely used and described for monitoring pedestrian behavior by many researchers including [6] and [7]. In one of the shopping streets in Manchester, [8] Measured the time between pedestrian departure from the kerb and the nearest vehicle. It was found that the pedestrian could cross a street with a width of 6.1 meter, easily within 7 seconds of the arrival of the vehicle, and only those who were agile could safely pass through Less than 4 seconds. The purpose of this study is to investigate how urban characteristics and land use affects pedestrian mobility in terms of crossing speed, and to model the effect of pedestrian characteristics such as clothing tradition, age group, and gender on crossing speed.

Table 1 Dimension of crossing width for each Street

City	Street	Width (M)
Baghdad	Al- Mashtal	12.3
	Al- Kadhimiya	8.3
Nasiriya	Al-Haboubi	7
	Al-Jumhuria	7

2. COUNTS METHOD

The pedestrian speed data were collected at two selected locations in Baghdad and Nasiriya CBD area. It was expected that sites with different land use could show different pedestrian characteristics. The collection of the field data was made for sample lengths of 2 hour and during good weather conditions, i.e. a sunny or cloudy day without rain. The hours in which the counts were performed, were the ones where the peak hour was expected to take place. These hours were selected considering the background information of the place. Specifically, the ranges selected were 17:00-19:00. The workdays were used as the main sample days for this study. The data that was gathered which include the crossing time; lag time (accepted or rejected); the crossing direction of pedestrians; approximate age which was based on a subjective judgment. Young were considered to be below 18 years, adults between 18 and 50 years and the rest as elderly. Clothing Tradition style including Arabic and western styles (trousers) have been considered for both genders. The required data of each survey site are recorded. The number of lanes and the lane width were recorded and measured for each survey site. The lane width was measured directly on the sites by using measuring tape. It was

observed to be in the range of 3.3 -3.75 m for the nearest lane to the curb side. Video recording was performed; the video provided more details that could be observed in a repetitive manner and with awareness. The video camera used was a Canon EOS 5D and the sampling period was for 2 hour. The studied segment of crossing has dimensions shown in Table 1.

3. PEDESTRIAN CROSSING SPEED

3.1. Variation of Crossing Speed with Gender

Fig.1, shows the crossing speed of male and female pedestrian for Baghdad city. The data presented indicates that the crossing speed of male is higher than female for Mashtal site with average crossing speed of 1.278 m/sec and 1.224 m/sec for male and female respectively; while in Kadhimiya it was 1.364 and 1.297 m/sec for male and female respectively. The crossing speed of male and female for Nasiriya City is presented in Fig. 2, and it shows that male is crossing faster than female for both sites. And the mean crossing speed was 1.135 and 1.021 m/sec for male and female respectively in Haboobi site, While in Jumhuria, it was 1.157 and 1.104 m/sec for male and female respectively. These findings are in agreement with those reported by [9].

