ERGONOMIC EVALUATION OF SCHOOL BUSSES

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

ERGONOMIC EVALUATION OF SCHOOL BUSSES

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In this study, perceived comfort and discomfort regarding school busses is assessed with the main focus on students. A total of 149 students and 38 drivers from a private school in Ankara was chosen participated in the study. Two different surveys were conducted on students and drivers separately, in order to assess perceived comfort and discomfort and suitability of the seat design features. Using SPSS Software to analyze the data, factors contributing to safety, driver distraction, perceived discomfort and perceived comfort were investigated. Bus seat comfort is found to be the most influential factor on the general assessment of bus comfort. Although no evidence of significant discomfort related to specific body parts such as neck, shoulders, back, thigh or legs is found, in-depth analysis revealed that seat features such as seat pan cushion firmness or armrest height are in correlation with seat comfort

Keywords: school busses, perceived comfort, ergonomic evaluation, school bus seat design

ÖZ

OKUL SERVİS ARAÇLARININ ERGONOMİK DEĞERLENDİRMESİ

Özdemir, Pınar
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Bu çalışmada, okul servislerinde algılanan konfor ve rahatsızlık, öğrenciler temel alınarak incelenmiştir. Çalışma Ankara'daki bir özel okulda gerçekleştirilmiş olup, 149 öğrenci ve 38 servis şoförü katılmıştır. Araçların konfor özelliklerinin ve tasarımların ergonomik açıdan incelenmesi amacıyla, öğrencilere ve şoförlere iki ayrı anket çalışması uygulanmıştır. Elde edilen bilgilerin analizinde SPSS bilgisayar programı kullanılarak veriler: güvenlik, sürücünün dikkatini dağıtan etmenler, algılanan konfor ve rahatsızlıklar yönünden incelenmiştir. Servislerin koltuk rahatlığının genel servis aracı konfor değerlendirmesi bakımından en önemli etken olduğu sonucuna varılmıştır. Araştırmada; servislerin, boyun, omuzlar, sırt, kalça ve bacak gibi belirli bölgelerde yol açtığı rahatsızlık açısından kayda değer bir kanıt bulunamamasına karşın; derinlemesine yapılan analizler koltuk alt minder sertliği, kolçak yüksekliği gibi koltuk özelliklerinin servisin konforuyla yadsınmaz bir ilişkisi olduğunu göstermiştir.

Anahtar Kelimeler: Okul servisleri, algılanan konfor, ergonomik değerlendirme, okul aracı koltuk tasarımı

To my lifelong guide and support; my dear grandfather, M.Necati KAYNAR

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CHAPTER 1

INTRODUCTION

1.1. Significance of the Study

According to the Republic of Turkey Ministry of National Education's statistics of years 2010-2011 regarding the formal education, there are 46,287 schools and institutions with a total of 16,845,528 students including public, private and open-education schools, and pre-primary, primary and secondary education (www.meb.gov.tr). A great part of transportation of these students is provided by school transportation vehicles. Although seen as one of the safest modes of transportation there many cases with minor accidents or near-miss accidents. Most of the injuries are because of the inner design or driver mistakes.

Beside the yearly statistics on injuries, with the elongation of journey durations on the road, proper sitting, correct postures and comfort became as important as the avoidance of accidents. An adult may pick himself or herself a car with all the comfortable specifications, children, without having this opportunity, exposed to bad design of school furniture and school busses during the growth stage.

In order to reduce the risk of developing further musculoskeletal disorders, injuries related to interior design of the busses, and to provide children with comfortable environments, both school furniture and school busses need to be designed adequately both for the passengers and drivers in addition to reducing any driver distracting factors. Safety, comfort and suitability of these vehicles for both passengers and drivers need to be evaluated for a clear definition of problematic areas and necessary changes

1.2. Aim of the Study

Aim of this study is the ergonomic evaluation of school transportation vehicles regarding students of age 12 between 15 and drivers by the assessment of perceived comfort and discomfort measures, adequacy of design features, and safety in order to reveal the underlying factors of discomfort, comfort and safety.

This study will include a statistical analysis on the target population's perception on the suitability of design features, perceived discomfort ratings, factors with contribution to comfort of school busses. Also with the inclusion of objective measurements for the current design of the school bus, recent situation and any positive and negative implications will be covered.

1.3. Scope of the Study

Firstly a literature survey on concepts of comfort, discomfort, assessment of their perceived values, anthropometric measures of target age of students, seating comfort, and driver distraction is carried out.

Secondly recent legislations in Turkey regarding school busses and properties of the school busses used in the chosen private school are investigated. Two questionnaires covering the necessary aspects as comfort, discomfort and ergonomics are designed and conducted on students and school bus drivers of the private school.

Then statistical analysis of the questionnaire was done to investigate the recent perception of comfort and discomfort, their relationship with ergonomic features, and implications for safety. Correlations among different contributors were evaluated and adequacies of recent design features were determined depending on the perceived comfort, discomfort.

1.4. Research Questions

In order to clearly define the topic that will be covered in this study and get meaningful results, answers of the below questions will be sought:

- What influences perceived discomfort?
- How good do the current school busses fit to the range of students between the age of 12 and 15 and drivers?
- Do students provide a source for driver distraction?
- How the current school busses are perceived regarding comfort for the target population?
- Which changes can be made to overcome any possible ergonomic problems?
- Which seat features are most likely to affect seating comfort?

1.5. Structure of the Thesis

This study will be conducted in six chapters starting with Introduction as the first chapter. The significance and aim of the study in addition to research questions that this study was interested in were included in this chapter in the name of clarity.

Second chapter consisting of literature review, which begins with an investigation of concepts of comfort and discomfort and different assessment methods, continues with seat design and sitting dynamics in order to reveal the mechanisms underlying the concepts of comfort and discomfort and lastly driver distraction in regard to driver and school bus safety.

In the third chapter current situations of the vehicles in use were given. Also in this part of the study legislations regarding school transportation were investigated. As the method in this study is based on questionnaires, detailed explanations on their structure is given.

Results of the study were given in Chapter 4. Answers given to questionnaires were investigated in depth, in order to answer the research questions previously addressed in this chapter.

Lastly in Chapter 5 of the study concludes the findings from previous chapters and results were reviewed.

CHAPTER 2

LITERATURE REVIEW

2.1. Comfort, Discomfort and Their Assessment

Assessment of comfort and discomfort is a long-debated issue, as definitions of these two terms are not strict and clear (Helander and Zhang, 1997; Zhang et al., 1996; Slechta et al., 1957; Kolich et al., 2004). As stated by Zhang et al. (1996), in common sense, comfort term refers to both comfort and discomfort. A common definition is hard to achieve as there is no agreement on the relationship between comfort and discomfort (Kolich, 2008). Whether comfort and discomfort should be regarded as two opposite ends of a continuum or as two experiential dimensions (Fazlollahtabar, 2010) is the main reason behind this debate (Kolich, 2008; Zhang et al., 1996; DeLooze et al., 2003). As cited by DeLooze et al. (2003) and Helander (2003) in early researches on the subject Hertzberg (1958) and Floyd and Roberts (1958) conceptualized comfort as the absence of discomfort, with only two possible states of comfort as; comfort present or absent. Branton (1969) cited by Helander (2003) also stated that comfort is the absence of discomfort and to reach comfort, discomfort factors need to be eliminated. Kölsh et al. (2003) in a way similar to Branton (1969), rather than defining comfort distinctly, used the term "comfort dimension", where comfort, unaware discomfort, aware discomfort, fatigue and pain lie on a continuum and in order to reach comfort pain, fatigue, aware and unaware discomfort needs to be eliminated. The formal definitions of comfort can be given as, "a state of being relaxed and feeling no pain" (http://www.webster-dictionary.org/definition/comfort) and "a feeling of relief or encouragement, a satisfying or enjoyable experience" (http://www.merriam-webster.com/dictionary/comfort). Zhang et al. (1996), DeLooze et al. (2003) and Vink et al. (2012) cited the definition of Slater (1985) as "a pleasant state of physiological, psychological, and physical harmony between a human being and the environment". From these definitions it is clear that comfort is not just a state, or absence of discomfort, but it consists of multiple layers and is a combination of several factors. In the assessment of comfort, evaluation should be done covering both physical and psychological aspects (Pearson, 2009; Zhang et al., 1996). Helander (2003) showed that comfort is not a binary state as being the lack of discomfort, but it is a continuous variable. Approach of considering comfort and discomfort as two different concepts, a unidimensional scale for the measurement of both led way to the usage of a Likert scale in measurement of comfort and discomfort (Helander and Zhang, 1997; Zhang et al., 1996).

In the assessment of comfort and discomfort two approaches can be used as objective and subjective measures (DeLooze et al., 2003; Kolich et al., 2004; Helander, 2003). Objective methods of assessment can be named as electromyography, disc pressure measurement, vibration transmissibility, pressure distribution at the occupant–seat interface and microclimate at the occupant–seat interface (Kolich, 2003; DeLooze et al., 2003). Objective methods have the advantage of being less time consuming, requiring a smaller number of subjects, being less prone to errors or bias (DeLooze et al., 2003; Lee et al., 1993). Considering comfort is a subjective state or feeling (DeLooze et al., 2003; Kolich et al., 2004; Kölsch et al., 2003), while objective measures can give an indication of an individual's sitting comfort (DeLooze et al., 2003), on the other hand, subjective assessment can be regarded as the most direct method. Subjective evaluation methods of comfort include surveys, rating scales and interviews (Pearson, 2009). Results of the subjective methods yield perceived comfort as it solely depends on the individual assessments and tolerance levels for discomfort (Slechta, 1957). In order to achieve a better result, both subjective and objective assessment need to be considered, as objective measures such as pressure distribution were proven to be related with subjective ratings (DeLooze et al., 2003; Kyung, 2008; Kolich 2008).

In the assessment of comfort and discomfort subjectively, well-established scales were used by researchers. These scales are,

- **General Comfort Rating (GCR) (Scale developed by Shackel et al. (1969)):** GCR includes both comfort and discomfort descriptors. The advantage of GCR is that it is very practical as it produce a single number (Helander and Zhang, 1997) for overall comfort. But the design of GCR does not assume comfort and discomfort as independent factors, as it measures a single comfort score by asking both questions on discomfort and comfort at the same time. (Helander and Zhang, 1997)

Table 2.1 – GCR by Shackel et al. (1969)

Rating	Description
1	I feel completely relaxed
2	I feel perfectly comfortable
3	I feel quite comfortable
4	I feel barely comfortable
5	I feel uncomfortable
6	I feel restless and fidgety
7	I feel cramped
8	I feel stiff
9	I feel numb (or pins and needles)
10	I feel sore and tender
11	I feel unbearable pain

- **Body Part Discomfort (BPD) (Scale developed by Corlett and Bishop (1976)):** This scale was developed to measure discomfort. In this scale, an illustration of a human body with segmentations is used for the subjects to evaluate the level of discomfort they feel specifically using a 5-point scale, and the summation of the ratings is considered as BPD index (Corlett and Bishop, 1976).

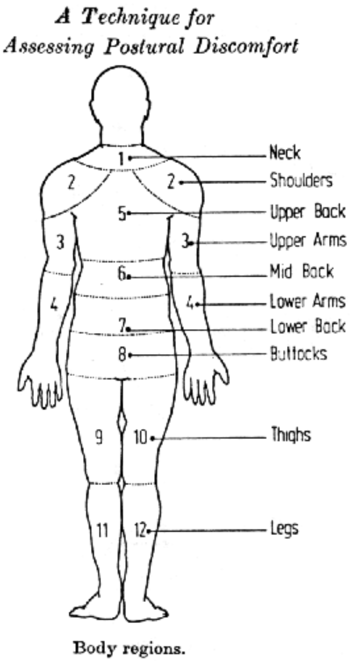


Figure 2.1 – Body Part Discomfort Scale by Corlett and Bishop (1976)

- **Automobile Seat Comfort Survey (Kolich et al., 2004):** Having 10 questions respondents were asked to rate the level of satisfaction regarding comfort and support (Zhang et al., 1996). With the box of "just right" in the middle corresponding to a score of zero, possible score from an item varies between -3 and 3. A single score of overall comfort index (OCI) is obtained with summing the absolute deviations of each item, indicating a higher comfort as the total values gets closer to zero.

	Stop! Start over	Poor, major improvements needed	Fair, minor improvements needed	Good, slight improvements needed	World class seat				
Overall Seat Appearance	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐				
Item		−3	−2	−1	Just right	1	2	3	
Seatback									
A. Amount of lumbar support	Too little	☐	☐	☐	☐	☐	☐	☐	Too much
B. Lumbar comfort	Uncomfortable	☐	☐	☐	☐				
C. Amount of mid-back support	Too little	☐	☐	☐	☐	☐	☐	☐	Too much
D. Mid-back comfort	Uncomfortable	☐	☐	☐	☐				
E. Amount of back lateral support	Too little	☐	☐	☐	☐	☐	☐	☐	Too much
F. Back lateral comfort	Uncomfortable	☐	☐	☐	☐				
G. Seat back feel/firmness	Too soft	☐	☐	☐	☐	☐	☐	☐	Too firm
Cushion									
H. Ischial/buttocks comfort	Uncomfortable	☐	☐	☐	☐				Too much
I. Thigh comfort	Uncomfortable	☐	☐	☐	☐				
J. Cushion lateral comfort	Uncomfortable	☐	☐	☐	☐				

Figure 2.2 – Automobile Seat Comfort Survey (Kolich, 2004)

- **Chair Feature Check List modified by Goonetilleke et al. (2001):** First proposed by Shackel et al. (1969), and later modified by Drury and Coury (1982) in order to obtain mean and distribution effects of various aspects of a seat. Goonetilleke et al. (2001) modified the list by adding features such as cushioning, stability, personal acceptability and overall discomfort.

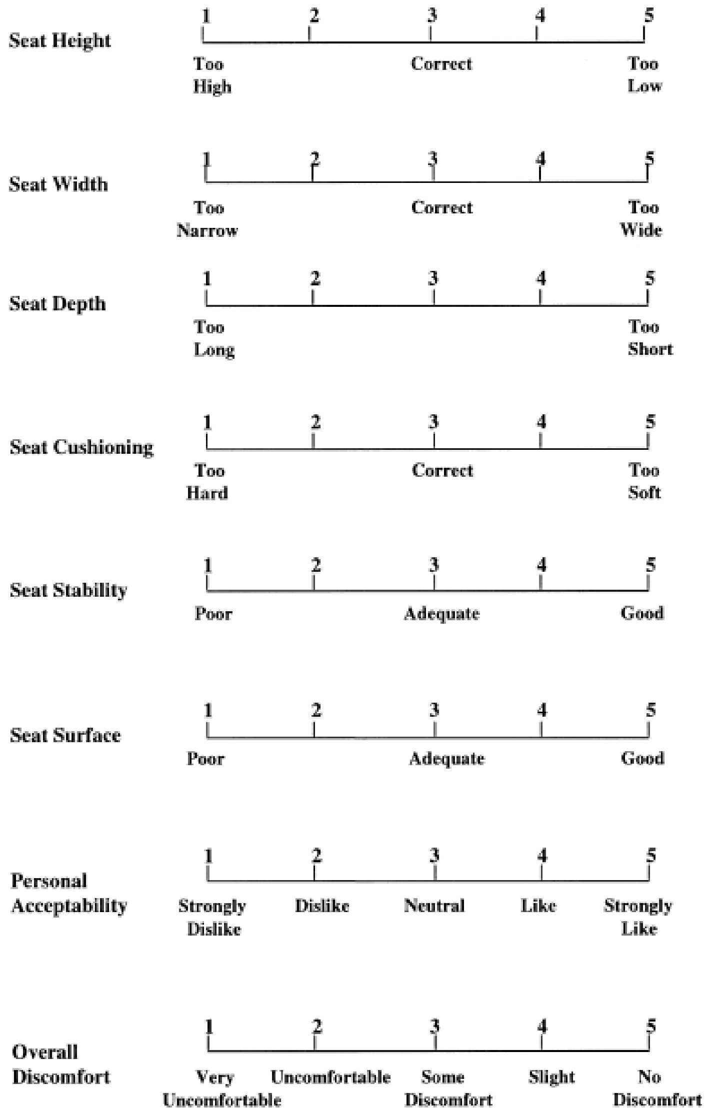
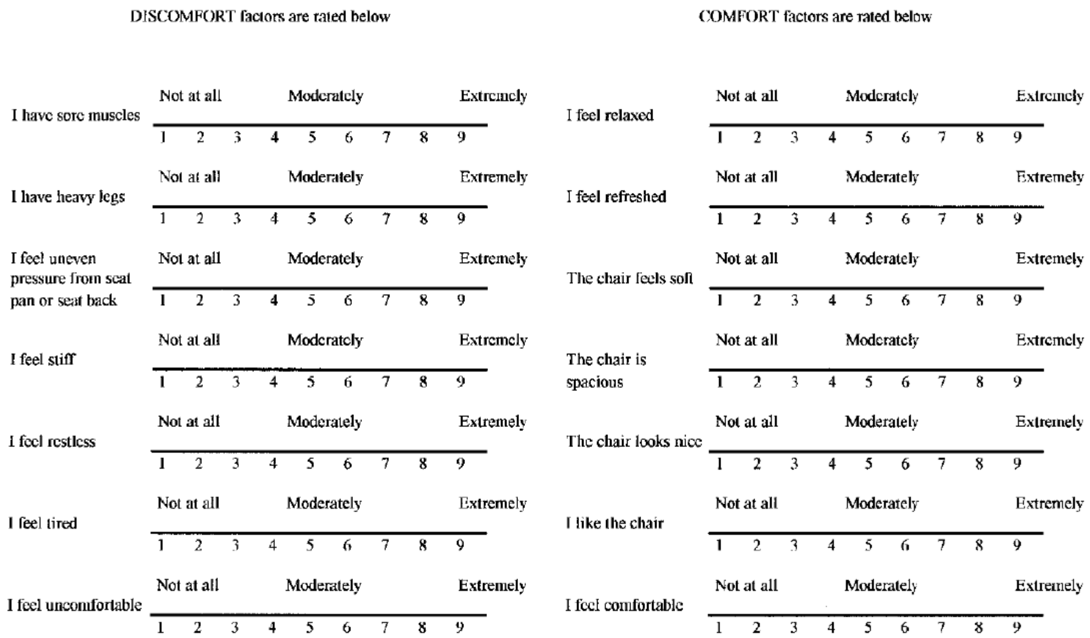


Figure 2.3 - Chair Feature Check List modified by Goonetilleke et al. (2001)

- **Chair Evaluation Checklist (Helander and Zhang, 1997):** Defining discomfort and comfort as two different concepts, related with different factors, Helander and Zhang (1997) developed a Chair Evaluation Checklist with 14 descriptors, stemming from their previous study (Zhang et al., 1996) on factors and feelings associated with perception of comfort and discomfort which gave the result that two concepts can be assessed independently.


DISCOMFORT factors are rated below

	Not at all			Moderately					Extremely
I have sore muscles	1	2	3	4	5	6	7	8	9
I have heavy legs	1	2	3	4	5	6	7	8	9
I feel uneven pressure from seat pan or seat back	1	2	3	4	5	6	7	8	9
I feel stiff	1	2	3	4	5	6	7	8	9
I feel restless	1	2	3	4	5	6	7	8	9
I feel tired	1	2	3	4	5	6	7	8	9
I feel uncomfortable	1	2	3	4	5	6	7	8	9

COMFORT factors are rated below

	Not at all			Moderately					Extremely
I feel relaxed	1	2	3	4	5	6	7	8	9
I feel refreshed	1	2	3	4	5	6	7	8	9
The chair feels soft	1	2	3	4	5	6	7	8	9
The chair is spacious	1	2	3	4	5	6	7	8	9
The chair looks nice	1	2	3	4	5	6	7	8	9
I like the chair	1	2	3	4	5	6	7	8	9
I feel comfortable	1	2	3	4	5	6	7	8	9

Figure 2.4 – Chair evaluation Checklist (Helander and Zhang, 1997)

Zhang et al. (1996) examined the association of factors affecting comfort and discomfort in sitting, stemming from the idea that discomfort is primarily associated with physiological and biomechanical factors and that comfort is primarily associated with aesthetics. Using a questionnaire to assess respondent's perceptions on concepts, their study revealed that, discomfort is associated with biomechanical factors (joint angles, muscle contractions, pressure distribution) which were associated with feelings like pain, soreness, numbness and stiffness (Helander, 2003). Kamp (2011) also cited Vink (2005) as saying "…discomfort is more related to physical characteristics, whereas comfort is more related to experience, emotion, unexpected features and luxury". This perception of discomfort coincides with De Looze et al. (2003) in which authors commented as "feelings of discomfort are mainly associated with pain, tiredness, soreness and numbness. These feelings are assumed to be imposed by physical constraints and mediated by physical factors like joint angles, tissue pressure and circulation blockage". Kyung et al. (2008) also promotes the use of discomfort ratings to measure the basic qualities of seats. On the other hand, comfort is associated with feelings of relaxation and well-being (Zhang et al., 1996). Thus the assessment of comfort and discomfort should hence be based on different types of criteria (Helander and Zhang, 1997; Kyung et al., 2008).

Zhang et al. (1996) proposed a model for the perception of discomfort and comfort (Figure 2.5). Depending on the proposed model, if discomfort is low, comfort may be perceived and if discomfort is increased, comfort will decrease (Zhang et al., 1996). This view coincides with Helander (2003) as comfort and discomfort can be indicators of each other, while low discomfort cannot predict high comfort, high discomfort can be associated with low comfort and high comfort can be associated with low discomfort values.

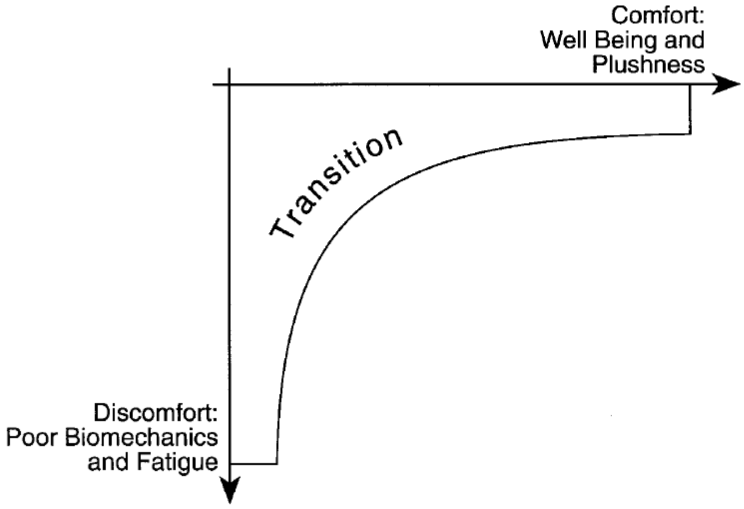


Figure 2.5 – Hypothetical model of comfort and discomfort (Zhang et al., 1996)

2.2. Seat Design

Most of the research findings concerning industrial and office chair design can be applied to auto seat design; however, there are several important considerations that should be made because of the unique environment of a vehicle (Reed et al.. 1994). As Kyung (2008) defined; "designing a car seat is a challenging task that must meet multiple requirements; within a confined space where vibration is generally present, the car seat is required to accommodate diverse groups of people by firmly supporting and physically fitting their preferred postures as well as by allowing freedom to change postures".

Seat design need to be evaluated as features such as seat width, seat cushion hardness, and available legroom are related to comfort (Vink et al., 2012). It may seem that chair design and biomechanics of sitting are not so important unless the design severely and obviously violates basic design criteria (Helander and Zhang, 1997).

2.2.1. Sitting Dynamics

The dynamics of sitting is related to both mechanics of body parts and external support systems involved in sitting (Parcells et al., 1999). When a person sits a great part of the body weight is transferred to the supporting surfaces (Nag et al., 2008; Helander, 2003; Oyewole et al., 2010). With the heavy load concentrated on the seat pan, legs, feet and back areas are used to produce equilibrium. Leg support is critical for distributing and reducing buttock and thigh loads (Parcells et al., 1999; Oyewole et al., 2010; Nag et al., 2008). Feet need to rest on the floor (Corlett, 1999) or if there exists on a foot support so that the lower leg weight is not supported by the front part of the thighs, which may contribute to a discomfort by effecting circulation. Lower pressure ratios at the buttocks and higher pressure ratios at the upper and lower back, balanced pressure between the buttocks and between the lower and upper body is found to be improve sitting comfort in objective evaluation methods (Kolich, 2008). What can be said, given the current state of knowledge, is that a good pressure distribution indicates sufficient and balanced support to body areas in contact with the automobile seat (Kolich, 2008; Fazlollahtabar, 2010).

2.2.2. Seat Features

While the upper body is supported by seat pan, backrest and the armrest, lower leg and thighs take their support from the floor (Nag et al., 2008). Comfort, stability, and balance need to be provided by the seat with minimal pressure on lower extremities such as legs and thighs, with appropriate weight and force distribution by support such as backrest, armrest (Nag et al.., 2008). Better distribution of load to the components of the seat can minimize stress and prevent discomfort. Without proper design, sitting will require greater muscular force and control to maintain stability and equilibrium. This, in turn, results in greater fatigue and discomfort (Parcells et al. 1999).

As stated by Kolich (2003) due to large part in Akerblom's (1948) work, "ergonomics criteria related to anthropometry have long been considered a key aspect of comfortable seating". As in the passenger car design, where a single type of seat must accommodate a large percentage of the population using that vehicle, knowledge of anthropometry is required (Reed et al., 1994).

Widely used design criterion is that the seat should accommodate the members of the population who lie between the 5th-percentile-female and 95th-percentile-male values on the anthropometric measure of interest (Reed et al., 1994; Kolich, 2003). Looking from this perspective designer must ensure that a range of people from small to large fit in the seat (Kolich, 2003; Reed et al., 1994).

There exists research on the relationship between anthropometric measurements and seat design, concentrating on the match between subject measures and design features (Parcells et al., 1999; Panagitopoulou et al., 2004; Castellucci et al., 2010; Gouvali and Boudolos, 2006). Match or mismatch conditions and definitions of the anthropometric measures are given in Section 2.2.3.

2.2.2.1. Seat Back

Related to seat back, rather than an upright position, a tilted back can reduce the weight distribution at seat pan and therefore decrease pressure (Nag et al., 2008). In order to provide this decrease, seat back should adjustable, allowing an incline up to 120 degrees, with a minimum of 100 degrees (Helander, 2003). The backrest width above and below the waist level should be larger to accommodate the greater hip width below and chest width above (Reed at al., 1994).

2.2.2.2. Seat Pan

Seat pan depth, width, height in addition to cushion hardness can be regarded as important contributors to seat comfort.

Seat pan depth is an important determinant of comfort for several reasons. A seat pan that is too long can put pressure on the back of legs near the knee (Reed et al., 1994; Helander, 2003), an area that has many superficial nerves and blood vessels and underside of the thighs which has low resistance to deformation (Kolich et al., 2004). Pressure in these areas can lead to local discomfort and restricted blood flow to the legs. Goonetilleke et al. (2001) cited Phesant's (1991) comments on the seat depth saying "a seat which is too deep deprives the user of the full benefit of the seat back rest". Leaning back in a flexed position with an unsupported lumbar region, or sitting forward and loosing contact with the seat back are given as two consequences of a deep seat (Reed et al., 1994; Goonetilleke et al., 2001). Also it can restrict the leg movement if there left a narrow space between the front seat and the occupant of the seat, which may restrict the movement and prevent postural changes such as changing legs or pressure from side to side, which are necessary. Seat pan depth is constrained by the buttock-to-popliteal length of the 5th percentile female segment but a strict criterion for seat pan depth is difficult as buttock-popliteal length change leading to variations in anthropometric measurements (Goonetilleke et al., 2001).

In the case of seat pan width, the 95th percentile female sitting hip breadth is used as a specification limit.

Regarding the seat pan cushioning Helander (2003) states a rounded edge is necessary to prevent blood circulation cut off in the legs. Seat pan cushioning hardness is also important as a seat cushion that is too firm or soft may lead to pressure on the thighs and affect circulation. If the circulation is affected, not only on the place of excess pressure, whole body discomfort can be observed (Kolich et al., 2004; Reed et al., 1994).

Also as stated before, position of the seat back is closely related to seat pan. Backward slope greater than 95 degrees up to 115 degrees was also shown to be reducing the weight distribution on the seat pan (Nag, et al,. 2008). As the angle becomes more upright, greater part of the occupant's weight is taken by the seat pan (Kolich et al., 2004).

If the seat pan is too high, the underside of the thigh becomes compressed causing discomfort and restriction in blood circulation. In that situation sitting person moves forward to the end of the seat pan and lack back support. Also if the seat is too high, feet do not have contact with floor surface which weakens the stability, and puts more weight on the buttocks and thighs (Parcells et al., 1999; Corlett 1999). However if the seat pan is too low, also weight is transferred to hip area leading to a lack of proper pressure distribution.

2.2.2.3 Armrest

The presence of armrest can decrease the weight distribution on the seat pan (Nag et al., 2008). Armrest has a great contribution in reducing weight on the seat pan and mitigating stress on the spinal and other structures if designed at a suitable height, therefore optimizing the height of the armrest (Nag et al., 2008) is important and may contribute to comfort.

2.2.3 Suitability of Seat Features and Anthropometric Measures

Castellucci et al. (2010), Parcells et al. (1999), Panagiotopoulou et al. (2004), and Gouvali and Boudolos (2006) gave definitions and design limits on seating, regarding the anthropometric measures. With specific equations, incompatibility between the dimensions of the school bus seat and the dimensions of the student's body is defined as a mismatch.

In order to assess if there is a mismatch between school bus seat dimensions and student's anthropometric measurements, exact measures are needed.

Seat dimensions of interest were defined as;

- **Seat Height (SH):** measured as the vertical distance from the floor to the middle point of the front edge of the seat.
- **Seat Depth (SD):** measured as the distance from the back to the front of the sitting surface.
- **Seat width (SW):** measured as the horizontal distance between the lateral edges of the seat.

Anthropometric measurements used in the comparison were;

- **Popliteal Height (PH):** measured with 90 knee flexion, as the vertical distance from the floor or footrest and the posterior surface of the knee (popliteal surface).
- **Buttock-Popliteal Length (BPL):** taken with a 90 angle knee flexion as the horizontal distance from the posterior surface of the buttock to the popliteal surface.
- **Hip Width (HW):** the horizontal distance measured in the widest point of the hip in the sitting position.

