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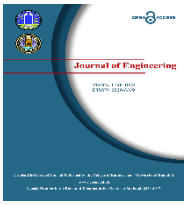

Civil and Architectural Engineering

Assessment of Pedestrian Walking Speed Through the Religious Occasions in Iraq

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ABSTRACT

The design of safe pedestrian facilities usually depends on the assessment of pedestrian characteristics and behavior. In this investigation, pedestrian walking speed through the religious occasion have been monitored at three locations, Al- Kadhimiya (Imam AL-Kadim), Najaf and Karbala (Imam AL-Husain) holy shrines. Video captures of the pedestrian through their walking to the two holy shrines have been prepared and analyzed for walking speed, gender, age groups, and clothing tradition. The pedestrian sample size is 468, 501, and 447 for Al- Kadhimiya, Karbala, and Najaf respectively. When the gender is taken into consideration, it can be noted that the walking speed of male and female pedestrian is (0.97, 1.68, and 1.63) and (0.82, 1.46, and 1.48) meter/second for Al- Kadhimiya, Karbala, and Najaf respectively. When the cloth tradition is considered, female pedestrian wearing Arabic style is slower than male by 9% for Karbala and Najaf and 3% for Al-Kadhimiya. On the other hand, when age groups are considered, the elder pedestrian is slower in walking by 6% regardless of the gender and location. It was recommended that the restricted walking path at Al- Kadhimiya could be improved to control the jam density of pedestrian and increase the walking speed to its standard limit.

Keywords: Pedestrian, walking speed, religious occasions, clothing tradition, age group.

تقييم سرعة المشاة خلال المناسبات الدينية في العراق

الخلاصة

يعتمد تصميم مرافق المشاة الآمنة عادةً على تقييم خصائص وسلوك المشاة .في هذا التحري ، تم رصد سرعة المشي للمشاة خلال المناسبة الدينية في ثلاثة مواقع ، الكاظمية (الإمام الكاظم) والنجف وكربلاء (الإمام الحسين) الأضرحة المقدسة .تم إعداد لقطات فيديو للمشاة من خلال المشي إلى المزارات المقدسة وتحليلها لسرعة المشي والجنس والفئات العمرية وتقاليد الملابس . يبلغ حجم عينة المشاة 468 و 501 و 447 لكل من الكاظمية وكربلاء والنجف على التوالي .عندما يؤخذ نوع الجنس في الاعتبار ، يمكن ملاحظة أن سرعة المشي للذكور والإناث هي (0.97 ، 1.68 ، و 1.63) و (0.82 ، 1.46 ، و 1.48) متر

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/ ثانية للكاظمية ، كربلاء ، و النجف على التوالي .عندما يتم اعتبار تقاليد الملابس ، فإن الإناث اللواتي يرتدين النمط العربي أبطأ من الذكور بنسبة 9٪ في كربلاء والنجف و 3٪ للكاظمية .من ناحية أخرى ، عندما يتم اعتبار الفئات العمرية ، يكون المشاة الأكبر سناً أبطأ في المشي بنسبة 6٪ بغض النظر عن الجنس والمكان .وأوصت بتحسين مسار المشي المقيّد في الكاظمية للتحكم في كثافة زحام المشاة وزيادة سرعة المشي إلى الحد القياسي.
الكلمات الرئيسية : المشاة ، سرعة المشي ، المناسبات الدينية ، تقاليد الملابس ، الفئة العمرية.