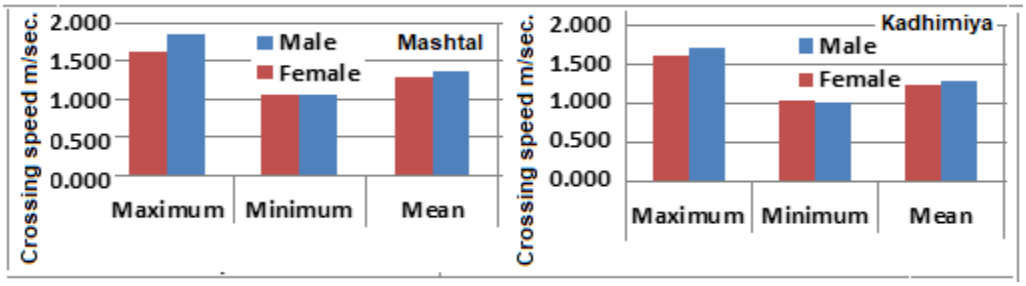

Figure 1 Variation of Crossing Speed with Gender for Baghdad

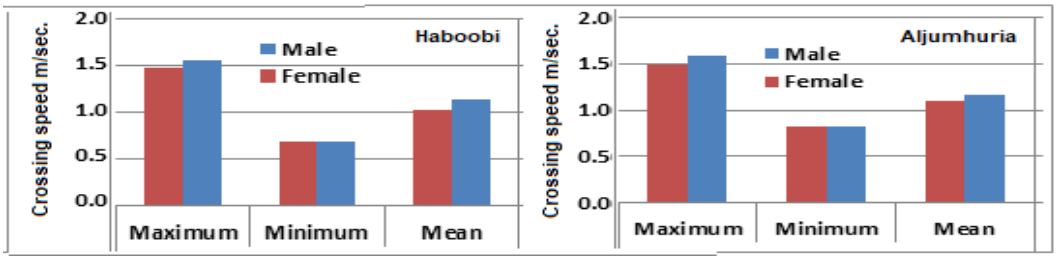

Figure 2 Variation of Crossing Speed with Gender for Nasiriya

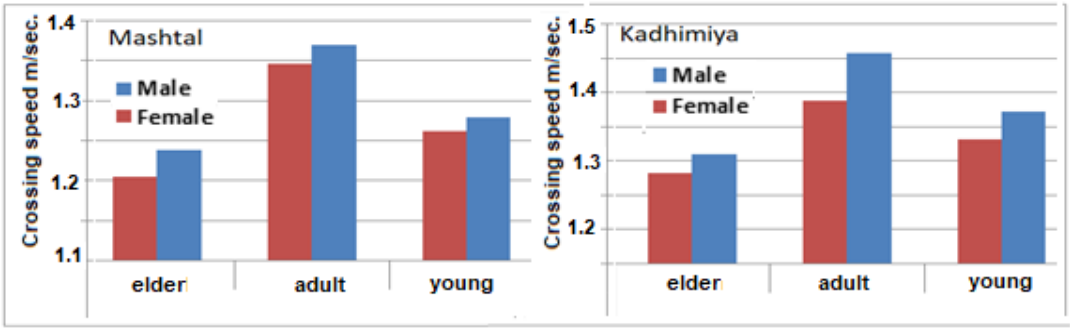

Figure 3 Variation of Crossing Speed with Age for Baghdad

3.2. Variation of Crossing Speed with Age

As demonstrated in Fig.3, adult pedestrian of age group (18-50) are faster than elder while crossing for both genders and for all sites. Their mean crossing speed in Baghdad was 1.37 m/sec and 1.34 for male and female respectively for pedestrian of (Mashtal) site. While it is 1.47 m/sec and 1.39 m/sec for male and female respectively for Kadhimiya.Fig.4 exhibit that the mean crossing speed in the city of Nasiriya is 1.277 m / s and 1.09 m / s for male and female, respectively in the site of Al-Haboubi. On the other hand, the location of Jumhuria Street is 1.28 m / s and 1.24 m / s for male and female, respectively. The variation of crossing speed among

different sites could be attributed to the flow rate of pedestrian which is higher at Baghdad site 2 and Nasiriya site 2. Similar findings were reported by [5], who stated that Pedestrians in the age group of 15–30 years had the highest speed of the range 1.65 – 1.35 m/sec for Baghdad. It can be mentioned that Data for all sites studied in Australia, [10] indicated an average crossing speed of 1.42 m/s (in the range 1.36 to 1.52 m/s) for individual sites and periods. It was stated that the crossing speed for all sites combined is very close to the general design speed of 1.2 m/s recommended by the Australian and US design guides. On the other hand, [11] reported the road crossing speeds at busy crossings for a mix of pedestrian age groups and found them varying in the range of 1.2–1.35 m/s.

