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## **THE ECONOMETRIC ANALYSIS OF THE MUSEUM AUDIENCE OF THE OPEN-AIR MUSEUM IN POLAND DEPENDING ON THE WEATHER FACTORS**

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It is very important to analyze the tourist attractions of museums, which can be studied by the questionnaire surveys or by analyzing the numbers of sold tickets. To prepare forecasts of the museum audience it is helpful to find out factors which influence on the number of sold tickets. In the case of an open-air museums there seems to be interesting to find out if and in which categories of the museum audience (normal tickets, reduced-price tickets and group tickets) the factors of the weather such as temperature, humidity, speed of the wind and so on, influence on the decision to visit the museum.

The purpose of this paper is to analyze the museum audience in two categories of the open-air museum in a small village in Poland in the years 2001-2004 to find out which factors of the weather are the most important in making decisions to visit the museum.

**Keywords:** *econometric analysis, tourism, museum audience*

### **1. Introduction**

Museums play a very important role in tourism, all cities and towns have found at least one. Their founders want to show history, geographical and ethnographical aspects of the region or famous people who lived in their city or town. On the other way some tourists go to all museums, some like visiting these, which have interesting exhibitions for them, and finally some people do not like going to museums at all. The role of the staff of a museum is preparing exhibitions in such a way to be very interesting for many people, adults and children.

The special role in the tourism play open-air museums, which can show buildings, gardens, transport equipment and so on. These museums are more sensitive to weather because seeing exhibitions may be difficult and unpleasant because of rain or snow and what is more important from our point of view is that if the weather is bad, tourists visit open-air museums less willingly.

The research includes the museum audience in the Narrow-Gauge Railway Museum in Wenecja (NGRM), which the main part of exhibition is situated in an open-air space. This museum is a part of Museum of Pałucka Land in Żnin (MPL), which is divided into three departments, two of them are situated in Żnin: Magistrat and Baszta and the last one, called Narrow-Gauge Railway, is located near Żnin in Wenecja. MPL was founded by members of Polish Touring Society in 1963. In Magistrat there are two permanent very interesting exhibitions: "Ethnography of Pałuki" and "History of Printing in Żnin". Moreover there are occasional exhibitions for example there is an exhibition about artists who work in Pałuki.



*Fig. 1.1. Narrow-Gauge Railway Museum in Wenecja (photo by A.Mrela)*

Narrow-Gauge Railway Museum was founded in 1972 and is situated near one of the stations of narrow-gauge train from Żnin to Gaśawa. On the other side of the track there are ruins of the castle from IV century, which belonged to Mikołaj Nałęcz, called Bloody Devil of Wenecja. In NGRM there can be

seen the permanent exhibition of rolling-stock, steam locomotives, carriages and trucks of narrow-gauge railway. There is also an stylistic waiting-room where tourists can send postcards with the original date marker and buy souvenirs or books about railway.

The purpose of the paper is to analyze the influence on the museum audience the weather factors in the open-air museum NGRM in years 2001-2004. Thanks to the director of MPL the research can include daily data, numbers of sold tickets from 01.01.2001 to 31.12.2004 in three categories:

- Normal tickets,
- Reduced price tickets,
- Group tickets (it means the number of people who come in one group).

Meteorological data is gathered by the staff of Instytut Melioracji i Użytków Zielonych in five categories:

- the amount of precipitation (in mm),
- daily total solar radiation (in  $W \cdot m^{-2}$ ),
- temperature measured at 12:00 GMT (in  $^{\circ}C$ ),
- solar radiation measured at 12:00 GMT (in  $W \cdot m^{-2}$ ),
- relative humidity measured at 12:00 GMT (in %),
- the speed of the wind measured at 12:00 GMT (in  $m \cdot s^{-1}$ ),

which are taken in Frydrychowo near Bydgoszcz.

Unfortunately there is no gathered data in Wenecja, Frydrychowo is about 50 km from Wenecja. But except the storm, the weather in Poland is rather stable, so there can be assumed that the weather factors in Frydrychowo are similar to the ones in Wenecja.

The aim of the research is looking for the weather factors that influence on the decision of visiting the Museum in Wenecja. The most important factors seem to be the temperature and the amount of precipitations because people like to go somewhere especially the open-air places when there is warm (but not too warm) and if there is no rain. Most tourists like sunny days, so the solar radiation may be also important.

## 2. The Museum Audience

In the paper the museum audience is measured by the number of sold tickets in three categories (Fig. 2.1)

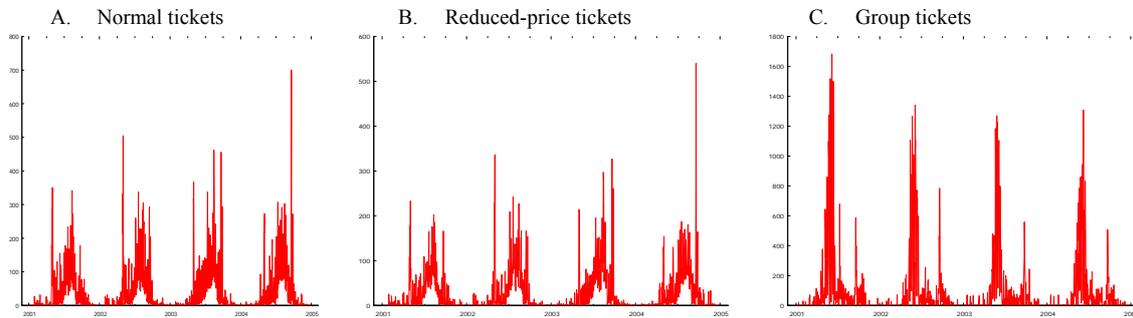


Fig. 2.1. The museum audience in NGRM in Wenecja in years 2001-2004 (daily data)

Analyzing the data there can be seen in each category a clear regularity: the number of tourists is much bigger in springs, summers and in autumns than in winters. There are differences, of course, the pick of number of tickets in the case of individual tickets (normal and reduced-price tickets) takes place in summers (June and August) but in the case of group tickets takes place in Mays, Junes and in Septembers. In the case of individual tourists more people have free time in summers and can visit museums with their children. In the case of group tourists the most visitors are school children, so the most excursions take place in late springs or in early autumns.

