Technology, 13(4), 261-271, (2010)

TECHNOLOGY

DETERMINATION OF BUS PASSENGER'S ENVIRONMENTAL ERGONOMICS EXPECTIONS AND PREFERENCES

Abdullah Cemil İLÇE[*], Barış ÇAYIR[*]
[*]Duzce University, Technical Education Faculty, Duzce, TURKEY

Abstract

The purpose of this study is to reach the main problems of discomfort by determining environmental ergonomic preferences and expectations of the people making intercity bus travel and as a result of this, is to propose improvements to bus designers and companies giving travel services.

The study population consists of individuals who travel on buses from Istanbul. The numbers of individuals by considering data collection term have been accepted 1,400,000 persons. The sampling population consists of 500 people who travel in a company and want to participate as voluntary in the study. In this study, the situation of environmental conditions playing important role in ensuring the comfort, the seat location preferences and reasons for these preferences is researched. The chi-square test in SPSS 15.0 is used for detecting statistical relations.

As a result, the environmental conditions during bus traveling are determined and presented solutions to this discomfort.

Key words: Ergonomics, passenger comfort, bus traveling, environmental conditions.

1. Introduction

Long-distance passenger transportation by bus having more use in developing countries remains indispensability in our country despite car ownership increased in recent years. According to 2004 data, approximately 200 million people have traveled long–distance by bus. This number is higher than the number of passenger in other European countries [1].

In addition to competition among travel companies, understanding of comfortable service has increased its own importance with the increasing of competition in the transport system. Bus passenger transport sector has tended to give importance to passengers preferences and offer similar of opportunities in aircraft in order to not to give its share to aircraft and passenger transport sector. In this increasingly competitive, that it is brought the most appropriate and general acceptance level of comfort expectations which is different from person to person must be basic tasks of Travel Company and the bus manufacturer.

To ensure the restructuring of products and services by identifying discomfort and preferences of people traveling is important for the creation of healthy and comfortable environment. Moreover, traveling rate by bus being public transport with being ensured satisfaction of the passengers by taking healthy and comfortable services can be increased and thus the damage to environment can be reduced. In our country which has quite large area, some travels may take one day. But in European countries, bus travel is usually used for only short distance. Even the smallest defect of environmental conditions in long distance bus travel used widely in our country can cause significant discomfort. So, first the most appropriate environmental conditions must be provided for healthy travel. The purpose of this study is to determine the environmental problems inside the bus according to users' preferences and disorders and is to propose solutions to the problems for designers and bus businesses.

Corresponded Author;cemil.ilce@gmail.com

1.1. Environmental Ergonomic Factors Affecting Comfort on Travel

When environmental temperature is above or below of the person's temperature and comfort limits, discomfort occurs. In general, temperature comfort of a dressed person is between 20–24°C in winter and 20–22° C in summer. In the environment at the top of the temperature values, the feeling of sleep and fatigue occurs in people. If the temperature falls down, people become restless and less attentive. The job of the people, physiological characteristics and climate in region which people lived in are effective in temperature perceptions. Age and gender create difference in temperature perceptions. Old, baby, children and disabled people feel comfortable in high temperatures. Because women react more easily to outside environment temperature degree, they feel cold more than men. When the temperature falls, the blood flow going to the arms and legs of women is reduced more rapidly and cooling of fingers is much faster [2].

Moisture is more important than thought in terms of comfort and health. High humidity level gives disturbance especially in hot weather [3]. Processes called air-conditioning are needed to keep residence and working environmental in desired temperature and humidity. This processes are "felt heating" (raising of temperature), " felt cooling" (reduction of temperature)," hydration "(addition of water vapor) and " dehumidification " (Separation of water vapor in the air).Sometimes a few of these operations are applied together to bring air to the desired level of temperature and humidity [4].

The best course action is ventilation for the protection and the formation of comfort conditions in closed spaces. The master data in the creation of the ventilation plant is the amount of ventilation providing internal environment air. The determination of the amount of air is done on the basis of one or more from some basic criteria such as clean air requirement of people, to be kept under the limit values the concentrated levels of certain pollutants, pressure control and temperature control [5]. Poor air quality along with other environmental factors can cause many health problems. These are irritation in the eyes, nose and throat, headache, dry in mucous membranes, skin dryness, mental fatigue and concentration difficulties, nausea and dizziness, rising in respiratory tract infections incidences [6].

