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DRIVER'S SEAT FEATURES AND USER COMFORT ANALYSIS USING A STATISTICAL TOOL

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ABSTRACT

The improvements in Automobile car seat design of driver seats have been the area of immense interest for the past 10 years. It requires satisfying the ergonomics guidelines as well as considers the comfort expectation of the population. The number of cars reviewed for driver's seat features and user comfort are based on the analysis using a statistical tool. Improper design and uncomfortable seats imposes a lot of stress upon different body parts of driver. The response on the seat features of the consumers is collaborated and imported into the analytical workbench of SPSS. 1/3 of all drivers reported that they experienced moderate or severe low-back discomfort in a typical week and Low-back related sickness absence is 6 times greater for those who drive >4 hours a day. it can be concluded that the continuous movements of the seat have a beneficial effect on objective and subjective indicators of well-being.

KEYWORDS: driver seats, ergonomics, statistical, consumers, indicators

1. INTRODUCTION

Today's global competition has prompted many automotive manufacturers to design their products based on consumer's preference and satisfaction. In a car seat design and development, posture of car drivers among others is a critical factor that had to be considered closely and effectively. A car driver controls the vehicle and his/her comfort and safety is important to avoid any road injury or unfortunate accident. . This static sitting is known to cause physical fatigue [1] and restricted postures also lead to a higher risk of musculoskeletal complaints [2]. It is generally encouraged to periodically engage in non-sedentary activities [3], since remaining seated causes discomfort over time. However, this is not possible when traveling by car since both the vehicle interior and the driving task restrain posture [4] and thus it would result into abandoning the driving task and interrupting the journey. Previous research on comfort in office work has suggested that allowing for body movement is beneficial when the task does not allow for non-sedentary activities [5-13]. For instance, it seems necessary to enable frequent change between body postures provided that they are healthy and stable in order to improve seating comfort [5]. Graf et al. [6] also supported that natural movements (within an acceptable range) are desirable in workplaces. Furthermore, Fujimaki and Noro [7] showed in their research that during prolonged sitting natural movements occur in order to decrease discomfort. In their comfort model, Vink and Hallbeck [8] also identify body posture change as an enabler for comfort. Office chairs offering dynamic sitting have been developed according to this knowledge. These chairs are provided with certain swinging mechanisms for example, and these systems allow for a greater variation in the inclination angles of the seat [9]. Research shows positive effects of these kinds of chairs on muscle activity [10]. Groenesteijn et al. [11] also found that such a swing-system chair is related to positive comfort evaluations in the context of posture-restricting computer tasks. Moreover, an office chair with an unstable seat pan resulted in significant lower heart rate as well as the maintenance of oxygen levels in the tissues surrounding the ischial tuberosities [12]. Van Deursen et al. [13] also found that passive rotation in an office chair results in significantly more spinal length compared to no passive micro-movements for the same office tasks. Hence, posture variation can be considered beneficial to provide comfort during prolonged sitting. Here, the concept in the present research is to enable wellsupported postural change when travelling in a car by varying the seating angles. By alternating the seat configuration,

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different postures can be offered rather than solely providing micromovements locally. Hypothetically, this could counter physical fatigue or discomfort, since it should result into variation in pressure distribution and muscle activity. Recurring posture variation could not only decrease discomfort from prolonged sitting, but could also result in more perceived comfort for car drivers since pleasant stimulation of tactile sensation is related to comfort [8]. For car seats, the possibilities to vary posture are limited: Fast moving or instable systems could be dangerous during driving, the space in the vehicle interior is limited, and the driving task restricts the size and the direction of body movement. Therefore, this postural change cannot be achieved with swinging mechanisms as used in office chairs because of safety concerns. For this reason, the vehicle occupant's body is moved passively by varying the seat configuration electrically in this study.

Rajesh Kumar et.al [14] - performed the analysis of passenger car vehicle seat. In this study they found that comfort of seat can classified under two categories static and dynamic. They also analyse the factors like user subjectivity, seat geometry, occupant anthropometry and the amount of time spent affect the comfort during sitting. Main attention was given to lumbar support and after Hpoint measurement, pressure mapping and survey (jury evaluation) concluded that seat A has less lumbar support. Hanumant N Kale et.al [15] - studied about the various parameter involved in the design of driver seat. they showed how poorly designed driver seat affects the driver health and psychological condition of mind and discussed about all the parameters like anthropometry of human, ergonomics related parameters, seat materials, safety related parameters, comfort related parameters as well as weight and aesthetics with classification and basics of driver seat. He stated that apart from all other parameter safety and health related parameters are very important.