## 3. The Econometric Analysis of Museum Audience depending on weather factors

The museum audience is irregular (Fig 2.1), the number of sold tickets in each category is much bigger in late spring, summer and in early autumn then in the rest of the year. Because of that the data in each category is not homogenous, so we have chosen a few months to analyze the museum audience.

Because there can be noticed a clear weekly fluctuations of the museum audience, there have to be used the seasonal dummies  $Q_{it}^*$  equal to 1 in the  $m$ -th day of the week and 0 otherwise, where  $d_i$  are seasonal coefficients measuring of seasonal effect in the  $m$ -th day of the week. Because of the co linearity

of seasonal dummies  $Q_{it}^*$  ( $i = 1, 2, \dots, 7$ ) there have to be done transformation of  $Q_{it}^*$ , so from each of dummies  $Q_{it}^*$  ( $i=2, 3, \dots, 7$ ) one dummy  $Q_{1t}^*$  is subtracted, i.e.  $Q_{it} = Q_{it}^* - Q_{1t}^*$ .

To analyse the museum audience depending on the weather factors there are used the following variables:

- $AM_t$  – the amount of precipitation (in mm),
- $TSR_t$  – daily total solar radiation (in  $W \cdot m^{-2}$ ),
- $T_t$  – temperature measured at 12:00 GMT (in  $^{\circ}C$ ),
- $SR_t$  – solar radiation measured at 12:00 GMT (in  $W \cdot m^{-2}$ ),
- $RH_t$  – relative humidity measured at 12:00 GMT (in %),
- $SW_t$  – the speed of the wind measured at 12:00 GMT (in  $m \cdot s^{-1}$ ),
- $ET_t$  – the effective temperature.

There will be estimated model of the following form:

$$Aud_i = d_0 + \sum_{i=2}^7 d_i Q_{it} + \alpha_1 AM_t + \alpha_2 TSR_t + \alpha_3 T_t + \alpha_4 SR_t + \alpha_5 RH_t + \alpha_6 SW_t + \eta_t,$$

where missing seasonal coefficient  $d_1$  is calculated from the condition:  $\sum_{i=1}^7 d_i = 0$ , hence  $d_1 = -\sum_{i=2}^7 d_i$ .

The seasonal fluctuations occur if at least one seasonal coefficient is statistically significant.

In the estimated models besides these dummies and variables the one additional dummy is included in order to eliminate outlier<sup>1</sup>, being displayed as the increase of the museum audience, and at the same time to improve the fit of models. This outlier in the museum audience was caused by the opening of an attractive exhibition in Archeological Museum in Biskupin near Wenecja in the third Saturday of September in years 2001-2004. Because of that the dummy  $Fest_t$  is equal 1 in the third Saturday in September and zero otherwise.

During doing the research we have found out that people who come in groups (group tickets) are not influenced on the weather factors. They planned coming to the museum in advance and the bad weather i.e. small rain does not affect their previous decision. Because of that in the paper there is only presented the models about individuals (normal, reduced-price tickets) coming to NGRM in Wenecja.

There were chosen the following months the econometric models to be build: April, June and September.

### 3.1 April

April is a month of spring, so on this example there can be seen the influence of the weather factors on the museum audience.

#### 3.1.1 Normal tickets

**Table 3.1.1.** Estimation results for models of the museum audience – normal tickets in NGRM in Wenecja

Variable	2001		2002		2003		2004	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Const	-203,56	-3,62**	-223,024	-1,772*	-0,53316	-0,1291	-20,6215	-0,9306
Time	1,83992	3,436**	0,47336	1,79*	-	-	-	-
d2	-10,8737	-0,9494	2,01175	0,3832	-3,36786	-0,8094	-	-
d3	-14,5146	-1,265	-10,4927	-1,854*	-2,96277	-0,7211	-	-
d4	0,937636	0,0822	-6,79983	-1,212	-5,5127	-1,224	-	-
d5	-15,6681	-1,368	-8,69117	-1,547	-4,14346	-0,9043	-	-
d6	1,54871	0,1355	5,87204	0,9516	-0,67714	-0,1501	-	-
d7	45,5351	4,0**	24,0886	3,918**	11,3459	2,519**	-	-
$AM_t$	-3,5987	-2,207*	-2,72635	-2,66**	-	-	-	-
$TSR_t$	-	-	-	-	-	-	0,0897779	1,886*
$T_t$	2,44748	2,575**	1,56174	2,611**	-	-	-	-
$SR_t$	-	-	-	-	0,040704	-1,859*	-	-
$RH_t$	-	-	-	-	-	-	-	-
$SW_t$	-	-	-	-	-	-	-	-
	S(u)=±24,6	N=30	S(u)=±12,2	N=30	S(u)=±9,8	N=30	S(u)=±41,1	N=30
	$R^2=0,65$	$R_{sk}^2=0,5$	$R^2=0,63$	$R_{sk}^2=0,49$	$R^2=0,38$	$R_{sk}^2=0,18$	$R^2=0,12$	$R_{sk}^2=0,08$
	DW=1,99	$\rho_{11}=0,01$	DW=1,77	$\rho_{11}=0,01$	DW=2,23	$\rho_{11}=-0,1$	DW=1,15	$\rho_{11}=0,27$

\*, \*\* denote significance at 10% and 5% level respectively

<sup>1</sup> The outlier is the observation that is significantly different from the last ones.