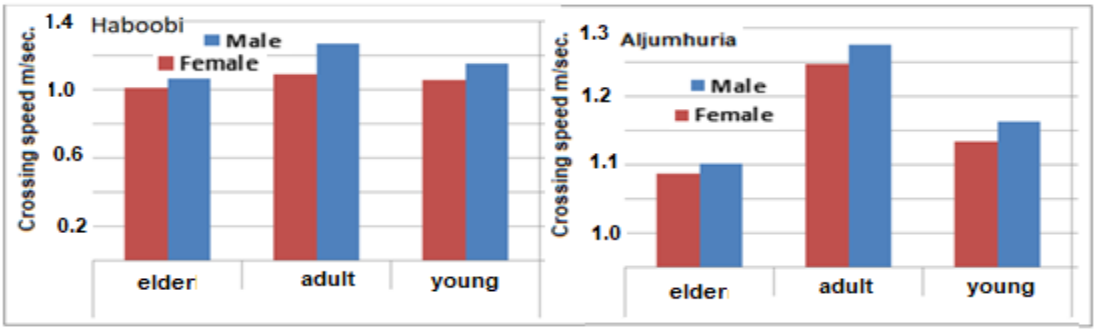

Figure 4 Variation of Crossing Speed with Age for Nasiriya

3.3. Variation of Crossing Speed with Clothing Traditions

Table 2illustrate the influence of clothing tradition on crossing speed for male and female for Baghdad and Nasiriya. It can be observed that male pedestrians have slower crossing speed of the range 1.24 – 1.32 m/sec when implementing Arabic style clothing, while male pedestrians have faster crossing speed of the range 1.29 – 1.38 m/sec when using western cloth style (trousers). This may be attributed to the limitations practiced in the step length which is restricted due to clothing when using the Arabic clothing tradition. When female pedestrian are considered, the variation of crossing speed among using different clothing style was not significant. This could be attributed to the slower (as compared to male) average crossing speed range of 1.22 – 1.29 m/sec of female when implementing Arabic style clothing , while the range was 1.26 – 1.32 m/sec when using trousers. Similar results were presented by [5] and [12] in their study of pedestrian in Baghdad and Saudi Arabia. On the other hand, for Nasiriya, Table 2 demonstrated that male wearing Arabic style have slower crossing speed of 1.08– 1.17 m/sec than those wearing trousers. Female pedestrians have slower crossing speed of the range 1.01 – 1.09 m/sec when implementing Arabic style clothing, while male pedestrians have faster crossing speed of the range 1.10 – 1.17 m/sec when using trousers. This may be attributed to the limitations practiced in the step length which is restricted due to clothing when using the Arabic clothing tradition.

Table 2 Variation of Crossing Speed with Gender and Clothing Tradition

Gender	Clothing Tradition	Baghdad Site	Nasiriya site	Crossing speed m/sec	
				Baghdad	Nasiriya
Male	Arabic	Mashtal	Haboobi	1.24	1.08
	western			1.29	1.16
Female	Arabic			1.22	1.01
	western			1.26	1.10
Male	Arabic	Kadhimiya	Jumhuria	1.32	1.11
	western			1.38	1.18
Female	Arabic			1.29	1.09
	western			1.32	1.17

4. PEDESTRIAN CROSSINGS DIRECTION

As demonstrated by Fig.5 and 6, a range of 31 – 41 % of pedestrians are spending more time on the street while crossing at a direction other than the perpendicular to the traffic flow. Such high range may indicate lower traffic education level. Similar findings

were obtained by [5]. The figure shows that a greater risk observed on multi-lane highways with a great ADT rates. [2] Had indicated that crossing the road at a direction other than that perpendicular to traffic flow can increase the walking distance of risky exposure to traffic while crossing the road. Normally, the tendency of the pedestrian is to take the shortest course while crossing even if it includes a convinced quantity of risk, [5].