1. NTRODUCTION

Pedestrian facilities are an integral part of the overall transportation network. Despite the technological progress of our time, walking is still the most common and efficient mode of transportation, especially at the beginning and end of each journey. Therefore, the adoption of high efficiency in pedestrian facilities is very important. To enable and encourage safe and healthy walking, understanding of the characteristics of pedestrian movements is vital. The Iraqi people are accustomed to greeting some religious events on foot every year. Perhaps such events did not lead to a noticeable highlight in the research work. The number of pedestrians participating in such religious occasion is very large, reaching millions. The most important of these events is the 40th visit to Imam AL-Husain holy shrine in Karbala which coincides with the 20th of Safar In the Hijri and other appropriate dates, Imam al-Kadhim visit on 25 Rajab. This action examines factors that affect walking speed. Differences in walking speed are designed for pedestrians and are related to pedestrian characteristics such as gender, clothing traditions and age group. The pedestrian numbers were executed using video shooting. A study by, **(Sarsam and Abdulameer, 2014)** on pedestrian had concluded that the walking speed in the commercial area in Baghdad was of 29.85 m/minutes, while pedestrian characteristics such as age, gender, and clothing traditions were found to significantly contribute to pedestrian speed. The influence of age group on the walking speed was investigated by, **(Sarsam, 2013).** it was reported that pedestrians in the age range from 18-50 years old were the fastest group of pedestrians and pedestrians over 50 years old were the slowest**. (Daamen, 2004).**studied the walking speed obtained from previous studies in uncongested corridors and found that the mean walking speed of 1.34 m / second with a standard deviation of 0.37 for pedestrians in non-crowded situations (free-flow-speed) could be detected. New Zealand Government Planning and Walking Guide (**2009**), chooses 1.5 m / second as the average walking speed for a "fit and healthy" adult, which is about 25% faster than the United States. **(Hoogendoorn et al. 2003).** found that the high density of pedestrians happens in particular areas, for example waiting in front of the stairs and therefore, the average density measured depends heavily on how to measure the selected area.

2.RESEARCH METHODOLOGY

2.1 Selection of Sample Size

The data were collected during good weather conditions on a sunny or cloudy day without rain and during the expected peak hours for the pedestrians at the target location in the study. The data collection of pedestrian were carried out in the provinces of Najaf and Karbala while pedestrians were heading to Imam AL Husain, while data collection in Al- Kadhimiya was carried out while pedestrians were heading to Imam AL Kadhim. In Al- Kadhimiya, the data collection time was between 5:00 p.m. and 7:00 p.m. Videos were captured on random days, including holidays and normal days. In Karbala and Najaf, however, the situation was different, considering that the time of study was during the 40th visit. The peak time for pedestrians was between 8:00 and 10:00 am. Data collection days were extended from July 2017 to February 2018. The collected data included the following information:

Time taken to cut a specific distance either on a side walkway or through the street, the gender, the age group which was divided into three categories, (young people under 18 years of age, adults aged between 18 and 50 years, and elder, those over the age of 50 years) as suggested by**, (Sarsam, 2013)**. The data collection area was demonstrated in **Fig. 1** for Al- Kadhimiya, **Fig. 2** for Karbala, and **Fig. 3** for Najaf. The clothes style which was divided into two groups, the Arabic and the western clothing styles are demonstrated in **Fig. 4**. The sample size was calculated using Eq. 1. The manual counting was implemented through the videos that were previously recorded in the study areas. The videos were recorded using two cameras, one Canon EOS 5D, and the other Sony XR500. The period of filming usually takes about two hours.

Sample size = (Z- score) ^{2} x SD x (1-SD) / (Significance level) ^{2} …… (1)

where:

Z-score: fixed value corresponds to confidence level (95% confidence level, Z-score = 1.96)
SD = standard deviation
Significant level = 0.05.

Figure 1. Al- Kadhimiya city In Baghdad, Google Maps, 2018.

Table 1. demonstrates the calculations of sample size for each site for walking speed. Statistics 24 software was used to analyze data statistically.

Table 1. Calculations of Sample Size of a pedestrian for religious occasion.

Site	SD	N	Required N
Najaf	0.238	447	279
Karbala	0.273	501	305
Al- Kadhimiya	0.258	468	294

Figure 2. Tuwerij city in Karbala, Google Maps, 2018.

Figure 3. Kufa Street in Najaf, Google Maps, 2018.

Figure 4. Arabic clothing style.