In the case of normal tickets the museum audience (comp. Table 3.1.1) is dependent on the weather factors in a medium (2001, 2002) and low (2003, 2004) degree, and only one or two weather factors are statistically significant: in years 2001, 2002: the amount of precipitation and the temperature at 12:00 GSM, in 2002: the solar radiation measured at 12:00 GMT and in 2003: the total solar radiation. What is interesting, that in 2004 there are no weekly fluctuations?

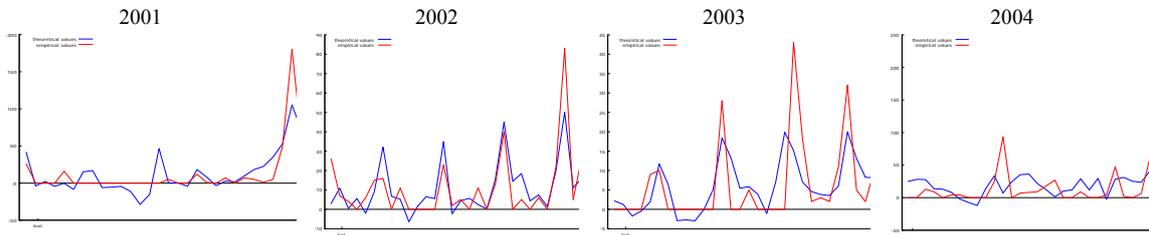


Fig. 3.1.1. The museum audience in the case of normal tickets in NGRM in Wenecja

### 3.1.2 Reduced-price tickets

Table 3.1.2. Estimation results for models of the museum audience – reduced-price tickets in NGRM in Wenecja

Variable	2001		2002		2003		2004	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Const	-118,226	-3,33***	2,42633	0,05602	11,4566	1,87*	-16,9944	-1,406
Time	1,09007	3,236***	-	-	-	-	-	-
d2	-10,7491	-1,492	-	-	-2,82786	-0,8913	-	-
d3	-12,7553	-1,767*	-	-	-4,94562	-1,579	-	-
d4	8,28466	1,155	-	-	-6,48769	-1,818*	-	-
d5	-10,8754	-1,509	-	-	-6,38498	-1,708	-	-
d6	3,14402	0,4372	-	-	1,55996	0,4198	-	-
d7	28,8723	4,031**	-	-	8,95712	2,53**	-	-
AM <sub>t</sub>	-2,72635	-2,657*	0,906644	0,3161	-	-	-	-
TSR <sub>t</sub>	-118,226	-3,338**	-0,08284	-0,2997	-	-	0,0711464	2,740**
T <sub>t</sub>	-	-	0,752024	0,8636	0,376933	1,603	-	-
SR <sub>t</sub>	-	-	0,049821	1,019	-	-	-	-
RH <sub>t</sub>	-	-	-0,02706	-0,0633	-	-	-	-
SW <sub>t</sub>	-	-	-7,39702	-0,9463	-7,84775	-2,32**	-	-
	S(u)=±24,6	N = 30	S(u)=±16,7	N=30	S(u) = ±7,4	N=30	S(u) =±22,4	N=30
	R <sup>2</sup> = 0,65	R <sup>2</sup> <sub>sk</sub> = 0,5	R <sup>2</sup> = 0,13	R <sup>2</sup> <sub>sk</sub> = 0,1	R <sup>2</sup> = 0,55	R <sup>2</sup> <sub>sk</sub> = 0,4	R <sup>2</sup> = 0,21	R <sup>2</sup> <sub>sk</sub> = 0,2
	DW = 1,98	ρ <sub>11</sub> = 0,01	DW = 2,16	ρ <sub>11</sub> = -0,1	DW = 2,48	ρ <sub>11</sub> = -0,2	DW = 1,35	ρ <sub>11</sub> = 0,2

\*, \*\* denote significance at 10% and 5% level respectively

In the case of reduced-price tickets the museum audience (comp. Table 3.1.2) is dependent on the weather factors in a medium (2001, 2002) and low (2003, 2004) degree. Notice that one or two weather factors are statistically significant, namely in year 2001: the amount of precipitation and the total solar radiation, in 2002 there are no statistically significant weather factors and no weekly fluctuations, in 2003 there are two of them: the temperature at 12:00 GMT and the speed of the wind measured at 12:00 GMT, and finally in 2004 there is one statistically significant weather factor: the total solar radiation but no weekly fluctuations.

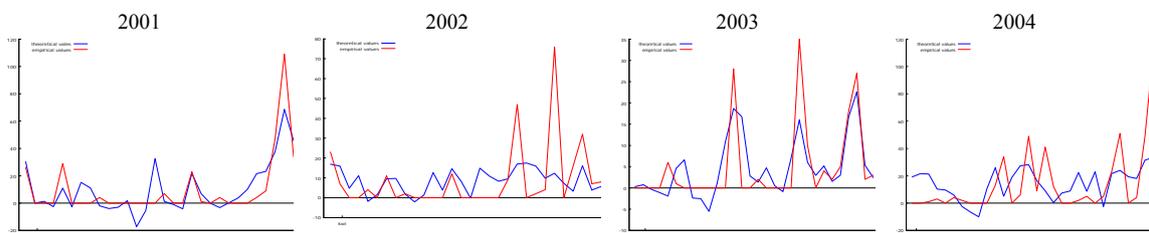


Fig. 3.1.2. The museum audience in the case of reduced-price tickets in NGRM in Wenecja

### 3.2 June

June is the first month of summer, so on this example there was done the research if the weather factors influence on the museum audience.