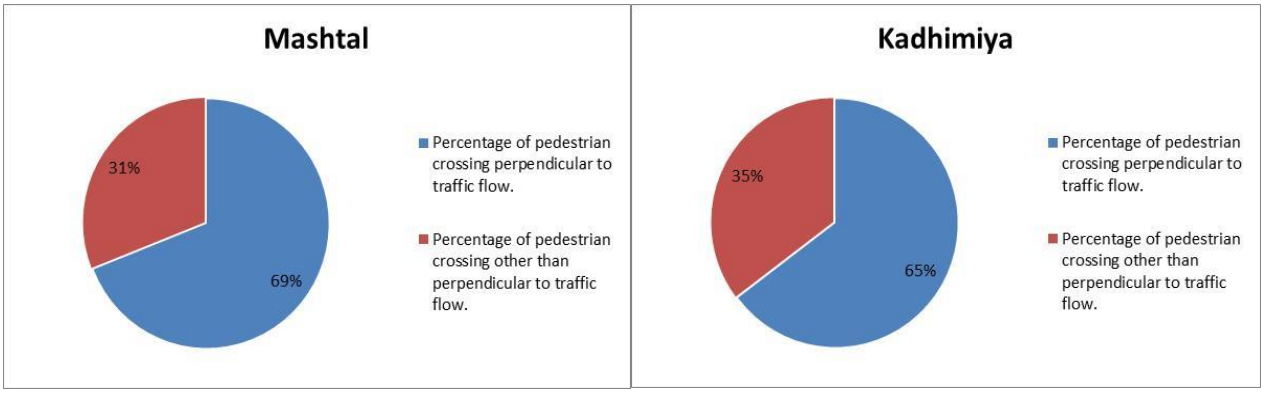

Figure 5 Crossing Direction for Baghdad

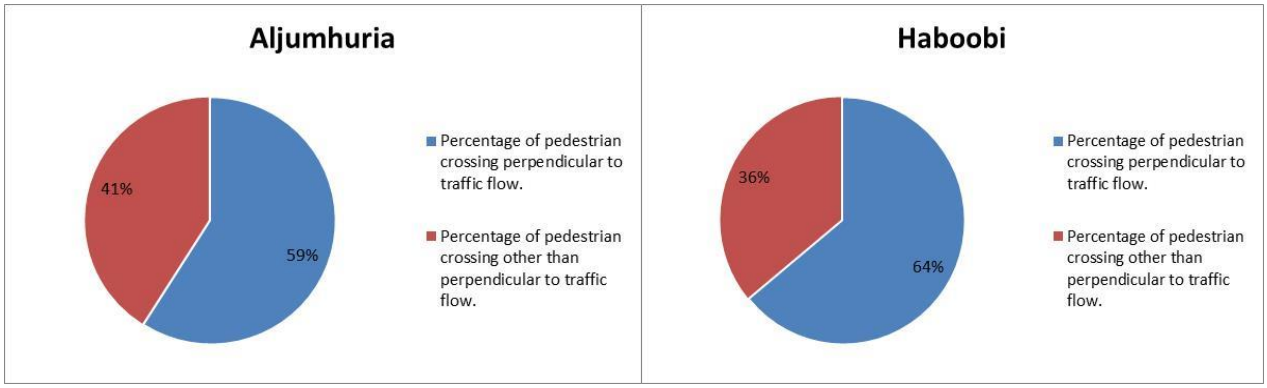

Figure 6 Crossing Directions for Nasiriya

5. PEDESTRIAN LAG ACCEPTANCE BEHAVIOR

The calculated percentages of the observed accepted lags are presented in the form of histogram as shown by Fig. 7 for Baghdad and Fig. 8 for Nasiriya, and Tables as illustrated by Table 3 for Baghdad and Table 4 for Nasiriya. The observed data were assumed to follow the cumulative normal distribution and the parameters of the distribution are calculated using the method of transformation of cumulative normal distribution to linear relationship using Probit method of analysis, [13]. The calculated Probit values are regressed against the mid class interval as shown in the Figures. Linear regression is used to find the best-fit line that represents the data. The adopted linear model is as given in Equation 1:

$$Y = a + b X \qquad \text{Equation (1)}$$

Where:

Y is the Probit value,

X is the mid class interval and

a and b are coefficients.

The value of Y can be calculated from Equation 2 or from table presented by [13].

$$P = \frac{1}{\sqrt{(2\pi)}} \int_{-\infty}^{Y-5} e^{-\frac{1}{2}u^2} du. \qquad \text{Equation (2)}$$