Conditions and limits were formed as following;

Popliteal Height – Seat Height Mismatch:

According to Parcells et al. (1999) and Panagiotopoulou et al. (2004) popliteal height should be greater than seat height. If seat height is high, occupant may lack the feet support from the floor and therefore it may increase the pressure on the posterior area of knee and thighs. A seat height that is greater than 95% or smaller than 88% of the popliteal height was defined as a mismatch.

$$0.88 * PH < SH < 0.95 * PH$$

Castellucci et al. (2010) and Gouvali and Boudolos (2006) also stating that seat height should be smaller than popliteal height, included 5 to 30 degrees of angle between vertical and the lower leg with a 3 cm correction for shoe height, and stated that seat height should be;

$$(PH +3) \cos 30° \leq SH \leq (PH +3) \cos 5°$$

Buttock Popliteal Length – Seat Depth:

A mismatch is defined if the seat depth is either greater than 95% or smaller than 80% of the buttock popliteal length. If seat depth is larger than BPL measure, thighs may be compressed and blood circulation may be prohibited. Castellucci et al. (2010) and Gouvali and Boudolos (2006) also increased the upper limit to 99% from 95%.

$$0.80 * BPL \leq SD \leq 0.99 * BPL$$

Hip Breadth – Seat Width Mismatch:

Seat width should be large enough to accommodate even the largest student hip breadth. Although Parcells et al. (1999) found a seat width greater than hip breadth as sufficient, according to Gouvali and Boudolos (2006) seat width should be at least 10% (in order to accommodate hip breadth) and at most 30% larger than hip breadth for space of economy.

$$1.1 * HB \leq SW \leq 1.3 * HB$$

2.3. Driver Distraction

Lee et al. (2008) defined driver distraction as "a diversion of attention away from activities critical for safe driving towards a competing activity". Driver distraction can contribute to errors through affecting cognitive processes such as perception, planning, decision making and situation awareness, as well as by interfering with vehicle control tasks, and lead to road traffic crashes, accidents or dangers (Young et al., 2012).

Despite the complexities of driving drivers regularly engage in various non-driving related activities (Young et al., 2012). Distraction can be related to technology related, non-technology related and external sources (Young et al., 2012). Adjusting the radio, dealing with passengers, using vehicle or climate controls, checking mirrors are some of the distraction sources among many.

Koppel et al. (2011) researched the relationship between child occupants and driving distraction, and found that distraction related to child occupants account for 12 % of all potential sources of driver distraction. Usage of seat belts in school buses were also found to decrease the risk of distraction by preventing discipline problems (Lou et al., 2011), as behaviors such as standing, moving inside the bus or talking to each other or to driver.

CHAPTER 3

METHODOLOGY

3.1. Introduction

In the light of previously consulted studies regarding the ergonomic evaluation of school busses and assessment of perceived comfort, questionnaires were designed to cover all the necessary aspects of the study, considering the recent regulations on school busses. This chapter will consist of information on regulations in Turkey, investigation of the school transportation vehicles used in the private school of interest, the sample frame, different groups of participants, parts of the questionnaire and relation of questions included regarding the evaluation of conformity and assessment of perceived comfort and discomfort.

3.2. School Busses

School busses are believed to be one of the safest ways for transportation of school children from all ages (Gangopadhyay et al, 2011; Lou et al., 2011; Yang et al., 2009). School transportation is provided by private carrier firms to transport students from their homes to school and the way back. Public and private schools make annual contracts with these firms according to their expectations and level of service.

3.2.1. Regulations in Turkey

In Turkey all the school buses have to meet the standards of Service Legislation of School Transportation Vehicles determined by Republic of Turkey Ministry of Transport, Maritime Affairs and Communications, Directorate General of Road Transport Regulation. The aim of this legislation is to coordinate and provide safe student transportation for all the pre-school and other students included in the compulsory education, to define and determine the adequacy and working conditions of real and legal entities that will transport students and to provide the necessary auditing services regarding the Service Legislation of School Transportation (http://www.kugm.gov.tr).

Service Legislation of School Transportation Vehicles determined by Republic of Turkey Ministry of Transport, Maritime Affairs and Communications, Directorate General of Road Transport Regulation defines the conditions and attributes for general interior and exterior design features of the bus, driver choices and their responsibilities in different clauses (Appendix C)

3.2.1.1 Conditions of Interest

Having a reflective zone in adequate color, size and shape including the writing “OKUL TAŞITI” (school bus) at the back of the vehicle provides greater visibility and safety. The reflective zone is 832 and 1040 millimeters in height and width respectively (Figure 3.1), and consists of black, white and yellow colors (Figure 3.2)

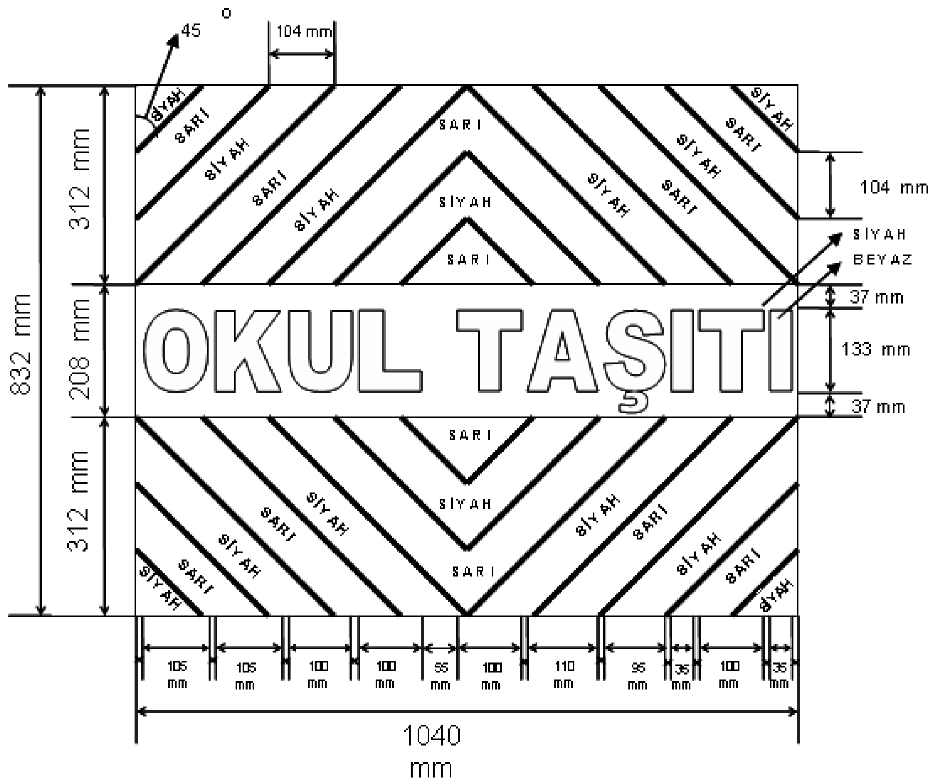


Figure 3.1 - Design of the reflective zone at the back of the school busses.

Figure 3.2 – Colored design of the reflective zone

The reason behind the need for a reflective zone is the importance of visibility. The size of the label is 13.3 centimeters and according to Letter Size to Visibility Chart in Figure 3.3 (http://www.elliott-design.net), this provides readability from a maximum distance around 400 centimeters. Signages that MUST be read from longer distances require the use of more contrasting colors (http://www.elliott-design.net). Color contrast made by using white letters on a black background also increases visibility.

MAXIMUM READABLE DISTANCE	READABLE DISTANCE FOR MAXIMUM IMPACT	LETTER HEIGHT
100'	30'	3"
150'	40'	4"
200'	60'	6"
350'	80'	8"
400'	90'	9"
450'	100'	10"
525'	120'	12"
630'	150'	15"
750'	180'	18"
1000'	240'	24"
1250'	300'	30"
1500'	360'	36"
1750'	420'	42"
2000'	480'	48"
2250'	540'	54"
2500'	600'	60"

Figure 3.3 – Letter size visibility chart

Existence of a lamp emitting red light while passengers are getting on or off the bus , with at least a diameter of 30 centimeters, having a black label "DUR"(stop) at the back of the vehicle increases the visibility on a higher level in order to match the eye level of other drivers in traffic.

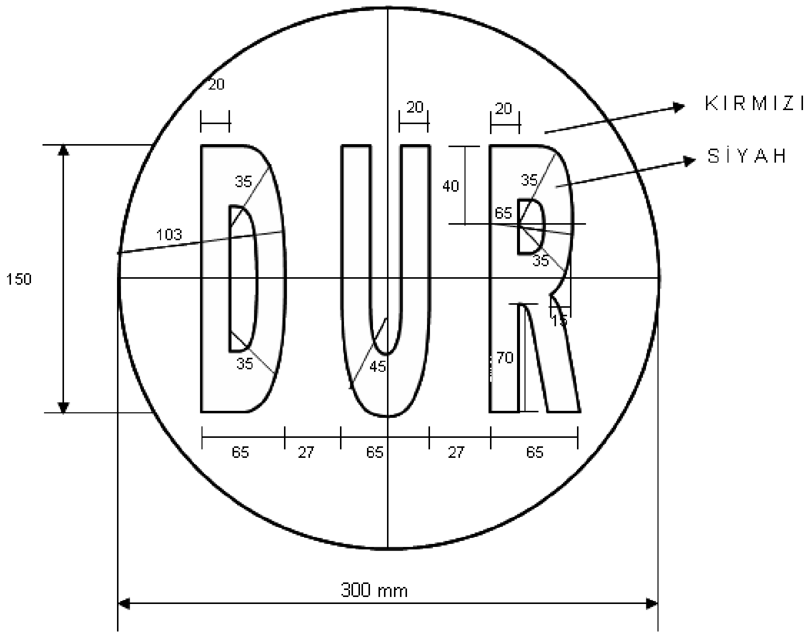


Figure 3.4 – Design of the lamp

Fixation of windows is to avoid behaviors like bending over from the window, sticking out body parts like arms, legs or head, and also to protect the passengers from the environment outside the school bus, which may lead to injuries or accidents.

Covering metal components with a soft material also provides safer interior environment and prevents injuries, bruises or wounds that may result from any kind of contact with those components during the journey or while getting on or off from the vehicle and also at the occurrence of accidents.

Another condition that relates to safety of the students is door mechanism. Having a manual or automatic door mechanism that informs the driver with visual or audio signals to prevent injuries that may occur by being stuck between the door and its mechanism. Also with the increased technology many of the vehicles used in school transportation have sensors to avoid this kind of injuries.

Existence of a wireless or mobile phone for any kind of necessity, and mandatory seat belts for each passenger can be listed as other features that are related to safety. Also the legislation states that any audio or visual systems should not be used during journeys, as any visual or audio stimulant may cause driver distraction.

In addition to previously addressed conditions regarding the vehicle itself, the legislation also states the job definitions for drivers, necessary qualifications of drivers as their ages, years of driving experience based on their driving licenses, educational level, their traffic and criminal records.

3.2.2. School Busses of the Private School

Service Legislation of School Transportation Vehicles gives “rule of thumb” for manufacturers and designers. Although any vehicle used in school transportation must meet those basic standards, interior and exterior design depends on the manufacturer, in other means the brand of the vehicle or a private car design firm. There are numerous car brands having commercial vehicles in their product ranges. In order for a commercial vehicle to be considered as a school bus, it must be designed adequately regarding the Service Legislation of School Transportation Vehicles terms.

For the sake of simplicity and convenience only the brands that are used by the contracted private carrier firm of the relevant school are studied and will be called as Brand A, Brand B and Brand C throughout the study.

Brand A, B and C are two car brands, having commercial vehicles in their product range, they both have the same qualifications and design with minor differences regarding their exterior design (length vary with only centimeters) and aesthetics. For the simplicity only Brand A vehicles were investigated in deep.

Brand A vehicles are of 6945mm in length and in width. Weight of the vehicle is 3880 kilograms. They have sixteen seats reserved for passengers, one in the front and fifteen at the back of the bus, with slope adjustment at their back.

Figure 3.5 – Exterior of Brand A vehicles

All the vehicles reserved for school transportation have several features regarding the interior and exterior design, comfort and safety, which can be given as;

- MP3 players, radio
- colored windows,
- side lamps,
- passenger side interior lighting,
- comfort type driver seat,
- single front passenger seat,
- 3-point seat belts,
- driver side airbag,
- electronic sliding side door of 1.30m wide and 1.82m length,
- automatic step under the sliding door,
- side bars near the door for ease on getting on and off the bus,
- sensors on the door
- Emergency exit on the ceiling
- PVC floor cover
- Curtains
- Air conditioner in the front and at the ceiling for the back of the bus
- Outer heat level indicator
- School bus and stop signs at the back
- First aid kit
- Driving wheel with height and slope adjustments
- High ceiling
- Fixed windows on the passenger side

The distance between passenger seats, which is the aisle width, is 39cm. Width, depth and height of the seat is 44, 45 and 76 centimeters respectively.

Figure 3.6 – Passenger seats

The distance measured from the top of the seat pan and floor is 48 cm, with around 18 centimeters of cushion height. Arm rests are 19cm in height, 4 cm in width and 32 cm in length. With the current design 26-27 centimeters are left for legs between two seats.

Figure 3.7 – Distance between seats

All of the seats can be tilted back with a maximum of 30 degrees. Driver's seats are 51 cm in width, 47 cm in depth and 80 cm in height. The distance between the top of the seat pan and floor is 48 cm.

Figure 3.8 – Sliding door at the right of the bus

3.3. Parameters of the Study

3.3.1. Sample frame

The interviews with the management of selected private school, drivers in the contracted private carrier firm and students of grades 6, 7 and 8 in addition to the completion of two types of questionnaires were held between May and June 2012 in Ankara.

3.3.2. Groups of Participants

The study includes two groups of participants namely as drivers and students. As children with smaller ages may not be able to comprehend the questions asked in the survey, and students with greater ages can be considered as more mature in relation to anthropometric measures, students of age 12 between 15 were taken as subjects of the study. Students are sub-divided into three different sub-groups according to their grade as 6^{th}, 7^{th} and 8^{th} grade students. To address the changing importance and priorities as a result of their status during the journey and differences in their seat design, students and drivers were held as two distinct groups.

3.4. Questionnaire Design

In this study a questionnaire is designed to both assess how comfortable the participants feel, their perceptions about ergonomics and design of the seats, and if there exists the degree of their discomfort regarding different parts of their body. Questionnaires and scales from similar studies have been investigated and literature was reviewed. In order to cover necessary aspects of the research a questionnaire used in seat testing procedures from Wright Air Development Center (Slechta et al., 1957) and Kolich's Automobile Seat Comfort Survey (Kolich et al., 2004) were combined with studies of Helander and Zhang's Chair Evaluation Checklist (Helander and Zhang, 1997) in addition to questions that are designed especially for this study.

3.4.1. Parts of the Questionnaires

Two different questionnaires were designed for two main groups of participants, students and drivers, as their roles and expectations are distinct because of their status during the journey. Also design of driver seat and passenger seat differ from each other in school transportation vehicles, therefore the questions included were specific for those two groups.

The survey consists of different questions on comfort, discomfort and design features. As the aim of the study is the ergonomic evaluation of school buses and how good the design of the bus fits the related groups of participants, questions were designed to assess their perceptions on design and comfort.

Questionnaires begin with a brief explanation of the intent of the study and gives information about how to answer the questions included.

The questionnaires beginning with questions regarding demographics and school bus usage, continues with questions on perceived comfort and discomfort, questions regarding determination of areas of discomfort if there exists any, followed by the questions on design features.

3.4.1.1. Survey Questions

Two different questionnaires were designed regarding the aforementioned reasons. Complete survey for students and drivers can be seen in Appendix A and Appendix B respectively.

3.4.1.1.1. Questionnaire for Students

Survey consists of 4 parts with a total of 74 questions. In the first part, age, gender, grade, residence district, frequency of usage and approximate journey durations were asked. Age, gender and grade were used in grouping of students for statistical analysis. Residence district and approximate journey duration were subjects of interest as to examine and analyze the effect of short, medium or long periods of journeys on comfort.

Second part of the survey was designed to assess thermal comfort related to weather conditions, jouncing, noise and degree of discomfort related to their existence, safety of the bus by asking questions on seat belts, windows and doors, and driver behaviors. Answers were organized accordingly to a 5-point Likert scale in order to indicate the level of suitability for the participant.

Survey continues with part 3 which includes questions on the existence, location and level of discomfort, followed by the questions related to the design features. The aim of this part is to relate any type of discomfort with the interior design of the school bus.

In the last part questions on preferred adjustments and settings of bus seats were asked to gain insight on possible design changes that can be made in the future.

3.4.1.1.2. Questionnaire for Drivers

Questionnaire for drivers was made up of a total 68 questions in four parts. Although the general survey share similarities with the one designed for students, there exists some aspects to be covered, as the design of the seat; role and expectations differ from each other.

In the first part age, years of having driver license and experience with school busses in addition to the approximate journey durations and districts they are responsible from were asked. These questions were asked both to evaluate any difference that may occur in the results according to the length of journey, and their suitability regarding the Service Legislation of School Transportation Vehicles. Also information on the years of having driving license and driving experience were considered to be useful for the investigation of their effect on driving abilities.

Similar to the questionnaire for students, second part of the survey includes questions related to the assessment of thermal comfort, level of vibration or noise and degree of distraction and discomfort related to their existence. Questions on the status of windows, doors, both passenger and driver seat belts were designed as an indication of safety. Also attitudes of drivers on different situations were questioned. Consistent with the survey design of students, answers were organized accordingly to a 5-point Likert scale indicating the level of suitability.

Third and fourth parts of the questionnaires were same for both of the groups

CHAPTER 4

RESULTS

As stated in the previous chapter, in order to address the changing importance and priorities as a result of their status during the journey and differences in their seat design, students and drivers were held as two distinct groups. With this distinction, results of the questionnaire study were evaluated separately for two groups.

First parts of both surveys were used to gather information on demographics, usage rates and journey durations. Remaining questions were used to gain insight on safety and perceived comfort and discomfort.

Using SPSS Software, descriptive statistics for both groups were found (Appendix D, Appendix I). For the explanation of the results, questions were evaluated on different basis. Based on the nature of questions, different comparisons were used. In the descriptive statistics, first column named as "Questions" define the content of the original question in abbreviations. N gives the number of valid responses. Min and Max columns are the lowest and highest scores for a given question by all the respondents. Mean and Std.Deviation gives the main statistics of the data. Also two values, Skewness and Kurtosis were included in the table.

Skewness is a measure of the asymmetry of the set of data. Its value can be positive, negative or zero as in the case of Normal Distribution. A negative skew indicates that data bulks at the right side of the mean, greater than the mean. Tail on the left side of the distribution tends to be longer and this is why a data set with a negative skew is called left skewed. On the other hand a positive skew is the opposite of negative skew, being bulked at the right of the mean, with a great amount of data points having a value smaller than the mean. As with positive skew, right side of the distribution tends to be longer and called right skewed. In the zero Skewness case, data is symmetric and data points are evenly distributed on both sides, so there is zero asymmetry (http://statistics.about.com/od/Descriptive-Statistics/a/What-Is-Skewness.htm, http://www.itl.nist.gov/div898/handbook/eda/section3/eda35b.htm).

Kurtosis is the measure of the peakedness of a distribution, and indicates how high the distribution is around the mean. The normal distribution is found to have a kurtosis of three. A distribution with kurtosis value of three is called "mesokurtic", while a distribution with kurtosis greater than three is "leptokurtic" and a distribution with kurtosis less than three is "platykurtic" (http://statistics.about.com/od/Descriptive-Statistics/a/What-Is-Kurtosis.htm, http://www.itl.nist.gov/div898/handbook/eda/section3/eda35b.htm).

SPSS assumes normality. As stated, in Normal Distribution Skewness value is equal to zero and Kurtosis value is equal to three. But as mentioned before and can be seen in Appendix D and Appendix I on descriptive statistics, Skewness and kurtosis values tend to be different than what is considered to be "Normal". For this reason a concept called "Bootstrapping" needs to be introduced. The idea behind bootstrap is using the data of a sample like a population in order to approximate the sampling distribution of a statistic. By using bootstrapping, re-sampling from the data is used to create a large number of samples which are called bootstrap samples. The sample summary is then computed on each of the bootstrap samples which usually go up to few thousand (Singh and Xie, 2010). From the comparison, as there is no significant difference between the values of parametric and nonparametric results, it is found to be safe to use either of the results.

4.1. Students

4.1.1. Response Rates

A total of 183 surveys were gathered from students of grades 6, 7 and 8. Within the total number of participants, 149 student surveys, 76 from 6th grade, 47 from 7th grade and 26 from 8th grade, were considered in evaluation. First reason of exclusion is that, the questionnaires were found to be blank except age, grade and gender information. As a second reason of exclusion, school bus is just one way for transportation. Some of the students declared that they are using another ways of transportation (family car, taxi, etc.) instead of school busses. These questionnaires were also excluded as the main interest of this study is related to school buses.

4.1.2. Demographics, Usage Rates and Journey Durations

Average age of students using school buses from 6th, 7th and 8th grades were found to be 12.74, with a Skewness of 0.459. This value can be explained by having a greater number of 6 grade students in our survey (Figure 4.1). As Skewness is 0.459, the distribution of age data is right skewed, meaning there exists more values smaller than the mean of 12.74.

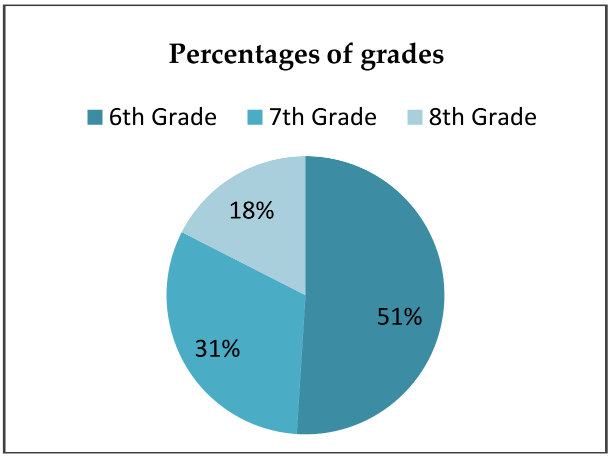


Figure 4.1 – Percentage of grades

Gender distribution was found to be in favor of females, with 66 male and 83 females in total. Table 4.1 gives the distributions specific for grades and total number of students with each gender.

Table 4.1 – Distribution of genders for grades

	6th Grade	7th Grade	8th Grade	Total
Male	29	23	14	66
Female	47	24	12	83
Total	76	47	26	149

As previously stated students using other ways of transportation were excluded from data. A student is included even if he or she uses school bus for transportation on the way to school from home or from school to their home. Depending on the nature of the question asked in the survey, this information is gathered using two questions, one asking about their school bus usage in the mornings and one asking about their school bus usage in the evenings. Questions were asked in order to rate their usage in a scale changing from 1 to 5, with 1 corresponding to "*Never*" and 5 corresponding to "*Always*". As can be seen in Appendix D, students use school bus with an average of 4.24 in the mornings and 4.55 in the evenings.

In order to further assess any difference on perceived comfort or discomfort, students were asked about their average journey durations both in the morning and in the evening. Approximate durations for morning and evening were found to be 30.65 minutes and 33.43 minutes respectively. Both have positive Skewness values, indicating that journey durations are mostly under those values.

4.1.3. Safety

While getting on or off the bus, any difficulty may lead to an injury, as students may fall or have problem with balance. Thus if a student needs help, this information can be interpreted as a safety related issue. In the survey questions on the need of assistance, although the rating scale was given from *Strongly Disagree* to *Strongly Agree* with corresponding ratings of 1 to 5, answers were evaluated on a binary basis. Answers of *Strongly Agree* and *Agree* were considered as 1, showing a need for the assistance, while *Strongly Disagree* and *Disagree* were considered as 0. As can be seen in Appendix D, mean value of these questions were 0 and 0.01 indicating that, students do not need help while getting on or off the bus. Also this result was expected as school buses have an automatic step activated as the door opens and handlebar at the side of the door. Even if a student may have difficulty while getting on or off the bus, this step and handlebar serves as a help.

Sleepiness was also considered to be related with safety, as it may lead to cognitive and physical shortcomings resulting in dangerous behaviors. Although sleepiness is not a major problem in the evening journeys, students were found to be sleepy in the morning journeys with a mean of 3.59, standard deviation of 1.48 and Skewness of -0.666, meaning that a larger number of students feel sleepy.

The last but most important component of safety in school bus or any type of transportation is the usage of seat belts. Seat belt usage showed results that do not match with rules in school bus transportation. According to the interviews done with drivers during the course of study, seat belt usage were defined to be mandatory, whereas the results showed students do not tend to fasten their belts at the beginning or throughout their journeys. With mean values of 2.28 and 2.20 respectively, results were compared with a mean value of 3. Hypothesis was formed as;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Looking at the One-Sample T-test results (Appendix F), significance level lower than 0.05, observed with negative mean difference values, leading to the rejection of null hypothesis. This can be indicated as a safety rule violation. Even in near-miss or minor accidents, a student with no seat belt can easily get injured by hitting on a part of the vehicle or each other. Also behaviors such as standing (Lou et al., 2011) or moving from place to place in the school bus can affect driver's distraction negatively, and cause lack of attention from the road, leading to accidents.

Having the same hypothesis for suitability of the seat belt, it was observed that this value was not significantly different than 3, with a significance level of 0.621, hypothesis that mean is equal to zero cannot be rejected. It can be said that students do not perceive seat belts as nonconforming or conforming either. As this result does not show a negative conformity, it can be said that, students feel neutral towards seat belts.

Correlations between fastening the seat belt at the beginning of the journey, staying fasten throughout the journey and seat belt suitability were examined (Table 4.2).Hypothesis was formed as ρ being the correlation coeffiecient;

$$H_0: \rho = 0$$
$$H_1: \rho \neq 0$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

With significance levels of zero, null hypothesis is rejected and fastening the seat belt at the beginning of the journey and staying fasten throughout the journey were found to be highly correlated. This indicated that students who fasten their seat belts as soon as they get on the bus also tend to keep their belts fasten throughout the journey.

It was found that students tend to not fasten their seat belts and there exists no positive or negative conformity result. With significance levels of zero and rejection of the null hypothesis, fastening behavior was found to be correlated with the suitability of the seat belt. This correlation can be explanatory of the behavior of not fastening the seat belt. As there exists a correlation between fastening behavior, a further analysis on the seat belts and their conformance with the anthropometric measures of the students is needed.

Table 4.2 –Correlations between fastening behaviors and seat belt suitability

Correlations				Fasten the seat belt as soon as getting on the bus	Belt is fasten throughout the journey	Seat belt is suitable for the student
Fasten seat belt as soon as getting on the bus	Pearson Correlation			1	**0.86**	**0.442**
	Sig. (2-tailed)				**0**	**0**
	N			148	148	148
	Bootstrap	Bias		0	0.001	0.003
		Std. Error		0	0.043	0.064
		95% Confidence Interval	Lower	1	0.768	0.314
			Upper	1	0.936	0.562
Belt is fasten throughout the journey	Pearson Correlation			**0.86**	1	**0.443**
	Sig. (2-tailed)			**0**		**0**
	N			148	148	148
	Bootstrap	Bias		0.001	0	0.004
		Std. Error		0.043	0	0.063
		95% Confidence Interval	Lower	0.768	1	0.315
			Upper	0.936	1	0.563
Seat belt is suitable for the student	Pearson Correlation			**0.442**	**0.443**	1
	Sig. (2-tailed)			**0**	**0**	
	N			148	148	148
	Bootstrap	Bias		0.003	0.004	0
		Std. Error		0.064	0.063	0
		95% Confidence Interval	Lower	0.314	0.315	1
			Upper	0.562	0.563	1

Fastening behavior and suitability of the seat belt was also examined regarding grade and gender, in order to see it there exists a pattern for different age groups or genders. Before starting this analysis gender of students were coded as 1 indicating “male” and 0 indicating “female”. Descriptive statistics on the behavior of fastening and seat belt is given in the Table 4.3 below. Also estimated marginal mean graphics can be seen in Figures 4.2, 4.3 and 4.4.