### 3.2.1 Normal tickets

**Table 3.2.** Estimation results for models of the museum audience – normal tickets in NGRM in Wenecja

Variable	2001		2002		2003		2004	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Const	99,6093	4,234**	126,519	1,808*	-752,276	-2,281**	-102,111	-0,8681
Time	-	-	-	-	0,882632	2,398**	-	-
d2	-14,327	-1,02	-33,8251	-2,764**	-18,2383	-2,259**	-38,8332	-1,771*
d3	-27,4832	-1,988*	-14,3787	-1,418	-17,416	-2,168**	-19,1652	-0,794
d4	-8,35712	-0,5654	-22,5998	-1,758*	-7,88527	-0,994	1,48153	0,05474
d5	-14,2313	-1,025	-27,7691	-2,786**	-40,8265	-4,507**	4,83987	0,2084
d6	26,3807	2,095**	42,7732	3,653**	24,78	3,115**	36,2502	1,61
d7	58,8145	4,358**	77,5074	7,131**	88,2836	12,03**	49,9964	2,153**
AM <sub>t</sub>	-	-	3,27765	1,332	7,95124	5,814**	-8,3811	-1,686
TSR <sub>t</sub>	-	-	0,11349	0,4793	-	-	-0,132	-0,3166
T <sub>t</sub>	-	-	-4,90247	-2,976**	-	-	2,23389	0,4625
SR <sub>t</sub>	-	-	0,070177	1,233	-	-	0,101896	0,9886
RH <sub>t</sub>	-0,5201	-1,64	-0,81602	-1,386	-	-	1,47683	1,45
SW <sub>t</sub>	-35,2998	-1,746*	9,52374	0,7186	-	-	0,910396	0,07116
	S(u)=±29,1	N=30	S(u)=±38,7	N=30	S(u)=±17,2	N=30	S(u)=±53,4	N=30
	R <sup>2</sup> = 0,61	R <sup>2</sup> <sub>sk</sub> =0,46	R <sup>2</sup> = 0,85	R <sup>2</sup> <sub>sk</sub> =0,75	R <sup>2</sup> = 0,91	R <sup>2</sup> <sub>sk</sub> =0,87	R <sup>2</sup> = 0,59	R <sup>2</sup> <sub>sk</sub> =0,30
	DW = 1,8	ρ <sub>11</sub> = 0,1	DW = 1,74	ρ <sub>11</sub> =0,06	DW = 2,41	ρ <sub>11</sub> = -0,3	DW = 1,12	ρ <sub>11</sub> =0,44

\*, \*\* denote significance at 10% and 5% level respectively

In the case of normal tickets the museum audience (comp. Table 3.2.1) there can be noticed different types of models in each year but the museum audience is dependent on the weather factors in medium and high degree. In 2001 the degree of dependence the museum audience on the relative humidity at 12:00 GMT and the speed of the wind is medium (R<sup>2</sup>= 0,61). In 2002 the museum audience is influenced on the temperature, the speed of wind and the effective temperature at 12:00 GMT in a high degree (R<sup>2</sup>=0,85). In 2003 the museum audience depends only on the amount of precipitation in a very high degree (R<sup>2</sup> = 0,91). In 2004 the model has the degree of dependence in medium size, there is no weather factor which is statistically significant.