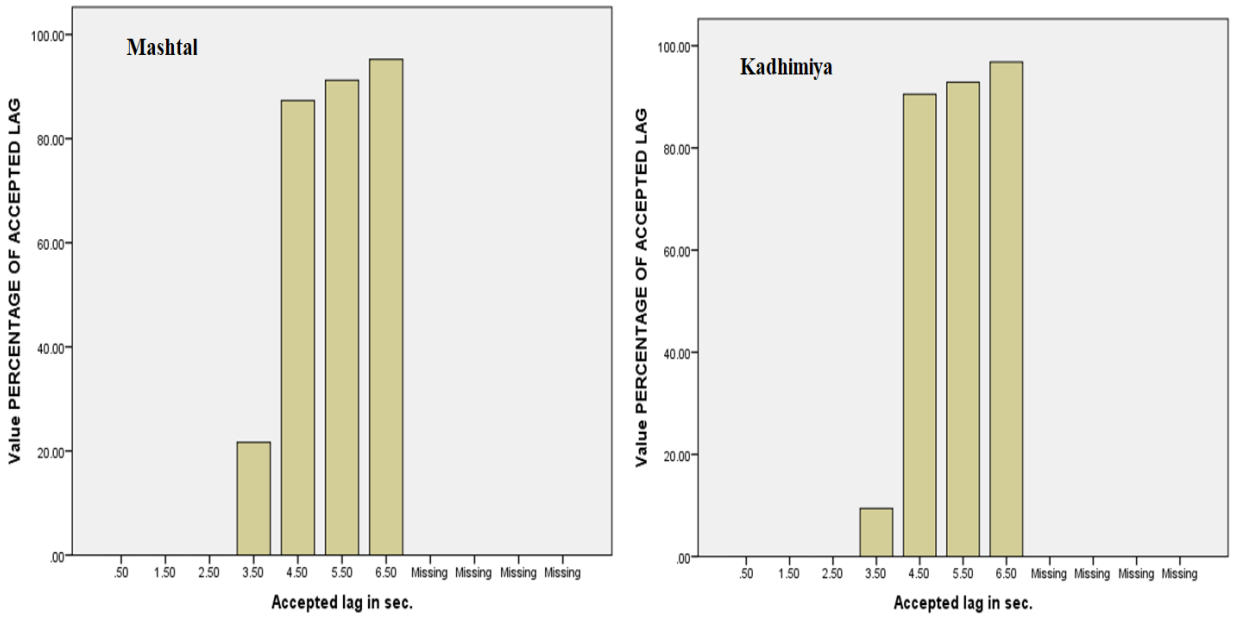

Figure 7 Observed behavior of pedestrian lag acceptance data for Baghdad

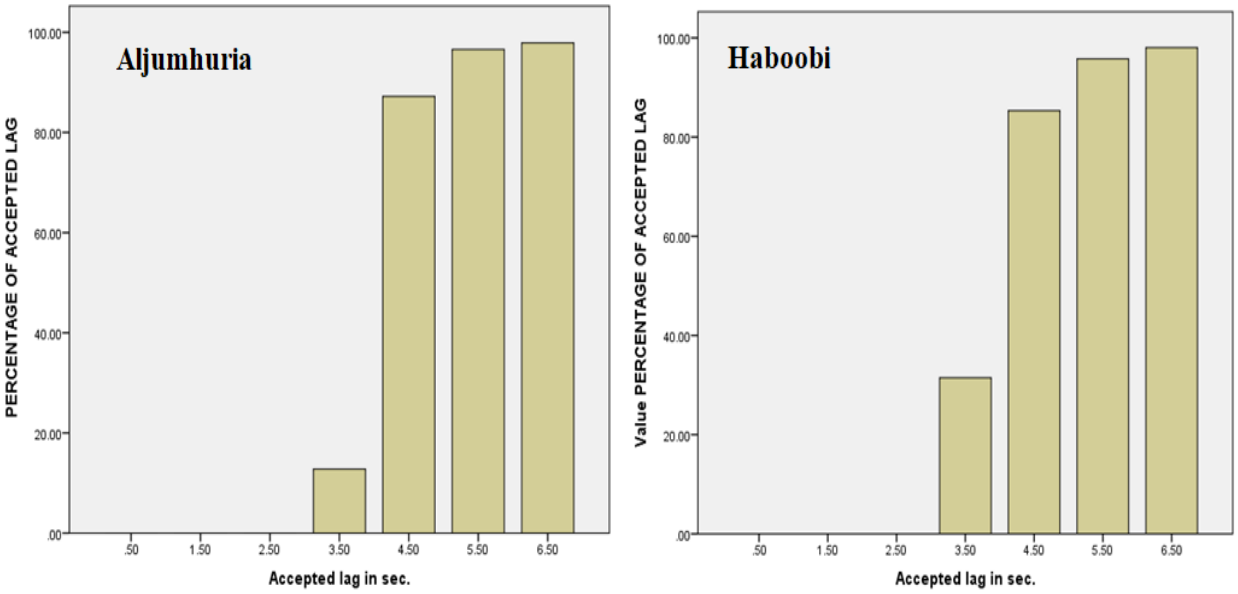

Figure 8 Observed behavior of pedestrian lag acceptance data for Nasiriya

Table 3 Observed behavior of pedestrian lag acceptance data for Baghdad

Site	Class Width	Accepted Lag	Rejected Lag	Total Offered Lag	Percentage Of Accepted Lag	Probit Value
Mashtal	0-1	0	58	58	0	0
	1-2	0	148	148	0	0
	2-3	0	145	145	0	0
	3-4	21	76	97	21.64948	4.215914
	4-5	179	26	205	87.31707	6.141508

	5-6	166	16	182	91.20879	6.353725
	6 or more	40	2	42	95.2381	6.668391
	Total	406	471	877		
Kadhimiya	0-1	0	23	23	0	-
	1-2	0	133	133	0	-
	2-3	0	155	155	0	-
	3-4	5	48	53	9.43	3.686
	4-5	143	15	158	90.51	6.311
	5-6	169	13	182	92.86	6.465
	6 or more	61	2	63	96.83	6.856
	Total	378	389	767		

Table 4 Observed behavior of pedestrian lag acceptance data for Nasiriya

Site	Class Width	Accepted Lag	Rejected Lag	Total Offered Lag	Percentage Of Accepted Lag	Probit Value
Haboobi	0-1	0	59	59	0	0
	1-2	0	153	153	0	0
	2-3	0	144	144	0	0
	3-4	11	75	86	12.79	3.86
	4-5	150	22	172	87.21	6.14
	5-6	169	6	175	96.57	6.82
	6 or more	92	2	94	97.87	7.04
	Total	422	461	883		
Jumhuria	0-1	0	59	59	0	0
	1-2	0	153	153	0	0
	2-3	0	144	144	0	0
	3-4	11	75	86	12.79	3.86
	4-5	150	22	172	87.21	6.14
	5-6	169	6	175	96.57	6.82
	6 or more	92	2	94	97.87	7.04
	Total	422	461	883		

The obtained regression equations are listed in Table 5. To facilitate understanding the line which represents the regression equation, it is super-imposed on the observed Probit values as showing Fig.9.

Table 5 Calculated values of mean and Standard deviation

Site	Model	Mean (sec)	Standard deviation (sec)
Baghdad (Mashtal)	Y = 0.76 X+2.06	3.87	1.32
Baghdad (Kadhimiya)	Y = 0.97 X+1.00	4.12	1.03
Nasiriya (Haboobi)	Y = 0.83 X+1.95	3.67	1.20
Nasiriya (Jumhuria)	Y = 1.02 X+0.86	4.06	0.98

The regression equation is used to calculate the mean and standard deviation of the normal distribution. Setting Y equal to 5 as demonstrated in equation 7, which represents the mean, the reciprocal of the coefficient of x results in the standard deviation of the normal distribution as represented in equation 8. These Mean values and standard deviation of all sites are shown in Table 5.