Table 4.3 – Descriptive statistics on the behavior of fastening and suitability of the seat belt according to gender and grade

Descriptive Statistics		Fastening seat belt as soon as getting on the bus			Belt is fasten throughout the journey			Seat belt is suitable for the student		
Gender	Grade	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation	N
Female	6	2.52	1.574	46	2.4	1.424	47	3.13	1.393	47
	7	2.17	1.494	24	2	1.319	24	3	1.351	24
	8	2.42	1.621	12	2.5	1.624	12	2.67	1.723	12
	Total	**2.4**	**1.546**	**82**	**2.3**	**1.421**	**83**	**3.02**	**1.423**	**83**
Male	6	2.17	1.466	29	1.97	1.239	29	3.21	1.544	29
	7	1.96	1.397	23	1.78	1.347	23	3.04	1.581	23
	8	2.29	1.729	14	2.79	1.805	14	2.86	1.834	14
	Total	**2.12**	**1.483**	**66**	**2.08**	**1.439**	**66**	**3.08**	**1.601**	**66**
Total	6	2.39	1.532	75	2.24	1.365	76	3.16	1.443	76
	7	2.06	1.436	47	1.89	1.323	47	3.02	1.452	47
	8	2.35	1.648	26	2.65	1.696	26	2.77	1.751	26
	Total	2.28	1.52	148	2.2	1.428	149	3.05	1.499	149

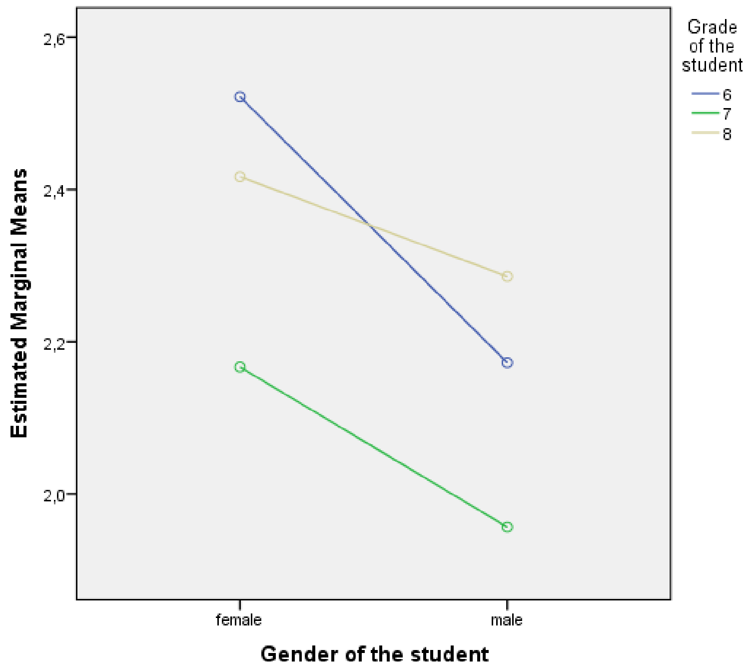


Figure 4.2 - Estimated marginal means of fastening the seat belt as soon as getting on the bus

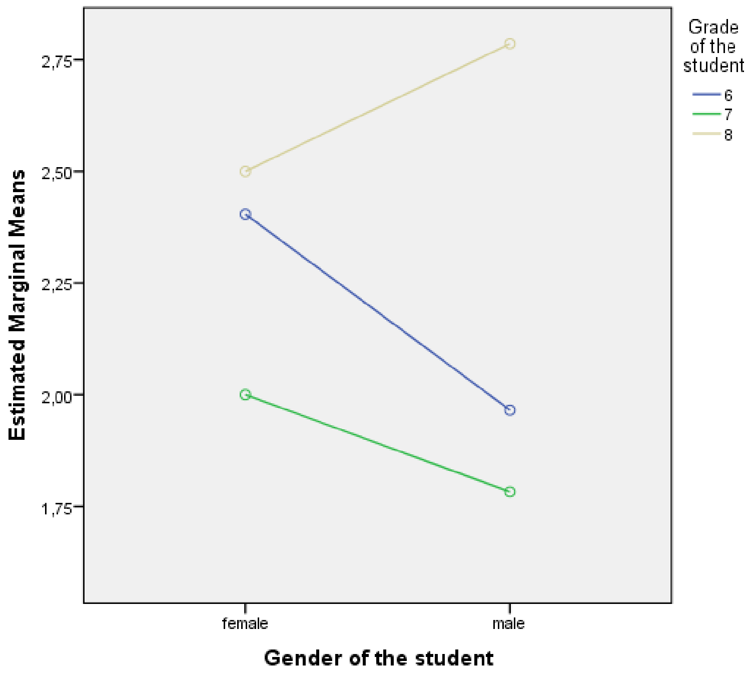


Figure 4.3 - Estimated marginal means of keeping the seat belt fasten throughout the journey

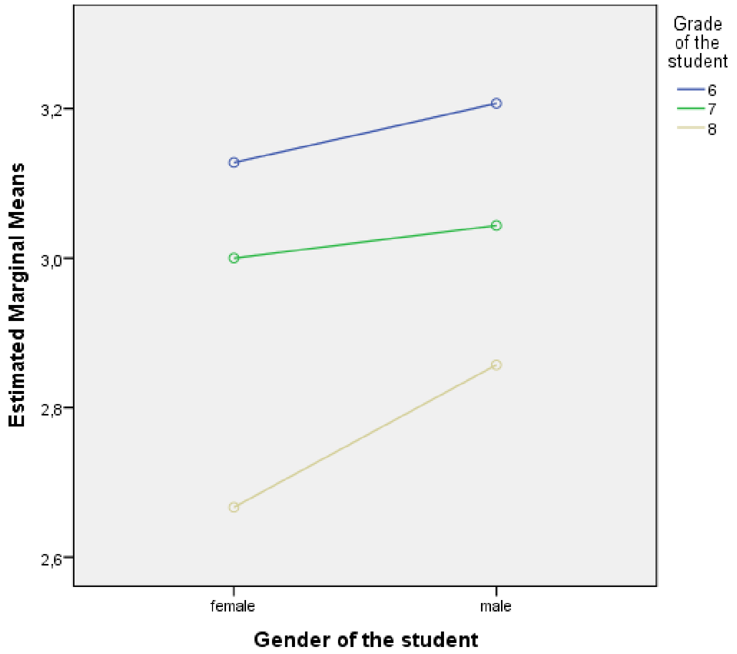


Figure 4.4 - Estimated marginal means of suitability of the seat belt

In the univariate analysis, it was asked if gender, grade or both can be used to explain the fastening behavior or suitability. As there are 3 different conditions of interest, different hypotheses were formed. Similar to the multiple regression models, the aim is to decide whether the coefficients of the factors gender, grade or both of them together are different than zero. Let the coefficients of gender, grade and both of them together beβ_1, β_2 and β_3 respectively. The hypotheses were then formed as following;

For Gender;

$H_0: \beta_1 = 0$
$H_1: \beta_1 \neq 0$
$\alpha = 0.1$
Reject H_0 if, $\alpha < 0.1$

For Grade;

$H_0: \beta_2 = 0$
$H_1: \beta_2 \neq 0$
$\alpha = 0.1$
Reject H_0 if, $\alpha < 0.1$

For Gender and Grade together;

$H_0: \beta_3 = 0$
$H_1: \beta_3 \neq 0$
$\alpha = 0.1$
Reject H_0 if, $\alpha < 0.1$

Looking at the Tests Between–Subjects Effects with the dependent variable choice as being fastening the seat belt as soon as getting on the bus (Table 4.4), considering the significance values, null hypotheses cannot be rejected, as they have values greater than α value of 0.1. As a result, behaviour of fastening the saet belt as soon as getting on the bus is not found to be related to gender or grade separately or at the same time.

Table 4.4 – Test Between-Subjects Effects for behavior of fastening the seat belt as soon as getting on the bus

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5.962	5	1.192	.507	.770	.018
Intercept	617.241	1	617.241	262.672	.000	.649
Gender	1.610	1	1.610	.685	.409	.005
Grade	2.600	2	1.300	.553	.576	.008
Gender * Grade	.278	2	.139	.059	.943	.001
Error	333.680	142	2.350			
Total	1107.000	148				
Corrected Total	339.642	147				

Considering the behavior of keeping the seat belt fasten throughout the journey, looking at the Tests Between–Subjects Effects with the relevant dependent variable choice (Table 4.5), null hypothesis regarding Grade, with a corresponding significance value of 0.099, is rejected. Although if α value was to be taken as 0.1, grade may be considered as significant with 10% meaningfulness. Looking at Table 4.3 for keeping the seat belt fasten throughout the journey, mean value for 7th grade students were found to be lower than 6th and 8th grade students.

Table 4.5 - Test Between-Subjects Effects for behavior of keeping the seat belt fasten throughout the journey

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	14.405	5	2.881	1.433	.216	.048
Intercept	610.765	1	610.765	303.731	.000	.680
Gender	.464	1	.464	.231	.632	.002
Grade	9.444	2	4.722	2.348	.099	.032
Gender * Grade	2.500	2	1.250	.622	.539	.009
Error	287.555	143	2.011			
Total	1024.000	149				
Corrected Total	301.960	148				

Lastly for the suitability of the seat belt, gender, grade or both together were found to be not significant, with having significance values of 0.705, 0.504 and 0.980 respectively (Table 4.6). Not rejecting the null hypotheses as the significance values are greater than α, it can be inferred that the suitability of seat belt does not show any difference for grade or gender.

As a result it can be inferred that, neither gender nor the grade (age) of the students have an effect on the fastening behavior, which is also supported by Lou et al. (2011).

Table 4.6 - Test Between-Subjects Effects for the suitability of the seat belt

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3.341	5	.668	.290	.918	.010
Intercept	1083.912	1	1083.912	470.650	.000	.767
Gender	.332	1	.332	.144	.705	.001
Grade	3.169	2	1.584	.688	.504	.010
Gender * Grade	.093	2	.046	.020	.980	.000
Error	329.330	143	2.303			
Total	1716.000	149				
Corrected Total	332.671	148				

4.1.4. Perceived Discomfort

4.1.4.1. Thermal Discomfort

Regarding the discomfort from weather conditions questions 12, 13, 14 and 15 were asked. In these questions whether it is hot or cold in the bus regarding spring and winter were asked then, students were questioned to mention if they feel any discomfort regarding this conditions were asked as feeling of discomfort from high or low temperatures. One sample statistics of the results (Appendix E) showed that students evaluated the bus as hot in spring months with a mean value of 4.32, and mentioned discomfort regarding the high temperature with a mean value of 4.06. In both, confidence intervals do not include value 3, which indicates discomfort from high temperatures also. This result can be associated with the design of the school buses. As the windows at the passenger side of the bus are locked and cannot be opened, design of the ventilation or air conditioner placements may not be sufficient to provide thermal comfort in these months.

On the other hand, in winter months, students did not tend to express discomfort regarding cold. Mean values of whether it is cold and whether they feel cold were found to be 2.88 and 2.63 respectively. Looking at the confidence intervals, it is seen that although the answer to whether it is cold in the bus includes mean value of 3, answer on if they feel any discomfort from that, namely feel cold, does not include value 3 (Appendix E). From this result it can be said that, although students rate the bus as cold, they mentioned less discomfort from cold. This may have a psychological aspect, but it is not examined in depth, as it is not in the scope of this study.

Also with One-Sample T-test, for the comparison of mean values with 3, hypothesis was formed to be;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Looking at the 1st, 3rd and 4th rows of Appendix F, it is observed that they have significance smaller than 0.05, which indicates the rejection of the null hypothesis H_0, showing non-equality to 3. Looking at the mean differences it is observed that students tend to assess the school bus as hot, and feel discomfort related to this as they have positive values. Feeling of cold on the other hand has negative mean difference, indicating no discomfort.

Looking at the correlations between assessing the school bus as hot or cold and feeling hot and cold, with the hypothesis;

$$H_0: \rho = 0$$
$$H_1: \rho \neq 0$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Significance level is zero between bus being hot and disturbance by hot and bus being cold and disturbance by cold, null hypothesis is rejected, which concludes that there exists a correlation between these values. Also from Table 4.7 it is seen that, a higher correlation exists between buses being cold and feeling cold, which implies that sensation of cold is perceived greater than hot.

Table 4.7 – Correlation between thermal assessment of school bus and feelings of hot/cold

Correlations				It is hot in the bus in spring months	It is cold in the bus in winter months	Disturbance of hot	Disturbance of cold
It is hot in the bus in spring months	Pearson Correlation			1	0.3	**0.453**	0.203
	Sig. (2-tailed)				0	**0**	0.013
	Sum of Squares and Cross-products			128.17	59.362	74.846	40.034
	Covariance			0.866	0.401	0.506	0.27
	N			149	149	149	149
	Bootstrap	Bias		0	0.001	0.002	0.004
		Std. Error		0	0.069	0.08	0.069
		95% Confidence Interval	Lower	1	0.161	0.286	0.069
			Upper	1	0.426	0.6	0.329
It is cold in the bus in winter months	Pearson Correlation			0.3	1	0.244	**0.685**
	Sig. (2-tailed)			0		0.003	**0**
	Sum of Squares and Cross-products			59.362	305.06	62.141	208.839
	Covariance			0.401	2.061	0.42	1.411
	N			149	149	149	149
	Bootstrap	Bias		0.001	0	0	0.002
		Std. Error		0.069	0	0.076	0.059
		95% Confidence Interval	Lower	0.161	1	0.095	0.571
			Upper	0.426	1	0.385	0.801

4.1.4.2. Discomfort from noise and jouncing

Disturbance from the music or noise of other students were found to be low with mean values between 1.5 and 2.31 as given in Appendix E. For testing the equivalence of the mean values to 3, hypothesis was formed as;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Looking at One-Sample T-test results (Appendix F), although with significance values smaller than 0.05 indicates the rejection of H_0, mean differences were negative, which shows that students do not feel discomfort in relation to music or noise of their friends.

Although students do not tend to be disturbed by music or noise, it was examined if the timing of the journey has any relationship with this type of discomfort. In order to assess whether students tend to feel more discomfortable in the morning or in the evening by music or noise of their friends, first the hypothesis was created in order to see if there exists a correlation between morning and evening disturbances. As ρ being the population correlation coefficient, two pairs are considered. Pair 1 consists of music disturbance in the morning and in the evening; Pair 2 consists of disturbance from noise of others in the morning and in the evening. For both pairs, hypotheses were formed as;

$$H_0: \rho = 0$$
$$H_1: \rho \neq 0$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

For both pairs the significance levels were found to be smaller than 0.05 with correlations of 0.623 and 0.661 respectively for Pair 1 and Pair 2 (Table 4.8). This leads to the rejection of null hypothesis that correlation does not exist. As a result it can be said that morning disturbance from music can be explained or interfered by using the amount of evening disturbance with a value around 0.39, the square of their correlation coefficient. Also existence of a correlation indicated that mean difference is expected to be zero, indifferent.

Table 4.8 - Correlation between morning and evening journeys and disturbance from music or noise

Paired Samples Correlations		**N**	**Correlation**	**Sig.**	**Bootstrap for Correlation**			
					Bias	**Std. Error**	**95% Confidence Interval**	
							Lower	**Upper**
Pair 1	Music disturbs in the morning journeys & Music disturbs in the evening journeys	149	**0.623**	**0**	0	0.097	0.423	0.801
Pair 2	Friends making noise disturbs in the morning journeys & Friends making noise disturbs in the evening journeys	149	**0.661**	**0**	0.001	0.064	0.533	0.782

Also a Paired Sample Test was done to compare the mean values within pairs. For this test a new hypothesis was formed. Mean differences between morning and evening journeys for both types of discomforts were calculated as;

$$X_d = X_m - X_e$$

Where $X_m$is the mean value of disturbance in the morning from music or noise and X_e is the mean value of disturbance in the evening from music or noise. Taking the mean value of $X_d$measures of each data point, $\bar{X}_d$ value is obtained. From this sample data inferences were made on μ_d . At the end the hypothesis is formed in order to see if there exists a difference between morning and evening journeys to be;

$$H_0: \mu_d = 0$$
$$H_1: \mu_d \neq 0$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

As seen in Table 4.9, significance levels of both pairs were found to be greater than 0.05 with values 0.925 and 0.841 respectively for Pair 1 and Pair 2. With this values, null hypothesis is not rejected, meaning there exists no significant difference between the answers of students given on morning and evening disturbances regarding music and noise of their friends. From these results, it can be indicated that, if a student feels discomfort from music or noise in the morning, he or she would probably feel the same in the evening, and this type of discomfort is not dependent on the timing of journey.

Table 4.9 – Paired Sample Test between disturbances from music or noise in the morning and evening journeys.

Paired Sample Test		**Paired Differences**					**t**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**				
					Lower	**Upper**			
Pair 1	Music disturbs in the morning journeys & Music disturbs in the evening journeys	**-0.007**	0.866	0.07	-0.147	0.133	-0.095	148	**0.925**
Pair 2	Friends making noise disturbs in the morning journeys & Friends making noise disturbs in the evening journeys	**0.02**	1.222	0.1	-0.178	0.218	0.201	148	**0.841**

Discomfort level from the jouncing during the journey was also found to be low, with a mean value of 2.64. This can be related with the mechanics of the school busses used. With the age limitations and continuous maintenance, jouncing is prevented.

4.1.4.3 Discomfort on Body Parts

Five main body areas were considered in this study which are, neck, shoulders, back, thighs and legs. In addition to a general assessment of existence of discomfort, specific types of discomfort were defined as;

- Excessive Pressure
- Stiffness
- Ache
- Soreness
- Prickling Sensation
- Numbness

Selection of these descriptive terms for discomfort is based on Slectra et.al. (1957). Terms are associated with three different origins of body discomfort. As stated by Slectra et.al. (1957); "*excessive pressure* is associated with superficial sensations originating in the skin and underlying tissues caused by contact with parts of the seat. *Stiffness*, *ache* and *soreness* would describe discomforts originating in the deeper-lying body parts such as the muscles and joints which would be involved in postural discomfort. *Prickling sensation* and *numbness* would be associated with pressures caused by contact with the seat which are great enough to interfere with the circulation of blood in certain body regions".

With the given frequencies among the students with a discomfort on the specific body part (Table 4.10), leading complaints were, ache on the neck, stiffness on the shoulders, ache on the back, numbness on the thighs and legs. The most problematic areas were found to be neck and legs.

Table 4.10 – Frequencies of Discomfort on Body Parts experienced by students

Frequency Table	Existence of any kind of discomfort	Excessive Pressure	Stiffness	Ache	Soreness	Prickling Sensation	Numbness
Neck	52.3%	3.4	19.5	23.5	2.7	5.4	8.7
Shoulders	39.6%	2	16.1	14.1	4	4	6.7
Back	48.3%	5.4	10.7	24.2	4	4.7	8.7
Thighs	36.9%	2.7	6	8.7	6.7	7.4	10.1
Legs	51%	2.7	4.7	11.4	2.7	14.1	28.2

As from the nature of the questions, participants were able to express more than one type of discomfort for each body part. In general stiffness is most commonly felt in neck and shoulders. Ache is experienced primarily in the neck and back. Prickling sensation and numbness is frequent primarily on the thighs and legs, which suggests that excessive pressure caused an interference with the circulation in this area.

4.1.4.3.1 Neck Discomfort

Mean value of feeling discomfort in this area is found to be 2.42. From one-sample t-test results with the hypothesis;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Null hypothesis is rejected with significance level of zero, indicating the mean is different than 3. With a mean difference value of -0.581, neck discomfort is not a significant problem. Further analysis although showed that 52.3% of the students expressed that they feel discomfort on the neck area. Among the participants expressing a discomfort on this area, ache is the primary complaint followed by stiffness. Among body parts, although found to be insignificant, neck discomfort is rated as the most problematic area. This can be attributed to neck region being the most sensitive area in which even at very low levels of pressure can discomfort can be observed (Franz et al., 2012).

In order to identify the relationship between neck discomfort and factors of gender, grade, seat dimensions and features were evaluated and a regression analysis was made. For the regression analysis, Backward Regression Method is used. In this method, all the possible factors that may contribute to explain the variation are given in the first model, which is named as Full Model. SPSS runs F-test with all possible variables at a 0.1 level of significance, and removes the ones with smaller significance from the model in each step. , Y being the Full Model, $\hat{Y}$ being the Restricted Model, two regression equations, beginning and end models can be given as;

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \varepsilon_1 \quad (1)$$

$$\hat{Y} = \alpha_0 + \alpha_1X_1 + \alpha_2X_2 + \alpha_3X_3 + \alpha_4X_4 + \alpha_5X_5 + \alpha_6X_6 + \alpha_7X_7 + \alpha_8X_8 + \alpha_9X_9 + \alpha_{10}X_{10} + \alpha_{11}X_{11} + \alpha_{12}X_{12} + \alpha_{13}X_{13} + \varepsilon_2 \quad (2)$$

Hypothesis test is done for each β_i value, with i =1, 2… 13 as;

$$H_0: \beta_i = 0$$
$$H_1: \beta_i \neq 0$$
$$\alpha = 0.10$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.10$$

Rejection of the null hypothesis results as the removal of the corresponding variable from the regression model, therefore forming the restricted model.

Performing the same hypothesis test for each variable end model is formed at 10^{th} model, with an R^2 value of 0.284, meaning 28% of the total variation in neck discomfort can be explained by the factors in the restricted model. Regarding neck discomfort, seat pan cushion hardness, seat back height, back cushion shoulder and waist support were found to be explaining 28% of variation in neck discomfort.

Table 4.11 – Summary of model relating neck discomfort to gender, grade and seat dimensions and features

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
10	**.533**	**0.284**	**0.264**	**1.227**

Table 4.12 – ANOVA Model relating neck discomfort to gender, grade and seat dimensions and features

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	91.817	13	7.063	4.525	.000
	Residual	210.693	135	1.561		
	Total	302.51	148			
10	**Regression**	**85.863**	**4**	**21.466**	**14.268**	**.000**
	Residual	**216.647**	**144**	**1.504**		
	Total	**302.51**	**148**			

Table 4.13 – Coefficients for model relating neck discomfort to gender, grade and seat dimensions and features

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
10	**(Constant)**	**3.889**	**0.364**		**10.673**	**0**
	Seat pan cushion hardness	**0.296**	**0.095**	**0.24**	**3.118**	**0.002**
	Seat back height	**0.244**	**0.13**	**0.139**	**1.878**	**0.062**
	Seat back cushion shoulder support	**-0.294**	**0.112**	**-0.259**	**-2.631**	**0.009**
	Seat back cushion waist support	**-0.189**	**0.107**	**-0.172**	**-1.768**	**0.079**

4.1.4.3.2 Shoulder Discomfort

Mean value of feeling discomfort on the shoulders is found to be 2.21. From one-sample t-test results with the hypothesis;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Null hypothesis is rejected with significance level of zero, indicating the mean is different than 3. With a mean difference value of -0.791, shoulder discomfort is not a significant problem. Further analysis although showed that 39.6% of the students expressed that they feel discomfort on the shoulder area. Among the participants expressing a discomfort on this area, stiffness is the primary complaint followed by ache.

In order to identify the relationship between shoulder discomfort and factors of gender, grade and physical features were evaluated and with a regression analysis was, as similar to the one done for the neck area. For the regression analysis, hypothesis test is done for each β_i value, with i =1, 2… 13 as;

$$H_0: \beta_i = 0$$
$$H_1: \beta_i \neq 0$$
$$\alpha = 0.10$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.10$$

Performing the same hypothesis test for each variable end model is formed at 12th model, with an R^2 value of 0.213, meaning 21% of the total variation in shoulder discomfort can be explained by back cushion hardness and back cushion shoulder support.

Table 4.14 – Summary of model relating shoulder discomfort to gender, grade and seat dimensions and features

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
12	**.462**	**0.213**	**0.203**	**1.21**

Table 4.15 – ANOVA Model relating shoulder discomfort to gender, grade and seat dimensions and features

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	68.455	13	5.266	3.498	.000
	Residual	203.236	135	1.505		
	Total	271.691	148			
12	**Regression**	**57.963**	**2**	**28.981**	**19.798**	**.000**
	Residual	**213.728**	**146**	**1.464**		
	Total	**271.691**	**148**			

Table 4.16 – Coefficients for model relating shoulder discomfort to gender, grade and seat dimensions and features

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
12	**(Constant)**	**3.078**	**0.335**		**9.182**	**0**
	Seat back cushion hardness	**0.301**	**0.089**	**0.268**	**3.394**	**0.001**
	Seat back cushion shoulder support	**-0.311**	**0.085**	**-0.289**	**-3.654**	**0**

4.1.4.3.3 Back Discomfort

Mean value of feeling discomfort on the back is found to be 2.40. From one-sample t-test results with the hypothesis;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Null hypothesis is rejected with significance level of zero, indicating the mean is different than 3. With a mean difference value of -0.601, back discomfort is not a significant problem. Further analysis although showed that 48.3% of the students expressed that they feel discomfort on this area, with ache being the primary complaint.

In order to identify the relationship between back discomfort and factors of gender, grade and physical features were evaluated and with a regression.

For the regression analysis, hypothesis test is done for each β_i value, with i =1, 2… 13 as;

$$H_0: \beta_i = 0$$
$$H_1: \beta_i \neq 0$$
$$\alpha = 0.10$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.10$$

Performing the same hypothesis test for each variable end model is formed at 12th model, with an R^2 value of 0.259, meaning nearly 26% of the total variation in of discomfort on the back area can be explained by back cushion hardness and back cushion waist support.

Table 4.17 – Summary of model relating back discomfort to gender, grade and seat dimensions and features

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
12	**.509**	**0.259**	**0.249**	**1.255**

Table 4.18 – ANOVA Model relating back discomfort to gender, grade and seat dimensions and features

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	89.377	13	6.875	4.206	.000
	Residual	220.65	135	1.634		
	Total	310.027	148			
12	**Regression**	**80.256**	**2**	**40.128**	**25.498**	**.000**
	Residual	**229.771**	**146**	**1.574**		
	Total	**310.027**	**148**			

Table 4.19 – Coefficients for model relating back discomfort to gender, grade and seat dimensions and features

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
12	**(Constant)**	**3.667**	**0.332**		**11.031**	**0**
	Seat back cushion hardness	**0.257**	**0.092**	**0.214**	**2.78**	**0.006**
	Seat back cushion waist support	**-0.43**	**0.086**	**-0.387**	**-5.025**	**0**

4.1.4.3.4 Thigh Discomfort

Mean value of thigh discomfort is found to be 2.19. From one-sample t-test results with the hypothesis;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Null hypothesis is rejected with significance level of zero. With a mean difference value of -0.811, thigh discomfort is not a significant problem. Analysis although showed that 36.9% of the students mentioned a specific type of discomfort on thigh area, with numbness ranked as the highest complaint.

For the regression analysis to identify the relationship between thigh discomfort and factors of gender, grade and physical features, hypothesis test is done for each β_i value, with i changing from 1 to 13 as;

$$H_0: \beta_i = 0$$
$$H_1: \beta_i \neq 0$$
$$\alpha = 0.10$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.10$$

End model is formed at 12th model, with an R^2 value of 0.314, meaning 31% of the total variation in of discomfort on the back area can be explained by seat pan cushion hardness and back cushion waist support.

Table 4.20 – Summary of model relating thigh discomfort to gender, grade and seat dimensions and features

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
12	**.561**	**0.314**	**0.305**	**1.14**

Table 4.21 – ANOVA Model relating thigh discomfort to gender, grade and seat dimensions and features

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	93.091	13	7.161	5.269	.000
	Residual	183.46	135	1.359		
	Total	276.55	148			
12	**Regression**	**86.884**	**2**	**43.442**	**33.44**	**.000**
	Residual	**189.667**	**146**	**1.299**		
	Total	**276.55**	**148**			

Table 4.22 – Coefficients for model relating thigh discomfort to gender, grade and seat dimensions and features

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
12	**(Constant)**	**3.379**	**0.293**		**11.523**	**0**
	Seat pan cushion hardness	**0.338**	**0.086**	**0.288**	**3.934**	**0**
	Seat back cushion waist support	**-0.41**	**0.077**	**-0.391**	**-5.351**	**0**

4.1.4.3.5 Leg Discomfort

Mean value of perceived leg discomfort is found to be 2.24. From one-sample t-test results with the hypothesis;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Null hypothesis is rejected with significance level of zero. With a mean difference value of -0.764, leg discomfort is not a significant problem. Analysis although showed that 51% of the students mentioned a specific type of discomfort on this area, with numbness ranked as the highest complaint.

For the regression analysis to identify the relationship between leg discomfort and factors of gender, grade and physical features, hypothesis test is done for each β_i value, with i changing from 1 to 13 as;

$$H_0: \beta_i = 0$$
$$H_1: \beta_i \neq 0$$
$$\alpha = 0.10$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.10$$

End model is formed at 12th model, with an R^2 value of 0.207, meaning nearly 21% of the total variation in of discomfort on the back area can be explained by seat pan cushion hardness and back cushion waist support.

Table 4.23 – Summary of model relating leg discomfort to gender, grade and seat dimensions and features

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
12	**.455**	**0.207**	**0.196**	**1.186**

Table 4.24 – ANOVA Model relating leg discomfort to gender, grade and seat dimensions and features

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	56.409	13	4.339	2.895	.001
	Residual	202.37	135	1.499		
	Total	258.779	148			
12	**Regression**	**53.555**	**2**	**26.777**	**19.05**	**.000**
	Residual	**205.224**	**146**	**1.406**		
	Total	**258.779**	**148**			

Table 4.25 – Coefficients for model relating thigh discomfort to gender, grade and seat dimensions and features

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
12	**(Constant)**	**3.107**	**0.305**		**10.184**	**0**
	Seat pan cushion hardness	**0.28**	**0.089**	**0.246**	**3.135**	**0.002**
	Seat back cushion waist support	**-0.31**	**0.08**	**-0.306**	**-3.892**	**0**

Being the second highest area of discomfort, 51% of the participants mentioned that they feel a specific type of discomfort on their legs. Numbness was the leading type of discomfort for this area.

Table 4.26 – Relationship between discomfort types and variation sources

	Gender	*Grade*	*Seat pan cushion hardness*	*Seat pan width*	*Seat pan length*	*Seat back cushion hardness*	*Seat back width*	*Seat back height*	*Seat back cushion shoulder support*	*Seat back cushion back support*	*Seat back cushion waist support*	*Existence of headrest*	*Existence of armrest*
Neck Discomfort			✔					✔	✔		✔		
Shoulder Discomfort						✔			✔				
Back Discomfort						✔					✔		
Thigh Discomfort			✔								✔		
Leg Discomfort						✔					✔		

4.1.4.3.6 Comparison of Discomfort Levels

In order to see if any specific area of discomfort was assessed to be more problematic, one way ANOVA comparisons were used. In the hypothesis testing, null hypothesis of equal importance is compared with the alternative hypothesis of at least one different.

μ_1: Mean discomfort on the neck
μ_2 : Mean discomfort on the shoulders
μ_3 : Mean discomfort on the back
μ_4 : Mean discomfort on the legs
μ_5 : Mean discomfort on the thighs
Hypothesis was formed as;

$$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$$
$$H_1: At\ least\ one\ \mu_j\ is\ different, j = 1,2,3,4,5$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

According to the result of ANOVA with this hypothesis, significance was found to be 0.449 (Table 4.27). This significance level is greater than the significance level of the hypothesis so the null hypothesis is not rejected, meaning none of the discomfort types are significantly different then each other.

Table 4.27 – ANOVA for the significance of mean on discomfortable body parts

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7.093	4	1.773	.924	.449
Within Groups	1419.557	740	1.918		
Total	1426.650	744			

4.1.4.4 Suitability and Comparison of Seat Features

In this part, questions with answers ranging from value of -3 to 3 were evaluated and compared with value of "0", which is the mid value, corresponding to "suitable". One-Sample Statistics and One sample t-test Table for the related questions were given in Appendix Q and Appendix T respectively. For all the comparisons same hypothesis test were done, which is given as following;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Questions considered in this part are mainly related to design features of the bus seat. Four main features were subject to evaluation as, seat pan, seat back, headrest and armrest. Ratings for specific answers are given in Table 4.28 below.

Table 4.28 – Rating scale for answers regarding seat dimensions and features

	3	1	0	-1	-3
Seat Pan Cushion Hardness	too firm	firm	normal	slightly soft	too soft
Seat Pan Width	too wide	wide	normal	slightly narrow	too narrow
Seat Pan Length	too long	long	normal	short	too short
Seat Back Cushion Hardness	too firm	firm	normal	slightly soft	too soft
Seat Back Width	too wide	wide	normal	slightly narrow	too narrow
Seat Back Height	too long	long	normal	short	too short
Headrest Cushion Hardness	too firm	firm	normal	slightly soft	too soft
Headrest Width	too wide	wide	normal	slightly narrow	too narrow
Headrest Height	too high	high	normal	low	too low
Armrest Length	too long	long	normal	short	too short
Armrest Width	too wide	wide	normal	slightly narrow	too narrow
Armrest Height	too high	high	normal	low	too low
Armrest Distance	too close together	close	normal	slightly apart	too apart

Among the mean comparisons related to design features, three features were found to have a significance level α smaller than 0.05. These were seat pan cushion hardness, seat back cushion hardness and headrest cushion hardness. Rest of the features lack the evidence for the rejection of the null hypothesis stating the mean value to be equal to zero. Seat pan cushion hardness with significance level of 0.003 and positive mean difference of 0.676 indicates the result that students perceive the seat pan as "firm" rather than "normal". Also seat back cushion hardness and headrest cushion hardness have significance levels of 0.020 and 0.024 and positive mean differences of 0.459 and 0.432 respectively, indicating a perception of firmness.