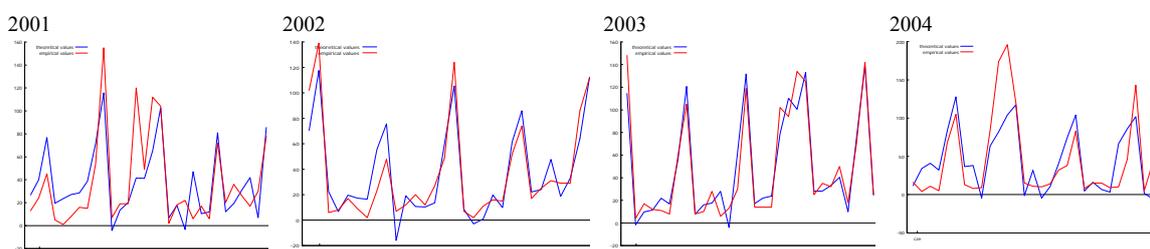


Fig. 3.2.1. The museum audience in the case of normal tickets in NGRM in Wenecja

### 3.2.2 Reduced-price tickets

**Table 3.1.2.** The estimation results for models of the museum audience – reduced-price tickets in NGRM in Wenecja

Variable	2001		2002		2003		2004	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Const	29,0166	1,266	-469,861	-2,529**	28,9879	8,762**	-38,6251	-0,4981
Time	-	-	0,983482	2,777**	-	-	-	-
d2	-8,55804	-1,075	-14,0879	-1,568	-10,4879	-1,367	-	-
d3	-9,27871	-1,171	-6,31402	-0,7555	-2,06387	-0,2699	-	-
d4	-6,01615	-0,7191	-12,1451	-1,627	5,69811	0,7541	-	-
d5	-5,78864	-0,7652	-17,1496	-2,29**	-24,0059	-2,783**	-	-
d6	20,8046	2,902**	12,2133	1,443	12,2521	1,624	-	-
d7	19,4612	2,518**	42,1229	5,365**	40,4209	5,784**	-	-
AM <sub>t</sub>	-	-	-	-	3,26002	2,517**	-7,5847	-2,774**
TSR <sub>t</sub>	-	-	-	-	-	-	-0,13904	-0,5988
T <sub>t</sub>	1,53054	1,765*	-2,03765	-1,99*	-	-	2,2198	0,6989
SR <sub>t</sub>	-	-	0,041308	1,298	-	-	0,077253	1,205
RH <sub>t</sub>	-	-	-	-	-	-	0,889292	1,414
SW <sub>t</sub>	-31,7446	-2,768**	-	-	-	-	-10,6331	-1,538
	S(u)=±16,7	N=30	S(u)=±26,1	N=30	S(u)=±16,4	N=30	S(u)=±34,3	N=30
	R <sup>2</sup> = 0,60	R <sup>2</sup> <sub>sk</sub> =0,45	R <sup>2</sup> = 0,74	R <sup>2</sup> <sub>sk</sub> =0,6	R <sup>2</sup> = 0,70	R <sup>2</sup> <sub>sk</sub> =0,61	R <sup>2</sup> = 0,35	R <sup>2</sup> <sub>sk</sub> =0,18
	DW = 2,58	ρ <sub>11</sub> = -0,3	DW = 1,35	ρ <sub>11</sub> =0,23	DW = 1,86	ρ <sub>11</sub> = 0,05	DW = 1,42	ρ <sub>11</sub> = 0,29

\*, \*\* denote significance at 10% and 5% level respectively

In the case of reduced-price tickets the museum audience is dependent on the weather factors in medium (years 2001, 2002, 2003) and low degree (comp. Table 3.2.2). There can be noticed that in 2001 the temperature measured at 12:00 GMT influenced on the museum audience, in 2002 there are two factors (the temperature and the solar radiation, both measured at 12:00 GMT), in 2003 there is only one factor: the amount of precipitation, and finally in 2004 there are important all weather factors but only the amount of precipitation is statistically significant and there is no weekly fluctuations.

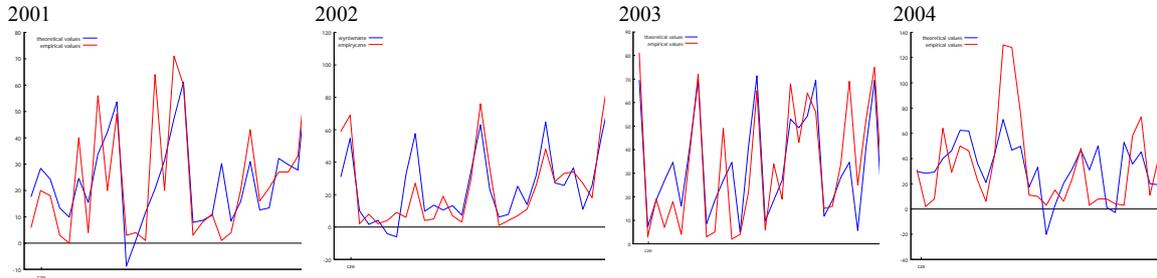


Fig. 3.2.2. The museum audience in the case of reduced-price tickets in NGRM in Wenecja

### 3.3 September

September is the first month of autumn, so on this example there can be seen the influence the weather factors on the museum audience.

#### 3.3.1 Normal tickets

Table 3.3.1. The estimation results for models of the museum audience – normal tickets in NGRM in Wenecja

Variable	2001		2002		2003		2004	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Const	31,5213	5,245**	-53,6533	-1,885*	2,24721	0,04244	360,874	4,931**
Time	-	-	-	-	-	-	-	-
d2	-14,8746	-1,396	-42,0828	-2,44**	-55,0669	-2,435**	-10,3415	-0,2908
d3	-27,5045	-2,492**	-42,27	-2,492**	-50,2586	-2,092**	-55,4657	-1,676
d4	-32,6866	-2,945**	-30,4228	-1,857*	-53,7302	-2,252**	-46,4718	-1,467
d5	-9,83846	-0,8979	-17,7092	-1,052	-40,5986	-1,746*	-79,3492	-2,26**
d6	28,3898	2,913**	46,5736	2,758**	43,6898	1,846*	23,4765	0,6517
d7	70,5031	7,003**	97,0579	6,57**	201,931	7,736**	226,307	6,398**
Fest <sub>t</sub>	35,7539	3,823**	75,6398	4,271**	63,659	3,047**	148,719	4,506**
AM <sub>t</sub>	-3,41039	-3,154**	4,46355	2,066*	-	-	19,1231	2,791**
TSR <sub>t</sub>	-	-	-	-	-	-	-	-
T <sub>t</sub>	-	-	-	-	4,72717	1,621	-	-
SR <sub>t</sub>	-	-	0,248382	3,081**	-0,18179	-1,759*	-	-
RH <sub>t</sub>	-	-	-	-	-	-	-5,23436	-4,46**
SW <sub>t</sub>	-	-	-	-	-	-	-	-
	S(u) = ±23	N=30	S(u) = ±34,8	N=30	S(u) = ±105	N=30	S(u) = ±74,1	N=30
	R <sup>2</sup> = 0,81	R <sup>2</sup> <sub>sk</sub> = 0,73	R <sup>2</sup> = 0,82	R <sup>2</sup> <sub>sk</sub> = 0,74	R <sup>2</sup> = 0,84	R <sup>2</sup> <sub>sk</sub> = 0,77	R <sup>2</sup> = 0,81	R <sup>2</sup> <sub>sk</sub> = 0,7
	DW = 1,48	ρ <sub>11</sub> = 0,25	DW = 2,10	ρ <sub>11</sub> = -0,1	DW = 2,04	ρ <sub>11</sub> = -0,03	DW = 2,56	ρ <sub>11</sub> = -0,3