Mean = (5-a)/b Equation 7

Standard deviation = 1/b Equation 8

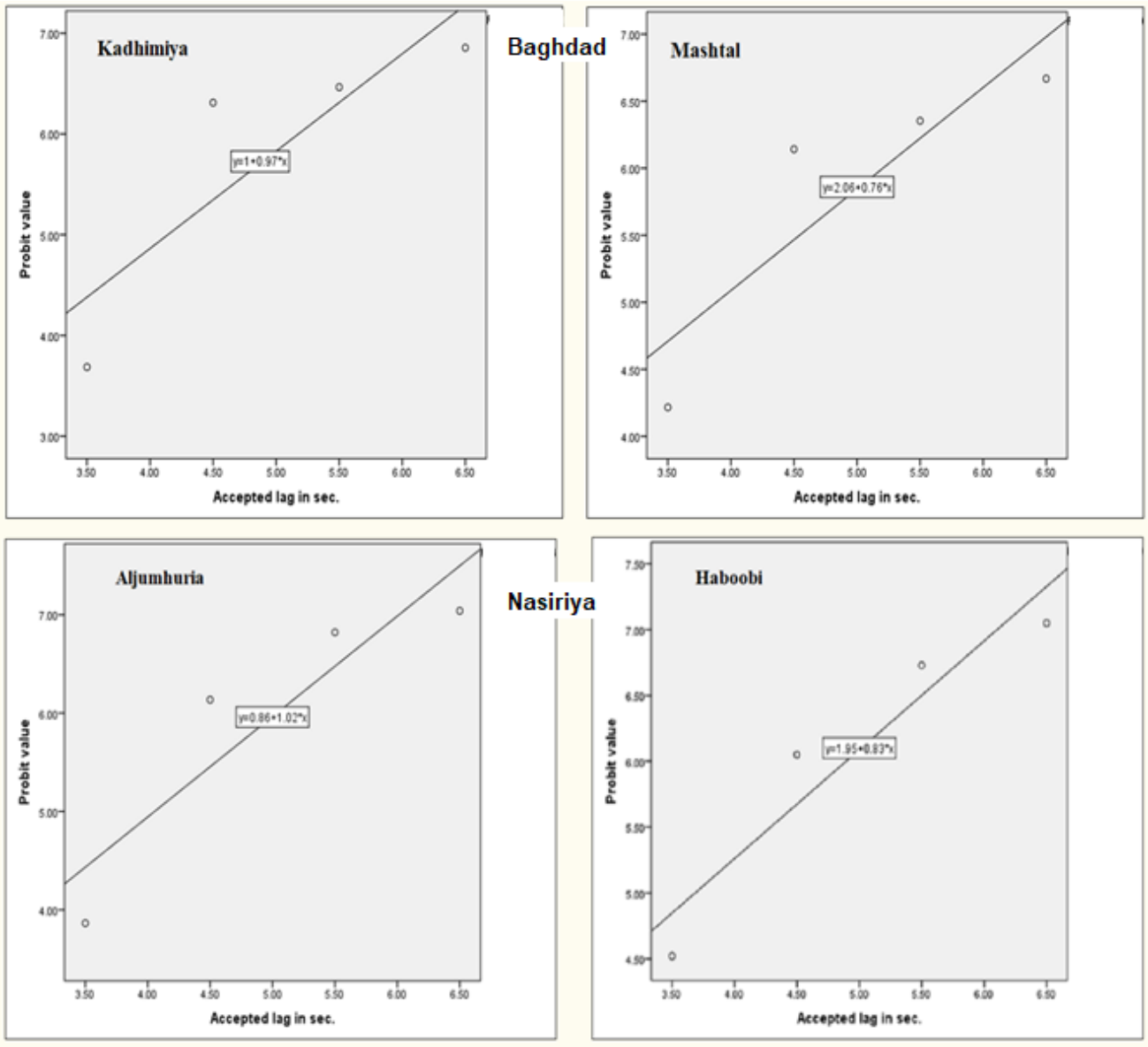

Figure 9 Linear regression of observed Probit values for pedestrian lag acceptance

5.1. Influence of Gender on Pedestrian Lag Acceptance Behavior

The influence of gender on lag acceptance was investigated. The percentages of observed accepted lag of male and female observed data are presented in the Tables 13and 14. It was assumed that the observed data follow the cumulative normal distribution and the parameters of the distribution are calculated using Probit method of analysis, [13].The parameters of the distribution are calculated using linear regression equations. The obtained equation of male and female lag acceptance for all sites are presented in Table 15. The mean of data distribution can be calculated by setting Y equal to 5 and the reciprocal of the coefficient of X results in the standard deviation for all sites.