Another factor is air stream to be ensured comfort related to the ventilation. There are several drawbacks that airflow is more or less than needed. For example, it is difficult to withstand temperature because more temperature in the body is difficult to be taken out through evaporation and transpiration in environments where there is very little air flow. On the other hand, excessive air flow can also cause cold. Therefore, the environment temperature and humidity level should be considered when creating air flow [7]. While the environment temperature and radiant temperature levels are within the normal range, the ideal air flow should be around of 150 mm/sc. If temperature level of moving air decreases, complaints increase. That is because the human body is more sensitive to feel cold. If he air flow is still the same even though the temperature is increased, this doesn't cause same complaints [8]. In buses, ventilation and air flow are provided with air conditioner. That small capacity of buses is exposure to high heat load on the moving with heat load that the number of passengers transported brought require a very large capacity the use of a very large capacity air conditioning. Therefore, the bus air-conditioners are devices that provide quite high cooling capacity (136.000 - 150.000 Btu/h) [9].

Noise, of course, is an essential factor for protection and ensuring of comfort conditions in closed spaces. The main physiological effects of noise on humans have been identified as muscle strains, stress, rising in blood pressure, changes of heartbeat and blood circulation, pupil growth and insomnia. Most of these are short-lasting effects. Only stress and insomnia are long-term physiological effects of noise. It has been suggested that the effect of noise could be important in the emergence of diseases such as migraine, peptic ulcer and gastritis. However, it has not been proven that noise is effective in directly in showing the head of these diseases. At the beginning of the psychological effects of noise, nervous disorders, fear, discomfort, anxiety, fatigue, slowdown of mental activities and reduction in yield [10]. Molu [11], states that there is the effect of mechanical components, the fuel type, tire type, and additional insulation to vehicle interior noise as a result of his work in order to determine the factors that affect vehicle interior noise and states that there isn't the effect of wheather conditions. Soydaş [12], states that engine noise of diesel vehicles having the capacity of the same engine is more than gasoline vehicles, vehicle noise on gravel road has reached to proportions disturbing people compared to the asphalt road and engine noise in high speeds of old-fashioned, worn-out vehicles is more than the other vehicles with reasons such as lack of vibration and noise isolation in his study to determine the causes of noise in vehicles.

Vibration that many ergonomists consider in their study is an important necessity of comfort. Vibration has

got various adverse effects on humans. In particular, when the vibration frequency overlaps with the number of specific vibrations of various internal organs or the human body, in the case of resonance, the effect of vibration increases altogether and this situation causes various illnesses from shortness of breath to back and headaches. Therefore, the vibrations must be eliminated at their source and must be prevented in transmitted spread (Su, 2001). Source of vehicle vibration is forces from road roughness, braking, acceleration and inertia and aerodynamic forces generated during maneuvering. Suspension systems have been developed to fulfill this task to isolate the effects caused vibration in vehicle [13]. Vibrations of long-term vehicle disturb the driver and passengers and lead to decline in the efficiency of driving by making effects such as dizziness and car sickness. The vibrations also affect carried load and vehicle itself. For these reasons, ensuring of smooth ride and comfort is one of the main goals in the design of vehicles. Vibrations are mainly caused by imperfections on the road. Imperfections in $3 \approx 5$ mm length and in $8 \approx 10$ mm height are called as small roughness and imperfections in $10 \approx 12$ mm height and in $5 \approx 8$ mm length are called as the wave. Kong [14] has determined the effects of vibration on comfort during the bus travel. He tested the body of his seat with a simple suspension mechanism and vibration damping properties of widely used the seats in his study. After the test, writer has detected that the effect of vibration between 2% and 52%of suspension featured seat reduces.

Vibration frequencies of the human body can be divided into 4 resonance region under the influence of body vibration .These regions;

•Waist and stomach in 3 -6 Hz frequencies
•Head, neck and shoulder in 20 -30 Hz frequencies
•Eyeballs in 60-90 Hz frequencies
•Resonance frequencies of the legs and arms in 100-120 Hz frequencies

For these people, the most the negative of them are the vibration frequencies between 3-6 Hz in first region. Because sensitivity of the human is high against vibrations in this region of vibrations and vibration isolation facilities are limited in these frequencies at same time. Possibilities of being absorbed by the human body of vibrations in other resonance regions are high and easy [15].