\*, \*\* denote significance at 10% and 5% level respectively

In the case of normal tickets the museum audience (comp. Table 3.3.1) is dependent on the weather factors in high degree (R<sup>2</sup> is bigger than 0,7 in all years). The must be added the variable Fest<sub>t</sub> because the opening of very attractive exhibition in Biskupin causes the increase of the museum audience in Wenecja. There can be seen that in 2001 there is only one statistically significant weather factor: the amount of precipitation, in 2002 there are two weather factors: the amount of precipitation and the solar radiation measured at 12:00 GMT, in 2003 there are two factors: the temperature and the solar radiation measured at 12:00 GMT and finally in 2004 there are two weather factors: the amount of precipitation and the relative humidity measured at 12:00 GMT.

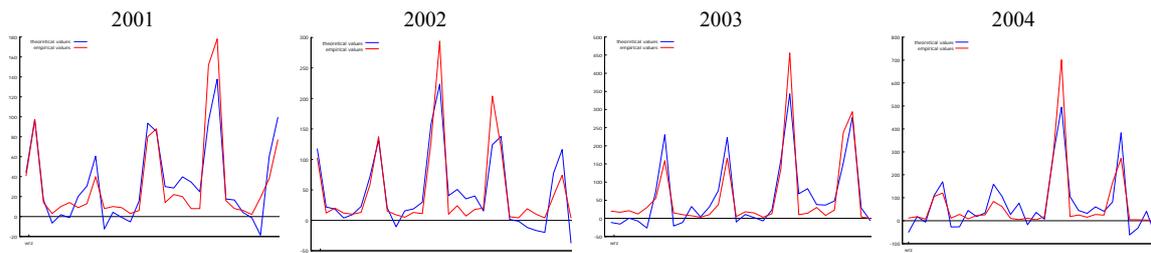


Fig. 3.2.1. The museum audience in the case of normal tickets in NGRM in Wenecja

### 3.3.2 Reduced-price tickets

**Table 3.3.2.** Estimation results for models of the museum audience – reduced-price tickets in NGRM in Wenecja

Variable	2001		2002		2003		2004	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Const	23,0798	4,145**	-8,95754	-0,693	10,1992	0,2052	454,326	3,526**
Time	-	-	-	-	-	-	-	-
d2	-15,1513	-1,534	-22,0701	-2,16**	-45,7436	-2,155**	23,8759	0,787
d3	-25,1965	-2,464**	-32,0355	-3,192**	-41,0573	-1,821*	-46,0816	-1,703
d4	-21,9813	-2,137**	-15,2165	-1,587	-35,0678	-1,566	-40,5303	-1,58
d5	-0,75648	-0,07451	-14,3609	-1,441	-26,9312	-1,234	-47,9718	-1,69
d6	24,5747	2,721**	45,1279	4,671**	52,0432	2,343**	13,8115	0,4741
d7	53,7317	5,76**	54,7956	6,272**	130,877	5,342**	150,873	5,275**
Fest	37,8149	4,363**	49,532	4,978**	70,5155	3,596**	113,791	4,07**
AM <sub>t</sub>	-2,67407	-2,669**	-	-	-	-	13,1714	2,374**
TSR <sub>t</sub>	-	-	-	-	-	-	-	-
T <sub>t</sub>	-	-	-	-	3,4077	1,245	-	-
SR <sub>t</sub>	-	-	0,096318	2,424**	-0,18071	-1,862*	-0,19566	-1,802*
RH <sub>t</sub>	-	-	-	-	-	-	-5,39203	-3,95**
SW <sub>t</sub>	-	-	-	-	-	-	-	-
	S(u)=±38,6	N=30	S(u)=±20,6	N=30	S(u)=±47,2	N=30	S(u)=±60	N=30
	R <sup>2</sup> = 0,78	R <sup>2</sup> <sub>sk</sub> =0,69	R <sup>2</sup> = 0,84	R <sup>2</sup> <sub>sk</sub> =0,78	R <sup>2</sup> = 0,78	R <sup>2</sup> <sub>sk</sub> =0,67	R <sup>2</sup> = 0,79	R <sup>2</sup> <sub>sk</sub> =0,68
	DW = 1,24	ρ <sub>11</sub> =0,38	DW = 2,37	ρ <sub>11</sub> =-0,21	DW = 1,95	ρ <sub>11</sub> =0,02	DW = 2,34	ρ <sub>11</sub> =-0,20

\*, \*\* denote significance at 10% and 5% level respectively

In the case of reduced-price tickets the museum audience (comp. Table 3.3.2) is dependent on the weather factors in high degree. Similarly as in the normal tickets there is one more variable Fest to improve the fit of the models. There can be noticed that in 2001 there is only one statistically significant weather factor: the amount of precipitation in 2002 there is also one weather factor: the solar radiation measured at 12:00 GMT, in 2003 there are two weather factors: the temperature and the solar radiation measured at 12:00 GMT, and in 2004 there are three weather factors: the amount of precipitation, the solar radiation and the relative humidity measured at 12:00 GMT.