Table 13 Influence of gender on observed behavior of male and female lag acceptance data for Baghdad

	Mashtal				Kadhimiya			
Class width	% Accepted lag		Probit		% Accepted lag		Probit	
	Male	Female	Male	Female	Male	Female	Male	Female
0-1	0	0	0	0	0	0	0	0

1-2	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0
3-4	25.64	5.26	4.35	3.38	11.11	6.35	3.78	3.47
4-5	87.64	85.71	6.16	6.07	92.42	80.76	6.43	5.87
5-6	92.45	90.69	6.44	6.32	95.62	84.44	6.71	6.01
6 or more	97.14	95.71	6.90	6.72	100	90.9	8.09	6.33

Table 14 Influence of gender onobserved behavior of male and female lag acceptance data for Nasiriya

Class width	Haboobi				Jumhuria			
	% Accepted lag		Probit		% Accepted lag		Probit	
	Male	Female	Male	Female	Male	Female	Male	Female
0-1	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0
3-4	38.8	9.9	4.72	3.71	16.92	12.35	4.04	3.84
4-5	85.79	82.85	6.07	5.95	94.77	60.53	6.62	5.27
5-6	100	93.3	8.09	6.50	96.85	95.83	6.86	6.73
6 or more	100	96.87	8.09	6.86	98.67	100	7.20	8.09

Table 15 Models of gender impacton lag acceptance

SITE		MALE			FEMALE		
		Model	Mean	St. De.	Model	Mean	St. De.
Baghdad	Mashtal	Y=2.00+0.79X	3.80	1.27	Y=0.49+1.03X	4.38	0.97
	Kadhimiya	Y=0.35+1.32X	3.52	0.76	Y=1.06+0.87X	4.52	1.15
Nasiriya	Haboobi	Y=0.68+1.21X	3.57	0.89	Y=0.75+1.00X	4.25	1.00
	Jumhuria	Y=1.32+0.97X	3.79	1.03	Y=-1.12+1.42X	4.31	0.79

5.2. Influence of Age on Pedestrian Lag Acceptance Behavior

The influence of age on lag acceptance was investigated. The percentages of observed accepted lag of age groups observed data are presented in the Tables 16 and 17 for Baghdad and Nasiriya respectively. It was assumed that the observed data follow the cumulative normal distribution and the parameters of the distribution are calculated using Probit method of analysis, [13].The parameters of the distribution are calculated using linear regression equations. The obtained equation of male and female lag acceptance for all sites are presented in Table 18. The mean of data distribution can be calculated by setting Y equal to 5 and the reciprocal of the coefficient of X results in the standard deviation for all sites.

Table 16 Influence of age group on observed accepted lag for Baghdad

Class width	Mashtal						Kadhimiya					
	% Accepted lag			Probit			% Accepted lag			Probit		
	Young	Adult	Elder	Young	Adult	Elder	Young	Adult	Elder	Young	Adult	Elder
0-1	0	0	0	0	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0	0	0	0	0
3-4	21.68	66.67	3.15	4.22	5.43	3.25	8.66	17.85	9.16	3.64	4.08	3.67
4-5	85	91.82	81.33	6.04	6.39	5.89	96.29	91.01	85.71	6.79	6.34	6.07
5-6	88.9	94.18	88.5	6.22	6.57	6.2	100	96.87	88.65	8.09	6.86	6.21
6 or more	96.3	100	94.74	6.79	8.09	6.62	100	100	94.6	8.09	8.09	6.61

Table 17 Influence of age group on observed accepted lag for Nasiriya

Class width	Haboobi						Jumhuria					
	% Accepted lag			Probit			% Accepted lag			Probit		
	Young	Adult	Elder	Young	Adult	Elder	Young	Adult	Elder	Young	Adult	Elder
0-1	0	0	0	0	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0	0	0	0	0
3-4	35.71	62.22	16.23	4.63	5.31	4.01	18.92	50	12.56	4.12	5.00	3.86
4-5	81.25	89.81	80	5.89	6.27	5.84	91.3	96.42	73.84	6.4	6.80	5.64
5-6	82	95.34	98.5	5.92	6.68	7.19	100	98.97	92.85	8.09	7.33	6.46
6 or more	100	97.36	100	8.09	6.94	8.09	100	100	97.95	8.09	8.09	7.05