1.2. Seat Layout Scheme in Buses

Instead of buses replaced by 45 people in 2 +2 seating layout scheme widely used in the past years, no longer 46, 48, 49, 50, 51, 52 and 54-person buses (Fig 1) have started to be produced in 2 +2 seating layout scheme depending on brands and models of buses. 2 +1 seating layout scheme with 32, 36 and 38 seat capacity in our country about 6 years has been used by travel companies to prevent diseases that occur due to lack of passenger usage area occurring in 2+2 layout scheme and to provide more comfortable travel services. (Fig 2).

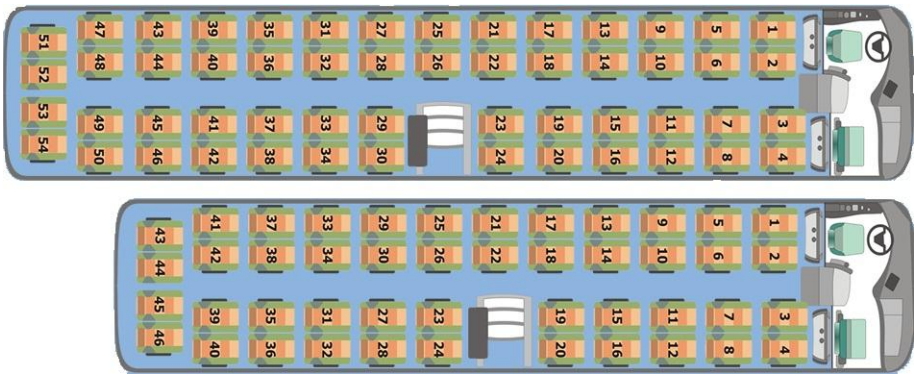

Figure 1. Top view of 46 and 54-person bus in 2 +2 seating layout scheme

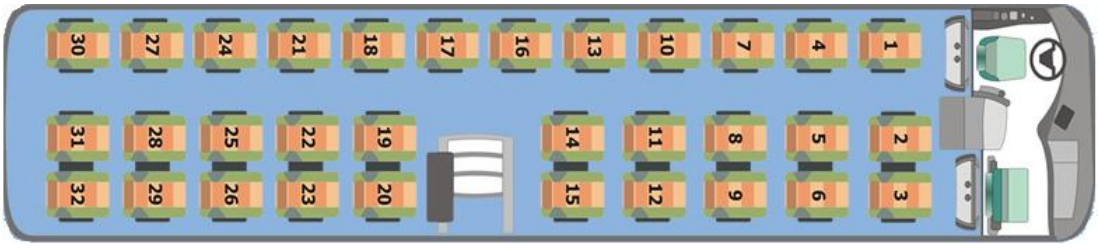

Figure 2. Top view of 32-person bus in 2 +1 seating layout scheme

2. Material and Method

2.1. Population and Sampling

This study is the type of descriptive. Population of the study consists of individuals who travel on buses from Istanbul. The number of individuals is average of 700,000 in the monthly data are collected. Because of two-month planning of research, research population was taken as 1.400.000 people.

The following formula is used to determine the sampling size of the study.

$$n=\frac{P.Q.Z_{\alpha}^{2}}{d^{2}}$$

n: sampling size
P: The rate of observing a phenomenon in the universe, Q (1-P): The rate of not observing a phenomenon
Zα: α = value of 1.96 for 0.05
d = sampling error

The number of sampling calculated for universe of 1,400,000 people from this formula is 384. 500 data collection forms have been prepared in accordance with the researcher opportunities in order to increase the reliability of the study and these forms have been applied to volunter 500 people agreed to participate in to research in a company's vehicles.

Participants have been chosen with random sampling procedure in vehicles.

2.2. Data Collection

Survey form to collect data in the study has been used. Surveys have been applied during the journey through the service staff in order to ensure high reliability of research. Thus, it has been provided that the participants who will fill out the form are away from many environmental effects and they are in environment where resting state can be considered. Also it has been aimed to identify problems by living and ease of access to materials in survey questions with the implementation of the survey during the travel. The data has been collected in November –December period of 2009.

2.3. Analysis of the Data

Collected survey forms have been subjected to statistical procedures with the help of computer package program SPSS (Statistical Package for Social Sciences) 15.0 program by being sorted and coded. "Chi-square" test used in the non-parametric data to determine whether there is a significant relationship between the variables or not has been applied. The level of significance has been adopted as $P < 0.05$.

3. Result and Discussion

3.1. Socio-Demographic Characteristics

The values of participants' gender, age, height and weight are shown in Table 1 and the values of education level are shown in Table 2.