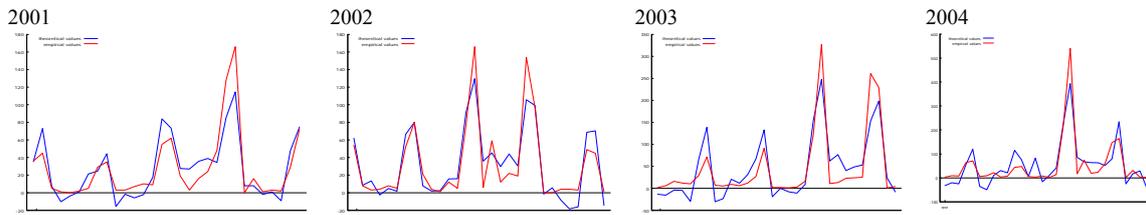


Fig. 3.3.2. The museum audience in the case of reduced-price tickets in NGRM in Wenecja

### 3.4 November

November is the last month of autumn, so on this example there can be seen the influence of the weather factors on the museum audience.

#### 3.4.1 Normal tickets

**Table 3.4.1.** Estimation results for models of the museum audience – normal tickets in NGRM in Wenecja

Variable	2001		2002		2003		2004	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Const	-19,194	-2,193**	60,3512	0,449	2394,01	1,274	-33,7374	-2,662**
Time	-	-	-0,08123	-0,422	72,7224	2,312**	-	-
d2	-0,95676	-0,4096	-1,41622	-0,642	-	-	-1,56593	-0,5385
d3	-2,0472	-0,8742	-0,89082	-0,4091	0,51124	0,1575	-3,64191	-1,138
d4	-4,04301	-1,729	-2,02288	-0,8442	-2,13324	-0,6338	8,65674	2,872***
d5	0,198278	0,09403	-2,29348	-1,189	-1,97352	-0,6008	0,73264	0,2424
d6	-1,78702	-0,7645	7,07839	2,749**	-2,81369	-0,9007	-2,50984	-0,8027
d7	12,4264	4,986**	2,24897	1,086	-0,46567	-0,1599	-1,83395	-0,6294
AM <sub>t</sub>	0,055498	0,07923	-1,01467	-1,767*	7,92999	2,605**	-	-
TSR <sub>t</sub>	0,011808	0,02843	-0,1833	-0,8749	-0,50289	-0,7892	0,259947	2,884**
T <sub>t</sub>	0,250125	0,658	0,214202	0,7425	-0,66157	-1,817*	-	-
SR <sub>t</sub>	0,103173	1,181	-	-	-	-	0,054508	2,379**
RH <sub>t</sub>	0,182037	2,398**	-	-	-0,6253	-2,101**	0,334171	2,434**
SW <sub>t</sub>	-	-	-0,01029	-0,0056	-	-	-	-
	S(u)=±6,15	N=30	S(u)=±4,61	N=30	S(u)=±6,6	N=30	S(u)=±6,2	N=30
	R <sup>2</sup> = 0,63	R <sup>2</sup> <sub>sk</sub> =0,41	R <sup>2</sup> = 0,46	R <sup>2</sup> <sub>sk</sub> =0,13	R <sup>2</sup> = 0,43	R <sup>2</sup> <sub>sk</sub> =0,13	R <sup>2</sup> = 0,58	R <sup>2</sup> <sub>sk</sub> =0,39
	DW = 1,7	ρ <sub>11</sub> =0,15	DW = 2,68	ρ <sub>11</sub> =-0,36	DW = 1,43	ρ <sub>11</sub> =0,25	DW = 1,78	ρ <sub>11</sub> =0,1

\*, \*\* denote significance at 10% and 5% level respectively

In the case of normal tickets the museum audience (comp. Table 3.4.1) the museum audience is dependent on the weather factors in medium degree ( $R^2$  is about 05). It can be noticed that in 2001 the relative humidity at 12:00 GMT is statistically significant, in 2002 it is the amount of precipitation, in 2003 there are three statistically significant weather factors: the amount of precipitation, the temperature and the relative humidity at 12:00 GMT and finally in 2004 there are also three statistically significant factors: the total solar radiation, the solar radiation and the relative humidity measured at 12:00 GMT. It is interesting that the relative humidity is important in November.

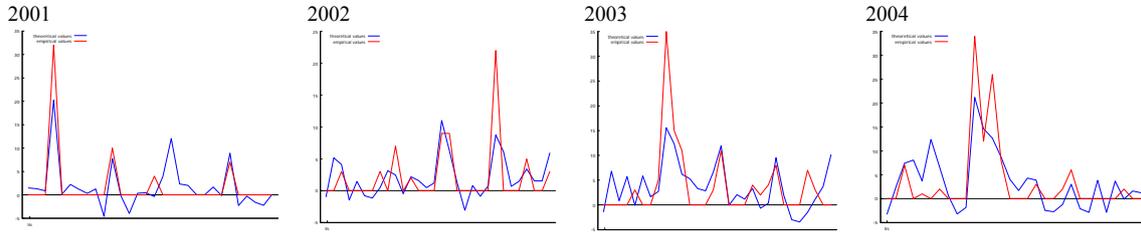


Fig. 3.4.1. The museum audience in the case of normal tickets in NGRM in Weneja

### 3.4.2 Reduced-price tickets

Table 3.4.2. The estimation results for models of the museum audience – reduced-price tickets in NGRM in Weneja