4.1.4.4.1 Comparison of Seat Pan Features

One-way ANOVA is used then to compare if a specific factor have been considered as more important or different by students in the course of evaluation of seat feature. In order to see if any specific area of discomfort was assessed to be more problematic

Regarding the Seat pan, three main features, seat pan cushion hardness, seat pan width and seat pan length were considered. In order to form the hypothesis, first μ values need to be assigned properly.
μ_1: Mean value for seat pan cushion hardness
μ_2 : Mean value for seat pan width
μ_3 : Mean value for seat pan length

Hypothesis is as follows;

$$H_0: \mu_1 = \mu_2 = \mu_3$$
$$H_1: At\ least\ one\ \mu_j\ is\ different, j = 1,2,3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

According to the result of ANOVA with this hypothesis, significance was found to be 0 (Table 4.29). This significance level is lower than the significance level of 0.05 so the null hypothesis is rejected. This result showed that at least one of the features is different regarding its mean value. In order to see which one is significant further evaluation was made using paired samples (Table 4.30).

Table 4.29 – ANOVA model for Seat Pan Features

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	33.105	2	16.553	18.104	.000
Within Groups	405.960	444	.914		
Total	439.065	446			

In the Multiple comparisons, all three features related to seat pan is compared in pairs with the remaining features rather than itself. Hypothesis was structured as the null hypothesis suggesting the equality of their means and alternative hypothesis suggesting the non-equality of their means, at a significance level of α=0.05

Table 4.30 – Multiple comparisons between seat pan features

	(I) Type of the Seat Pan Feature	(J) Type of the Seat Pan Feature	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Dunnett T3	Hardness	Width	.584	0.12	0	0.3	0.87
		Length	.570	0.114	0	0.3	0.85
	Width	Hardness	-.584	0.12	0	-0.87	-0.3
		Length	-0.013	0.097	0.999	-0.25	0.22
	Length	Hardness	-.570	0.114	0	-0.85	-0.3
		Width	0.013	0.097	0.999	-0.22	0.25

From Table 4.30 with a significance level of zero, rejecting the null hypothesis on equality of the mean values, cushion hardness was found to be the most distinctive feature of the seat pan in relation to discomfort. From the previous results showing neck, thigh and leg discomfort as related with seat pan cushion hardness, seat pan cushion hardness may be regarded as a possible problem with being too firm. This also shows that students are able to detect the difference of contribution to discomfort between seat pan cushion hardness, seat pan width and length.

4.1.4.4.2 Comparison of Seat Back Features

Regarding the Seat Back, again three main features, as seat back cushion hardness, seat back width and seat back height were considered. μ values are assigned as;

μ_1: Mean value for seat back cushion hardness
μ_2 : Mean value for seat back width
μ_3 : Mean value for seat back height

Hypothesis is as follows;

$$H_0: \mu_1 = \mu_2 = \mu_3$$
$$H_1: At\ least\ one\ \mu_j\ is\ different, j = 1,2,3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

According to the result of ANOVA with this hypothesis, significance was found to be 0 (Table 4.31). This significance level is smaller than 0.05, which is the significance level of the hypothesis. As the null hypothesis is rejected, with at least one of the features being different in mean value, in order to identify the feature with different mean, further evaluation was made using paired samples (Table 4.32).

Table 4.31 – ANOVA model for Seat Back features

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	51.315	2	25.658	29.379	.000
Within Groups	387.758	444	.873		
Total	439.074	446			

All three features related to seat back are compared in pairs with the remaining features rather than itself. Hypothesis was structured as the null hypothesis suggesting the equality of their means and alternative hypothesis suggesting the non-equality of their means, at a significance level of α=0,05

Table 4.32 – Multiple comparisons between seat back features

	(I) Type of the Seat Back Feature	(J) Type of the Seat Back Feature	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Dunnett T3	Hardness	Width	.758	0.115	0	0.48	1.03
		Height	.671	0.119	0	0.38	0.96
	Width	Hardness	-.758	0.115	0	-1.03	-0.48
		Height	-0.087	0.088	0.691	-0.3	0.13
	Height	Hardness	-.671	0.119	0	-0.96	-0.38
		Width	0.087	0.088	0.691	-0.13	0.3

From Table 4.32 with a significance level of zero, rejecting the null hypothesis on equality of the mean values, cushion hardness was found to be the most distinctive feature of the seat back in relation to discomfort. This also shows that students are able to detect the difference of contribution to discomfort between distinct features.

4.1.4.4.3 Comparison of Armrest Features

In evaluation of armrest features, length, width, height and distance between armrests were considered. μ values are assigned as;

μ_1: Mean value for armrest lenght
μ_2 : Mean value for armrest width
μ_3 : Mean value for armrest height
μ_4 : Mean value for armrest distance
Hypothesis is as follows;

$$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4$$
$$H_1: At\ least\ one\ \mu_j\ is\ different, j = 1,2,3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

From ANOVA with this hypothesis, significance was found to be 0.001 (Table 4.33). This significance level is less than 0.05, the significance level of the hypothesis. The null hypothesis is rejected, with a conclusion of at least one of the features being different in mean value. Further evaluation was made using paired samples (Table 4.34).

Table 4.33 – ANOVA model for Armrest features

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.485	3	2.162	5.431	.001
Within Groups	132.155	332	.398		
Total	138.640	335			

All three features related to seat back are compared in pairs with the remaining features rather than itself. Hypothesis was structured as the null hypothesis suggesting the equality of their means and alternative hypothesis suggesting the non-equality of their means, at a significance level of α=0.05

Table 4.34 – Multiple comparisons between armrest features

	(I) Type of the armrest feature	(J) Type of the armrest feature	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	Length	Width	.214	0.097	0.028	0.02	0.41
		Height	-0.06	0.097	0.541	-0.25	0.13
		Place	-0.167	0.097	0.088	-0.36	0.02
	Width	Length	-.214	0.097	0.028	-0.41	-0.02
		Height	-.274	0.097	0.005	-0.47	-0.08
		Place	-.381	0.097	0	-0.57	-0.19
	Height	Length	0.06	0.097	0.541	-0.13	0.25
		Width	.274	0.097	0.005	0.08	0.47
		Place	-0.107	0.097	0.272	-0.3	0.08
	Place	Length	0.167	0.097	0.088	-0.02	0.36
		Width	.381	0.097	0	0.19	0.57
		Height	0.107	0.097	0.272	-0.08	0.3

From Table 4.34 with significance levels below 0.05, rejecting the null hypothesis on equality of the mean values, armrest width was found to be the most distinctive feature of the armrest in relation to discomfort.

4.1.4.5 Journey Duration and Discomfort

Discomfort increases with prolonged sitting (Helander and Zhang, 1997). In order to examine the contribution of journey duration on discomfort, correlation between morning and evening durations and any kind of discomfort existence needs to be investigated. Journey durations in the mornings and evening were found to be correlated significantly, indicating that students tend to spend approximately same amount of time in the mornings and in the evenings. With a correlation between journey durations, as also seen in Table 4.35, correlations with discomfort in specific body parts were found to be close to each other. The hypotheses on population correlation were formed as;

$$H_0: \rho = 0$$
$$H_1: \rho \neq 0$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

The most related location of discomfort with the journey duration is found to be the neck area with correlation coefficient of 0.226 and significance level of 0.006, which is lower than 0.05, indicating the rejection of the null hypothesis that there exists no correlation. If examined separately for morning and evening journeys, duration of the evening journey is found to be also related with discomfort in back, legs and thighs. Although the correlation coefficients are relatively small, indicating a weak correlation, this result can be tied to a reason. In the evenings after a school day with attention in lectures, seating in school furniture, spending energy, students tend to be more aware of feeling discomfort as a result of accumulation, and may feel more discomfort.

Table 4.35 – Correlations between journey durations and types of discomfort

Correlations		Journey dur. in the morn.	Journey dur. in the even.	Discom. on the neck	Discom. on the shoulder	Discom. on the back	Discom. on the legs	Discom. on the thigh
Journey dur. in the morn.	Pears. Corr.	1	0.765	0.226	0.104	0.153	0.158	0.145
	Sig.(2-tailed)		0	0.006	0.209	0.063	0.055	0.077
	N	149	149	149	149	149	149	149
Journey dur. in the even.	Pears. Corr.	0.765	1	0.226	0.134	0.162	0.21	0.183
	Sig.(2-tailed)	0		0.006	0.102	0.049	0.01	0.025
	N	149	149	149	149	149	149	149
Discom. on the neck	Pears. Corr.	0.226	0.226	1	0.735	0.672	0.643	0.618
	Sig.(2-tailed)	0.006	0.006		0	0	0	0
	N	149	149	149	149	149	149	149
Discom. on the shoulder	Pears. Corr.	0.104	0.134	0.735	1	0.773	0.544	0.599
	Sig.(2-tailed)	0.209	0.102	0		0	0	0
	N	149	149	149	149	149	149	149
Discom. on the back	Pears. Corr.	0.153	0.162	0.672	0.773	1	0.571	0.674
	Sig.(2-tailed)	0.063	0.049	0	0		0	0
	N	149	149	149	149	149	149	149
Discom. on the legs	Pears. Corr.	0.158	0.21	0.643	0.544	0.571	1	0.616
	Sig.(2-tailed)	0.055	0.01	0	0	0		0
	N	149	149	149	149	149	149	149
Discom. on the thigh	Pears. Corr.	0.145	0.183	0.618	0.599	0.674	0.616	1
	Sig.(2-tailed)	0.077	0.025	0	0	0	0	
	N	149	149	149	149	149	149	149

From the Table 4.35, it was also found that, there exist significantly strong correlations between feelings of discomfort in different regions. From this result it can be inferred that students feeling discomfort in one of the regions tend to feel discomfort in others too. This result is relevant, as for the relation between neck and shoulder, same muscle groups are used.

4.1.4.5.1 Logistic Regression

Logistic regression is suitable to use when the dependent variable is not continuous. In the logistic regression, likelihood of Y, the response variable is predicted on given X values. With $\hat{p}$ being the probability that the dependent variable is equal to 1, logistic formula is stated as;

$$\ln\left(\frac{\hat{p}}{1-\hat{p}}\right) = \beta_0 + \beta_1 X$$

From this definition including a familiar equation of regression line and natural logarithm, $\hat{p}$ value can also be computed from the regression equation for a given value of X by;

$$\hat{p} = \frac{e^{\beta_0+\beta_1 X}}{1+ e^{\beta_0+\beta_1 X}}$$

Binary logistic regression is most useful when the dependent variable is either 1 or 0. With the light of this information logistic regression is used in this study to see if journey time could be used to estimate the likelihood of having neck, shoulder, back, and thigh or leg discomfort.

When the morning and evening journey durations were used for the estimation of any neck related discomfort, the hypothesis was formed as following, with β_1 being the coefficient of X, the evening journey duration, model omits morning journey duration, as it is highly correlated with evening journey duration;

$$H_0: \beta_1 = 0$$
$$H_1: \beta_1 \neq 0$$
$$\alpha = 0.10$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.10$$

With this hypothesis the coefficient of X, being a constant number rather than zero indicated that possibility of Y can be explained depending on X. Variables in the equation were found as related to evening journey duration and the coefficients were found as in Table 4.36 below;

Table 4.36 – Logistic Regression Coefficients for neck discomfort

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	Morning_duration	.006	.017	.134	1	.715	1.006
	Evening_duration	.022	.016	1.717	1	.190	1.022
	Constant	-.814	.406	4.029	1	.045	.443
Step 2	β_1:Evening_duration	.026	.011	5.918	1	**.015**	1.027
	β_0:Constant	-.772	.389	3.940	1	**.047**	.462

With a significance level of 0.015 evening journey duration was found to be related to any type of neck discomfort. The equation can be formed as;

X: evening journey duration (evening_time)
$\hat{p}$= P (Any neck related discomfort response given the evening journey time)

$$\hat{p} = \frac{e^{(-0.772+0.026*X)}}{1 + e^{(-0.772+0.026*X)}}$$

Table 4.37 – Model summary of logistic regression between neck discomfort and journey time

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	199.716	.043	.057
2	199.850	.042	.056

Having the same hypothesis for shoulder , back and thigh related discomfort and if it can be estimated by journey durations yield only constant values for , meaning the coefficient β_1 is zero, thus evening journey duration can not be used to estimate the likelihood of any shoulder, back or thigh discomfort.

Table 4.38 - Logistic Regression Coefficients for shoulder discomfort

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	Morning_time	-.018	.018	.942	1	.332	.982
	Evening_time	.024	.017	2.127	1	.145	1.024
	Constant	-.684	.404	2.869	1	.090	.505
Step 2	Evening_time	.012	.010	1.292	1	.256	1.012
	Constant	-.811	.383	4.474	1	.034	.444
Step 3	Constant	-.422	.168	6.355	1	.012	.656

Table 4.39 - Logistic Regression Coefficients for back discomfort

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	Morning_time	-.001	.017	.002	1	.964	.999
	Evening_time	.015	.016	.926	1	.336	1.015
	Constant	-.550	.395	1.934	1	.164	.577
Step 2	Evening_time	.015	.010	2.068	1	.150	1.015
	Constant	-.555	.377	2.170	1	.141	.574
Step 3	Constant	-.067	.164	.168	1	.682	.935

Table 4.40 - Logistic Regression Coefficients for thigh discomfort

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	Morning_time	.004	.017	.066	1	.798	1.004
	Evening_time	.004	.016	.061	1	.806	1.004
	Constant	-.803	.407	3.894	1	.048	.448
Step 2	Morning_time	.008	.011	.468	1	.494	1.008
	Constant	-.771	.386	4.000	1	.045	.462
Step 3	Constant	-.536	.170	9.967	1	.002	.585

On the other hand with the same hypothesis formed, with β_1 being the coefficient of X, the evening journey duration for the estimation of any leg discomfort also revealed that evening journey duration can be used to estimate existance of any kind of leg discomfort. With β_1, the coefficient of evening journey duration being 0.029, with 0.008 significance level. The possibility can be written as;

p̂= P (Any leg related discomfort response given the evening journey time)

$$\hat{p} = \frac{e^{(-0.906+0.029*X)}}{1 + e^{(-0.906+0.029*X)}}$$

Table 4.41 - Logistic Regression Coefficients for leg discomfort

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	Morning_time	-.006	.017	.099	1	.753	.995
	Evening_time	.033	.017	3.733	1	.053	1.033
	Constant	-.870	.408	4.545	1	.033	.419
Step 2	Evening_time	.029	.011	6.929	1	.008	1.029
	Constant	-.906	.392	5.326	1	.021	.404

Table 4.42 - Model summary of logistic regression between neck discomfort and journey time

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	198.858	.050	.067
2	198.957	.049	.066

These results also show consistency with the previous explanation given under the heading on Correlation between Journey Duration and Discomfort. It was shown that Evening journey duration has stronger correlations with neck discomfort and leg discomfort.

4.1.5 Perceived Comfort

4.1.5.1 General Bus Comfort

Mean value of 3.63 were found regarding general bus comfort, with significance level smaller than 0.05 again and positive mean difference from t-test, it can be inferred that students feel comfortable in the bus.

In order to find out which factors contribute to the general comfort evaluation of the bus, firstly correlations of general bus comfort with other comfort related questions were evaluated. It was found that bus comfort is highly correlated with bus seat comfort as given in Table 4.43 among the other possible factors. This result coincides with the findings of Kolich (2008) as seat comfort playing an important role in the perception of a vehicle's overall comfort.

Table 4.43 – Correlations between general bus comfort, seat comfort, music, jouncing and weather

Correlations		Pearson Correlation	Sig. (1-tailed)	N	Bootstrap for Pearson Correlation			
					Bias	Std. Error	95% Confidence Interval	
							Lower	Upper
General bus comfort	General bus comfort	1	.	149	0	0	1	1
	Bus seat comfort	**0.716**	0	149	-0.001	0.053	0.602	0.815
	Music	0.356	0	149	-0.003	0.084	0.177	0.514
	Jouncing	-0.25	0.001	149	-0.002	0.088	-0.427	-0.075
	Hot weather	-0.364	0	149	0.001	0.06	-0.473	-0.238
	Cold weather	-0.332	0	149	0	0.083	-0.494	-0.164

Taking 5 factors which are possibly related to bus comfort, an ANOVA was made. The hypothesis formed measures if there exists a relationship between these factors and bus comfort.

$$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$$
$$H_1: At\ least\ one\ \beta_j\ is\ nonzero, j = 1,2,3,4,5$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Table 4.44 - ANOVA Model relating general bus comfort to seat comfort, music disturbance, jouncing disturbance, weather disturbance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	**Regression**	130.624	5	26.13	36.508	.000
	Residual	102.329	143	0.716		
	Total	232.953	148			

With significance level smaller than 0.05 (Table 4.44), the null hypothesis is rejected. The significance level in ANOVA shows the overall significance, but in order to assess which factor lies on the top in the hierarchy, individual significances are important (Table 4.45). With a coefficient of 0.573 and a significance level of zero, seat comfort is found to be the highest. From the Table, it can be said that even with a significance level set at 0.01, bus comfort is highly dependent on seat comfort. Having General bus comfort as the dependent variable of the regression equation, final equation is as follows;

$\hat{Y} = 1.673 + 0.573X_1 + 0.140X_2 - 0.019X_3 - 0.129X_4 - 0.062X_5$

Table 4.45 – Individual correlations and significances

Coefficients	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	1.673	0.46		3.633	0		
Bus seat comfort	0.573	0.06	0.606	9.559	0	0.763	1.31
Music	0.14	0.056	0.149	2.49	0.014	0.862	1.16
Jouncing	-0.019	0.053	-0.02	-0.36	0.719	0.841	1.189
Hot weather	-0.129	0.063	-0.12	-2.052	0.042	0.843	1.187
Cold weather	-0.062	0.055	-0.07	-1.124	0.263	0.783	1.277

4.1.5.2 Seat Comfort

Bus seat is regarded as comfortable with mean value of 3.71. Also significance level smaller than 0.05 for this question and positive mean difference value, indicates that students perceive the seat as comfortable.

4.1.5.2.1 Correlation and Regression Analysis

Having seat comfort as the most related factor for general bus comfort, correlations between seat comfort and factors of gender, grade and seat features were evaluated and a regression analysis was made. From Table 4.46 much of the physical features of the seat were found to have a correlation with seat comfort at a significance level of 0.05.

Table 4.46 – Correlations between seat comfort gender, grade and seat features

		Pearson Correlation	Sig. (1-tailed)	N
Bus Seat Comfort	Bus seat comfort	1	.	149
	Gender	0.117	0.077	149
	Grade	0.069	0.203	149
	Seat pan cushion hardness	-0.337	0	149
	Seat pan width	0.168	0.02	149
	Seat pan length	0.157	0.028	149
	Back cushion hardness	-0.347	0	149
	Back width	0.189	0.01	149
	Back height	0.195	0.009	149
	Back cushion shoulder support	0.38	0	149
	Back cushion back support	0.462	0	149
	Back cushion waist support	0.437	0	149
	Existence of Headrest	0.086	0.148	149
	Existence of Armrest	0.151	0.033	149

For the regression analysis, Backward Regression Method is used. In this method, all the possible factors that may contribute to explain the variation are given in the first model, which is named as Full Model. SPSS runs F-test with all possible variables at a 0.1 level of significance, and removes the ones with smaller significance from the model in each step. In order to explain clearly, Y being the Full Model, $\hat{Y}$ being the Restricted Model, two regression equations, beginning and end models can be given as;

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \varepsilon_1$$

$$\hat{Y} = \alpha_0 + \alpha_1X_1 + \alpha_2X_2 + \alpha_3X_3 + \alpha_4X_4 + \alpha_5X_5 + \alpha_6X_6 + \alpha_7X_7 + \alpha_8X_8 + \alpha_9X_9 + \alpha_{10}X_{10} + \alpha_{11}X_{11} + \alpha_{12}X_{12} + \alpha_{13}X_{13} + \varepsilon_2$$

Hypothesis test is done for each β_i value, with i =1, 2...13 as;

$$H_0: \beta_i = 0$$
$$H_1: \beta_i \neq 0$$
$$\alpha = 0.10$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.10$$

Rejection of the null hypothesis leads to deleting the corresponding variable from the, therefore forming the restricted model.

Performing the same hypothesis test for each variable, end model, in other words restricted model is formed at 11th model, with an R^2 value of 0.28. 28% of the total variation in seating comfort can be explained by the factors in the restricted model. Regarding seat comfort, back cushion hardness, back cushion back support and existence of an armrest was found to be explaining 28% of variation in seat comfort assessment.

Table 4.47 - Summary of model relating seat comfort to gender, grade and seat dimensions and features

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
11	.529	0.28	0.265	1.138

Table 4.48 - ANOVA Model relating seat comfort to gender, grade and seat dimensions and features

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	84.489	13	6.499	4.97	.000b
	Residual	176.518	135	1.308		
1	Total	261.007	148			
	Regression	73.107	3	24.369	18.805	.0001
	Residual	187.899	145	1.296		
11	Total	261.007	148			

Table 4.49 - Coefficients for model relating seat comfort to gender, grade and seat dimensions and features

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	2.215	0.328		6.753	0
	Back cushion hardness	-0.227	0.082	-0.206	-2.756	0.007
11	Back cushion back support for the student	0.41	0.077	0.4	5.345	0
	Existence of an armrest	0.417	0.189	0.156	2.213	0.028

Existence of an armrest is found to be affecting seat comfort. This result is also supported by survey results, as existence of an armrest was found to be important in student's perception. Mean value of 4.01 for comfort with the existence of an armrest was found. With the hypothesis formed as;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

significance level is below 0.05 (Appendix F) leading to the rejection of the null hypothesis. Also with a positive mean difference of 1.007, it can be inferred that students perceive the existence as a factor contributing to comfort.

Arms representing approximately 10% of the total body weight, if not supported, can result in discomfort in the back, shoulders and neck. Supporting the arm weight can reduce the stress on related body parts. With the same kind of approach for the evaluation of armrest features revealed that width and height were found to be related to seat comfort.

Height of the armrests was given as 67 cm which provides adequate support. But from the analysis, width of the armrest of 4 cm was evaluated as being narrow. Increasing the width of armrests can therefore increase the well being of students and their perception of comfort.

4.1.5.2.2 Crosstab Analysis

In addition to regression and correlation analysis, crosstab analysis was done. In the crosstab analysis, physical features of the seat were compared with seat comfort. Null hypothesis of the assumption that seat comfort and selected variable are independent from each other was tested against the alternative hypothesis of an existence of a relationship between them. At a significance level of $\alpha = 0.05$, seat pan cushion hardness, seat pan width, back cushion hardness, back cushion shoulder, back and waist support were found to have a relationship with seat comfort at significance levels of, 0.01, 0.029, 0.003, 0, 0 an 0 respectively. The reason that these finding differ from the previous regression analysis is the effect of chosen significance level.

4.1.5.2.3 Bus Seat Comfort Assessment in Existence or Lack of Any Discomfort

Students evaluated bus seat as comfortable, with a mean value of 3.70. In this part answers to the question regarding seat comfort was examined on the basis of existence or absence of any kind of discomfort related to a body part. For neck, shoulder, back, thigh and leg area, answers were separated into two groups. First group consists of students with positive answers on feelings of discomfort, in other words, expressed any kind of discomfort related to a body part, and second group consists of students with negative answers, in other words, did not expressed any kind of discomfort related to a body part. Hypothesis was formed in order to compare the mean values for those groups regarding the seat comfort. μ_0 was set to represent the mean value regarding seat comfort of students with no discomfort, and μ_1 was set to represent the mean value regarding seat comfort of students with any kind of discomfort for the specific region of the body. General structure of this hypothesis can be given as;

$$H_0: \mu_0 = \mu_1$$
$$H_0: \mu_0 \neq \mu_1$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

4.1.5.2.3.1 Neck Area

μ_0 : Mean value of assessed seat comfort of students with no discomfort on the neck
μ_1 : Mean value of assessed seat comfort of students with discomfort on the neck

From group statistics, μ_0 was found to be 4.14, and μ_1 was found to be 3.31. Independent Samples T-test was performed and given in Table 4.50.

Table 4.50 - Independent Samples Test on equality of the mean seat comfort in existence or lack of neck discomfort

			Bus seat is comfortable	
			Equal variances assumed	**Equal variances not assumed**
Levene's Test for Equality of Variances	F		8.499	
	Sig.		**.004**	
t-test for Equality of Means	T		4.016	**4.057**
	Df		147	**144.697**
	Sig. (2-tailed)		.000	**.000**
	Mean Difference		.833	**.833**
	Std. Error Difference		.207	**.205**
	95% Confidence Interval of the Difference	Lower	.423	**.427**
		Upper	1.243	**1.239**

Testing the equality of the variances for two groups, a significance level of 0.004 was found, which is smaller than 0.05 indicating that variances of these groups are not equal. With this knowledge right side of the Table 4.50 became the subject of interest. Looking at the mean difference value of 0.833 with a significance of 0 which is smaller than the 0.05 significance level set for this hypothesis, the null hypothesis was rejected, and it is concluded that mean values μ_0 and μ_1 are not equal. With a mean difference value of 0.833 which is significant, it can be said that, students with no discomfort in the neck area tend to assess the bus as more comfortable compared to students with any kind of discomfort in this area. Having any kind of discomfort on the neck area affects the assessment of seat comfort negatively.

4.1.5.2.3.2 Shoulder Area

μ_0 : Mean value of assessed seat comfort of students with no discomfort on the shoulders
μ_1 : Mean value of assessed seat comfort of students with discomfort on the shoulders

From group statistics, μ_0 was found to be 3.97, and μ_1 was found to be 3.31. Independent Samples T-test was performed and given in Table 4.51

Table 4.51 - Independent Samples Test on equality of the mean seat comfort in existence or lack of shoulder discomfort

			Equal variances assumed	Equal variances not assumed
			Bus seat is comfortable	**Bus seat is comfortable**
Levene's Test for Equality of Variances	F		3.317	
	Sig.		**.071**	
t-test for Equality of Means	T		**3.057**	2.985
	Df		**147**	114.055
	Sig. (2-tailed)		**.003**	.003
	Mean Difference		**.662**	.662
	Std. Error Difference		**.216**	.222
	95% Confidence Interval of the Difference	Lower	**.234**	.222
		Upper	**1.089**	1.101

Testing the equality of the variances for two groups, a significance level of 0.071 was found, which is greater than 0.05 indicating equality of the variances. With equal variances assumption, left side of Table was found relevant. Mean difference value of 0.662 with a significance of 0.003 which is smaller than the 0.05 significance level of the hypothesis, the null hypothesis was rejected. It is therefore concluded that mean values μ_0 and μ_1 are not equal. With a mean difference value of 0.662 which is significant, it can be said that, students with no discomfort in the shoulder area tend to assess the bus as more comfortable compared to students with any kind of discomfort in this area. Having any kind of discomfort on the shoulder area affects the assessment of seat comfort negatively.

4.1.5.2.3.3 Back Area

μ_0 : Mean value of assessed seat comfort of students with no discomfort on the back
μ_1 : Mean value of assessed seat comfort of students with discomfort on the back

From group statistics, μ_0 was found to be 4.13, and μ_1 was found to be 3.25. Independent Samples T-test was performed and given in Table 4.52

Table 4.52 - Independent Samples Test on equality of the mean seat comfort in existence or lack of back discomfort

			Bus seat is comfortable	
			Equal variances assumed	**Equal variances not assumed**
Levene's Test for Equality of Variances	F		7.998	
	Sig.		**.005**	
t-test for Equality of Means	T		4.270	**4.244**
	Df		147	**138.396**
	Sig. (2-tailed)		.000	**.000**
	Mean Difference		.880	**.880**
	Std. Error Difference		.206	**.207**
	95% Confidence Interval of the Difference	Lower	.473	**.470**
		Upper	1.287	**1.290**

Testing the equality of the variances for two groups, a significance level of 0.005 was found, with being smaller than 0.05 variances are found to be not equal. Non-equal variance assumption led to the usage of the right side of Table. Mean difference value of 0.880 with a significance of 0 which is smaller than the 0.05 significance level, signs the rejection of the null hypothesis. Therefore μ_0 and μ_1 are not equal. With a mean difference value of 0.880 which is significant, it can be said that, students with no back discomfort tend to assess the bus as more comfortable as compared to students with any kind of discomfort in their back. Having any kind of discomfort on the back area affects the assessment of seat comfort negatively.

4.1.5.2.3.4 Thigh Area

μ_0: Mean value of assessed seat comfort of students with no discomfort on the thighs
μ_1 : Mean value of assessed seat comfort of students with discomfort on the thighs

From group statistics, μ_0 was found to be 4.00, and μ_1 was found to be 3.20. Independent Samples T-test was performed and given in Table 4.53

Table 4.53 - Independent Samples Test on equality of the mean seat comfort in existence or lack of thigh discomfort

		Bus seat is comfortable	
		Equal variances assumed	**Equal variances not assumed**
Levene's Test for Equality of Variances	F	7.943	
	Sig.	**.005**	
t-test for Equality of Means	T	3.697	**3.510**
	Df	147	**96.110**
	Sig. (2-tailed)	.000	**.001**
	Mean Difference	.800	**.800**
	Std. Error Difference	.216	**.228**
	95% Confidence Interval of the Difference Lower	.372	**.348**
	95% Confidence Interval of the Difference Upper	1.228	**1.252**

Testing the equality of the variances for two groups, a significance level of 0.005 was found. As the significance level is below 0.05 variances are assumed to be not equal. Using the right side of Table, mean difference value of 0.800 with a significance of 0.001 was observed. This significance is smaller than the 0.05 significance level of the hypothesis, and as a result null hypothesis was rejected. Therefore μ_0 and μ_1 are not equal. With a mean difference value of 0.880 which is significant, it can be said that, students with no discomfort on the thighs tend to assess the bus as more comfortable in comparision to students with the expression of any kind of discomfort on their thighs. Having any kind of discomfort on the thighs affects the assessment of seat comfort negatively.

4.1.5.2.3.5 Leg Area

μ_0 : Mean value of assessed seat comfort of students with no discomfort on thelegs
μ_1 : Mean value of assessed seat comfort of students with discomfort on the legs

From group statistics, μ_0 was found to be 4.18, and μ_1 was found to be 3.25. Independent Samples T-test was performed and given in Table 4.54.