Table 1. Socio-Demographic Information

		Average	Standard Deviation	Minimum	Maximum	Total	Missed	General Total
AGE	Male (%53,4)	32,4	13,1	18	75	249	18	267
	Female (%46,6)	30,4	12,5	18	70	225	8	233
	General	31,4	12,9	18	75	474	26	500
HEIGHT	Male	176,8	6,6	155	192	264	3	267

	Female	164,5	5,9	150	185	227	6	233
	General	171,1	8,8	150	192	491	9	500
WEIGHT	Male	77,8	12,3	50	141	265	2	267
	Female	59	9,2	44	94	229	4	233
	General	69,1	14,4	44	141	494	6	500

Table 2. Education Level

Education Level	Primary Education	Secondary Education	Higher Education	Total
Number (N)	24	118	358	500
Percent (%)	4,8%	23,6%	71,6%	100,0%

Accordingly, it is determined that participants in the research are 267"male" and 233 "female " in the range of 18-75 ages ,150-192 cm height, 44-141 kg body weight. The distribution of 4.8% "primary education", 23.6% "secondary education and "71.6% "higher education" in the case of education of the participants has been observed.

3.2. Preferences

Distribution on seats location preferences of the participants are shown in Table 3.

Table 3. Seat Location Preference

Which location would you prefer in your seat in general?	N	Percent (%)	G. Percent (%)
Front and window seat	187	37,4	43,1
Front and aisle seat	72	14,4	16,6
Middle and window seat	118	23,6	27,2
Middle and aisle seat	33	6,6	7,6
Back and window seat	18	3,6	4,1
Back and aisle seat	6	1,2	1,4
Total	434	86,8	100,0
Missed	66	13,2	
G. Total	500	100,0	

Accordingly ,they have preferred sitting in areas such as 43.1% "front and window seat ", 16.6%"front and aisle seat," 27.2% "middle and window seat, "7.6% " middle and aisle seat ,"%, 4.1" back and window seat " and 1.4% of the" back and aisle seat "13.2% response of sampling has been adopted as invalid.

Distribution according to the reasons of participants' seat location preference is shown in Table 4.

Table 4. The Reason of Seat Location Preference

What is the reason for choosing a seat?	N	Percent (%)
Window seat	360	26,7
Desire to sleep	183	13,6
Observing the environment	173	12,8
Security	137	10,1
Dual seat, single-sit	103	7,6
Solar effect	96	7,1

Watching TV	78	5,8
Aisle seat	76	5,6
Being away from the door	75	5,6
Being empty of front seat	38	2,8
Noise	31	2,3
Total	1350	100

Accordingly, participants have reported the main reasons in the seat location preference by marking 26.7% "window seat 13.6% "desire to sleep," 12.8% " observing the environment," 10.1% "security," 7.6% "dual seat, single-sit", 7.1% "solar effect", 5.8% "watch TV", 5.6% "aisle seat and " being away from the door", 2.8% " being empty of front seat," and 2.3% "noise" of them.

Distribution on the choice of brand-model of bus with thought of the participants' seat comfort was shown in Table 5.

Table 5. Bus Brand-Model Choice

Do you prefer brand-model bus with the idea of the seat comfort while you are taking ticket?	N	Percent (%)	G.Percent (%)
Consistently	336	67,2	67,5
Sometimes	124	24,8	24,9
No	38	7,6	7,6
Total	498	99,6	100,0
Missed	2	,4	
G. Total	500	100,0	

Accordingly, while the participants are taking ticket with 67.5% "continuous" and 24.9% "sometimes" options, they have indicated that they make choice for brand-model bus with the idea of seat comfort. They reported that 7.6% participants did not do such a choice with "no option". Response of 0.4% of sampling has been invalid.

Distribution on preference of the type of Participants' seat upholstery is shown in Table 6.

Table 6. Upholstery Type Preference

What type of seat upholstery do you feels more comfortable yourself?	N	Percent (%)	G. Percent (%)
Fabric	155	31,0	31,4
Leather	70	14,0	14,2
Leather -Fabric	175	35,0	35,4
It is not matter	94	18,8	19,0
Total	494	98,8	100,0
Missed	6	1,2	
G. Total	500	100,0	

Accordingly, these participants have stated that they prefer the type of 31, 4% "fabric", 14, 2% for "leather", 35, 4%, "leather and fabric," seat upholstery. 19 % of participants have reported that upholstery type was unimportant with "it does not matter" option. Response of 1, 2% of sampling has been invalid.