Peter Le et.al [16] -identified how physiological measures relate to vehicle seating discomfort. The study consisted of anthropometric characteristics of 12 people and was evaluated via three physiological measures– near infrared spectroscopy, electromyography and pressure mapping. Subjective discomfort in specific body location was predicted with help of conditional discomfort model through dichotomised physiological responses and anthropometry to predict subjective discomfort in specific body location. Nishant Srivastava et.al [17] - reviewed about the overall design and contour of vehicle seat for comfort and safety of drivers and passengers. He also find out that how improper design and unbalanced pressure distribution lead to the problem of pain, shoulder pain, lower back pain and injury from lifting increased and concluded that overall contour and proper designing directly and indirectly affects human life and also suggested for proper design of vehicle to reduce the problem of MSD among drivers. Ankit Jhinkwan et.al [18] – reviewed about the various injuries, comfort and discomfort factors related to the improper seat design of car and evaluate the design in order to optimize the different parameters which could reduce the injuries related to seat back and head rest and suggested that seat of driver should be ergonomically designed according to the contours of human body and head restraint so that it could provide necessary support to head & neck and leads to decreases the chance of injury. Niel Manfield et.al [19] – highlighted the effect of changing road condition and seat foam composition on driver discomfort in vehicle seats. Authors find that after 40 minutes there is discomfort in both the seat but the difference was insignificant and suggested for long duration dynamic testing while developing vehicle seats.

2. MATERIALS AND METHODS

The participants and parameters of study procedure for data measurement process and the statistical analysis are described in detailed. The final questionnaire went through various stages during the design and development phase. Many factors were considered, e.g. questions had to be specific, short and easy to understand for older people. Generally some people do not want to give their personal details such as name, date of birth etc. These types of questions were excluded from the survey for example; tick boxes were used to indicate their age range (20-34, 35-49, 50-64). However there was an option for participants to give their contact details for follow-up interviews or for clarification of any points.

Pilot study

A pilot study was conducted on the questionnaire survey; online and paper based versions focusing on the following points:

- To check the wording and structure of the questionnaire.
- To ensure that the responses were as anticipated.

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- To capture the time taken to complete the survey.
- To develop a strategy for data analysis using SPSS.

Participants
A convenience sample of drivers was obtained. This involves participants that are easy to find or available for the study (Owen 1998). It is a simple and quick method, commonly used in pilot studies. A total number of 77 participants took part in the pilot study .

Procedure
Prior to the data measurement process, the objectives and procedures of the study were explained in detail and participants were required to fill in their personal information in a form given to them. The measured anthropometrics dimensions were recorded in the same form. Before the postural angle measurement process was carried out, each participant anthropometric data was photographed and recorded. Participants are then required to sit on the driver's seat in their comfortable driving postures.

Statistical analysis: Data collection was made from Ujjain East to Ujjain West. The study was conducted on different age group from 20 to 65 years. The responses obtained through the data collection were tested to examine the validity and reliability of variable to obtain a statically proven identification of customer requirements. Data management and analysis was performed using SPSS tool. Statistical analysis involves a collection of methods used to evaluate large bulk of data and report the general trends obtained with highest scores.

3. RESULTS AND ANALYSIS

The measurement of body movements is as an objective indication of discomfort. These results show significant more body movement in the static seat for all body sections. This indicates that over time the human body could reject the position in which it is forced by the seat or that the resulting pressure distribution could grow uncomfortable. Therefore, the body posture is repeatedly adjusted. However, the urge to adjust the position of the head, arms, or legs is lower when the seat executes continuous movements in the seat pan and backrest. A possible explanation is that alternating the pressure distribution and body posture results in less experienced strain. It is also observed that body movements start to occur when discomfort reaches a certain level during 60 minutes of sitting. However, it is also possible that participants – who are laymen in comfort theories - do not clearly distinguish between support and comfort when rating the seat. However, it can be concluded that movements of the seat principally are experienced rather positively regarding comfort.

Table no. 1 Car Model Statistics for different age group

Age Group	Frequency	Percent	Valid Percent	Cumulative Percent
20-30	16	20.8	20.8	20.8
31-40	28	36.4	36.4	57.1
40-50	21	27.3	27.3	84.4
above 50	12	15.6	15.6	100.0
Total	77	100.0	100.0	

The anthropometric data and driver characteristics of the 77 participants were collected. Participants were 20-65 years of age (M = 57; F = 20), with differing levels of driving experience, ranging from (estimated) 1000 to 100,00 KM driven in Maruti and Hyundai. The age group between 20-30 year having valid percent 20.8 , 31-40 years is 36.4% and 40-50 years 27.3% while above 50 is 15.6% i.e comparatively less with others. In this survey participation of female respondent were 26% while 74% respondent were male. If we are see cars model v/s gender cross-tabulation it is clear that in maruti car maximum respondent were 24 for alto 800 and for Hyundai car maximum respondent were 16 for i10.