Table 4.54 - Independent Samples Test on equality of the mean seat comfort in existence or lack of neck discomfort

			Bus seat is comfortable	
			Equal variances assumed	**Equal variances not assumed**
Levene's Test for Equality of Variances	F		6.053	
	Sig.		**.015**	
t-test for Equality of Means	T		4.538	**4.554**
	Df		147	**144.537**
	Sig. (2-tailed)		.000	**.000**
	Mean Difference		.928	**.928**
	Std. Error Difference		.205	**.204**
	95% Confidence Interval of the Difference	Lower	.524	**.525**
		Upper	1.332	**1.331**

Significance level for the equality of the variances were found as 0.015, which is smaller than 0.05. Lower significance value indicates the non-equality of the variances, leading to the usage of the values at the right hand side of Table. Mean difference of 0.928 was found with a significance level of 0. This significance level is smaller than the significance of the hypothesis, thus, the null hypothesis was rejected. With a mean difference value of 0.928, being significant, students feeling no discomfort on their legs tend to assess the bus as more comfortable as opposed to students with any kind of discomfort in this related body part. Having any kind of discomfort on the legs affects the assessment of seat comfort negatively.

4.2. Drivers

4.2.1. Response Rates

A total of 51 surveys were gathered from drivers. Within the total number of participants, 38 surveys were considered in evaluation as the rest of the questionnaires were found to be blank except demographics and usage information

4.2.2. Demographics, Usage Rates and Journey Durations

Ages of the drivers are found to be changing between 23 and 63 with an average of 39.18. With a skewness of 0.590, greater numbers of drivers are below the age of 39. Driver's age can be taken as factor relating to accident risk. Tseng (2012) showed that, with age at-fault accident risk decreases and drivers below the age of 40 were found to have more at-fault accident risk, with 60 or over were found to have lower risk. With an average near 40, drivers in this study is still considered in the risky area.

Driving experience varies between 4 to 42 years, with an average of 18.84. Average school bus driving experience is 9.21 years ranging from 1 to 40 years. Experience being the most influential factor on at-fault accident rate, being a novice driver with less than 3 years of experience or over 20 years can be considered as risky, whereas lowest risk group is 6 to 14 years of experience (Tseng 2012). With an average of bus driving experience 9.21, although the group was found to be risky in relation to age, as experience is the most influential factor, drivers can be considered in the safe zone.

On the average journey duration was found to be 68.55 and 72.50 minutes in the mornings and in the evenings respectively. This average value is almost twice to average journey of student, which can be explained as drivers spend almost half the duration before or after they start to pick up students from their homes or from the school.

4.2.3. Perceived Discomfort

Discomfort of drivers need to be examined in a way differently than students. As drivers and students have different roles in school bus, this study mostly concentrates on the students and take driver as a factor in student safety. In the survey for drivers, general bus comfort and seat comfort was not assessed, but discomfort was taken as a contributing factor to driver distraction therefore safety.

4.2.3.1. Thermal Discomfort

Regarding the discomfort from weather conditions questions 24, 25, 26 and 27 were asked. In these questions whether it is hot or cold in the bus regarding spring and winter were asked then, drivers were questioned to mention if they feel any discomfort regarding this conditions were asked as feeling of discomfort from high or low temperatures.

One sample statistics of the results (Appendix J) showed that drivers evaluated the bus as hot in spring months with a mean value of 3.16, and mentioned discomfort regarding the high temperature with a mean value of 2.66. In both, confidence intervals include value 3. Hypothesis is formed in order to compare the results of One-Sample T-test as;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Looking at the One-Sample T-test results (Appendix I), with significance levels of 0.422 and 0.146, null hypothesis cannot be rejected for these two questions, implying that drivers assessed temperature in spring months as normal and did not expressed a discomfort from high temperatures.

Also One sample statistics of the results (Appendix J) showed that drivers evaluated the bus as cold in winter months with a mean value of 1.87, and mentioned discomfort regarding the cold with a mean value of 1.95. In both, confidence intervals are below 3. Forming the hypothesis on the equivalence of mean values to 3 as;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

From the One-Sample T-test results (Appendix K), although with significance values smaller than 0.05 indicates the rejection of H_0, mean differences were negative, which shows that drivers do not feel discomfort in relation cold.

4.2.3.2. Discomfort from noise and jouncing

Disturbance from the music and noise of students were found to be 2.39 and 2.87 respectively as given in Appendix J. For testing the equivalence of the mean values to 3, hypothesis was formed as;

$$H_0: \mu = 3$$
$$H_1: \mu \neq 3$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

Looking at One-Sample T-test results (Appendix K), significance level of disturbance from the noise of students was found to be greater than 0.05, therefore the null hypothesis is not rejected. Regarding the disturbance from music, significance level of 0.001 led to the rejection of the null hypothesis, meaning the mean value is different than 3. Looking at the mean differences, both music and noise disturbance were found to be negative, indicating that driver do not feel any discomfort regarding these two components.

Discomfort level from the jouncing during the journey was also found to be low, with a mean value of 2.32. Confidence interval do not include 3 and also indicates an interval lower than 3, corresponding to no discomfort related to jouncing.

4.2.3.3. Discomfort on Body Parts

Discomfort on neck, shoulder, back, thigh and leg area was assessed. Specific types of discomfort on body parts were defined as, excessive pressure, stiffness, ache, soreness, prickling sensation and numbness.

When asked whether they feel discomfort for a specific area, all of the answers were found to be below 3. Mean values of regional discomfort were; neck discomfort with 2.03, shoulder discomfort with 1.92, back discomfort with 1.89, leg discomfort with 1.66 and thigh discomfort with 1.71. None of the results revealed a mean value above 3, or a confidence interval including 3 or having an upper limit greater than 3.

Although with these values, no area was found to be problematic, about 76% of the drivers mentioned a specific type of discomfort for a body region. From the frequencies given in Table 4.55, stiffness on the neck was found to be on the top of hierarchy with a frequency of 15.8, followed by stiffness and ache on the shoulders, ache on the back and numbness on the legs.

Table 4.55 - Frequencies of Discomfort on Body Parts experienced by drivers

Frequency Table	Existence of any kind of discomfort	Excessive Pressure	Stiffness	Ache	Soreness	Prickling Sensation	Numbness
Neck	23.7%	0	15.8	7.9	0	0	0
Shoulders	21.1%	0	10.5	10.5	0	0	0
Back	13.2%	2.6	5.3	10.5	0	2.6	0
Thighs	15.8%	0	0	5.3	0	2.6	7.9
Legs	10.5%	0	0	0	0	0	10.5

Regarding the driver seat, with the hypothesis formed as;

$$H_0: \mu = 0$$
$$H_1: \mu \neq 0$$
$$\alpha = 0.05$$
$$\text{Reject } H_0 \text{ if, } \alpha < 0.05$$

None of the driver seat features, regarding seat pan or back was found to have a mean value different that 0, which is the value for suitability. As given in Appendix M, significance levels are all greater than 0.05, which indicates that the null hypothesis is not rejected. This result also match with the result that there exist no type of discomfort with a mean value higher than 3.

4.2.4. Safety and Driver Distraction

Safety related factors considered in this part do not only consist solely of the safety of the driver, but safety of the passengers also. Drivers engage in various activities in addition to the driving task itself. Their responsibilities include opening and closing the school bus door, adjusting the temperature using air conditioner or by opening windows on hot weather, controlling devices in the bus, making sure of getting on or off the bus behaviors of students and also if necessary intervening with the behaviors of children in order to maintain their safety. These mostly non-driving related activities act as various distraction sources which as a result affect the cognitive processes as well as driving and may constitute to mistakes and even accidents.

4.2.4.1. Directly Related Factors

Starting with personal safety of the driver, seat belt usage is an important factor. It was found that with an average of 4.74; nearly all the drivers fasten their belts.

As drivers are responsible for opening and closing the school bus door, from the results given in Appendix it was observed that, with a mean value of 4.76, drivers close the door before they start driving and open the door after bus completely stops. These are important to avoid any injuries or accidents related to students. As an open door while driving can be very dangerous, it may lead to a student falling off the school bus. Also drivers, with an average of 4.66 mentioned that they start driving after all students sit at their places. This is also important to prevent possible injuries such as hitting on a part of the bus, tripping on a school bag or even windows, which may occur as a result of standing behavior.

Sleepiness was also considered to be related with safety, as it may lead to cognitive and physical shortcomings resulting in dangerous behaviors. Drivers with a mean around 1.37 mentioned that they do not feel sleepy in the journeys.

4.2.4.2. Distraction Related Factors

Previously driver distraction was defined by citing Lee et.al (2008) as "a diversion of attention away from activities critical for safe driving towards a competing activity". Also as Young et al. (2012) defined, sources of distraction can be technology related, non-technology related and external. Activities such as controlling devices related to vehicle or climate, adjusting radio or intervention in the behaviors of students can be named as distraction factors (Young et.al, 2012).

From the information in Appendix J, it was found that drivers were engaged in control of climate and music with a mean value of 2.5 and 2.66 respectively. Both confidence intervals do not include 3, and are between lower values. Also they mentioned that they can easily reach the control panel with a mean of 4.45, indicating that controlling these devices does not constitute a problem.

On the other hand, from the interviews it was found that, drivers intervene to students if they argue or behave opposing to rules such as standing up or walking. This may be considered as a source of distraction.

4.2.5. Perceived Comfort

Compared with the weather related discomfort results of the students, drivers have no discomfort whereas students feel discomfort. Reason for that difference can be given as, drivers are controlling the temperature inside the bus and also from the design of the school bus, ventilation, can open window. As the windows at the passenger side of the bus are locked and cannot be opened, ventilation or usage of air conditioner is not sufficient to provide thermal comfort in these months.

CHAPTER 5

CONCLUSION

In this study, in order to subjectively assess the safety and perceived comfort and discomfort of the school buses, two surveys consisting of demographics, bus usage information, comfort and discomfort assessments were used. Ergonomic evaluations, measurements and investigations, especially regarding the interior of the school buses are used to gain insight on suitability of the design features and how good the current design of the busses fit to the user groups in comparison to their perceived comfort and discomfort and seat design evaluations.

Survey on students cover 6th, 7th and 8th grade students of the selected private school whereas survey on drivers cover drivers working on the school buses preserved for the transportation of these group of students. Due to their different roles and expectations, students and drivers were held as two separate shareholders in the school bus, with main concentration on students.

In Turkey School Transportation Vehicles Legislation defines the main rules and conditions for a comfortable and safe transportation. With the investigation of school busses of the selected private school, it is found that busses reflect the conditions regarding safety and design parameters given in the legislation, therefore there exist no prominent safety or design violations in direct relation to the design or mechanics of the buses.

With a total of 149, 66 male and 83 female students participated in the survey with an average age of 12.74. Average age is affected by the greater proportion of 6th grade students participated in the survey. Among the group of students, usage rate of school bus is high especially from school to their home, with an average of 4.55 over 5, corresponding to a value between *Often* and *Always.* Average journey duration is found to be about half an hour. On the other hand, average journey duration of drivers was almost two times the students, which in common sense included the amount of time they travel before picking the first student.

Students do not feel the need of help while getting on or off the bus, which in the end can be attributed to the design of the bus. Automatic step activation simultaneously with opening of the door and handlebar at the side of the door serve as a help if necessary and may prevent any injury related to balance loss, or fall as a result of inability to get on or off the bus easily. Especially in the morning student tend to feel sleepy, and it may contribute to safety related problems as sleepiness can have detrimental effects on attention and perception.

Among all the contributors to the safety, seat belt is the most important. Seat belt usage, with being low, with no difference between genders or grades, showed results that do not match with rules in school bus transportation. According to the interviews done with drivers during the course of study, seat belt usage were defined to be mandatory, whereas the results showed students do not tend to fasten their belts at the beginning or throughout their journeys. In addition to increasing the risk of injury for the student himself/herself, as this behavior can result in discipline issues, also it has indirect effect on driver distraction, which in turn may result in accidents. Students who fasten their seat belts as soon as they get on the bus also tend to keep their belts fasten throughout the journey. Also fastening behavior was found to be correlated with the suitability of seat belt, which may explain the low fastening rates as seat belts was not significantly identified as suitable or not.

Weather conditions and disturbance from hot or cold weather are considered to be related with thermal comfort. Students mentioned discomfort related to hot weather in spring months on an average of 4.32 corresponding to a high level of disturbance. As stated in Service Legislation of School Transportation Vehicles, windows at the passenger side of the school bus is fixed, in order to avoid behaviors like bending over from the window, sticking out body parts like arms, legs or head, and also to protect the passengers from the environment outside the school bus, which may lead to injuries or accidents. Given this condition, control of the interior temperature lies solely on the hands of the driver. When compared with the discomfort levels of drivers regarding hot weather, drivers assessed temperature in spring months as normal and did not express a discomfort from high temperatures. As drivers may well-adjust their near-environment in the bus, the ventilation may be insufficient at the back, leading to a difference in temperature. Also present design or placement of air conditioners may not be sufficient and proper, thus in order to utilize the even distribution of air, after detailed measurements, placement of the air conditioning can be changed.

On the other hand, although students rate the bus as being cold in winter months, they did not tend to express discomfort regarding cold, similarly to drivers. This may have a psychological aspect, but it is not examined in depth, as it lies out of the scope of this study.

Neither student nor drivers expressed discomfort from music, noise of students or jouncing. Children enjoy music in the school bus. During interviews, drivers mentioned that, they even behave better in order to pick a song of their choice when they play music. Jouncing on the other hand, is prevented by continuous maintenance of the vehicles, strict age limitations and with relatively smooth roads.

In this study, while factors like thermal discomfort and safety issues are covered, main interest was on the seating comfort and discomfort. For the assessment of discomfort, five main body areas were taken into account as; neck, shoulders, back, thigh and legs. Discomfort types of excessive pressure, stiffness, ache, soreness, prickling sensation and numbness were assessed on selected body parts. After the distinguishing the problematic areas, possible influence of seat dimensions and features and journey time on discomfort were investigated. Among respondents, neither of the areas was found to be highly problematic in general, but in depth analysis was made in order to get insight on the causal relationships. Although when asked if they feel discomfort in a specific body part tendency was towards a neutral state, when asked in detail about a specific type of discomfort on a body part, many of the respondents mentioned at least one distinct feeling of discomfort. Regarding drivers, most problematic area was found to be neck, with stiffness as the highest type of discomfort. Ache on the back and numbness on the legs were also mentioned by drivers. As given in Table 4.10, for the students, the most problematic area was also found to be the neck, followed by legs with 52.3% and 51% of the respondents indicated at least one type of discomfort. Overall, leading complaints were ache on the neck, stiffness on the shoulders, ache on the back, numbness on the thigh and legs. In order to learn the cause of these disturbances, regression analysis with a backward method is used and all five areas were separately compared with gender, grade, seat pan cushion hardness, seat pan width, seat pan height, seat back cushion hardness, seat back width, seat back height, seat back cushion shoulder, back an waist support levels and existence of seat features as the headrest and armrest. Table 4.26 gives the summary of the regression analysis. Both seat pan and seat back cushion hardness, and seat back cushion waist support were found to be in relation with discomfort on specific body parts.

When seat dimensions and features compared to a mean value of zero, indicating "just right" assessment, only three of them were found to be significant, which are seat pan, seat back and headrest cushion hardness and armrest width. With positive mean differences, this analysis indicates the perception of firmness of cushioning. As this may lead to pressure on the thighs and legs, resulting in circulation problems, a possible suggestion to manufactures or designers of the school buses could be to reduce the level of hardness.

Regarding the journey durations, there exist weak but significant correlations with discomfort in body parts. Again neck is found to be more influenced by journey duration. Correlations with evening journey durations and discomfort were found to be slightly higher, which can be attributed to the fact that students tend to be tired at the end of a school day and might assess the discomfort as being higher. Also using logistic regression analysis, neck and leg discomfort were found to be related to evening journey durations, and they can be estimated by looking at the length of the journey. In addition, there exist significantly strong correlations between discomforts of different body parts. Discomfort in a body part may affect others, especially is they use the same muscle groups as in the case of high correlations between feeling of discomfort on neck and shoulder.

Regarding the general comfort of the bus, with a mean value of 3.63, slightly over the normal, students rated the school bus as comfortable. From the investigation of the factors which may affect general bus comfort, seat comfort is found to be the most influential factor. With a mean value of 3.71, bus seat is also found to be comfortable among students. In order to reveal the factors influencing seat comfort, correlations between bus seat comfort rating, gender, grade, seat pan cushion hardness, seat pan width, seat pan height, seat back cushion hardness, seat back width, seat back height, seat back cushion shoulder, back an waist support levels and existence of seat features as the headrest and armrest were investigated and a regression analysis was made. Back cushion hardness, back cushion back support and existence of an armrest were found to be explaining 28% of variation in seat comfort assessment. Also with the Crosstab analysis, seat pan cushion hardness, seat pan width, seat back cushion hardness, back cushion shoulder, back and waist support were found to have a relationship with seat comfort. When the effect of feeling discomfort for a specific body part is examined, for the neck, shoulder, back, thigh and legs, students with no discomfort tend to assess the bus as more comfortable compared to students with any type of discomfort.

Future Work

As in this study a subjective way of assessment is done, findings may only reflect perceived comfort. A detailed examination of anthropometric measures of each student, matching with their perceived comfort and perceived mismatch of physical characteristic may provide deeper and more accurate insights on the assessment of school busses.

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APPENDIX A

QUESTIONNAIRE FOR STUDENTS

ASSESMENT OF COMFORT AND SAFETY OF SCHOOL BUSSES PERCEIVED BY STUDENTS AND DRIVERS

METU DEPARTMENT OF INDUSTRIAL ENGINEERING

Dear students,

The purpose of this survey is to collect useful information about the safety and comfort of school busses used daily in schools according to students and drivers. We ask that you share with us in your experience by taking a few moments to complete this short survey. There are 74 questions in total about the design and comfort of the busses. Sharing your name and contact information will be useful in the progressive aspects of the study in means of communication, however it is not compulsory. The information required in the following questions is completely aimed to be used in the research steps and all survey responses remain strictly anonymous.
We greatly appreciate your time and effort and value your feedback. Your participation will be greatly appreciated. We wish you all happy holidays.

Pınar ÖZDEMİR
METU Department of Industrial Engineering Master's Student

PART 1

1. Age:

2. Gender:

3. Grade:

a) 6th grade
b) 7th grade
c) 8th grade

4. Your home's district:

		Always	Often	Sometimes	Seldom	Never
5	I use school bus to get to school.					
6	I use school bus back from school.					

7. Please state the approximate duration of your journeys:

In the mornings:
In the evenings:

PART 2

Please answer the following questions with regard to your convenience.

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
8	I need help while getting on the bus.					
9	I need help while getting off the bus.					
10	There exist a step to assist getting in and getting off the bus.					
11	The emergency exits are labeled.					
12	It is hot in the spring inside the bus.					
13	It is cold in the winter inside the bus.					
14	The temperature inside the bus disturbs me in spring.					
15	I am cold in the bus in winter.					
16	In the bus music (radio, CD, etc…) is played.					
17	In the mornings, the noise made by other students in the bus disturbs me.					
18	In the mornings, music played in the bus disturbs me.					
19	In the evenings the voice made by other students disturbs me.					
20	In the evenings the music played in the bus disturbs me.					

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
21	The driver interferes when my friends make noise.					
22	I can walk and sit easily in the bus.					
23	I can sit to where I want easily.					
24	I fasten seat belt when I get seated.					
25	During the journey I keep the seat belt fastened.					
26	The shaking of the bus during the journey disturbs me.					
27	I open a window when it is hot inside the bus.					
28	During the journey the doors are closed.					
29	I feel sleepy during the morning journeys.					
30	I feel sleepy during the evening journeys.					
31	My seat in the bus is comfortable.					
32	I feel comfortable in the bus.					
33	I am pleased with the driver's attitude.					
34	It disturbs me when my friend sitting in front of me lays down his seat.					
35	The seat belts are suitable for me.					

PART 3

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
36	I feel discomfort in my neck during the journeys.					
37	I feel discomfort on my shoulders during the journeys.					
38	I feel discomfort on my back during the journeys.					
39	I feel discomfort on my legs during the journeys.					
40	I feel discomfort on my thigh during the journeys.					

Please answer the following questions with regards to the zone you feel the pain and the type of your discomfort.

		Excessive Pressure	Stiffness	Ache	Soreness	Prickling sensation	Numbness
41	**Neck**						
42	**Shoulders**						
43	**Back**						
44	**Thigh**						
45	**Legs**						

		Too firm	Firm	Normal	Slightly soft	Too soft
46	According to me, hardness of the seat pan cushion is;					

		Too wide	wide	Normal	Slightly Narrow	Too narrow
47	According to me, width of the seat pan is;					

		Too long	Long	Normal	Short	Too short
48	According to me, length of the seat pan is;					

		Too firm	Firm	Normal	Slightly soft	Too soft
49	According to me, seat back cushion is;					

		Too wide	wide	Normal	Slightly Narrow	Too narrow
50	According to me, width of seat back cushion is;					

		Too high	High	Normal	Short	Too short
51	According to me, height of seat back cushion is;					

		Strongly Agree	Agree	Undecided	Disagree	Strongly disagree
52	Seat back cushion supports my shoulders					
53	Seat back cushion supports my back					
54	Seat back cushion supports my waist					

Please answer the following questions stating if the described part exists or not.

55. There is headrest in seats.

YES ☐ **NO** ☐

If your answer is yes please go to the 56th question.
If your answer is no please skip to the 60th question.

		Too firm	Firm	Normal	Slightly soft	Too soft
56	According to me, hardness of the headrest is;					

		Too wide	Wide	Normal	Slightly narrow	Too narrow
57	According to me, width of the headrest is;					

		Too high	high	Normal	Low	Too low
58	According to me, height of the headrest is;					

		Too far forward	Slightly forward	Normal	Slightly back	Too far back
59	According to me, the headrest is;					

60. There are arm rests in seats

YES ☐ **NO** ☐

If your answer is yes please go to the 61st question.
If your answer is no please skip to the 65th question.

		Too long	long	Normal	Short	Too short
61	According to me, length of the arm rest is;					

		Too Wide	Slightly wide	Normal	Slightly narrow	Too Narrow
62	According to me, width of the arm rest is;					

		Too high	high	Normal	Low	Too low
63	According to me, height of the arm rest is;					

		Too close together	Close	Normal	Slightly apart	Too far apart
64	According to me, arm rests are;					

PART 4

Please answer the following questions with regard to the current situation of your bus.

		Strongly agree	**Agree**	**Undecided**	**Disagree**	**Strongly Disagree**
65	I would feel more comfortable if the seat had an headrest					
66	I would feel more comfortable if the seat had an armrest					
67	I would feel more comfortable if the seat had armrests on both sides					
68	I would feel more comfortable if the seat pan was sloped downward					
69	I would feel more comfortable if the seat pan was sloped upward					
70	I feel comfortable when the seat is laid back					
71	I feel comfortable when the seat is upright					
72	I can make myself comfort by moving the seat back and forth					
73	I can make myself comfort by tilting the seat back and forth					
74	I can make myself comfort by moving the seat upward or downward					

NAME:
SURNAME:
PHONE NUMBER:

Thank you for your cooperation.

APPENDIX B

QUESTIONNAIRE FOR DRIVERS

ASSESMENT OF COMFORT AND SAFETY OF SCHOOL BUSSES PERCEIVED BY STUDENTS AND DRIVERS

METU DEPARTMENT OF INDUSTRIAL ENGINEERING

Dear bus drivers,

The purpose of this survey is to collect useful information about the safety and comfort of school busses used daily in schools according to students and drivers. We ask that you share with us in your experience by taking a few moments to complete this short survey. There are 68 questions in total about the design and comfort of the busses. Sharing your name and contact information will be useful in the progressive aspects of the study in means of communication, however it is not compulsory. The information required in the following questions is completely aimed to be used in the research steps and all survey responses remain strictly anonymous.

We greatly appreciate your time and effort and value your feedback. Your participation will be greatly appreciated. We wish you all happy holidays.

Pınar ÖZDEMİR
METU department of Industrial Engineering master's student

PART 1

1. Age:

2. How many years you had your driving license? :

3. How long you have been a bus driver? :

4. The district you serve at:

5. Please state your approximate journey time

In the morning:

In the evening:

PART 2

Please answer the following questions with regard to your convenience.

		Strongly agree	Agree	Undecided	Disagree	Strongly disagree
6	While driving, I always fasten my seat belt					
7	While driving, I feel discomfortable in the presence of shaking					
8	When it is hot, I open windows					
9	When it is hot, I open the door					
10	While driving, I feel discomfortable by the noise of the students					
11	In the morning I feel discomfortable by the noise of the students					
12	In the evening, I feel discomfortable by the noise of the students					
13	We play the radio, CD etc..					
14	Music disturbs me while driving					
15	I can easily reach the control panel while driving					
16	I close the car door, before traveling					
17	After starting to move, I close the car door					
18	I start moving, after all the students take their seats					
19	I interfere when the student open windows					
20	I inform the students about the emergency exits					

		Strongly agree	Agree	Undecided	Disagree	Strongly disagree
21	While driving, I give attention to the devices such as the radio, air conditioner etc.					
22	I control the radio while driving.					
23	I open the car door after fully stopping					
24	It is hot in the spring inside the bus.					
25	It is cold in the winter inside the bus.					
26	The temperature inside the bus disturbs me in spring.					
27	I feel cold at winter months					
28	I am sleepy during the morning travels					
29	I am sleepy during evening journeys					

PART 3

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
30	I feel discomfort in my neck during the journeys.					
31	I feel discomfort on my shoulders during the journeys.					
32	I feel discomfort on my back during the journeys.					
33	I feel discomfort on my legs during the journeys.					
34	I feel discomfort on my thigh during the journeys.					

Please answer the following questions with regards to the zone you feel the pain and the type of your discomfort.

		Excessive Pressure	Stiffness	Ache	Soreness	Prickling sensation	Numbness
35	Neck						
36	Shoulders						
37	Back						
38	Thigh						
39	Legs						

		Too firm	Firm	Normal	Slightly soft	Too soft
40	According to me, hardness of the seat pan cushion is;					

		Too wide	wide	Normal	Slightly Narrow	Too narrow
41	According to me, width of the seat pan is;					

		Too long	Long	Normal	Short	Too short
42	According to me, length of the seat pan is;					

		Too firm	Firm	Normal	Slightly soft	Too soft
43	According to me, seat back cushion is;					

		Too wide	wide	Normal	Slightly Narrow	Too narrow
44	According to me, width of seat back cushion is;					

		Too high	High	Normal	Short	Too short
45	According to me, height of seat back cushion is;					

		Strongly Agree	Agree	Undecided	Disagree	Strongly disagree
46	Seat back cushion supports my shoulders					
47	Seat back cushion supports my back					
48	Seat back cushion supports my waist					

Please answer the following questions stating if the described part exists or not.

49. There is headrest in seats.

YES ☐ **NO** ☐

If your answer is yes please go to the 50th question.
If your answer is no please skip to the 54th question.

		Too firm	Firm	Normal	Slightly soft	Too soft
50	According to me, hardness of the headrest is;					

		Too wide	Wide	Normal	Slightly narrow	Too narrow
51	According to me, width of the headrest is;					

		Too high	high	Normal	Low	Too low
52	According to me, height of the headrest is;					

		Too far forward	Slightly forward	Normal	Slightly back	Too far back
53	According to me, the headrest is;					

54. There are arm rests in seats

YES ☐ **NO** ☐

If your answer is yes please go to the 61st question.
If your answer is no please skip to the 65th question.

		Too long	long	Normal	Short	Too short
55	According to me, length of the arm rest is;					

		Too Wide	Slightly wide	Normal	Slightly narrow	Too Narrow
56	According to me, width of the arm rest is;					

		Too high	high	Normal	Low	Too low
57	According to me, height of the arm rest is;					

		Too close together	Close	Normal	Slightly apart	Too far apart
58	According to me, arm rests are;					

PART 4
Please answer the following questions with regard to the current situation of your bus.

		Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
59	I would feel more comfortable if the seat had an headrest					
60	I would feel more comfortable if the seat had an armrest					
61	I would feel more comfortable if the seat had armrests on both sides					

		Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
62	I would feel more comfortable if the seat pan was sloped downward					
63	I would feel more comfortable if the seat pan was sloped upward					
64	I feel comfortable when the seat is laid back					
65	I feel comfortable when the seat is upright					
66	I can make myself comfort by moving the seat back and forth					
67	I can make myself comfort by tilting the seat back and forth					
68	I can make myself comfort by moving the seat upward or downward					

NAME:
SURNAME:
PHONE NUMBER:

Thank you for your cooperation.

APPENDIX C

SERVICE LEGISLATION OF SCHOOL TRANSPORTATION VEHICLES

28 Ağustos 2007 SALI **Resmî Gazete** Sayı : 26627

YÖNETMELİK

28.08.2007 tarih ve 26627 sayılı Resmi Gazete (Asıl)
11.10.2008 tarih ve 270217 sayılı Resmi Gazete (1. Değişiklik)
17.09.2009 tarih ve 27352 sayılı Resmi Gazete (2. Değişiklik)

Ulaştırma Bakanlığından:

OKUL SERVİS ARAÇLARI HİZMET YÖNETMELİĞİ

BİRİNCİ BÖLÜM
Amaç, Kapsam ve Dayanak, Tanımlar

Amaç

MADDE 1 – (1) Bu Yönetmeliğin amacı; zorunlu eğitim kapsamındaki okul öncesi ve diğer öğrenci taşıma hizmetlerini düzenli ve güvenli hale getirmek, bu amaçla taşıma yapacak gerçek ve tüzel kişilerin yeterlilik ve çalışma şartlarını belirlemek, bu Yönetmeliğin gerekli kıldığı denetim hizmetlerini yapmaktır.

Kapsam ve dayanak

MADDE 2 – (1) Bu Yönetmelik 3348 sayılı Ulaştırma Bakanlığının Teşkilat ve Görevleri Hakkında Kanun, 4925 sayılı Karayolu Taşıma Kanunu ve 2918 sayılı Karayolları Trafik Kanununun 75 inci maddesine dayanılarak çıkarılmış olup, kamu kurum ve kuruluşları ile gerçek ve tüzel kişilerce öğrenci taşımak için kullanılacak "Okul Servis Araçlarını, Taşımacıları ve Sürücüler ile Rehber Personeli" kapsar.