3. RESULTS AND DISCUSSION

Table 2 exhibits the pedestrian walking speed as related to gender, and it can be observed that male pedestrian walks faster than female by (9, 13 and 15) % for (Najaf, Karbala, and Al-Kadhimiya) respectively. **Fig. 5** shows that pedestrians at Kabala and Najaf walk faster than those at Al- Kadhimiya regardless of gender. This may be attributed to the fact that the walking distances at Karbala and Najaf are longer and the pedestrians became humble to visit the holy shrines and are fast enough to complete the ceremony.

Table 2. Pedestrian walking Speed as Related to Gender.

Site	Gender	Walking speed (m/s)		
		Mean	Minimum	Maximum
Najaf	Male	1.63	1.00	2.01
	Female	1.48	0.86	1.99
Karbala	Male	1.68	1.10	2.74
	Female	1.46	1.02	2.04
Al-Kadhimiya	Male	0.97	0.50	1.67
	Female	0.82	0.49	1.20

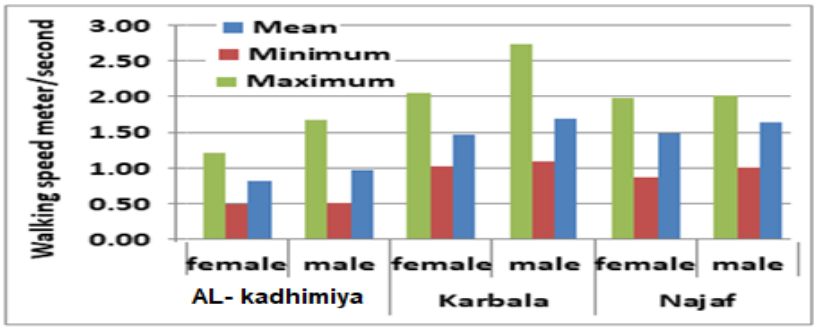


Figure 5. Pedestrian walking speed in relation to Gender.

The influence of age group on walking speed was demonstrated in **Table 3**. It can be noted that adult pedestrians walk faster than young and elder regardless of gender, the elder male pedestrians are slower than the adult male by (9, 7.5, and 14.5) %, while the elder female pedestrian is slower than adult female by (9.6, 9.7, and 10.5) for (Najaf, Karbala, and Al- Kadhimiya) respectively. Such findings are further supported by **Fig. 6**.

Table 3. Variation of Walking Speed with Gender and Age Groups.

Gender	Age group	Walking speed (m/s)		
		Najaf	Karbala	Al- Kadhimiya
Male	Young	1.63	1.72	1.00
	Adult	1.68	1.73	1.03
	Elder	1.52	1.60	0.88
Female	Young	1.51	1.51	0.85
	Adult	1.56	1.54	0.85
	Elder	1.41	1.39	0.76

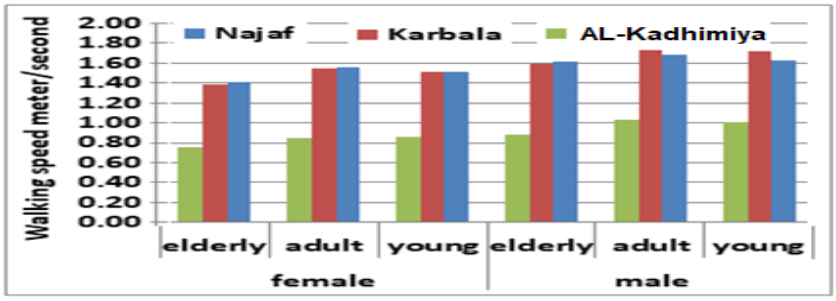


Figure 6 . Variation of Walking Speed with Gender and Age Groups.

The influence of clothing style on walking speed is shown in **Table 4**. It can be noted that pedestrian wearing western cloth style walks faster than those wearing Arabic cloth style by (1.2, 10, and 19) % for (Najaf, Karbala, and Al- Kadhimiya) respectively. This may be attributed to the limitations practiced in the step length, which is restricted due to clothing when using the Arabic clothing style. **Fig. 7** demonstrates the significant variations of walking speed among gender and clothing style.