3.3. Evaluation of Environmental Ergonomic Factors

Distribution on their discomfort and some opinions of the participants about travels is shown in Table 7 and Table 8.

Table 7 .Comments and Discomfort

		Always	Sometimes	Never	Total
Do you use an external pillow to support neck cavity in your traveling?	N	132	156	179	467
	Percent (%)	28,3%	33,4%	38,3%	100,0%
Do you think the cushion in the bus is hygienic?	N	52	101	338	491
	Percent (%)	10,6%	20,6%	68,8%	100,0%
Do you think the headrests are hygienic?	N	58	137	295	490
	Percent (%)	11,8%	28,0%	60,2%	100,0%
Do you have physical contact obligation due to the width of the aisle while you are sitting near the aisle and service personnel or passengers are passing from the aisle?	N	141	240	113	494
	Percent (%)	28,5%	48,6%	22,9%	100,0%
Do you have the problem of perspiration in contact with the seat?	N	61	171	261	493
	Percent (%)	12,4%	34,7%	52,9%	100,0%
Do you exposed to a different and disturbing heat from the heat of bus while sitting in window seat?	N	91	227	173	491
	Percent (%)	18,5%	46,2%	35,2%	100,0%
Do you have discomfort caused by ventilation?	N	67	260	164	491
	Percent (%)	13,6%	53,0%	33,4%	100,0%
Are you having trouble in removing this discomfort when you are uncomfortable from sunlight?	N	50	142	298	490
	Percent (%)	10,2%	29,0%	60,8%	100,0%
Do you have shaking and vibration disturbances?	N	94	224	172	490
	Percent (%)	19,2%	45,7%	35,1%	100,0%
Do you have discomfort due to the hardness of sitting area foam on the seat?	N	61	172	253	486
	Percent (%)	12,5%	35,4%	52,1%	100,0%
Do you have discomfort due to the soft of sitting area foam on the seat?	N	5	7	474	486
	Percent (%)	1,0%	1,4%	97,6%	100,0%
Do you have discomfort due to the hardness of backrest foam on the seat?	N	65	175	248	488
	Percent (%)	13,3%	35,9%	50,8%	100,0%
Do you have discomfort due to the soft of backrest foam on the seat?	N	1	6	481	488
	Percent (%)	0,2%	1,2%	98,6%	100,0%

Table 8. Discomfort Situation Because of Environment Temperature

	Hot		Cold		Hot And Cold				
	Always	Sometimes	Always	Sometimes	Always	Sometimes	Never	Total	Missed
Number (N)	33	75	8	21	56	147	138	478	22
Percent (%)	6,6	15	1,6	4,2	11,2	29,4	27,6	95,6	4,4
G. Percent (%)	6,9	15,7	1,7	4,4	11,7	30,8	28,9	100	

The results of the statistical analysis (Chi-square) made with opinions and discomfort of the participants and their socio-demographic characteristics in Table 7 are shown in Table 9.

Table 9. The Relationship between Opinions and Discomfort of Socio-Demographic Characteristics