Tanımlar

MADDE 3 – (1) Bu Yönetmelikte geçen;

a) Bakanlık: Ulaştırma Bakanlığını,

b) Durak: Kamu hizmeti yapan yolcu taşıtlarının ve okul servis araçlarının yolcuları bindirmek, indirmek gayesi ile duraklamaları için işaretle belirlenmiş yeri,

c) Güzergah: Okul servis araçlarının kalkış noktası ile varış noktası arasında kalan, trafik denetleme şube veya bürolarınca verilen özel izin belgelerinde belirtilen yolları,

ç) **(Değişik RG 11/10/2008 – 27021)** Okul Servis Aracı: Genel olarak okul öncesi eğitim, ilköğretim, ortaöğretim ve yüksek öğretim öğrencileri ile sadece rehber personel taşınmalarında kullanılan ticari tescilli yolcu taşımaya mahsus taşıtı,

d) Okul Öncesi Öğrenci: Mecburi öğrenim çağına gelmemiş 4-5 yaş grubu çocuklarının eğitimi amacıyla açılan kurumlara gidip gelen çocukları,

e) **(Değişik RG 11/10/2008 – 27021)** Özel İzin Belgesi: 2918 sayılı Karayolları Trafik Kanunu, 5216 sayılı Büyükşehir Belediyesi Kanunu, 5393 sayılı Belediye Kanunu, Karayolları Trafik Yönetmeliği ve bu Yönetmelik ile İl-ilçe trafik komisyonu kararlarına uygunluğu anlaşılan okul servis araçlarına büyükşehirlerde büyükşehir belediyelerince, diğer yerlerde ise ilgili belediyelerce verilen ve okul servis aracının işletenini, şoförünü, rehber personelini, taşıtın plakasını, cinsini, taşıma sınırını ve izleyeceği güzergâhı belirten belgeyi

f) Rehber Personel: Okul öncesi çocukları ve/veya ilköğretim öğrencilerini taşıyan okul servis araçlarında, araç içi düzenini sağlayan, öğrencilerin araca iniş ve binişlerinde yardımcı olan şahısları,

g) Şoför: Karayolunda, ticari olarak tescil edilmiş bir motorlu taşıtı süren kişiyi,

ğ) Taşıma: Bir ücret karşılığında okul öncesi eğitim, ilköğretim ve ortaöğretim ile yüksek öğretim öğrencilerinin kamuya açık karayolunda sürücüsü dahil en az 9 oturma yeri olan yolcu taşımaya mahsus taşıtlarla evden okula, okuldan eve getirilip götürülmesini,

h) Taşıma Sınırı: Okul servis aracının trafik tescil belgesinde belirtilen oturma yeri sayısını,

ı) Taşımacı: Öğrencilerin bir ücret karşılığı taşımasını üstlenen gerçek veya tüzel kişileri,

i) Taşıt: Karayolunda insan taşımak için imal edilmiş motorlu araçları,

j) Yolcu :Aracı kullanan şoför ile hizmetlilerin dışında araçta bulunan öğrencileri ve rehber personeli,

ifade eder.

İKİNCİ BÖLÜM
Taşıtlarda Aranacak Şartlar, Taşımacının Yükümlülüğü, Şikayetlerin Değerlendirilmesi, Okul Servis Araçlarının Kiralanması ve Taşıma İşlerinde Çalışanlar

Taşıtlarda aranacak şartlar

MADDE 4 – (1) Taşımacılar tarafından okul servis aracı olarak kullanılacak taşıtlarda aşağıdaki şartlar aranır.

a) Okul servis araçlarının arkasında "OKUL TAŞITI" yazısını kapsayan numunesine uygun renk, ebat ve şekilde reflektif bir kuşak bulundurulmalıdır. (EK: 1/1, EK: 1/2)

b) Okul servis aracının arkasında, öğrencilerin iniş ve binişleri sırasında yakılmak üzere en az 30 cm çapında kırmızı ışık veren bir lamba bulunmalı ve bu lambanın yakılması halinde üzerinde siyah renkte büyük harflerle "DUR" yazısı okunacak şekilde tesis edilmiş olmalı, lambanın yakılıp söndürülmesi tertibatı fren lambaları ile ayrı olmalıdır. (EK: 2)

c) Okul servis aracı olarak kullanılacak taşıtlarda, öğrencilerin kolayca yetişebileceği camlar ve pencereler sabit olmalı, iç düzenlemesinde demir aksam açıkta olmamalı, varsa yaralanmaya sebebiyet vermeyecek yumuşak bir madde ile kaplanmalıdır.

ç) Okul servis araçlarında Araçların İmal, Tadil ve Montajı Hakkında Yönetmelik ile Karayolları Trafik Yönetmeliğinde belirtilen standart, nitelik ve sayıda araç, gereç ve malzemeler her an kullanılabilir durumda bulundurulmalıdır.

d) Okul servis araçlarının kapıları şoför tarafından açılıp kapatılabilecek şekilde otomatik (Havalı, Hidrolikli v.b.) olabileceği gibi; araç şoförleri tarafından elle kumanda edilebilecek şekilde (Mekanik) de olabilir. Otomatik olduğu takdirde, kapıların açık veya kapalı olduğu şoföre optik ve/veya akustik sinyallerle intikal edecek şekilde olmalıdır.

e) Okul servis aracı olarak kullanılacak taşıtlar temiz, bakımlı ve güvenli durumda bulundurulmalı ve 6 ayda bir bakım ve onarımları yaptırılmakla birlikte; taşıtların cinsine göre Karayolları Trafik Yönetmeliğinin öngördüğü periyodik muayeneleri de yaptırılmış olmalıdır. (EK-3)

f) **(Değişik RG 17/09/2009 – 27352)** Okul servis aracı olarak kullanılacak taşıtların yaşları yirmi yaşından büyük olmamalıdır. Taşıtların yaşı fabrikasınca imal edildiği tarihten sonra gelen ilk takvim yılı esas alınarak hesaplanır. (**Danıştay 8. Dairesinin 12.02.2010 tarihli ve Esas No: 2009/10048 Sayılı Kararı uyarınca 12 yaş şartı uygulanmaktadır.)**

g) Araçların İmal, Tadil ve Montajı Hakkındaki Yönetmelik hükümlerine göre tayin edilen ve o araca ait tescil belgelerinde gösterilen oturacak yer adedi, aracın içerisine görülebilecek bir yere yazılarak sabit şekilde monte edilecektir.

ğ) Kamu Kurum ve Kuruluşları ile gerçek ve tüzel kişi ve kuruluşlara ait okul servis aracı olarak teçhiz edilmiş araçlar, taahhüt ettikleri öğrenci taşıma hizmetlerini aksatmamak kaydıyla, personel servis taşıma hizmetlerinde de kullanılabilir. Ancak, bu taşıma esnasında okul servis araçlarına ait ışıklı işaretlerin şoförler tarafından kullanılması yasaktır.

h) Okul servis aracı; Araçların İmal, Tadil ve Montajı Hakkındaki Yönetmelik hükümlerine uygun olmalıdır.

ı) Gerektiği hallerde ilgili meslek odası, okul veya işyeri ve öğrenci velileriyle haberleşebilmek için telsiz veya mobil telefon bulunmalıdır.

i) Taşıtlarda her öğrenci için bir emniyet kemeri bulunmalıdır.

j) Taşıtlarda görüntü ve müzik sistemleri taşıma hizmeti sırasında kullanılmamalıdır.

Taşımacının yükümlülüğü

MADDE 5 – (1) Okul servis araçları ile taşımacılık yapanlar;

a) Öğrencilerin oturarak rahat bir yolculuk yapmalarını sağlayacak tedbirleri alarak taahhüt ettiği yere kadar götürüp getirmekle ve servis hizmeti sırasında taşıta başka herhangi bir yolcu almamakla,

b) **(Değişik RG 17/09/2009 – 27352)** Taşıt içi düzeni sağlamak, okul öncesi eğitim ve ilköğretim öğrencilerinin inme ve binmeleri sırasında yardımcı olmak üzere rehber personel bulundurmakla,

c) **(Değişik RG 11/10/2008 – 27021)** İlgili belediyeden Özel İzin Belgesi (EK-4) almakla

ç) Taşımacıların yanında çalışanlar, hizmet akdine tabi olup, bunların sosyal güvenlik yönünden sigorta işlemlerinin yaptırılması zorunluluğuyla,

d) **(Değişik RG 11/10/2008 – 27021)** Yetkili mercilerce belirlenen okul servis araçları fiyat tarifelerindeki ücrete uymakla,,

e) **(Değişik RG 11/10/2008 – 27021)** Taşınan öğrencinin;

1) Okulun veya ikametgâhının değişmesi,

2) Uzun süreli tedaviyi gerektiren bir hastalık geçirmesi,

3) Okumaktan vazgeçmesi veya okuma hakkını kaybetmesi,

hallerinden herhangi birine bağlı olarak servisle taşınmaktan vazgeçmesi durumunda; varsa geri kalan ayların ücretlerini iade etmekle,

yükümlüdürler.

Şikayetlerin değerlendirilmesi

MADDE 6 – (1) Türk Ticaret Kanunu, Borçlar Kanunu ve Karayolları Trafik Kanunundaki işletenin ve araç sahibinin sorumluluğuna ilişkin hükümler ile taşımacı ve taşınan arasında vuku bulabilecek anlaşmazlıkların giderilmesi amacıyla açılacak davalara ait hususlar saklı kalmak kaydıyla; bu madde hükümleri ile bu Yönetmelikteki diğer hükümlere uygun davranmadıkları anlaşılanlarla ilgili şikayetler trafik zabıtasınca değerlendirilir.

Okul servis araçlarının kiralanması

MADDE 7 – (1) Okul servis araçlarının kiralanması; her yıl okul-aile birliği yönetim kurulu başkanının başkanlığında, okul-aile birliği yönetim kurulunca belirlenecek bir temsilci, okul-aile birliği yönetim kurulunca çocuğu servisle taşınan veliler arasından tespit edilecek dört veli, okul koruma derneği yönetim kurulunca belirlenecek bir temsilci ile varsa okul eğitim vakfı yönetim kurulunca belirlenecek bir temsilcinin katılımlarıyla oluşturulacak komisyon tarafından yapılır.

(2) Gerçek ve tüzel kişiler, birlikte taşıma hizmeti yapabilirler. Ancak, adlarına tescilli taşıtların koltuk sayısı, taşınacak toplam öğrenci sayısının beşte birinden az olamaz. Bu husus kiralanma aşamasında Komisyon tarafından dikkate alınır.

(3) Öğrenci velileri istemeleri halinde, çocuklarını herhangi bir okul servis aracı işleteni ile anlaşarak da taşıtabilirler.

(4) Okul yönetimi ve yukarıda belirtilen komisyon, servis hizmetlerinin sağlıklı, düzenli ve disiplinli bir şekilde yürütülmesine yönelik olarak, aksaklığı tespit edilen hususları, hizmeti sürdüren taşımacının bağlı olduğu meslek odalarına en kısa zamanda bildirirler. Bu odalar kendi mevzuatlarınca disiplin işlemlerini yapar ve sonucu okul yönetimine bildirirler.

(5) Bu maddede belirtilen şartlara uymayanların özel izin belgesi, söz konusu belgeyi düzenleyen kurum tarafından iptal edilir.

(6) **(Değişik RG 17/09/2009 – 27352)** Bu madde hükümleri taşımalı eğitimde uygulanmaz.

Taşıma işlerinde çalışanlar

MADDE 8 – (1) Okul servis araçlarını kullanan şoförler ile rehber personel;

a) Sorumlu ve yetkili olduğu hizmetin niteliklerine sahip olmak,

b) **(Değişik RG 17/09/2009 – 27352)** Rehber personel için 20 yaşını doldurmuş ve en az ilköğretim mezunu olmak, (**Danıştay 8. Dairesinin 12.02.2010 tarihli ve Esas No: 2009/10048 Sayılı Kararı uyarınca Rehber personel için 22 yaş ve en az lise mezunu olma şartı uygulanmaktadır.)**

c) Türk Ceza Kanununun 103, 104, 109, 188, 190, 191, 227 ve 5326 sayılı Kabahatler Kanununun 35 inci maddelerindeki suçlardan affa uğramış olsa bile hüküm giymemiş olmak,

ç) Şoförler; E Sınıfı Sürücü Belgesi için 3 yıllık, B Sınıfı Sürücü Belgesi için 5 yıllık sürücü belgesine sahip olmak,

d) **(Değişik RG 11/10/2008 – 27021)** Şoförler, son beş (5) yıl içerisinde; bilinçli taksirli olarak ölümlü trafik kazalarına karışmamış olmak, alkollü olarak araç kullanma ve hız kurallarını ihlal nedeniyle, sürücü belgeleri birden fazla geri alınmamış olmak,

e) Şoförler, "Yurtiçi Yolcu Taşımacılığı Sürücü Mesleki Yeterlilik Belgesi" ne sahip olmak,

zorundadırlar.

(2) Bu maddede belirtilen şartlara uymayanların özel izin belgesi, söz konusu belgeyi düzenleyen kurum tarafından iptal edilir.

ÜÇÜNCÜ BÖLÜM
Sigorta Zorunluluğu, Sigorta Şirketlerinin Yükümlülüğü ve Sigortasız Taşıma Yapılamayacağı

Sigorta zorunluluğu

MADDE 9 – (1) Okul servis araçları, öğrenci taşıyan gerçek ve tüzel kişiler ile kamu kuruluşları, taşıma hizmetinde kullanılan söz konusu araçlarına, Karayolları Trafik Kanununun öngördüğü Zorunlu Karayolu Mali Sorumluluk Sigortasını yaptırmak mecburiyetindedirler.

Sigorta şirketlerinin yükümlülüğü

MADDE 10 – (1) Türkiye'de kaza sigortası dalında çalışan ve ruhsatı bulunan her sigorta şirketi, okul servis araçlarına Zorunlu Karayolu Mali Sorumluluk Sigortası yapmak zorundadır.

Sigortasız taşıma yapılamayacağı

MADDE 11 – (1) Zorunlu Karayolu Mali Sorumluluk Sigortası bulunmayan servis araçları ile öğrenci taşımacılığı yapılamaz. Bu madde hükmüne aykırı olarak faaliyet gösteren araçlar hakkında 2918 sayılı Karayolları Trafik Kanununun 91 inci maddesi hükmü uygulanır.

DÖRDÜNCÜ BÖLÜM

Denetim, Geçici Hükümler,Yürürlük ve Yürütme

Denetim

MADDE 12 – (1) Bakanlık yapacağı denetimleri, kendi personelinin yanı sıra, valilikler, kolluk kuvvetleri (polis, zabıta, jandarma) ve yetkili kıldığı diğer kamu kurum ve kuruluşlarının personeli aracılığıyla yapar. Denetimle ilgili olarak bu kuruluşlar Bakanlıkla her zaman işbirliği içinde olmak ve Bakanlık talimatlarını yerine getirmek zorundadır. Çalışma şartları yönünden Milli Eğitim Bakanlığı ve diğer ilgili kuruluşlar da mevzuatları çerçevesinde her türlü denetimi yaparlar.

Taşımalı eğitim hizmetine ilişkin istisnalar

GEÇİCİ MADDE 1 – (Değişik RG 11/10/2008 – 27021) (1) Bu Yönetmeliğin 4 üncü maddesinin birinci fıkrasının (f) ve (i) bentleri, 5 inci maddesinin birinci fıkrasının (b), (d) ve (e) bentleri, 6 ncı maddesi, 7 nci maddesi, 8 inci maddesinin birinci fıkrasının (b) bendi hükümleri taşımalı eğitimde kullanılan servis hizmetleri için 1/7/2010 (**Değişik RG 17/09/2009 – 27352)** tarihine kadar uygulanmaz. (**Danıştay 8. Dairesinin 12.02.2010 tarihli ve Esas No: 2009/10048 Sayılı Kararı uyarınca 01/01/2010 tarihi esas alınmaktadır.)**

(2) 1/1/2010 tarihine kadar taşımalı eğitimde kullanılan servis hizmetlerine münhasır ve bu geçici maddede yer alan hususlarla sınırlı olmak üzere, Milli Eğitim Bakanlığının düzenlemeleri esas alınır.

(3) **(İlave RG 11/10/2008 – 27021)** Bu Yönetmeliğin 5 inci maddesinin birinci fıkrasının (c) bendi uyarınca trafik denetleme şube veya bürolarından 31/10/2008 tarihinden önce alınmış olan özel izin belgeleri, geçerlilik süresinin bitimine kadar kullanılır."

(4) **(İlave RG 11/10/2008 – 27021)** Bu Yönetmeliğin 8 inci maddesinin birinci fıkrasının (e) bendi 1/7/2010 tarihine kadar uygulanmaz."

Yürürlük

MADDE 13 – (1) Bu Yönetmeliğin 4 üncü maddesinin (f) bendi ile 8 inci maddesinin (e) bendi yönetmeliğin yayımı tarihinden 1 yıl sonra, diğer hükümleri yayımı tarihinde yürürlüğe girer.

Yürütme

MADDE 14 – (1) Bu Yönetmelik hükümlerini Ulaştırma Bakanı yürütür.

EK: 1/1

OTOBÜSLER İÇİN

× Tüm harf aralıkları eşit ve 11 mm'dir.

ÖLÇEK: 1/10

Figure C.1 – Dimensions of reflective zone at the back of school buses for larger vehicles

EK: 1/2

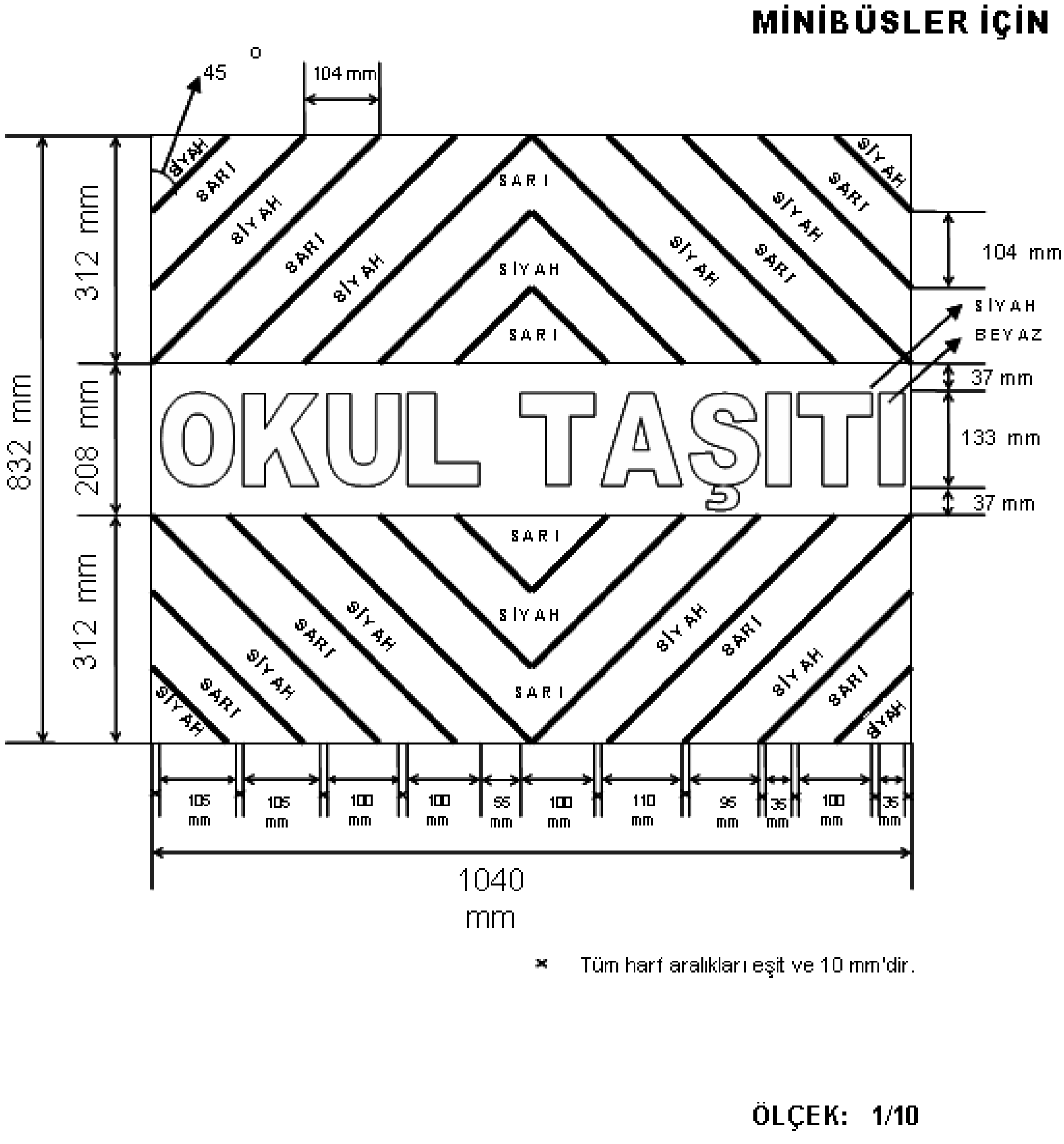
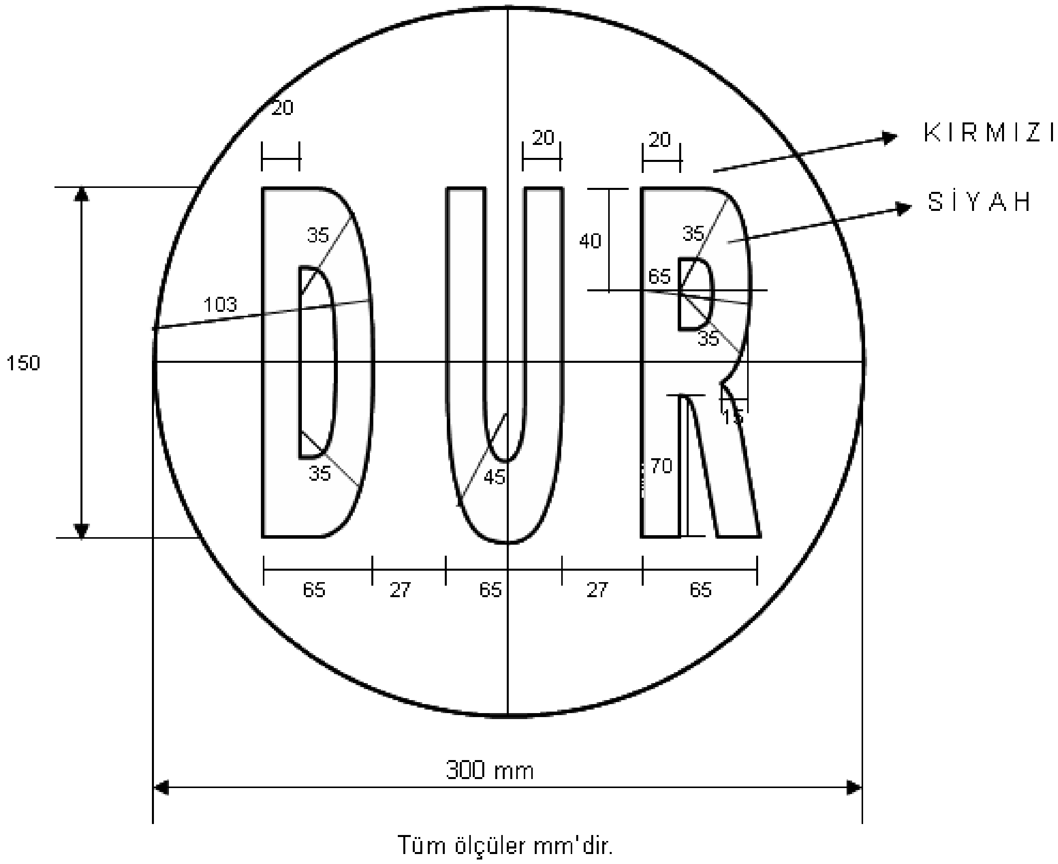


Figure C.2 – Dimensions of reflective zone at the back of school buses for smaller vehicles

EK: 2



ÖLÇEK: 1/3

Figure C.3 – Dimensions for the stop sign at the back of the school bus

EK-3
T.C.
......................................VALİLİĞİ
......................................EMNİYET MÜDÜRLÜĞÜ
............................TRAFİK DENETLEME ŞUBE MÜDÜRLÜĞÜ
BÜRO AMİRLİĞİ
OKUL SERVİS ARAÇI BAKIM VE ONARIM TAKİP FORMU

ÖZEL İZİN BELGESİ SAYISI	:..	
TAŞITIN PLAKASI	:..	
TAŞITIN CİNSİ	:..	
TAŞITIN SAHİBİ	:..	
BELGEYİ VEREN TRAFİK KURULUŞU, YETKİLİSİ VE İMZASI	:..	
BAKIM VE ONARIMIN YAPILDIĞI TARİH	HANGİ BAKIM VE ONARIMLARIN YAPILDIĞI	BAKIM VE ONARIMI YAPAN FİRMA KAŞE VE YETKİLİSİNİN İMZASI
		2918 sayılı Karayolları Trafik Kanunu ile Karayolları Trafik Yönetmeliği, Muayene İstasyonlarının Açılması ve İşletilmesi Hakkında Yönetmelik ve Araçların İmal Tadil ve Montajı Hakkında Yönetmelik'lerde belirtilen hususlar doğrultusunda, aracın bakım ve onarımı yapılmıştır.
		2918 sayılı Karayolları Trafik Kanunu ile Karayolları Trafik Yönetmeliği, Muayene İstasyonlarının Açılması ve İşletilmesi Hakkında Yönetmelik ve Araçların İmal Tadil ve Montajı Hakkında Yönetmelik'lerde belirtilen hususlar doğrultusunda, aracın bakım ve onarımı yapılmıştır.

Figure C.4 – School Transportation Vehicle Maintenance and Repair Form

EK-4 **(Değişik RG 11/10/2008 – 27021)**

.... BELEDİYESİ BAŞKANLIĞI
…………………………Daire Başkanlığı/Şube Müdürlüğü

. OKUL SERVİS ARACI ÖZEL İZİN BELGESİ

SAYISI	:..
VERİLİŞ TARİHİ	:..
GEÇERLİLİK TARİHİ	:..
TAŞITIN PLAKASI	:..
TAŞITIN CİNSİ	:..
TAŞIT SAHİBİNİN ADI SOYADI	:..
(ŞİRKET İSE ÜNVANI)	:..
TAŞITIN ŞOFÖRLERİ	1-:..
	2-:..
	3-:..
REHBER PERSONEL VEYA ÖĞRETMENİN ADI SOYADI	:..
TAŞITIN TAŞIMA SINIRI (KAPASİTESİ)	:..
TAŞITIN İZLEYECEĞİ GÜZERGAH	:..

....
....
....

Yukarıda işleteni, şoförü, rehber personeli, plakası ve güzergâhı belirtilen okul servis aracının 2918 sayılı Karayolları Trafik Kanunu, Karayolları Trafik Yönetmeliği ve Okul Servis Araçları Hizmet Yönetmeliği ile UKOME/ İl-ilçe Trafik Komisyonu kararlarına uygunluğu anlaşılmış olup, iş bu Özel İzin Belgesi tanzim edilerek verilmiştir.