Table 4. Variation of Walking Speed with Gender and Clothing.

Gender	Clothing	Walking speed (m/s)		
		Najaf	Karbala	Al-Kadhimiya
Male	Arabic	1.62	1.60	0.84
	Western	1.64	1.76	1.00
Female	Arabic	1.47	1.46	0.81

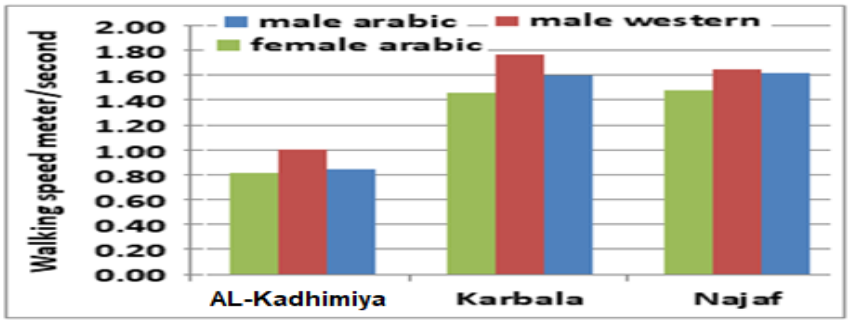


Figure 7. Variation of Walking Speed with Gender and Clothing style.

4.MODELING OF THE WALKING SPEED

4.1 Checking for Outliers

Extreme values are values located away from the master data set; the wrong note can be caused by an error. Chauvenet's standard can be used to checking The outliers and significant observations to test data outliers used to confirm correctness, (**Kennedy and Neville 1986)**. **Table 5** illustrations the outcomes of tests; note that all outcomes are less than the tabulated values. Therefore, there is no outliers.

Table 5. Results of Chauvinist Test for Outliers.

Location	N	Minimum	Maximum	Mean	Std. Deviation	max	min	tu
Najaf	447	0.8616	2.0122	1.583938	0.2379055	1.80	3.04	3.27
Karbala	501	1.0216	2.7406	1.623743	0.2733427	4.09	2.20	3.29
Al-Kadhimiya	468	0.34	1.77	0.92	0.258	3.39	2.28	3.46

Testing of Normality

Kolmogorov-Smirnov (**K-S test**) and **Shapiro-Wilk used** in this step as shown in **Table 6**.

Table 6. One-Sample Kolmogorov-Smirnov Test for Walking Speed.

Tests of Normality						
	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Dof.	Sig.	Statistic	Dof.	Sig.
Najaf	0.045	447	0.032	0.981	447	0.000
Karbala	0.075	501	0.000	0.973	501	0.000
Al-Kadhimiya	0.076	468	0.000	0.973	468	0.000

4.2 Multicollinearity

Matrix of correlation is created to find correlation coefficients of variables. The conclusion is made to insert or remove a variable based on the weather that the model variable improves. By using program IBM SPSS Statistics 24 software, correlation constants are calculated among all variables and the correlation matrix is prepared.

Table 7 demonstrations the matrix of correlation to recognize the original shape of the association concerning the predictor variable and the dependent variable.

Table 7. Partial Correlation Matrix for Walking.

Site	Dimension	Variance Proportions			
		(Constant)	Gender	Age group	Clothes style
Najaf	1	0.01	0.01	0.01	-
	2	0.02	0.82	0.3	-
	3	0.97	0.16	0.7	-
Karbala	1	0.00	0.14	0.03	-
	2	0.00	0.48	0.43	-
	3	1.00	0.37	0.54	-
Al-Kadhimiya	1	3.759	1.000	0.00	0.01
	2	0.146	5.067	0.00	0.21
	3	0.086	6.619	0.00	0.33

4.3 Stepwise Regression Models

The stepwise method was used with SPSS software to find linear regression models. **Tables 8** and **9** illustrate the coefficients and swift of stepwise regression for walking and crossing speed of pedestrian for Baghdad and Nasiriya.