	Gender		Height		Weight		Age		Education Level	
	Relationship	The level of significance	Relationship	The level of significance	Relationship	The level of significance	Relationship	The level of significance	Relationship	The level of significance
Physical contact obligation with aisle width	-	P=0,390 (sd: 2)	-	P=0,361 (sd: 10)	+	P=0,013 (sd: 8)	-	P=0,068 (sd:4)	+	P=0,053 (sd: 4)
Using external pillow	+	p=0,019 (sd: 2)	-	P=0,310 (sd: 10)	-	P=0,475 (sd: 8)	+	P=0,005 (sd: 4)	+	P=0,006 (sd: 4)
The hygiene of cushions	-	P=0,614 (sd: 2)	-	P=0,470 (sd: 10)	-	P=0,834 (sd: 8)	-	P=0,222 (sd: 4)	+	P=0,040 (sd: 4)
The hygiene of headrests	-	P=0,059 (sd: 2)	-	P=0,489 (sd: 10)	-	P=0,519 (sd: 8)	-	P=0,397 (sd:4)	+	P=0,034 (sd: 4)
Sweating problem in contact with the seat	+	P=0,014 (sd: 2)	-	P=0,601 (sd: 10)	+	P=0,014 (sd: 8)	-	P=0,085 (sd: 4)	-	P=0,306 (sd: 4)
The hardness of a sitting area foam on the seat	-	p=0,056 (sd: 2)	-	P=0,868 (sd: 10)	-	P=0,866 (sd: 8)	+	P=0,000 (sd: 4)	-	P=0,061 (sd: 4)
The soft of a sitting area foam on he seat	-	p=0,189 (sd: 2)	-	P=0,186 (sd: 10)	+	P=0,000 (sd: 8)	-	P=0,073 (sd: 4)	+	P=0,018 (sd:4)
The hardness of backrest foam on the seat	-	p=0,328	+	P=0,696 (sd: 10)	-	P=0,717 (sd: 8)	+	P=0,003 (sd:4)	-	P=0,252 (sd: 4)
The soft of backrest foam on the seat	-	p=0,189 (sd: 2)	-	P=0,029 (sd: 10)	-	P=0,643 (sd: 8)	-	P=0,320 (sd: 4)	-	P=0,439 (sd: 4)
Environment temperature difference with window seat	-	P=0,705 (sd:2)	-	P=0,940 (sd: 10)	-	P=0,061 (sd: 8)	+	P=0,028 (sd:4)	+	P=0,045 (sd: 4)
Discomfort caused by ventilation	-	P=0,898 (sd: 2)	-	P=0,734 (sd: 10)	-	P=0,909 (sd: 8)	+	P=0,000 (sd: 4)	-	P=0,094 (sd: 4)
Discomfort caused by sun	-	P=0,925 (sd: 2)	-	P=0,979 (sd: 10)	-	P=0,723 (sd: 8)	-	P=0,092 (sd: 4)	-	P=0,353 (sd: 4)
Discomfort caused by shaking and vibration	+	P=0,048 (sd: 2)	-	P=0,189 (sd:10)	-	P=0,061 (sd: 8)	-	P=0,136 (sd: 4)	-	P=0,410 (sd: 4)

4. Conclusion

Sampling group of the research consisted of a total of 500 people, 267 male and 233 female, between 18–75 ages without disabilities. It has been determined that the average age of the sampling is 31, 4 (male 32, 4, female 30, 4), the average height is 171, 1cm (male 176, 8, female 164, 5) and the average body weight is 69, 1kg (male 77, 8, female 59).

It has been determined that intensity of preferences is front seat at the edge of glass of the bus in seat location preferences of the participants and the least preferred section is back seats at the edge of aisle . 1, 4 and 5 numbered seats have been the most preferred first 3 seats at ranking of preference frequency of seat numbers. It has been determined that Six-seat number (22, 36, 43, 45, 48, and 49) hasn't preferred and nine-seat number (26, 33, 37, 40, 41, 42, 44, 50 and 53) has preferred by only one participant.

Window seat, desire to sleep, and request of observing the surroundings are followed by each other at ranking of the main reasons at the seat location preference. Noise, being away from the door and being empty

of the front seat have been at least effective 3 factors at the seat location preference. That number of participants who preferred 2 numbered seat next to it is 9 while number of participants who preferred 1 numbered seat at window seat is 43 is another indication of the degree of importance at the seat location preference of window seat. The reason that the most effective factor at the seat location preference is window seat is that it can serve the duty of observing environment and window can serve a support duty while compliance action are performed.

Rate of those who make the choice for bus brand-model bus with the idea of the seat comfort while taking ticket was determined as 92, 4%.This high rate may show important comfort differences between seats used at brands and models of buses. This result may also show that users have expectations of different comfort and they can find value for these expectations in different brand-models buses. About it, Pywell (1993) defends that comfort is subjective and the decision of design features which seat will provide to the user is difficult to define objectively.

Fabric and a mixture of leather and fabric have been the most preferred types of upholstery at the choice of the type of seat upholstery. Visual appreciation and upholstery material to provide thermal comfort (to prevent sweating) can be shown as the effective reasons for the choice of seat upholstery. Sweating of regions in contact with the seat is considered as thermal comfort necessities. One of proponents of this view, Bartels (2003), has determined that the fabric upholstery provides better moisture transfer than the leather upholstery under laboratory conditions in her study on thermal comfort in aircraft seats.

According to the findings, it hasn't been considered that 68.8% of external cushions and 60.2% of headrests are hygienic. As a result of the statistical evaluation, it has been determined that the relationship between educational status and with hygienic of cushions and headrests significant is significant. In bilateral comparison, the increase in the hygienic expectations depending on the level of education has been determined.