Variable	2001		2002		2003		2004	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Const	86,0909	2,154**	-3,01458	-0,6048	16,3035	2,861***	-0,47719	-0,2985
Time	-0,25906	-2,252**	-	-	-	-	-	-
d2	-1,04226	-0,8174	0,075856	0,07873	0,739102	0,5476	-0,23515	-0,0832
d3	-1,19423	-0,9463	-1,24407	-1,261	-0,46199	-0,3273	-1,91546	-0,6512
d4	-1,12724	-0,8864	-1,27372	-1,263	-2,63723	-1,861*	-0,99641	-0,3388
d5	-0,96583	-0,8495	-1,45625	-1,609	-0,11279	-0,08374	3,38463	1,143
d6	-0,56756	-0,4492	3,90741	3,317**	-0,26512	-0,2144	-5,4557	-1,744*
d7	6,53957	4,842**	0,792096	0,7735	3,58417	2,823**	4,99421	1,664
AM <sub>t</sub>	-0,08954	-0,2344	-0,58248	-2,35**	-	-	-	-
TSR <sub>t</sub>	-0,40148	-1,563	0,075733	0,6662	-	-	0,323791	3,682**
T <sub>t</sub>	-0,51733	-1,697	0,039444	0,3145	-	-	-	-
SR <sub>t</sub>	0,086029	1,756*	-0,01015	-0,4247	-	-	-	-
RH <sub>t</sub>	0,017112	0,4083	0,045684	0,9618	-0,16076	-2,516**	-	-
SW <sub>t</sub>	-	-	-	-	-	-	-	-
	S(u)= ±3,4	N=30	S(u)= ±2,2	N=30	S(u)=±2,92	N=30	S(u)=±6,38	N=30
	R <sup>2</sup> = 0,68	R <sup>2</sup> <sub>sk</sub> =0,45	R <sup>2</sup> = 0,48	R <sup>2</sup> <sub>sk</sub> =0,17	R <sup>2</sup> = 0,38	R <sup>2</sup> <sub>sk</sub> =0,19	R <sup>2</sup> = 0,53	R <sup>2</sup> <sub>sk</sub> =0,38
	DW = 2,06	ρ <sub>11</sub> =-0,03	DW = 2,08	ρ <sub>11</sub> = -0,1	DW = 1,5	ρ <sub>11</sub> =0,19	DW = 1,63	ρ <sub>11</sub> = 0,19

\*, \*\* denote significance at 10% and 5% level respectively

In the case of reduced-price tickets the museum audience (comp. Table 3.4.2) is dependent on the weather factors in medium (2001, 2002) and low (2003, 2004) degree. It can be noticed that in 2001 there is only one statistically significant weather factor: the solar radiation at 12:00 GMT, in 2002 it is the amount of precipitation, in 2003 it is the relative humidity at 12:00 GMT and in 2004 it is the total solar radiation.

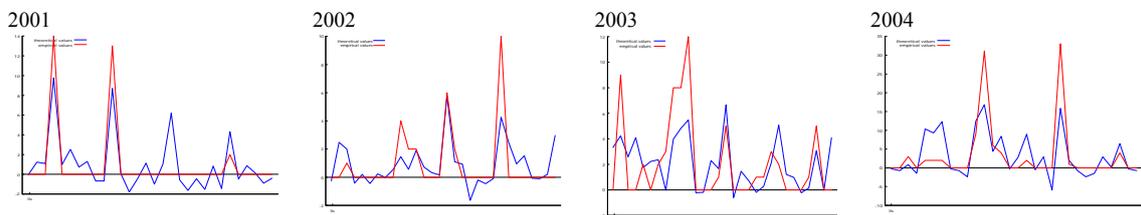


Fig. 3.4.2. Museum audience in the case of reduced-price tickets in NGRM in Weneja

### Summary

Nowadays it is very important to predict whether people will come to a museum or not. Of course, some historical, geographical or cultural aspects not economical are crucial in making a decision whether the particular museum should be founded or should be closed. Nevertheless if the museum does not need

the financial support from the local government, it is sure that the museum can stay and show its exhibitions.

The knowledge about periods in which more people come to the museum is very important to have the special occasional exhibitions and to plan how many people must be employed to open the museum longer hours.

In the case of open-air museums the weather factors seem to have a big influence on the museum audience if there are considered individual tourists. In the case of tourists coming in groups the season is important not the daily changes in the weather.

The models show that the museum audience is depended on the day of the week. There can be observed that almost in all models the weekly fluctuations are statistically significant. It is easy to see that people have more free time in weekends, so they can visit the museum in Wenecja.

The research gave the surprising answer that the weather factors do not influence on the museum audience in NGRM in Wenecja as much as it was expected. There was assumed that the temperature, the amount of precipitation and the solar radiation would play the important role, but they were not statistically significant in all or even almost all models. Of course, the season is very important, as it is easy to see that much more people come to the museum in late springs, in summers and in early autumns. So these weather factors are important because the temperature, the solar radiation have bigger values than in winters.

But the weather there is important, in almost all models some of the weather factors are statistically significant, unfortunately considering one month there are different factors significant in different years. What is crucial that very often the shape of the museum audience in two categories: normal tickets and reduced price tickets are similar, so the same weather factors are significant.

## References

1. Box, G.E.P, Jenkins G.M., *Analiza szeregów czasowych*, PWE, Warszawa,1983.
2. Eagleman, J. R., *Meteorology, The atmosphere in action*, Wadsworth Publishing Company, Belmont, California, USA, 1985.
3. Gołębski, G. (red), *Kompendium wiedzy o turystyce*, PWN, Warszawa Poznań, 2002.
4. Kozłowska–Szczęsna T., Błażejczyk K., Krawczyk B., *Bioklimatologia człowieka, Metody i ich zastosowanie w badaniach bioklimatu Polski*, Polska Akademia Nauk, Instytut Geografii i Przestrzennego Zagospodarowania, Monografie, 1, Warszawa, 1997.
5. Żygulski, Z., *Muzea na świecie*, PWN, Warszawa, 1982.
6. [www.um.znin.pl](http://www.um.znin.pl)
7. [www.znin.pl](http://www.znin.pl)
8. [www.paluki.pl](http://www.paluki.pl)