Table 8. Model Summary.

	Model Summary									
						Change Statistics				
	Model	R	R^2	Adjusted R^2	Std. Error of Estimate	R^2 Change	F Change	df_1	df_2	Sig. F Change
Najaf	1	0.298	0.089	0.087	0.227	0.089	43.247	1	445	0.000
	2	0.314	0.099	0.095	0.226	0.010	4.950	1	444	0.027
Karbala	1	0.440	0.194	0.190	0.245	0.040896	25.26887	1	498	0.000
	2	0.448	0.200	0.195	0.245	0.006318	3.927023	1	497	0.048
Al-Kadhimiya	1	.461[b]	0.213	0.209	0.1956842	0.021	11.837	1	451	0.001
	2	.470[c]	0.221	0.216	0.1948837	0.008	4.713	1	450	0.030

Table 9. Coefficients and summary of stepwise regression.

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
Najaf	(Constant)	1.861	0.047		39.596	0.000	1.768	1.953
	Gender	-0.147	0.024	-0.283	-6.212	0.000	-0.193	-0.100
	Age group	-0.038	0.017	-0.101	-2.225	0.027	-0.072	-0.004
Karbala	(Constant)	1.861	0.047		39.596	0.000	1.768	1.953
	Gender	-0.147	0.024	-0.283	-6.212	0.000	-0.193	-0.100
	Age group	-0.03804	0.017097	-0.10132	-2.224	0.026	-0.07164	-0.00444
Al-Kadhimiya	(Constant)	0.906	0.086	10.536	0.000	0.737	1.075	0.906

	Gender	-0.087	0.023	-0.194	-3.858	0.000	-0.131	-0.043
	Age group	-0.035	0.016	-0.104	-2.171	0.030	-0.067	-0.003

4.4 Analysis of Error

Linear goodness of models can be tested and the errors have a constant variance (σ2), this can be accomplished by plot of scattering for standardized residuals (e_s), (which is the difference between the predicted value and an observed value yi) on vertical axis and the estimated value of the dependent variable ($\hat{Y}$) on horizontal axis. Points should be similarly distributed about (zero line). **Fig. 8** shows the plot of scattering of standardized residuals and dependent variable (speed) for all models.