Onaylayanın: Adı Soyadı :
İmzası
Mühür

Figure C.5 – School Transportation Vehicle Allowance Form

APPENDIX D

DESCRIPTIVE STATISTICS FOR STUDENTS

Table D.1 – Descriptive Statistics for Students

Descriptive Statistics	N	Min.	Max.	Mean		Std. Dev.	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Age of the student	149	11	15	12.74	0.069	0.841	0.459	0.199	-0.633	0.395
Gender of the student	149	0	1	0.44	0.041	0.498	0.232	0.199	-1.973	0.395
Grade of the student	149	6	8	6.66	0.062	0.759	0.649	0.199	-0.979	0.395
School bus usage when going to school	148	1	5	4.24	0.114	1.392	-1.737	0.199	1.402	0.396
School bus usage when coming back to home	149	1	5	4.55	0.064	0.784	-2.261	0.199	6.026	0.395
Approximate duration of journey in the morning (minutes)	149	10	90	30.65	1.245	15.198	0.825	0.199	0.928	0.395
Approximate duration of journey in the evening (minutes)	149	10	90	33.43	1.358	16.571	0.815	0.199	0.639	0.395
Whether needs help getting on the bus	149	0	1	0.01	0.009	0.115	8.543	0.199	71.945	0.395
Whether needs help getting off the bus	149	0	0	0	0	0	.	.	.	.
Whether a stair that helps to get on or off to the bus exists or not	149	0	1	0.68	0.038	0.466	-0.802	0.199	-1.375	0.395

Table D.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Dev.	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Whether emergency exits are marked or not	149	0	1	0.7	0.037	0.458	-0.907	0.199	-1.194	0.395
It is hot in the bus in spring months	149	1	5	4.32	0.076	0.931	-1.487	0.199	2.096	0.395
It is cold in the bus in winter months	149	1	5	2.89	0.118	1.436	0.036	0.199	-1.349	0.395
Disturbance of hot in spring	149	1	5	4.07	0.098	1.201	-1.342	0.199	0.918	0.395
Disturbance of cold in winter	149	1	5	2.64	0.117	1.434	0.325	0.199	-1.271	0.395
Music plays in the bus	149	1	5	4.05	0.109	1.327	-1.177	0.199	0.034	0.395
Friends' noise disturbs in the morning journeys	149	1	5	2.3	0.12	1.46	0.663	0.199	-1.061	0.395
Music disturbs in the morning journeys	149	1	5	1.54	0.077	0.941	1.988	0.199	3.755	0.395
Friends' noise disturbs in the evening journeys	149	1	5	2.28	0.123	1.507	0.709	0.199	-1.061	0.395
Music disturbs in the evening journeys	149	1	5	1.54	0.085	1.043	2.092	0.199	3.606	0.395
Bus driver intervenes when students make noise	149	1	5	3.32	0.107	1.311	-0.434	0.199	-0.878	0.395
Student can easily walk and sit on the place	149	1	5	3.86	0.109	1.326	-0.972	0.199	-0.332	0.395
Student can sit according to their choice	149	1	5	3.68	0.117	1.429	-0.696	0.199	-0.913	0.395

Table D.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Fasten the seat belt as soon as getting on the bus	148	1	5	2.28	0.125	1.52	0.745	0.199	-1.006	0.396
Belt is fasten throughout the journey	149	1	5	2.2	0.117	1.428	0.809	0.199	-0.761	0.395
Disturbance of jouncing	149	1	5	2.64	0.117	1.429	0.351	0.199	-1.224	0.395
Open window when it is hot	149	1	5	3.23	0.14	1.705	-0.28	0.199	-1.656	0.395
The door is closed during the journey	149	1	5	4.44	0.086	1.049	-2.003	0.199	3.106	0.395
Student feels sleepy in the morning journeys	149	1	5	3.59	0.121	1.48	-0.661	0.199	-1.003	0.395
Student feels sleepy in the evening journeys	149	1	5	2.4	0.119	1.451	0.613	0.199	-1.042	0.395
Bus seat is comfortable	149	1	5	3.7	0.109	1.328	-0.81	0.199	-0.507	0.395
Student feels comfortable in the bus	149	1	5	3.62	0.103	1.255	-0.65	0.199	-0.54	0.395
Student is pleased about the behavior of the bus driver	149	1	5	4.09	0.095	1.159	-1.137	0.199	0.399	0.395
Student feels uncomfortable when front seat is laid down	149	1	5	3.15	0.135	1.646	-0.194	0.199	-1.559	0.395
Seat belt is suitable for the student	149	1	5	3.05	0.123	1.499	-0.093	0.199	-1.305	0.395
Student feels discomfort on the neck during the journey	149	1	5	2.43	0.117	1.43	0.446	0.199	-1.204	0.395

Table D.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Student feels discomfort on the shoulders during the journey	149	1	5	2.22	0.111	1.355	0.696	0.199	-0.835	0.395
Student feels discomfort on the back during the journey	149	1	5	2.41	0.119	1.447	0.556	0.199	-1.099	0.395
Student feels discomfort on the legs during the journey	149	1	5	2.23	0.108	1.322	0.66	0.199	-0.807	0.395
Student feels discomfort on the thigh during the journey	149	1	5	2.21	0.112	1.367	0.727	0.199	-0.842	0.395
Whether or not student feels any type of discomfort on the neck	149	0	1	0.52	0.041	0.501	-0.095	0.199	-2.018	0.395
Total number of discomfort types declared for the neck	149	0	6	0.63	0.066	0.8	2.775	0.199	14.554	0.395
Whether student feels excessive pressure on his/her neck or not	149	0	1	0.03	0.015	0.181	5.233	0.199	25.73	0.395
Whether student feels stiffness on his/her neck or not	149	0	1	0.19	0.033	0.397	1.558	0.199	0.434	0.395
Whether student feels an ache on his/her neck or not	149	0	1	0.23	0.035	0.425	1.263	0.199	-0.409	0.395

Table D.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Whether student feels soreness on his/her neck or not	149	0	1	0.03	0.013	0.162	5.914	0.199	33.429	0.395
Whether student feels prickling sensation on his/her neck or not	149	0	1	0.05	0.019	0.226	4	0.199	14.194	0.395
Whether student feels a numbness on his/her neck or not	149	0	1	0.09	0.023	0.283	2.955	0.199	6.824	0.395
Whether or not student feels any type of discomfort on the shoulder	149	0	1	0.4	0.04	0.491	0.43	0.199	-1.84	0.395
Total number of discomfort types declared for the shoulder	149	0	6	0.47	0.061	0.74	3.346	0.199	20.523	0.395
Whether student feels excessive pressure on his/her shoulder or not	149	0	1	0.02	0.012	0.141	6.902	0.199	46.265	0.395
Whether student feels stiffness on his/her shoulder or not	149	0	1	0.16	0.03	0.369	1.863	0.199	1.49	0.395
Whether student feels an ache on his/her shoulder or not	149	0	1	0.14	0.029	0.349	2.085	0.199	2.378	0.395
Whether student feels soreness on his/her shoulder or not	149	0	1	0.04	0.016	0.197	4.725	0.199	20.6	0.395

Table D.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Whether student feels prickling sensation on his/her shoulder or not	149	0	1	0.04	0.016	0.197	4.725	0.199	20.6	0.395
Whether student feels a numbness on his/her shoulder or not	149	0	1	0.07	0.021	0.251	3.495	0.199	10.356	0.395
Whether or not student feels any type of discomfort on the back	149	0	1	0.48	0.041	0.501	0.068	0.199	-2.023	0.395
Total number of discomfort types declared for the back	149	0	6	0.58	0.062	0.755	2.789	0.199	16.692	0.395
Whether student feels excessive pressure on his/her back or not	149	0	1	0.05	0.019	0.226	4	0.199	14.194	0.395
Whether student feels stiffness on his/her back or not	149	0	1	0.11	0.025	0.311	2.562	0.199	4.627	0.395
Whether student feels an ache on his/her back or not	149	0	1	0.24	0.035	0.43	1.22	0.199	-0.52	0.395
Whether student feels soreness on his/her back or not	149	0	1	0.04	0.016	0.197	4.725	0.199	20.6	0.395

Table D.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Whether student feels prickling sensation on his/her back or not	149	0	1	0.05	0.017	0.212	4.326	0.199	16.938	0.395
Whether student feels a numbness on his/her back or not	149	0	1	0.09	0.023	0.283	2.955	0.199	6.824	0.395
Whether or not student feels any type of discomfort on the thigh	149	0	1	0.37	0.04	0.484	0.548	0.199	-1.723	0.395
Total number of discomfort types declared for the thigh	149	0	6	0.42	0.057	0.698	3.801	0.199	26.495	0.395
Whether student feels excessive pressure on his/her thigh or not	149	0	1	0.03	0.013	0.162	5.914	0.199	33.429	0.395
Whether student feels stiffness on his/her thigh or not	149	0	1	0.06	0.02	0.239	3.728	0.199	12.061	0.395
Whether student feels an ache on his/her thigh or not	149	0	1	0.09	0.023	0.283	2.955	0.199	6.824	0.395
Whether student feels soreness on his/her thigh or not	149	0	1	0.07	0.021	0.251	3.495	0.199	10.356	0.395

Table D.1 (Continued)

	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Whether student feels prickling sensation on his/her thigh or not	149	0	1	0.07	0.021	0.262	3.293	0.199	8.963	0.395
Whether student feels a numbness on his/her thigh or not	149	0	1	0.1	0.025	0.302	2.681	0.199	5.26	0.395
Whether or not student feels any type of discomfort on the legs	149	0	1	0.51	0.041	0.502	-0.041	0.199	-2.026	0.395
Total number of discomfort types declared for the legs	149	0	6	0.64	0.07	0.856	2.807	0.199	13.515	0.395
Whether student feels excessive pressure on his/her legs or not	149	0	1	0.03	0.013	0.162	5.914	0.199	33.429	0.395
Whether student feels stiffness on his/her legs or not	149	0	1	0.05	0.017	0.212	4.326	0.199	16.938	0.395
Whether student feels an ache on his/her legs or not	149	0	1	0.11	0.026	0.319	2.452	0.199	4.069	0.395
Whether student feels soreness on his/her legs or not	149	0	1	0.03	0.013	0.162	5.914	0.199	33.429	0.395
Whether student feels prickling sensation on his/her legs or not	149	0	1	0.14	0.029	0.349	2.085	0.199	2.378	0.395

Table D.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Whether student feels a numbness on his/her legs or not	149	0	1	0.28	0.037	0.451	0.979	0.199	-1.055	0.395
Seat pan cushion hardness suitability	149	-3	3	0.59	0.095	1.163	0.379	0.199	1.537	0.395
Seat pan width suitability	149	-3	3	0.01	0.073	0.889	0.922	0.199	6.334	0.395
Seat pan length suitability	149	-3	3	0.02	0.064	0.775	0.671	0.199	9.819	0.395
Seat back cushion hardness suitability	149	-3	3	0.7	0.099	1.206	0.532	0.199	0.68	0.395
Seat back width suitability	149	-3	3	-0.06	0.058	0.709	-0.834	0.199	10.69	0.395
Seat back height suitability	149	-3	3	0.03	0.067	0.813	-0.049	0.199	7.778	0.395
Seat back cushion shoulder support	149	1	5	3.43	0.103	1.259	-0.446	0.199	-0.695	0.395
Seat back cushion back support	149	1	5	3.45	0.106	1.297	-0.453	0.199	-0.786	0.395
Seat back cushion waist support	149	1	5	3.34	0.107	1.304	-0.362	0.199	-0.873	0.395
Existence of headrest	149	0	1	0.34	0.039	0.476	0.672	0.199	-1.57	0.395
Headrest hardness suitability	51	-3	3	0.45	0.154	1.101	0.878	0.333	2.906	0.656
Headrest width suitability	51	-3	3	-0.16	0.129	0.925	-0.94	0.333	6.169	0.656

Table D.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Headrest height suitability	51	-1	3	0.12	0.082	0.588	2.437	0.333	11.391	0.656
Headrest placement suitability	51	-3	3	0	0.128	0.917	0	0.333	7.358	0.656
Existence of armrest	149	0	1	0.56	0.041	0.498	-0.26	0.199	-1.959	0.395
Armrest length suitability	84	-1	3	-0.04	0.073	0.667	2.039	0.263	9.193	0.52
Armrest width suitability	84	-3	3	-0.25	0.088	0.805	-0.648	0.263	6.127	0.52
Armrest height suitability	84	-1	3	0.02	0.045	0.41	4.477	0.263	35.192	0.52
Armrest placement suitability	84	0	3	0.13	0.063	0.576	4.643	0.263	20.904	0.52
Would feel more comfortable with a headrest present	149	1	5	3.87	0.103	1.259	-0.765	0.199	-0.462	0.395
Would feel more comfortable with an armrest present	149	1	5	4.01	0.1	1.219	-0.956	0.199	-0.14	0.395
Would feel more comfortable with armrests at both sides	149	1	5	3.92	0.112	1.363	-0.988	0.199	-0.365	0.395
Would feel more comfortable if seat pan was sloped downward	149	1	5	3.07	0.114	1.386	0.005	0.199	-1.094	0.395

Table D.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Would feel more comfortable if seat pan was sloped upward	149	1	5	3	0.11	1.346	-0.017	0.199	-0.967	0.395
Would feel more comfortable if seat is laid back	149	1	5	3.87	0.097	1.187	-0.757	0.199	-0.382	0.395
Would feel more comfortable if the seat is upright	149	1	5	2.66	0.113	1.374	0.277	0.199	-0.962	0.395
Ability to move the seat back forth to feel more comfortable	149	1	5	3.09	0.126	1.533	-0.069	0.199	-1.414	0.395
Ability to lay the seat back or forth to feel more comfortable	149	1	5	3.11	0.123	1.505	-0.124	0.199	-1.311	0.395
Ability to move the seat up and down to feel more comfortable	149	1	5	2.91	0.125	1.526	0.08	0.199	-1.356	0.395

APPENDIX E

ONE SAMPLE STATISTICS OF STUDENTS FOR COMPARISION WITH 3

Table E.1 - One Sample Statistics of Students for Comparison With 3

One-Sample Statistics		**Statistic**	**Bootstrap**			
			Bias	**Std. Error**	**95% Confidence Interval**	
					Lower	**Upper**
It is hot in the bus in spring months	**N**	148				
	Mean	4.32	0	0.08	4.15	4.47
	Std. Dev.	0.933	-0.002	0.077	0.784	1.072
	Std. Error Mean	0.077				
It is cold in the bus in winter months	**N**	148				
	Mean	2.88	0	0.12	2.66	3.11
	Std. Dev.	1.438	-0.003	0.045	1.337	1.516
	Std. Error Mean	0.118				
Disturbance of hot	**N**	148				
	Mean	4.06	0	0.1	3.84	4.24
	Std. Dev.	1.202	-0.002	0.085	1.021	1.358
	Std. Error Mean	0.099				
Disturbance of cold	**N**	148				
	Mean	2.63	0	0.11	2.41	2.85
	Std. Dev.	1.435	-0.005	0.05	1.331	1.526
	Std. Error Mean	0.118				
Music play	**N**	148				
	Mean	4.05	0	0.11	3.82	4.25
	Std. Dev.	1.329	-0.002	0.079	1.158	1.47
	Std. Error Mean	0.109				
Friends making noise disturbs in the morning journeys	**N**	148				
	Mean	2.31	0	0.12	2.08	2.53
	Std. Dev.	1.461	-0.007	0.057	1.33	1.559
	Std. Error Mean	0.12				
Music disturbs in the morning journeys	N	**148**				
	Mean	**1.54**	0	0.07	1.41	1.68
	Std. Dev.	**0.943**	-0.009	0.083	0.772	1.097
	Std. Error Mean	**0.078**				

Table E.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Friends making noise disturbs in the evening journeys	N	148				
	Mean	2.28	0	0.12	2.03	2.53
	Std. Dev.	1.512	-0.009	0.058	1.383	1.61
	Std. Error Mean	0.124				
Music disturbs in the evening journeys	N	148				
	Mean	1.53	0	0.09	1.39	1.71
	Std. Dev.	1.039	-0.005	0.1	0.838	1.219
	Std. Error Mean	0.085				
Bus driver intervenes when students make noise	N	148				
	Mean	3.31	0	0.1	3.11	3.5
	Std. Dev.	1.309	-0.005	0.057	1.189	1.409
	Std. Error Mean	0.108				
Student can easily walk and sit on the place	N	148				
	Mean	3.88	0	0.11	3.65	4.09
	Std. Dev.	1.309	-0.005	0.069	1.16	1.43
	Std. Error Mean	0.108				
Student can sit according to their choice	N	148				
	Mean	3.68	0	0.12	3.45	3.9
	Std. Dev.	1.434	-0.007	0.059	1.308	1.536
	Std. Error Mean	0.118				
Fasten the seat belt as soon as getting on the bus	N	148				
	Mean	2.28	0	0.12	2.05	2.51
	Std. Dev.	1.52	-0.005	0.06	1.39	1.622
	Std. Error Mean	0.125				
Belt is fasten throughout the journey	N	148				
	Mean	2.2	0	0.11	1.99	2.41
	Std. Dev.	1.432	-0.004	0.063	1.301	1.543
	Std. Error Mean	0.118				
Uncomfortable because of jouncing during the journey	N	148				
	Mean	2.64	0	0.12	2.4	2.86
	Std. Dev.	1.434	-0.006	0.053	1.325	1.528
	Std. Error Mean	0.118				

Table E.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Open the window when it is hot	**N**	148				
	Mean	3.22	0	0.14	2.95	3.49
	Std. Dev.	1.704	-0.004	0.04	1.617	1.774
	Std. Error Mean	0.14				
The door is closed during the journey	**N**	148				
	Mean	4.44	0	0.09	4.26	4.6
	Std. Dev.	1.051	-0.003	0.099	0.845	1.229
	Std. Error Mean	0.086				
Student feels sleepy in the morning journeys	**N**	148				
	Mean	3.6	0	0.12	3.37	3.83
	Std. Dev.	1.479	-0.005	0.061	1.351	1.581
	Std. Error Mean	0.122				
Student feels sleepy in the evening journeys	**N**	148				
	Mean	2.4	0	0.12	2.17	2.64
	Std. Dev.	1.456	-0.005	0.058	1.329	1.562
	Std. Error Mean	0.12				
Bus seat is comfortable	**N**	148				
	Mean	3.71	0	0.11	3.5	3.93
	Std. Dev.	1.331	-0.006	0.065	1.184	1.445
	Std. Error Mean	0.109				
Student feels comfortable in the bus	**N**	148				
	Mean	3.63	0	0.1	3.43	3.83
	Std. Dev.	1.258	-0.005	0.062	1.125	1.368
	Std. Error Mean	0.103				
Student is pleased about the behavior of the bus driver	**N**	148				
	Mean	4.1	0	0.1	3.91	4.3
	Std. Dev.	1.159	-0.003	0.073	1.008	1.291
	Std. Error Mean	0.095				
Student feels uncomfortable when front seat is laid back	**N**	148				
	Mean	3.14	0	0.13	2.88	3.4
	Std. Dev.	1.644	-0.005	0.045	1.549	1.726
	Std. Error Mean	0.135				

Table E.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Seat belt is suitable for the student	**N**	148				
	Mean	3.06	0.01	0.12	2.84	3.3
	Std. Dev.	1.495	-0.004	0.05	1.386	1.584
	Std. Error Mean	0.123				
Student feels discomfort on the neck during the journey	**N**	148				
	Mean	2.42	0	0.12	2.19	2.65
	Std. Dev.	1.429	-0.005	0.054	1.313	1.528
	Std. Error Mean	0.117				
Student feels discomfort on the shoulders during the journey	**N**	148				
	Mean	2.21	0	0.11	1.99	2.41
	Std. Dev.	1.352	-0.005	0.062	1.216	1.464
	Std. Error Mean	0.111				
Student feels discomfort on the back during the journey	**N**	148				
	Mean	2.4	0	0.12	2.16	2.63
	Std. Dev.	1.446	-0.007	0.057	1.316	1.549
	Std. Error Mean	0.119				
Student feels discomfort on the legs during the journey	**N**	148				
	Mean	2.24	0	0.11	2.03	2.45
	Std. Dev.	1.327	-0.005	0.058	1.203	1.433
	Std. Error Mean	0.109				
Student feels discomfort on the thigh during the journey	**N**	148				
	Mean	2.19	0	0.11	1.95	2.39
	Std. Dev.	1.352	-0.006	0.06	1.222	1.459
	Std. Error Mean	0.111				
Status of the seat back cushion shoulder support for the student	**N**	148				
	Mean	3.45	0	0.1	3.24	3.64
	Std. Dev.	1.247	-0.003	0.059	1.125	1.358
	Std. Error Mean	0.102				
Status of the seat back cushion back support for the student	**N**	148				
	Mean	3.47	0	0.1	3.25	3.66
	Std. Dev.	1.285	-0.003	0.059	1.163	1.394
	Std. Error Mean	0.106				

Table E.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Status of the seat back cushion waist support for the student	**N**	148				
	Mean	3.36	0	0.1	3.16	3.57
	Std. Dev.	1.294	-0.004	0.055	1.18	1.4
	Std. Error Mean	0.106				
Would feel more comfortable with a headrest present	**N**	148				
	Mean	3.88	0	0.1	3.68	4.07
	Std. Dev.	1.261	-0.002	0.063	1.131	1.383
	Std. Error Mean	0.104				
Would feel more comfortable with an armrest present	**N**	148				
	Mean	4.01	0	0.1	3.82	4.18
	Std. Dev.	1.221	-0.003	0.066	1.095	1.351
	Std. Error Mean	0.1				
Would feel more comfortable with armrests at both sides	**N**	148				
	Mean	3.91	0	0.11	3.71	4.11
	Std. Dev.	1.365	-0.006	0.069	1.217	1.49
	Std. Error Mean	0.112				
Would feel more comfortable if seat pan was sloped downward	**N**	148				
	Mean	3.07	0	0.11	2.86	3.27
	Std. Dev.	1.388	-0.006	0.054	1.274	1.482
	Std. Error Mean	0.114				
Would feel more comfortable if seat pan was sloped upward	**N**	148				
	Mean	2.99	0	0.11	2.76	3.19
	Std. Dev.	1.34	-0.006	0.056	1.215	1.442
	Std. Error Mean	0.11				
Would feel more comfortable if seat is laid back	**N**	148				
	Mean	3.86	0	0.1	3.68	4.05
	Std. Dev.	1.188	-0.006	0.061	1.058	1.302
	Std. Error Mean	0.098				
Would feel more comfortable if the seat is upright	**N**	148				
	Mean	2.68	0	0.11	2.47	2.87
	Std. Dev.	1.371	-0.004	0.058	1.246	1.481
	Std. Error Mean	0.113				

Table E.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Ability to move the seat back and forth to feel more comfortable	**N**	148				
	Mean	3.07	0	0.12	2.84	3.32
	Std. Dev.	1.53	-0.002	0.048	1.435	1.62
	Std. Error Mean	0.126				
Ability to lay the seat back or forth to feel more comfortable	**N**	148				
	Mean	3.1	0	0.12	2.87	3.32
	Std. Dev.	1.502	-0.003	0.051	1.4	1.595
	Std. Error Mean	0.123				
Ability to move the seat up and down to feel more comfortable	**N**	148				
	Mean	2.89	0	0.13	2.64	3.14
	Std. Dev.	1.521	-0.005	0.049	1.423	1.61
	Std. Error Mean	0.125				

APPENDIX F

ONE SAMPLE T-TEST FOR COMPARING MEAN RESPONSES OF STUDENTS WITH 3

Table F.1 - One Sample T-Test for Comparing Mean Responses of Students With 3

	Test Value = 3					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
It is hot in the bus in spring months	17.172	147	0	1.318	1.17	1.47
It is cold in the bus in winter months	-1.029	147	0.305	-0.122	-0.36	0.11
Disturbance of hot	10.735	147	0	1.061	0.87	1.26
Disturbance of cold	-3.151	147	0.002	-0.372	-0.6	-0.14
Music play	9.65	147	0	1.054	0.84	1.27
Friends making noise disturbs in the morning journeys	-5.739	147	0	-0.689	-0.93	-0.45
Music disturbs in the morning journeys	-18.826	147	0	-1.459	-1.61	-1.31
Friends making noise disturbs in the evening journeys	-5.763	147	0	-0.716	-0.96	-0.47
Music disturbs in the evening journeys	-17.16	147	0	-1.466	-1.64	-1.3
Bus driver intervenes when students make noise	2.89	147	0.004	0.311	0.1	0.52
Student can easily walk and sit on the place	8.165	147	0	0.878	0.67	1.09
Student can sit according to their choice	5.792	147	0	0.682	0.45	0.92
Fasten the seat belt as soon as getting on the bus	-5.786	147	0	-0.723	-0.97	-0.48
Belt is fasten throughout the journey	-6.832	147	0	-0.804	-1.04	-0.57
Uncomfortable because of jouncing during the journey	-3.095	147	0.002	-0.365	-0.6	-0.13
Open the window when it is hot	1.543	147	0.125	0.216	-0.06	0.49
The door is closed during the journey	16.655	147	0	1.439	1.27	1.61
Student feels sleepy in the morning journeys	4.947	147	0	0.601	0.36	0.84
Student feels sleepy in the evening journeys	-5.026	147	0	-0.601	-0.84	-0.36
Bus seat is comfortable	6.483	147	0	0.709	0.49	0.93
Student feels comfortable in the bus	6.078	147	0	0.628	0.42	0.83

Table F.1 (Continued)

	Test Value = 3					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Student is pleased about the behavior of the bus driver	11.56	147	0	1.101	0.91	1.29
Student feels uncomfortable when front seat is laid down	1	147	0.319	0.135	-0.13	0.4
Seat belt is suitable for the student	0.495	147	0.621	0.061	-0.18	0.3
Student feels discomfort on the neck during the journey	-4.948	147	0	-0.581	-0.81	-0.35
Student feels discomfort on the shoulders during the journey	-7.116	147	0	-0.791	-1.01	-0.57
Student feels discomfort on the back during the journey	-5.058	147	0	-0.601	-0.84	-0.37
Student feels discomfort on the legs during the journey	-7.001	147	0	-0.764	-0.98	-0.55
Student feels discomfort on the thigh during the journey	-7.296	147	0	-0.811	-1.03	-0.59
Status of the seat back cushion shoulder support for the student	4.351	147	0	0.446	0.24	0.65
Status of the seat back cushion back support for the student	4.413	147	0	0.466	0.26	0.68
Status of the seat back cushion waist support for the student	3.368	147	0.001	0.358	0.15	0.57
Would feel more comfortable with a headrest present	8.473	147	0	0.878	0.67	1.08
Would feel more comfortable with an armrest present	10.035	147	0	1.007	0.81	1.21
Would feel more comfortable with armrests at both sides	8.13	147	0	0.912	0.69	1.13
Would feel more comfortable if seat pan was sloped downward	0.592	147	0.555	0.068	-0.16	0.29
Would feel more comfortable if seat pan was sloped upward	-0.123	147	0.903	-0.014	-0.23	0.2
Would feel more comfortable if seat is laid back	8.86	147	0	0.865	0.67	1.06
Would feel more comfortable if the seat is upright	-2.877	147	0.005	-0.324	-0.55	-0.1
Ability to move the seat back and forth to feel more comfortable	0.591	147	0.555	0.074	-0.17	0.32
Ability to lay the seat back or forth to feel more comfortable	0.821	147	0.413	0.101	-0.14	0.35
Ability to move the seat up and down to feel more comfortable	-0.864	147	0.389	-0.108	-0.36	0.14

APPENDIX G

ONE SAMPLE STATISTICS OF STUDENTS FOR COMPARISON WITH 0

Table G.1 - One Sample Statistics of Students for Comparison With 0

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Seat pan cushion hardness suitability	**N**	37				
	Mean	0.68	-0.01	0.21	0.27	1.05
	Std. Dev.	1.313	-0.029	0.148	0.96	1.573
	Std. Error Mean	0.216				
Seat pan width suitability	**N**	37				
	Mean	0.03	0	0.13	-0.24	0.3
	Std. Dev.	0.799	-0.039	0.203	0.329	1.114
	Std. Error Mean	0.131				
Seat pan length suitability	**N**	37				
	Mean	0.08	0	0.14	-0.16	0.32
	Std. Dev.	0.862	-0.048	0.234	0	1.214
	Std. Error Mean	0.142				
Seat back cushion hardness suitability	**N**	37				
	Mean	0.46	0	0.19	0.11	0.81
	Std. Dev.	1.145	-0.029	0.177	0.762	1.443
	Std. Error Mean	0.188				
Seat back width suitability	**N**	37				
	Mean	-0.14	0	0.1	-0.38	0.05
	Std. Dev.	0.631	-0.036	0.174	0.287	0.917
	Std. Error Mean	0.104				
Seat back height suitability	**N**	37				
	Mean	0.14	0	0.09	-0.03	0.32
	Std. Dev.	0.585	-0.043	0.181	0.229	0.878
	Std. Error Mean	0.096				
Headrest hardness suitability	**N**	37				
	Mean	0.43	0	0.18	0.08	0.78
	Std. Dev.	1.119	-0.033	0.189	0.651	1.443
	Std. Error Mean	0.184				

Table G.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Headrest width suitability	**N**	37				
	Mean	-0.24	0	0.17	-0.62	0.08
	Std. Dev.	1.065	-0.032	0.187	0.646	1.378
	Std. Error Mean	0.175				
Headrest height suitability	**N**	37				
	Mean	0.11	0	0.1	-0.08	0.32
	Std. Dev.	0.658	-0.033	0.175	0.329	0.955
	Std. Error Mean	0.108				
Headrest placement suitability	**N**	37				
	Mean	0.08	0	0.14	-0.19	0.38
	Std. Dev.	0.924	-0.05	0.233	0.333	1.29
	Std. Error Mean	0.152				
Armrest length suitability	**N**	37				
	Mean	0	0	0.1	-0.19	0.22
	Std. Dev.	0.707	-0.034	0.162	0.372	1.004
	Std. Error Mean	0.116				
Armrest width suitability	**N**	37				
	Mean	-0.16	0	0.1	-0.4	0.03
	Std. Dev.	0.688	-0.028	0.163	0.364	0.968
	Std. Error Mean	0.113				
Armrest height suitability	**N**	37				
	Mean	-0.03	0	0.04	-0.11	0.05
	Std. Dev.	0.287	-0.016	0.084	0	0.405
	Std. Error Mean	0.047				
Armrest placement suitability	**N**	37				
	Mean	0.11	0	0.08	0	0.3
	Std. Dev.	0.516	-0.072	0.258	0	0.845
	Std. Error Mean	0.085				

APPENDIX H

ONE SAMPLE T-TEST FOR COMPARING MEAN RESPONSES OF STUDENTS WITH 0

Table H.1 - One Sample T-Test for Comparing Mean Responses of Students With 0

	Test Value = 0					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Seat pan cushion hardness suitability	3.129	36	0.003	0.676	0.24	1.11
Seat pan width suitability	0.206	36	0.838	0.027	-0.24	0.29
Seat pan length suitability	0.572	36	0.571	0.081	-0.21	0.37
Seat back cushion hardness suitability	2.441	36	0.02	0.459	0.08	0.84
Seat back width suitability	-1.303	36	0.201	-0.135	-0.35	0.08
Seat back height suitability	1.405	36	0.169	0.135	-0.06	0.33
Headrest hardness suitability	2.351	36	0.024	0.432	0.06	0.81
Headrest width suitability	-1.39	36	0.173	-0.243	-0.6	0.11
Headrest height suitability	1	36	0.324	0.108	-0.11	0.33
Headrest placement suitability	0.534	36	0.597	0.081	-0.23	0.39
Armrest length suitability	0	36	1	0	-0.24	0.24
Armrest width suitability	-1.434	36	0.16	-0.162	-0.39	0.07
Armrest height suitability	-0.572	36	0.571	-0.027	-0.12	0.07
Armrest placement suitability	1.276	36	0.21	0.108	-0.06	0.28

APPENDIX I

DESCRIPTIVE STATISTICS FOR DRIVERS

Table I.1 - Descriptive Statistics for Drivers

Descriptive Statistics	N	Min.	Max.	Mean		Std. Dev.	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Age of the driver	38	23	63	39.18	1.634	10.075	0.59	0.383	-0.531	0.75
Driving experience	38	4	42	18.84	1.597	9.843	0.519	0.383	-0.384	0.75
School bus experience	38	1	40	9.21	1.282	7.905	1.961	0.383	5.26	0.75
Approximate duration of journey in the morning(min.)	38	30	150	68.55	4.892	30.155	1.012	0.383	0.209	0.75
Approximate duration of journey in the evening(min.)	38	30	150	72.5	4.858	29.949	0.855	0.383	-0.152	0.75
Belt is fasten throughout the journey	38	3	5	4.74	0.082	0.503	-1.771	0.383	2.491	0.75
Uncomfortable because of jouncing dur. journey	38	1	5	2.32	0.185	1.141	1.173	0.383	0.664	0.75
Open the window when it is hot	38	1	5	3.79	0.193	1.189	-0.994	0.383	0.027	0.75
Open the door when it is hot	38	1	5	1.26	0.117	0.724	4.069	0.383	19.584	0.75
Driver feels discomfort from the noise of the students	38	1	5	2.87	0.233	1.436	0.358	0.383	-1.343	0.75
Feel discomf. from the noise of the students in the morning	38	1	5	2.53	0.209	1.289	0.818	0.383	-0.431	0.75
Feel discomf. from the noise of the students in the evening	38	1	5	2.74	0.225	1.389	0.437	0.383	-1.18	0.75

Table I.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Music plays in the service	38	1	5	3.55	0.198	1.224	-0.736	0.383	-0.446	0.75
Music disturbs the driver in the journeys	38	1	5	2.39	0.171	1.054	0.586	0.383	-0.326	0.75
Driver can easily reach to the control panel	38	2	5	4.45	0.105	0.645	-1.389	0.383	3.786	0.75
Driver closes the door before he starts driving	38	4	5	4.76	0.07	0.431	-1.289	0.383	-0.359	0.75
Driver closes the door after he starts driving	38	1	5	1.45	0.154	0.95	2.554	0.383	6.34	0.75
Driver starts driving after all students sit their places	38	2	5	4.66	0.102	0.627	-2.376	0.383	7.457	0.75
Driver intervenes when students try to open window	38	2	5	4.37	0.133	0.819	-1.108	0.383	0.446	0.75
Driver informs the students about emergency exits	38	2	5	4.45	0.123	0.76	-1.37	0.383	1.644	0.75
Driver concerns on radio, climate and such devices	38	1	5	2.5	0.216	1.331	0.218	0.383	-1.572	0.75
Driver concerns on the music	38	1	5	2.66	0.23	1.419	0.11	0.383	-1.527	0.75
Driver opens the door after fully stopping	38	4	5	4.76	0.07	0.431	-1.289	0.383	-0.359	0.75
It is hot in the bus in spring months	38	1	5	3.16	0.194	1.197	-0.221	0.383	-1.119	0.75

Table I.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
It is cold in the bus in winter months	38	1	5	1.87	0.165	1.018	1.412	0.383	1.787	0.75
Disturbance of hot weather in spring	38	1	5	2.66	0.23	1.419	0.589	0.383	-1.013	0.75
Disturbance of cold weather in winter	38	1	5	1.95	0.16	0.985	1.364	0.383	1.909	0.75
Driver feels sleepy in the morning journeys	38	1	4	1.37	0.103	0.633	2.212	0.383	6.655	0.75
Driver feels sleepy in the evening journeys	38	1	4	1.34	0.102	0.627	2.376	0.383	7.457	0.75
Driver feels discomfort on the neck during the journey	38	1	5	2.03	0.208	1.284	1.243	0.383	0.428	0.75
Driver feels discomfort on the shoulders during the journey	38	1	5	1.92	0.186	1.148	1.406	0.383	1.329	0.75
Driver feels discomfort on the back during the journey	38	1	5	1.89	0.18	1.11	1.47	0.383	1.781	0.75
Driver feels discomfort on the legs during the journey	38	1	5	1.66	0.157	0.966	2.276	0.383	6.098	0.75
Driver feels discomfort on the thigh during the journey	38	1	5	1.71	0.155	0.956	1.805	0.383	3.581	0.75
Whether or not driver feels any type of discomfort on the neck	38	0	1	0.24	0.07	0.431	1.289	0.383	-0.359	0.75

Table I.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Total number of discomfort types declared for the neck	38	0	1	0.24	0.07	0.431	1.289	0.383	-0.359	0.75
Whether driver feels excessive pressure on his/her neck or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels stiffness on his neck or not	38	0	1	0.16	0.06	0.37	1.954	0.383	1.918	0.75
Whether driver feels an ache on his neck or not	38	0	1	0.08	0.044	0.273	3.253	0.383	9.055	0.75
Whether driver feels soreness on his neck or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels prickling sensation on his neck or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels numbness on his neck or not	38	0	0	0	0	0	.	.	.	.
Whether or not driver feels any type of discomfort on the shoulder	38	0	1	0.21	0.067	0.413	1.479	0.383	0.195	0.75
Total number of discomfort types declared for the shoulder	38	0	1	0.21	0.067	0.413	1.479	0.383	0.195	0.75
Whether driver feels excessive pressure on his shoulder or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels stiffness on his shoulder or not	38	0	1	0.11	0.05	0.311	2.679	0.383	5.464	0.75

Table I.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Whether driver feels an ache on his shoulder or not	38	0	1	0.11	0.05	0.311	2.679	0.383	5.464	0.75
Whether driver feels soreness on his shoulder or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels prickling sensation on his shoulder or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels numbness on his shoulder or not	38	0	0	0	0	0	.	.	.	.
Whether or not driver feels any type of discomfort on the back	38	0	1	0.13	0.056	0.343	2.27	0.383	3.327	0.75
Total number of discomfort types declared for the back	38	0	2	0.21	0.094	0.577	2.654	0.383	5.808	0.75
Whether driver feels excessive pressure on his back or not	38	0	1	0.03	0.026	0.162	6.164	0.383	38	0.75
Whether driver feels stiffness on his back or not	38	0	1	0.05	0.037	0.226	4.174	0.383	16.27	0.75
Whether driver feels an ache on his back or not	38	0	1	0.11	0.05	0.311	2.679	0.383	5.464	0.75
Whether driver feels a pain on his back or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels prickling sensation on his back or not	38	0	1	0.03	0.026	0.162	6.164	0.383	38	0.75
Whether driver feels numbness on his back or not	38	0	0	0	0	0	.	.	.	.