77, 1% of the participants have reported that passengers and service staff have physical contact obligation during passing from aisle. It has been determined that the relationship between this discomfort and body weight is significant in the statistical analysis of socio-demographic characteristics. The reason for this is because the increase in body weight brings increase in volume of the body and this increase may cause to contact during the passing. This discomfort also may be due to reasons such as preferences of bus manufacturers using 4 seats on a single row, passengers and service staff that don't pass carefully.

It has been determined that 64, 7% percent of passengers who travel on the window seat are exposed to disturbing the temperature difference as different from environment temperature. In the statistical analysis, it has been determined that relationship between the age of passengers and this discomfort is significant. In bilateral comparison, it has been determined that declaration of discomfort increases according to the increase in value of age. As related to this result, Çelik and Bayazit [18] stated that the age is among active factors in the primary degree in the calculation of temperature balance of the human body.

The rate of discomfort caused by ventilation is 66, 6%. As a result of statistical analysis, it has been determined that the relationship between discomfort and age is significant. In bilateral comparison, it has been determined that declaration of discomfort increases according to the increase in value of age. The reason for this may be respiratory failure occurring in older people.

In the case of discomfort caused by sun rays, rate of those who have problems to solve these problems is 39, 2%. It has been determined that the relationship between this discomfort and any socio-demographic characteristics isn't significant in the statistical analysis. According to this result, discomfort may be due to physical impossibility in bus. The reason for this problem is that it is difficult to access solar curtains from some of the seats(in the middle of the window) in bus models with large windows and the sun coming from regions not providing curtains gives discomfort.

It has been reported that the rate of those who have discomfort caused by shaking and vibration is 64, 9%. It has been determined that the relationship between this discomfort and socio-demographic characteristics isn't significant in the statistical analysis. This result may be an indication that discomfort is experienced in general. Kong [14] has detected that suspension featured seat reduces the effect of vibration between 2% and 52% .Reason for this discomfort may be that seats widely used in Turkey haven't suspension characteristics.

In evaluation of foam hardness of seats, the seat backrest and sitting areas have been evaluated separately and it has been determined that in both regions have discomfort due to hardness. As related to this subject, hardness of foams used in the seat structure in evaluation of seat comfort which Kong [14] made with the subjective method has been reported by the participants. He has determined that the total contact area of a seat having hard surface is low value in measurement of pressure distribution on two seats having hard and soft seat sitting panel of Kong [14] and areas in contact with the bones of the iskiyum are high values in the pressure distribution. According to this result, hard seat-pan affects adversely the comfort of sitting and it must be provided that foam density should be in the most appropriate values because distribution of pressure is balanced.

The rate of those who have discomfort caused by environment temperature during the travel is 72, 4%. According to declarations of discomfort, it has been reported that different temperature discomfort in different journeys is observed. However, the number of those who report discomfort is much higher because the temperature is high. As a result of statistical analysis, it has been determined that relationship between age and weight of the passengers and those having discomfort from environment temperature is significant.

Suggestions:

1. Accessories can be made to be satisfied the most influential factors (window seat, desire to sleep, and observing environment) in the seat location preference to 22, 36, 43, 45, 48, 49 numbered seats which participants don't prefer. Both reasons that users prefer other seats can be provided and cost expenses of seat manufacturers or travel companies can be prevented with only the application to these seats of TV, video featured image units requiring high-cost. When it is needed to increase the number of seats having these characteristics, 33, 37, 40, 41, 42, 44, 50, 53 numbers only one user preferred as applied seats may be preferred.

2.Using or production of seats having a mixture of leather and fabric upholstery for using fabric in areas having contact with the body in the fabric or sitting position may be useful to supply user's expectations, and provide thermal comfort (to prevent sweating). Sweating problems in seat-user intersection with the use of a sandwich textile (spacer fabric) as upholstery fabric may be prevented (Fig 3).

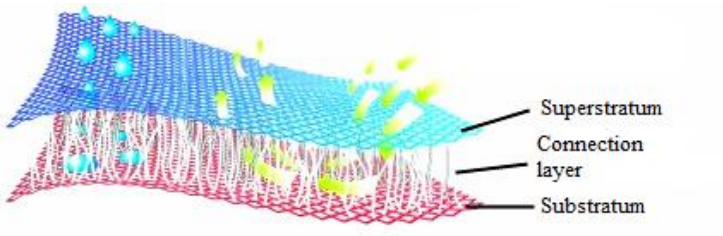

Figure 3. The mechanism of air and moisture permeability of sandwich textiles [19].