Table 18 Models of age group impact on lag acceptance

Site		Age group	Model	Mean	St. De.
Baghdad	Mashtal	Young	Y=1.87+0.79X	3.96	1.26
		Adult	Y=2.54+0.82X	3.00	1.22
		Elderly	Y=0.28+1.04X	4.54	0.96
	Kadhimiya	Young	Y=-0.67+1.47X	3.85	0.68
		Adult	Y=0.07+1.26X	3.91	0.79
		Elderly	Y=1.16+0.9X	4.27	1.11
Nasiriya	Haboobi	Young	Y=0.93+1.04X	3.90	0.96
		Adult	Y=3.65+0.53X	2.55	1.88
		Elderly	Y=0.51+1.36X	3.30	0.73
	Jumhuria	Young	Y=-0.13+1.36X	3.77	0.73
		Adult	Y=1.9+0.98X	3.16	1.02
		Elderly	Y=0.56+1.04X	4.26	0.96

5.3. Influence of Clothing Traditions on Pedestrian Lag Acceptance Behavior

The influence of clothing traditions on percentages of observed accepted lag is presented in the Tables 19 and 20. For Baghdad and Nasiriya respectively. It was assumed that the observed data follow the cumulative normal distribution and the parameters of the distribution are calculated using Probit method of analysis [13].The parameters of the distribution are calculated using linear regression equations. The obtained equation of male and female lag acceptance for all sites are presented in Table 21. The mean of data distribution can be calculated by setting Y equal to 5 and the reciprocal of the coefficient of X results in the standard deviation for all sites.

Table 19 Influence of Clothing Traditions on observed accepted lag for Baghdad

Class width	Mashtal				Kadhimiya			
	% Accepted lag		Probit		% Accepted lag		Probit	
	Arabic	Western	Arabic	Western	Arabic	Western	Arabic	Western
0-1	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0
3-4	5.71	30.64	3.42	4.49	4.17	13.79	3.27	3.91
4-5	84.41	89.06	6.01	6.23	86.67	92.04	6.12	6.41
5-6	88.88	93.48	6.22	6.51	88.5	96.84	6.20	6.86
6 or more	94.44	95.84	6.59	6.73	94.75	100	6.62	8.09

Table 20 Influence of Clothing Traditions on observed accepted lag for Nasiriya

Class width	Haboobi				Jumhuria			
	% Accepted lag		Probit		% Accepted lag		Probit	
	Arabic	Western	Arabic	Western	Arabic	Western	Arabic	Western
0-1	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0
3-4	6.06	46.42	3.45	4.91	4.88	20	3.34	4.16
4-5	82.92	86.88	5.95	6.12	73.02	95.41	5.61	6.69
5-6	95.34	94.62	6.68	6.61	93.67	98.95	6.53	7.33
6 or more	97.26	100	6.92	8.09	97.92	100	7.05	8.09

Table 21 Models of clothing traditions impact on lag acceptance

Site		clothing	Model	Mean (sec)	St. De. (sec)
Baghdad	Mashtal	Arabic	Y=0.7+0.97X	4.43	1.03
		Western	Y=2.49+0.7X	3.59	1.43
	Kadhimiya	Arabic	Y=0.49+1.01X	4.40	0.99
		Western	Y=-0.18+1.3X	3.98	0.77
Nasiriya	Haboobi	Arabic	Y=0.18+1.11X	4.34	0.90
		Western	Y=1.42+1.00X	3.58	1.00
	Jumhuria	Arabic	Y=-0.39+1.21	4.45	0.83
		Western	Y=0.35+1.24X	3.75	0.81

6. CONCLUSIONS

Within the limitations of field investigation procedure and assumptions, the following conclusions may be drawn:

1. Male pedestrians wearing western style are walking faster than those with Arabic style by 11% with mean walking speed of 1.04 and 1.17 m/sec for Baghdad and Nasiriya respectively, while the influence of cloth style was not significant for female pedestrian.
2. Male pedestrians have significantly faster crossing speeds than female pedestrians with average crossing speed of 1.31 m/sec for Baghdad and 1.13 m/sec for Nasiriya, while female exhibit average crossing speed of 1.26 and 1.06 m/sec for Baghdad and Nasiriya respectively.
3. Adult pedestrian of age group (18-50) are faster than elder while crossing for both gender and for all sites. Their crossing speed was in the range of 1.01 – 1.46 m/sec in Baghdad and Nasiriya city.
4. Male pedestrians accepted lags shorter than female pedestrians did with mean lag 3.66 and 3.68 sec for Baghdad and Nasiriya respectively, while female exhibit mean lag of 4.45 and 4.28 sec for Baghdad and Nasiriya respectively.
5. Pedestrians of 18–50 years old accepted lags shorter than did other groups of pedestrians with mean lag 3.5 and 2.85 sec for Baghdad and Nasiriya respectively.
6. Pedestrians wearing western style accepted lags shorter than did with Arabic style by 18% with mean lag 3.79 and 3.67 sec for Baghdad and Nasiriya respectively.

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