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Table no. 2 Car Model Statistics

Car Model	Frequency	Percent	Valid Percent	Cumulative Percent
Alto 800	24	31.2	31.2	31.2
Alto K10	12	15.6	15.6	46.8
Hyundai Eon	8	10.4	10.4	57.1
Hyundai i10	16	20.8	20.8	77.9
Hyundai i20	5	6.5	6.5	84.4
Maruti Celerio CNG Vxi	1	1.3	1.3	85.7
Maruti suzuki desire	1	1.3	1.3	87.0
Maruti Suzuki S-Cross	1	1.3	1.3	88.3
Swift vdi	1	1.3	1.3	89.6
Wagnor	8	10.4	10.4	100.0
Total	77	100.0	100.0	

Table no. 3 Car Model * Gender Cross tabulation

		Gender		Total
		Female	Male	
Car Model	**Alto 800**	5	19	24
	Alto K10	4	8	12
	Hyundai Eon	5	3	8
	Hyundai i10	4	12	16
	Hyundai i20	1	4	5
	Maruti Celerio CNG Vxi	0	1	1
	Maruti suzuki desire	0	1	1
	Maruti Suzuki S-Cross	0	1	1
	Swift vdi	0	1	1
	Wagnor	1	7	8
Total		20	57	77

The most important question was asked to the respondent that does the seat position make you feel congested and the fact was really shocking it was noticed that that the seating position is slightly low on the Maruti Suzuki compared to Hyundai. This does pose a problem for ingress and egress, especially for the elderly. You cannot walk into the cabin of the Alto like you can in a Hyundai Xcent. The seats at the front offer decent back and shoulder support. However, under thigh and lower back support leaves a lot to be desired. Another sore point is

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the integrated headrests, which aren't all that comfortable to rest the neck on. Maruti hasn't been stingy with the cushioning and the seats can be called comfortable.

So this clearly shows most of driver agree in keeping view of price but 37.7% drivers were very much disappointed by the dashboard height and the driver seat is not height adjustable.

Table no. 4 Does the seat position make you feel congested?

Does the seat position make you feel congested?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	21	27.3	27.3	27.3
	Disagree	20	26.0	26.0	53.2
	Strongly Agree	7	9.1	9.1	62.3
	Strongly disagree	29	37.7	37.7	100.0
	Total	77	100.0	100.0	

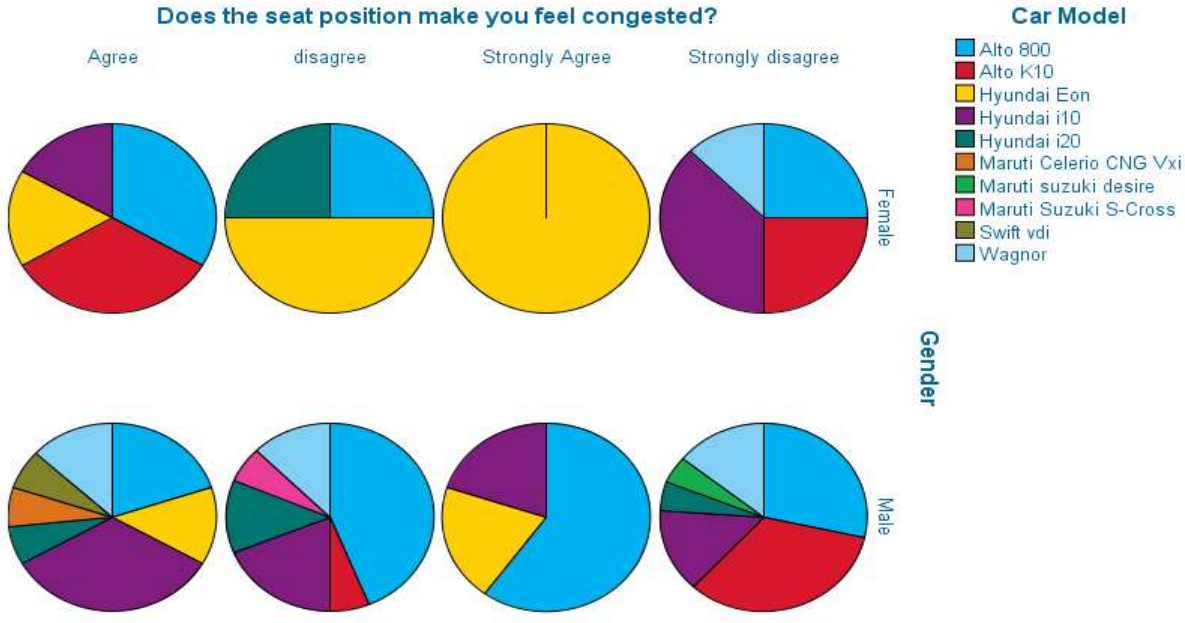

Fig 1 (Graph for Participants satisfaction)

4. CONCLUSION

This study has explained the central importance of incorporating comfort in driver's car seat design. The response on the seat features of the consumers is collaborated and imported into the analytical workbench of SPSS. The analysis of the feedback data provides the features of the different car seat models that are responsible for providing the most comfortable driving experience to its consumers. The seat's comfort and support are evaluated significantly better in the dynamic configuration. However, it can be concluded that the continuous movements of the seat have a beneficial effect on objective and subjective indicators of well-being. 1/3 of all drivers reported that they experienced moderate or severe low-back discomfort in a typical week and Low-back related sickness absence is 6 times greater for those who drive >4 hours a day.

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