3. Passenger's expectations about hygiene may be satisfied by being used surface coating materials being disposable spunbond nonwoven-type in neck supports and external pillow.

4. Systematic curtains which can be pulled up and down belongs to seat and each user can reach easily instead of back and forth curtain systems in buses having wide window can be used for preventing problems in solving this discomfort of those who having discomfort from sun rays.

5. Absorbing rubber-based materials preventing vibration between seat-floor connection or the structure with a simple suspension on seats can be used for preventing discomfort caused by shaking and vibration.

6. Personal temperature requests can be satisfied with control system allowing to adjust the degree of air temperature in each user's control panel. In this way, discomfort caused by environment temperature can be prevented.

Acknowledgements:

This study was made as a M.S. Thesis by Barış ÇAYIR in the Graduate School of Natural and Applied Sciences, Duzce University, Turkey

References

1. Bus World Magazine, 2006, Research: Most of the Field of Competition in Turkey is Bus Transportation, March-April 2006, No 1, 30–40.
2. Kıran, S., Ayoğlu, F.N., Oğur, R. and Güler, Ç., 2004, Ergonomic Aspects of the Health, Environment Temperature (Chapter 22), Editor: Çağatay GÜLER, Palme Publishing, Ankara, 9758624970.
3. Şaşmaz, T., Öner, S., Buğdaycı, R., Kurt, A.Ö., Öner, H and Güler, Ç., 2004, Ergonomic Aspects of the Health, Office Ergonomics (Chapter 17), Editor: Çağatay Güler, Palme Publishing, Ankara, 9758624970.
4. Ok, S., 2008, Automobile Air Conditioning System and Investigation of the Effects on Motor Performance of Air Conditioning System , M.Sc Thesis, Institute of Science of Yildiz Technical University, unpublished.
5. Eser, H.Ç., 2006, Investigation on Velocity and Temperature Distribution of a Ventilated Room, M.Sc. Thesis, Istanbul Technical University, Turkey.
6. Güler, Ç. (Editor), 2004, Ergonomic Aspects of the Health, Palme Publishing, Ankara, 9758624970.
7. Su, B.A., 2001, Ergonomics, Atılım University Publishing, Ankara, 9756707057.
8. Erkan, N., 2005, Ergonomics, 9. Edition, MPM Publishing, Ankara, 975-400-201-9
9. MEGEP, 2008, Installment Technology and Air Conditioning, Refrigerated Vehicle and Vehicle Air Conditioner Installation, Ankara.
10. Aktürk, N., Akdemir, O., Üzkurt, İ., 2003, Environmental Noise Caused by Traffic Lights Timing and Traffic Volume, Journal of the Faculty of Engineering and Architecture of Gazi University, Vol. 18, and No: 1, 71-87.
11. Molu, U., 2007, Investigation of the Factors Affecting Vehicle Interior Noise, M.Sc Thesis, Zonguldak Karaelmas University, Turkey.
12. Soydaş, H.İ., 2007, Determining and Preventing the Cause of the Noise on the Vehicles, M.Sc Thesis, Mustafa Kemal University, Turkey.
13. Taşkın, Y., 2008, Analysis and Control of Vehicle Vibrations, PhD Thesis, Institute of Science of Yildiz Technical University, Turkey.
14. Kong, T.W., 2006, Comfort Analysis in Commercial Vehicle's Passenger Seat, M.Sc Thesis, Malaysia Technology University.
15. Özgener, L., 2002, Modeling and Analyzing the Vibrations on a Traveling Truck Cabin by Computer, M.Sc Thesis, Institute of Science of Dokuz Eylul University, Turkey.
16. Pywell, J.F., 1993, Automotive Seat Design Affecting Comfort and Safety, Seat System Comfort and Safety, Warrendale, PA: Society Of Automotive Engineers, Inc.
17. Bartels, V.T., 2003, Thermal Comfort of Aeroplane Seats: Influence of Different Seat Materials and the use of Laboratory Test Methods, Applied Ergonomics (34) 393–399.
18. Çelik, N. and Bayazıt, Y., 2008, The Effects of Individual Differences on Thermo-Regulation in Human Body Simulations, Journal of Thermal Science and Technology, 28(1) 17-22.
19. Ertekin, G., and Marmaralı, A., 2010, Spacer Fabrics, Electronic Journal of Textile Technologies, Vol: 4, No: 1, (84-98).