Table I.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Whether or not driver feels any type of discomfort on the thigh	38	0	1	0.16	0.06	0.37	1.954	0.383	1.918	0.75
Total number of discomfort types declared for the thigh	38	0	1	0.16	0.06	0.37	1.954	0.383	1.918	0.75
Whether driver feels excessive pressure on his thigh or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels stiffness on his thigh or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels an ache on his thigh or not	38	0	1	0.05	0.037	0.226	4.174	0.383	16.27	0.75
Whether driver feels soreness on his thigh or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels prickling sensation on his thigh or not	38	0	1	0.03	0.026	0.162	6.164	0.383	38	0.75
Whether driver feels numbness on his thigh or not	38	0	1	0.08	0.044	0.273	3.253	0.383	9.055	0.75
Whether or not driver feels any type of discomfort on legs	38	0	1	0.11	0.05	0.311	2.679	0.383	5.464	0.75
Total number of discomfort types declared for the legs	38	0	1	0.11	0.05	0.311	2.679	0.383	5.464	0.75
Whether driver feels excessive pressure on his legs or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels stiffness on his legs or not	38	0	0	0	0	0	.	.	.	.

Table I.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Whether driver feels an ache on his legs or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels soreness on his legs or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels prickling sensation on his legs or not	38	0	0	0	0	0	.	.	.	.
Whether driver feels numbness on legs or not	38	0	1	0.11	0.05	0.311	2.679	0.383	5.464	0.75
Status of seat pan cushion hardness suit for the driver	38	0	1	0.03	0.026	0.162	6.164	0.383	38	0.75
Status of the seat pan width suit for the driver	38	0	3	0.21	0.114	0.704	3.61	0.383	12.55	0.75
Status of the seat pan height suit for driver	38	0	3	0.08	0.079	0.487	6.164	0.383	38	0.75
Status of the back cushion hardness suit for the driver	38	0	3	0.18	0.112	0.692	3.874	0.383	14.25	0.75
Status of the back width suit for the driver	38	-1	3	0	0.107	0.658	2.408	0.383	11.7	0.75
Status of the back height suit for the driver	38	-3	1	-0.11	0.091	0.559	-3.96	0.383	20.43	0.75
Status of the back cushion shoulder support for the driver	38	0	5	3.79	0.204	1.255	-1.56	0.383	2.125	0.75
Status of the back cushion back support for the driver	38	0	5	3.68	0.214	1.317	-1.24	0.383	0.909	0.75
Status of the back cushion waist support	38	0	5	3.79	0.204	1.255	-1.39	0.383	1.64	0.75

Table I.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Whether or not the service has a headrest	38	0	1	0.82	0.064	0.393	-1.69	0.383	0.926	0.75
Status of the headrest hardness suit for the driver	31	0	0	0	0	0	.	.	.	.
Status of the headrest width suit for the driver	31	-1	0	-0.03	0.032	0.18	-5.56	0.421	31	0.821
Status of the headrest height suit for the driver	31	-1	0	-0.03	0.032	0.18	-5.56	0.421	31	0.821
Status of the headrest place suit for the driver	31	-1	0	-0.06	0.045	0.25	-3.72	0.421	12.71	0.821
Whether or not the seat has an armrest	38	0	3	0.87	0.086	0.529	0.99	0.383	6.764	0.75
Status of the armrest hardness suit for the driver	31	0	3	0.13	0.101	0.562	4.86	0.421	24.59	0.821
Status of the armrest width suit for the driver	31	-1	3	0.06	0.103	0.574	4.54	0.421	25.08	0.821
Status of the armrest height suit for the driver	31	0	3	0.1	0.097	0.539	5.56	0.421	31	0.821
Status of the armrest place suit for the driver	31	-1	3	0.03	0.109	0.605	3.85	0.421	21.00	0.821
Driver would feel more comfortable if headrest exist	38	1	5	3.53	0.202	1.246	-0.59	0.383	-0.64	0.75
Driver would feel more comfortable if armrest exists	38	1	5	3.58	0.209	1.287	-0.66	0.383	-0.73	0.75

Table I.1 (Continued)

Descriptive Statistics	N	Min.	Max.	Mean		Std. Deviation	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Stat.	Std. Error	Stat.	Std. Error
Driver would feel more comfortable if armrest exist on both sides	38	1	5	2.45	0.187	1.155	0.57	0.383	-0.47	0.75
Driver would feel more comfortable if seat pan cushion were downward	38	1	5	2.45	0.198	1.224	0.45	0.383	-0.84	0.75
Driver would feel more comfortable if seat pan cushion were upward	38	1	5	2.5	0.199	1.225	0.41	0.383	-0.92	0.75
Driver would feel more comfortable if seat is laid back	38	1	5	2.37	0.186	1.149	0.67	0.383	-0.26	0.75
Driver would feel more comfortable if the seat is upright	38	1	5	2.76	0.208	1.283	0.06	0.383	-1.15	0.75
Driver is able to feel more comfortable by moving the seat back and forth	38	1	5	4.32	0.156	0.962	-1.65	0.383	2.926	0.75
Driver is able to feel more comfortable by tilting the seat back and forth	38	1	5	4.11	0.184	1.134	-1.39	0.383	1.407	0.75
Driver is able to feel more comfortable by moving the seat down and up	38	1	5	4.13	0.182	1.119	-1.49	0.383	1.782	0.75

APPENDIX J

ONE SAMPLE STATISTICS OF DRIVERS FOR COMPARISION WITH 3

Table J.1 - One Sample Statistics of Drivers for Comparison With 3

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Belt is fasten throughout the journey	N	38				
	Mean	4.74	0	0.08	4.55	4.87
	Std. Dev.	0.503	-0.011	0.082	0.343	0.645
	Std. Error Mean	0.082				
Uncomfortable because of jouncing during the journey	N	38				
	Mean	2.32	0.01	0.18	1.97	2.68
	Std. Dev.	1.141	-0.018	0.145	0.788	1.368
	Std. Error Mean	0.185				
Open the window when it is hot	N	38				
	Mean	3.79	0.01	0.19	3.39	4.13
	Std. Dev.	1.189	-0.026	0.133	0.853	1.409
	Std. Error Mean	0.193				
Open the door when it is hot	N	38				
	Mean	1.26	0	0.12	1.08	1.53
	Std. Dev.	0.724	-0.066	0.265	0.273	1.109
	Std. Error Mean	0.117				
Driver feels discomfort from the noise of the students	N	38				
	Mean	2.87	0.01	0.23	2.45	3.34
	Std. Dev.	1.436	-0.02	0.101	1.203	1.594
	Std. Error Mean	0.233				
Driver feels discomfort from the noise of the students in the morning	N	38				
	Mean	2.53	0	0.21	2.11	2.95
	Std. Dev.	1.289	-0.022	0.128	0.998	1.492
	Std. Error Mean	0.209				

Table J.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Driver feels discomfort from the noise of the students in the evening	N	38				
	Mean	2.74	0	0.22	2.32	3.18
	Std. Dev.	1.389	-0.02	0.104	1.152	1.551
	Std. Error Mean	0.225				
Music plays in the service	N	38				
	Mean	3.55	0.01	0.19	3.18	3.89
	Std. Dev.	1.224	-0.026	0.119	0.927	1.416
	Std. Error Mean	0.198				
Music disturbs the driver in the journeys	N	38				
	Mean	2.39	0	0.17	2.08	2.74
	Std. Dev.	1.054	-0.022	0.11	0.798	1.244
	Std. Error Mean	0.171				
Driver can easily reach to the control panel since driving	N	38				
	Mean	4.45	0	0.1	4.24	4.63
	Std. Dev.	0.645	-0.024	0.114	0.481	0.855
	Std. Error Mean	0.105				
Driver closes the door before he starts driving	N	38				
	Mean	4.76	0	0.07	4.63	4.89
	Std. Dev.	0.431	-0.006	0.046	0.311	0.489
	Std. Error Mean	0.07				
Driver closes the door after he starts driving	N	38				
	Mean	1.45	0.01	0.15	1.18	1.79
	Std. Dev.	0.95	-0.022	0.212	0.431	1.297
	Std. Error Mean	0.154				
Driver starts driving after all students sit their places	N	38				
	Mean	4.66	0	0.1	4.45	4.82
	Std. Dev.	0.627	-0.023	0.144	0.393	0.938
	Std. Error Mean	0.102				
Driver intervenes when students try to open window	N	38				
	Mean	4.37	-0.01	0.14	4.05	4.61
	Std. Dev.	0.819	-0.017	0.101	0.599	1.005
	Std. Error Mean	0.133				

Table J.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Driver informs the students about emergency exits	N	38				
	Mean	4.45	0	0.12	4.21	4.68
	Std. Dev.	0.76	-0.024	0.115	0.525	0.971
	Std. Error Mean	0.123				
Driver concerns on radio, climate and such devices	N	38				
	Mean	2.5	0	0.21	2.08	2.92
	Std. Dev.	1.331	-0.02	0.077	1.149	1.454
	Std. Error Mean	0.216				
Driver concerns on the music by himself till the journey	N	38				
	Mean	2.66	0	0.22	2.21	3.11
	Std. Dev.	1.419	-0.023	0.085	1.224	1.555
	Std. Error Mean	0.23				
Driver opens the door after the bus completely stops	N	38				
	Mean	4.76	0	0.07	4.61	4.89
	Std. Dev.	0.431	-0.007	0.047	0.311	0.495
	Std. Error Mean	0.07				
It is hot in the bus in spring months	N	38				
	Mean	3.16	0	0.19	2.76	3.55
	Std. Dev.	1.197	-0.023	0.093	0.983	1.358
	Std. Error Mean	0.194				
It is cold in the bus in winter months	N	38				
	Mean	1.87	0	0.16	1.55	2.18
	Std. Dev.	1.018	-0.026	0.155	0.683	1.297
	Std. Error Mean	0.165				
Disturbance from hot weather in spring months	N	38				
	Mean	2.66	0	0.23	2.24	3.11
	Std. Dev.	1.419	-0.026	0.115	1.149	1.591
	Std. Error Mean	0.23				
Disturbance from cold weather in winter months	N	38				
	Mean	1.95	0	0.16	1.63	2.26
	Std. Dev.	0.985	-0.032	0.158	0.634	1.249
	Std. Error Mean	0.16				

Table J.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Driver feels sleepy in the morning journeys	**N**	38				
	Mean	1.37	0	0.1	1.18	1.58
	Std. Dev.	0.633	-0.016	0.139	0.413	0.862
	Std. Error Mean	0.103				
Driver feels sleepy in the evening journeys	**N**	38				
	Mean	1.34	0	0.1	1.16	1.55
	Std. Dev.	0.627	-0.018	0.145	0.37	0.862
	Std. Error Mean	0.102				
Driver feels discomfort on the neck during the journey	**N**	38				
	Mean	2.03	0	0.21	1.66	2.47
	Std. Dev.	1.284	-0.032	0.157	0.917	1.527
	Std. Error Mean	0.208				
Driver feels discomfort on the shoulders during the journey	**N**	38				
	Mean	1.92	0	0.19	1.58	2.29
	Std. Dev.	1.148	-0.029	0.163	0.781	1.421
	Std. Error Mean	0.186				
Driver feels discomfort on the back during the journey	**N**	38				
	Mean	1.89	0	0.18	1.58	2.29
	Std. Dev.	1.11	-0.032	0.17	0.732	1.398
	Std. Error Mean	0.18				
Driver feels discomfort on the legs during the journey	**N**	38				
	Mean	1.66	0	0.16	1.37	1.97
	Std. Dev.	0.966	-0.044	0.221	0.5	1.319
	Std. Error Mean	0.157				
Driver feels discomfort on the thigh during the journey	**N**	38				
	Mean	1.71	0	0.16	1.42	2.05
	Std. Dev.	0.956	-0.034	0.18	0.547	1.247
	Std. Error Mean	0.155				
Status of the seat pan cushion hardness suit for the driver	**N**	38				
	Mean	0.03	0	0.02	0	0.08
	Std. Dev.	0.162	-0.037	0.096	0	0.273
	Std. Error Mean	0.026				

Table J.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Status of the seat pan width suit for the driver	**N**	38				
	Mean	0.21	0.01	0.12	0.03	0.47
	Std. Dev.	0.704	-0.038	0.229	0.162	1.033
	Std. Error Mean	0.114				
Status of the seat pan cushion height suit for the driver	**N**	38				
	Mean	0.08	0	0.08	0	0.24
	Std. Dev.	0.487	-0.095	0.3	0	0.82
	Std. Error Mean	0.079				
Status of the back cushion hardness suit for the driver	**N**	38				
	Mean	0.18	0.01	0.11	0	0.45
	Std. Dev.	0.692	-0.036	0.244	0	1.032
	Std. Error Mean	0.112				
Status of the back cushion width suit for the driver	**N**	38				
	Mean	0	0	0.11	-0.18	0.24
	Std. Dev.	0.658	-0.028	0.186	0.324	0.981
	Std. Error Mean	0.107				
Status of the back cushion height suit for the driver	**N**	38				
	Mean	-0.11	0	0.09	-0.29	0.05
	Std. Dev.	0.559	-0.048	0.218	0.162	0.891
	Std. Error Mean	0.091				
Status of the back cushion shoulder support for the driver	**N**	38				
	Mean	3.79	-0.01	0.2	3.37	4.18
	Std. Dev.	1.255	-0.024	0.198	0.801	1.589
	Std. Error Mean	0.204				
Status of the back cushion back support for the driver	**N**	38				
	Mean	3.68	0	0.21	3.26	4.05
	Std. Dev.	1.317	-0.025	0.174	0.916	1.605
	Std. Error Mean	0.214				
Status of the back cushion waist support for the driver	**N**	38				
	Mean	3.79	0	0.2	3.39	4.18
	Std. Dev.	1.255	-0.029	0.186	0.822	1.586
	Std. Error Mean	0.204				

Table J.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Driver would feel more comfortable if headrest exist	**N**	38				
	Mean	3.53	0	0.2	3.13	3.89
	Std. Dev.	1.246	-0.02	0.116	1.001	1.451
	Std. Error Mean	0.202				
Driver would feel more comfortable if armrest exist	**N**	38				
	Mean	3.58	-0.01	0.2	3.18	3.97
	Std. Dev.	1.287	-0.021	0.117	1.04	1.497
	Std. Error Mean	0.209				
Driver would feel more comfortable if armrest exist on both sides	**N**	38				
	Mean	2.45	0	0.18	2.13	2.82
	Std. Dev.	1.155	-0.018	0.11	0.921	1.351
	Std. Error Mean	0.187				
Driver would feel more comfortable if seat pan cushion was downward	**N**	38				
	Mean	2.45	0	0.19	2.08	2.82
	Std. Dev.	1.224	-0.021	0.103	1.004	1.397
	Std. Error Mean	0.198				
Driver would feel more comfortable if seat pan cushion was upward	**N**	38				
	Mean	2.5	0	0.19	2.11	2.87
	Std. Dev.	1.225	-0.023	0.1	0.997	1.388
	Std. Error Mean	0.199				
Driver would feel more comfortable if seat is laid back	**N**	38				
	Mean	2.37	0.01	0.18	2	2.74
	Std. Dev.	1.149	-0.02	0.115	0.905	1.344
	Std. Error Mean	0.186				
Driver would feel more comfortable if seat is upright	**N**	38				
	Mean	2.76	0	0.21	2.34	3.21
	Std. Dev.	1.283	-0.028	0.097	1.059	1.429
	Std. Error Mean	0.208				
Driver is able to feel more comfortable by moving the seat back and forth	**N**	38				
	Mean	4.32	-0.01	0.15	3.97	4.58
	Std. Dev.	0.962	-0.017	0.161	0.638	1.26
	Std. Error Mean	0.156				

Table J.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Driver is able to feel more comfortable by tilting the seat back and forth	**N**	38				
	Mean	4.11	-0.01	0.18	3.71	4.45
	Std. Dev.	1.134	-0.023	0.164	0.775	1.426
	Std. Error Mean	0.184				
Driver is able to feel more comfortable by moving the seat down and up	**N**	38				
	Mean	4.13	-0.02	0.18	3.74	4.45
	Std. Dev.	1.119	-0.018	0.169	0.751	1.398
	Std. Error Mean	0.182				

APPENDIX K

ONE SAMPLE T-TEST FOR COMPARING MEAN RESPONSES OF DRIVERS WITH 3

Table K.1 - One Sample T-Test for Comparing Mean Responses of Drivers with 3

	Test Value = 3					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Belt is fasten throughout the journey	21.277	37	0	1.737	1.57	1.9
Uncomfortable because of jouncing during the journey	-3.695	37	0.001	-0.684	-1.06	-0.31
Open the window when it is hot	4.093	37	0	0.789	0.4	1.18
Open the door when it is hot	-14.798	37	0	-1.737	-1.97	-1.5
Driver feels discomfort from noise of the students	-0.565	37	0.576	-0.132	-0.6	0.34
Driver feels discomfort from noise of the students in the morning	-2.265	37	0.029	-0.474	-0.9	-0.05
Driver feels discomfort from noise of the students in the evening	-1.168	37	0.25	-0.263	-0.72	0.19
Music plays in the service	2.784	37	0.008	0.553	0.15	0.95
Music disturbs the driver in the journeys	-3.541	37	0.001	-0.605	-0.95	-0.26
Driver can easily reach to the control panel since driving	13.832	37	0	1.447	1.24	1.66
Driver closes the door before he starts driving	25.226	37	0	1.763	1.62	1.9
Driver closes the door after he starts driving	-10.074	37	0	-1.553	-1.86	-1.24
Driver starts driving after all students sit their places	16.296	37	0	1.658	1.45	1.86
Driver intervenes when students try to open window	10.295	37	0	1.368	1.1	1.64
Driver informs the students about emergency exits	11.733	37	0	1.447	1.2	1.7
Driver concerns on radio, climate and such devices	-2.317	37	0.026	-0.5	-0.94	-0.06
Driver concerns on the music by himself till the journey	-1.486	37	0.146	-0.342	-0.81	0.12
Driver opens the door after the bus completely stops	25.226	37	0	1.763	1.62	1.9
It is hot in the bus in spring	0.813	37	0.422	0.158	-0.24	0.55
It is cold in the bus in winter	-6.852	37	0	-1.132	-1.47	-0.8

Table K.1 (Continued)

	Test Value = 3					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Disturbance from hot weather in spring months	-1.486	37	0.146	-0.342	-0.81	0.12
Disturbance from cold weather in winter months	-6.588	37	0	-1.053	-1.38	-0.73
Driver feels sleepy in the morning journeys	-15.88	37	0	-1.632	-1.84	-1.42
Driver feels sleepy in the evening journeys	-16.296	37	0	-1.658	-1.86	-1.45
Driver feels discomfort on the neck during the journey	-4.676	37	0	-0.974	-1.4	-0.55
Driver feels discomfort on the shoulders during the journey	-5.794	37	0	-1.079	-1.46	-0.7
Driver feels discomfort on the back during the journey	-6.139	37	0	-1.105	-1.47	-0.74
Driver feels discomfort on the legs during the journey	-8.561	37	0	-1.342	-1.66	-1.02
Driver feels discomfort on the thigh during the journey	-8.315	37	0	-1.289	-1.6	-0.98
Status of the seat pan cushion hardness suit for the driver	-113	37	0	-2.974	-3.03	-2.92
Status of the seat pan cushion width suit for the driver	-24.44	37	0	-2.789	-3.02	-2.56
Status of the seat pan cushion height suit for the driver	-37	37	0	-2.921	-3.08	-2.76
Status of the back cushion hardness suit for the driver	-25.089	37	0	-2.816	-3.04	-2.59
Status of the back cushion width suit for the driver	-28.122	37	0	-3	-3.22	-2.78
Status of the back cushion height suit for the driver	-34.218	37	0	-3.105	-3.29	-2.92
Status of the back cushion shoulder support for the driver	3.876	37	0	0.789	0.38	1.2
Status of the back cushion back support for the driver	3.202	37	0.003	0.684	0.25	1.12
Status of the back cushion waist support for the driver	3.876	37	0	0.789	0.38	1.2
Driver would feel more comfortable if headrest exist	2.603	37	0.013	0.526	0.12	0.94
Driver would feel more comfortable if armrest exist	2.774	37	0.009	0.579	0.16	1
Driver would feel more comfortable if armrest exist on both sides	-2.948	37	0.006	-0.553	-0.93	-0.17

Table K.1 (Continued)

	Test Value = 3					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Driver would feel more comfortable if seat pan cushion were downward	-2.784	37	0.008	-0.553	-0.95	-0.15
Driver would feel more comfortable if seat pan cushion were upward	-2.517	37	0.016	-0.5	-0.9	-0.1
Driver would feel more comfortable if heading of the seat is laid back	-3.389	37	0.002	-0.632	-1.01	-0.25
Driver would feel more comfortable if heading of the seat is upright	-1.138	37	0.262	-0.237	-0.66	0.18
Driver is able to feel more comfortable by moving the seat back and forth	8.435	37	0	1.316	1	1.63
Driver is able to feel more comfortable by tilting the seat back and front	6.008	37	0	1.105	0.73	1.48
Driver is able to feel more comfortable by moving the seat down and up	6.233	37	0	1.132	0.76	1.5

APPENDIX L

ONE SAMPLE STATISTICS OF DRIVERS FOR COMPARISON WITH 0

Table L.1 - One Sample Statistics of drivers for comparison with 0

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Status of the seat pan cushion hardness suit for the driver	N	29				
	Mean	0.03	0	0.03	0	0.1
	Std. Dev.	0.186	-0.04	0.111	0	0.31
	Std. Error Mean	0.034				
Status of the seat pan cushion width suit for the driver	N	29				
	Mean	0.28	0	0.14	0.03	0.59
	Std. Dev.	0.797	-0.051	0.259	0.186	1.152
	Std. Error Mean	0.148				
Status of the seat pan cushion height suit for the driver	N	29				
	Mean	0.1	0	0.1	0	0.31
	Std. Dev.	0.557	-0.129	0.345	0	0.93
	Std. Error Mean	0.103				
Status of the back cushion hardness suit for the driver	N	29				
	Mean	0.24	0	0.14	0	0.55
	Std. Dev.	0.786	-0.059	0.279	0	1.153
	Std. Error Mean	0.146				
Status of the back cushion width suit for the driver	N	29				
	Mean	0.03	-0.01	0.14	-0.21	0.34
	Std. Dev.	0.731	-0.054	0.208	0.325	1.088
	Std. Error Mean	0.136				
Status of the back cushion height suit for the driver	N	29				
	Mean	-0.03	0	0.06	-0.14	0.07
	Std. Dev.	0.325	-0.027	0.099	0	0.463
	Std. Error Mean	0.06				
Status of the back cushion shoulder support for the driver	N	29				
	Mean	3.76	0	0.24	3.28	4.21
	Std. Dev.	1.3	-0.039	0.233	0.779	1.661
	Std. Error Mean	0.241				

Table L.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Status of the back cushion back support for the driver	N	29				
	Mean	3.79	0	0.24	3.31	4.24
	Std. Dev.	1.292	-0.041	0.223	0.786	1.66
	Std. Error Mean	0.24				
Status of the back cushion waist support for the driver	N	29				
	Mean	3.79	0	0.24	3.31	4.24
	Std. Dev.	1.292	-0.039	0.223	0.774	1.66
	Std. Error Mean	0.24				
Status of the headrest hardness suit for the driver	N	29				
	Mean	0	0	0	0	0
	Std. Dev.	.000a	0	0	0	0
	Std. Error Mean	0				
Status of the headrest width suit for the driver	N	29				
	Mean	0	0	0	0	0
	Std. Dev.	.000a	0	0	0	0
	Std. Error Mean	0				
Status of the headrest height suit for the driver	N	29				
	Mean	0	0	0	0	0
	Std. Dev.	.000a	0	0	0	0
	Std. Error Mean	0				
Status of the headrest place suit for the driver	N	29				
	Mean	-0.03	0	0.03	-0.1	0
	Std. Dev.	0.186	-0.043	0.115	0	0.31
	Std. Error Mean	0.034				
Status of the armrest hardness suit for the driver	N	29				
	Mean	0.14	0	0.11	0	0.38
	Std. Dev.	0.581	-0.085	0.289	0	0.942
	Std. Error Mean	0.108				
Status of the armrest width suit for the driver	N	29				
	Mean	0.07	0	0.11	-0.1	0.31
	Std. Dev.	0.593	-0.089	0.299	0	0.988
	Std. Error Mean	0.11				

Table L.1 (Continued)

One-Sample Statistics		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Status of the armrest height suit for the driver	N	29				
	Mean	0.1	0	0.1	0	0.31
	Std. Dev.	0.557	-0.129	0.345	0	0.93
	Std. Error Mean	0.103				
Status of the armrest place suit for the driver	N	29				
	Mean	0.03	0	0.11	-0.14	0.28
	Std. Dev.	0.626	-0.072	0.275	0	1.037
	Std. Error Mean	0.116				

APPENDIX M

ONE SAMPLE T-TEST FOR COMPARING MEAN RESPONSES OF DRIVERS WITH 0

Table M.1 - One Sample T-Test for comparing mean responses of drivers with 0

	Test Value = 0					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Status of the seat pan cushion hardness suit for the driver	1	28	0.326	0.034	-0.04	0.11
Status of the seat pan cushion width suit for the driver	1.864	28	0.073	0.276	-0.03	0.58
Status of the seat pan cushion height suit for the driver	1	28	0.326	0.103	-0.11	0.32
Status of the back cushion hardness suit for the driver	1.653	28	0.109	0.241	-0.06	0.54
Status of the back cushion width suit for the driver	0.254	28	0.801	0.034	-0.24	0.31
Status of the back cushion height suit for the driver	-0.571	28	0.573	-0.034	-0.16	0.09
Status of the back cushion shoulder support for the driver	15.571	28	0	3.759	3.26	4.25
Status of the back cushion back support for the driver	15.807	28	0	3.793	3.3	4.28
Status of the back cushion waist support for the driver	15.807	28	0	3.793	3.3	4.28
Status of the headrest place suit for the driver	-1	28	0.326	-0.034	-0.11	0.04
Status of the armrest hardness suit for the driver	1.279	28	0.212	0.138	-0.08	0.36
Status of the armrest width suit for the driver	0.626	28	0.537	0.069	-0.16	0.29
Status of the armrest height suit for the driver	1	28	0.326	0.103	-0.11	0.32
Status of the armrest place suit for the driver	0.297	28	0.769	0.034	-0.2	0.27