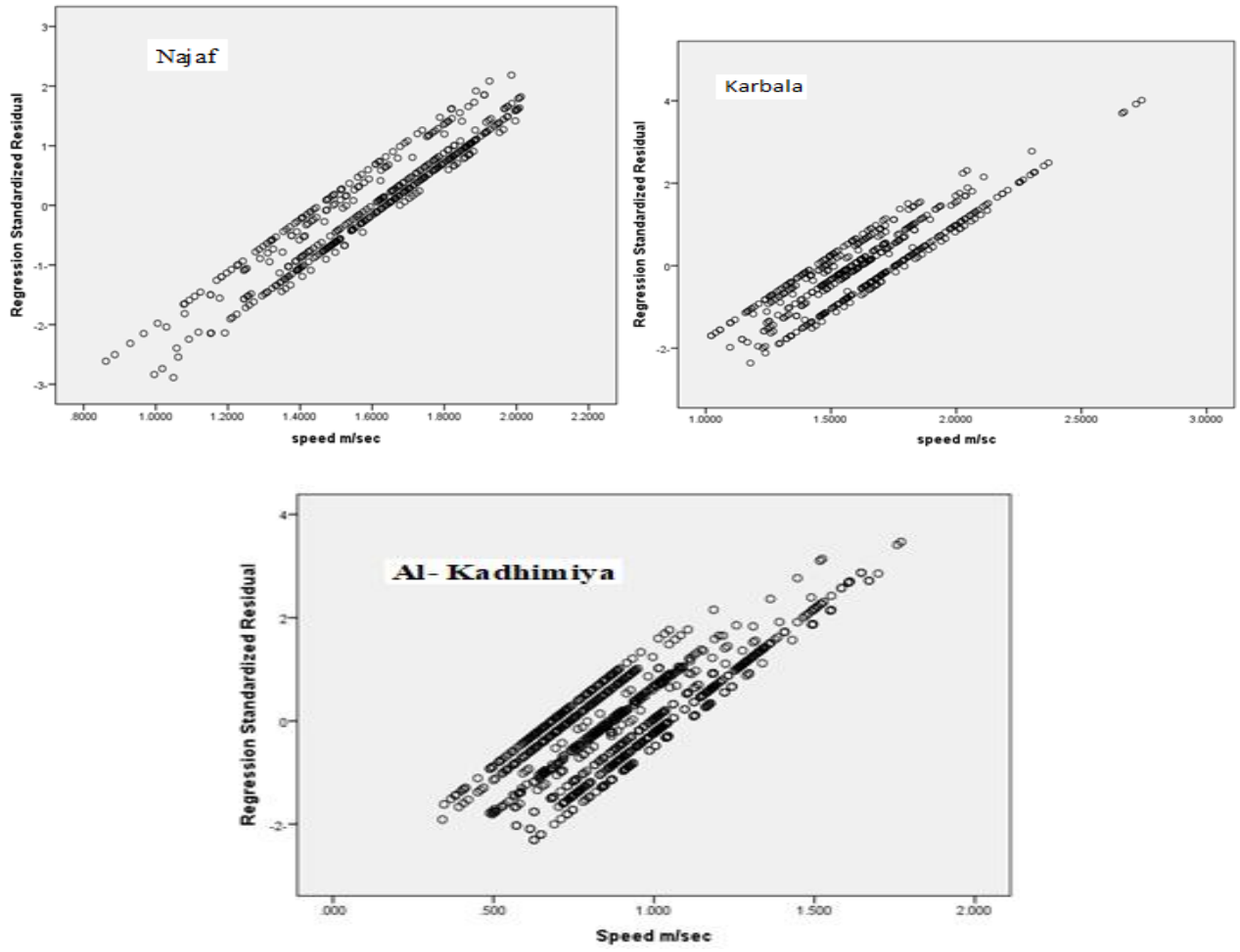


Figure 8. Scatter plot of standardized residuals and dependent variable.

4.5 Examination of R-Critical

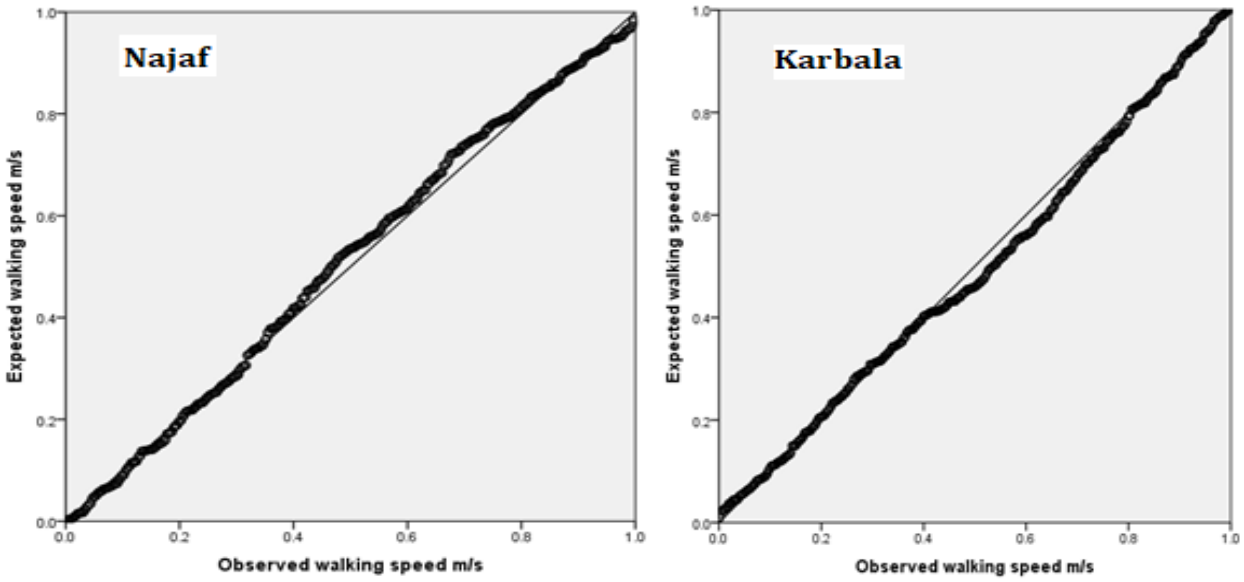
The correlation value R cannot be relied upon to conclude that the model represents the data obtained well. When the calculated R is greater than the tabulated R-value, the relationship between the independent and the dependence is significant at a certain probability degree when the obtained R is greater than the tabularized R-value. **Table 10** illustrates tabulated R values and calculated R for all models.

Table 10. Tabulated R values.

	N	$R_{calculated}$	$R_{tabulated}$
Najaf	447	0.314	0.083
Karbala	501	0.448	0.073
Al-Kadhimiya	468	0.470	0.079

4.6 Validation of the Developed Models

Graphing of observable and estimated data is a very useful way to evaluate the overall performance of the regression. If the point caused by the estimated data observatory tends to position near the line at 45^{o}, then the outcome model is satisfactory. This can be prepared by dividing the data into dual groups. About 70% of the data is used for regression modeling and 30% is used in the validation procedure for each site. **Fig. 9** demonstrations the results of plots.



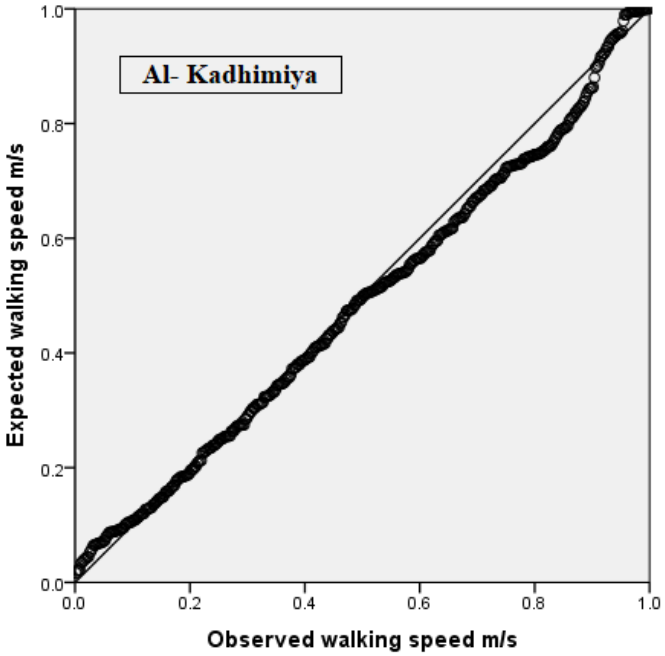


Figure 9. Validation of the models.

Figure 10. Pedestrians at Al- Kadhimiya city In Baghdad.

Figure 11. Pedestrians at Karbala.

Figure 12. Pedestrians at Najaf.

5.CONCLUSIONS

Based on the field observation and the statistical analysis, the following conclusions are drawn.

1- Iraqi pedestrians walk faster than other pedestrians do in the developed countries or the region through the religious occasions, the walking speed of male and female pedestrian is (0.97, 1.68, and 1.63) and (0.82, 1.46, and 1.48) m/s for Al- Kadhimiya, Karbala, and Najaf respectively.

2- Male pedestrians had significantly faster walking speeds than female pedestrians did. A female pedestrian wearing Arabic style is slower than male by 9% for Karbala and Najaf and 3% for Al-Kadhimiya.

3- The elder pedestrian is slower in walking speed by 6% regardless of the gender and location.

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