

Ergonomic Analysis of Bangladeshi Train Passengers

Sajia Afrin Shifa*, Md. Golam Kibria

Department of Industrial Engineering and Management, Khulna University of Engineering & Technology, Khulna-9203,
BANGLADESH

ABSTRACT

Though the train is a common mode of transportation in Bangladesh, it is imported for passengers without considering ergonomic design for the users. The objectives of this study were to identify performed activities and corresponding posture of the passengers, duration of the activities and to assess the comfort in respect of the performed activities and postures. Activities and duration were recorded with a smart phone. The postures were defined using coding technique. A comfort questionnaire was given to weigh the passengers comfort experiences in combination with the activities performed. Eight discrete postures were defined with four main activities: Staring, Sleeping, Talking and Listening to music or using mobile phone. The combination of activities and postures connected to comfort scores. For passenger seat design, it is very important to consider the postures. Vital consideration need to be taken for the long-performed activities (such as sleeping) to avoid musculoskeletal risks. The outcome can help to improve the existing seat design and interior facilities of train as to Bangladeshi passenger's ergonomic consideration.

Keywords: Train passenger comfort, activities, postures, seat design

1. Introduction

Most of the country prefer train as a safer and cheaper transportation mode than others. It is a common mode of transportation in Bangladesh also. Trains are imported for Bangladeshi passengers without considering ergonomic design for the users. As a result, people uncomfortably do their journey from one place to another. Particularly, passengers comfort during leisure and relaxation is important. These are the motivation to make ergonomic analysis of Bangladeshi train passengers. Dhaka-Khulna intercity trains were considered for this work. The study of corresponding postures is not involved though few studies in different countries on activities performed during train travel were carried out with survey or observations [1, 2]. The study assured that the postures and the muscle activities of the erector spinae and trapezius muscles rely more on the activities performed than on the use of a specific type of chair. [3]. To use as inputs for car seat design, the activities performed and the associated postures adopted were recommended [4]. In this study the experienced comfort is not considered. To create a comfort experience, it is necessary to consider the behavior, the perception and also the abundance of users. The comfort of rides has been identified as one of the top criteria that affect customer's satisfaction with public transportation systems, and it has been shown that comfort is a significant consideration for passengers that use public transportation [5, 6 and 7].

The article created some insight in activities, posture and comfort of seated train passengers and the outcome of the study can be used to design peaceful seating in the industry of transportation [8].

The objectives of the work were

1. To select mainly performed activities and resembling postures of train passenger

2. To identify the duration of the activities and assess the comfort in respect of the performed activity.

2. Methodology

The observations were made from different trains with same types of second class shovon chair over 200 passengers using smart phone.

2.1 Activities and Postures Observation

During real train rides in Bangladesh the activities and postures of train passenger were observed. The observations were made in two different train with same types of second class shovon chair. A portion of the observed travelers performed a brief questionnaire to assess the comfort experience with respect to their performed activities.

2.1.1 Momentary observation

It was performed in order to get highest performed activities of broad group of passengers. Total 200 observations were used including 66 females and 134 males where 182 persons of 18–60 years and 18 persons of greater than 60 years. Smart phone was used to record the observation.

2.1.2. Longer observation

A few group of passengers (23 passengers) was observed for longer period of time to study durations of performed activities and variation of activities in one journey. The observation duration lasted almost 7-8 hours. The passengers' activity and postures were determined at the beginning of the observation, and after that real-time activity changes and little movements were recorded.

2.2 Coding Technique:

In Table 1, the coding technique for defining postures are shown. Each posture was represented by a set of five figures for seat contact and three for body part postures: e.g. 34111212. The first figure refers to the contact of the head, the second to the backrest, the third to the seat, the fourth to the feet, the fifth to the arm, the sixth to the head position, the seventh to the trunk position and the eighth to the legs [8].

Table 1 Coding Technique for positions

	i. Head contact	ii. Backrest contact	iii. Seat contact	iv. Foot Contact
1	Back	Upper	Back	Footrest
2	Side	Middle	Middle	Floor
3	No contact	Lower back	Front part	Wall

	v. Arm contact	vi. Head	vii. Trunk	viii. Legs
1	Seat	straight	straight	Parallel
2	Arm rest	forward	forward	Not Parallel
3	Table	sideward	sideward	Crossed
4	No contact	asymmetric	asymmetric	Bended
5			slumped	

Along with this eight figures, the following variables were also recorded:

- Ride characteristics: train, bogies
- Person characteristics: seat number, sex, age
- Main activities: Using laptop, listening music or using mobile phone, reading book/paper/magazine, talking with people, making a call, writing, staring, sleeping, eating /drinking, other activities.

2.3 Comfort Questionnaire

A comfort questionnaire was made over 50 passengers who responded to assess the passengers comfort experiences in combination with the activities performed. On a 10-point scale (from 10 = high to 1 = low), the passengers were questioned about their seat comfort experience with their performed activity.

3.0 Data Analysis

3.1 Instantaneous Observation Analysis

This observation was performed to pick the most common activities that occurred with highest frequency. Low frequency activities were excluded for the ease of further analysis. Therefore, the following analysis steps were performed:

- 1) Generation of frequencies of all activities recorded;
- 2) Selection of the four main activities with the highest frequencies;

3) Selection of the main postures resembling to the four main activities using the top frequencies of the body part posture and seat part contact codes combination. The codes are head position, backrest contact, back posture, buttock seat contact and footrest contact which represent the most important body parts and contact areas in relation to seat design. For reducing the probable combination, arm and leg postures were trimmed as observed other criteria appear more relevant than these two.[8]

4) Identification of top eight of postures by selecting the posture-contact codes.

The top eight posture code with maximum frequencies are as follows:

Table 2 Top 8 postures code with frequency

No	Posture code	Frequency
1	21211351	11
2	33111211	9
3	21321352	8
4	33121212	8
5	21211352	7
6	31111151	7
7	34311351	7
8	21121341	6

3.2 Duration observation analysis

The average duration of activities over the subjects are shown in the table 3

Table 3 Activities with average duration

Activities	Average Duration (min)
1. Staring	116.27
2. Sleeping	198.87
3. Talking	25.67
4. Listening music or using mobile phone	47.93
5. Reading book/paper	15.5
6. Eating or Drinking	18.21
7. Making a call	14.53
8. Using laptop or notepad	76
9. Writing	15
10. Others	26.57

3.3 Comfort questionnaire analysis

The average comfort score for the seat and for the top eight postures was determined, from the data using the similar codes for observation and questionnaire per passenger. In this case, the data amount was not enough large to do a fine analysis.

4.0 Result and Discussion

4.1 Activities instantaneous observations

The Fig 1 depicts the percentages of various activities from which four top activities are found that are Staring, Sleeping, Talking and listening music or using mobile phone.

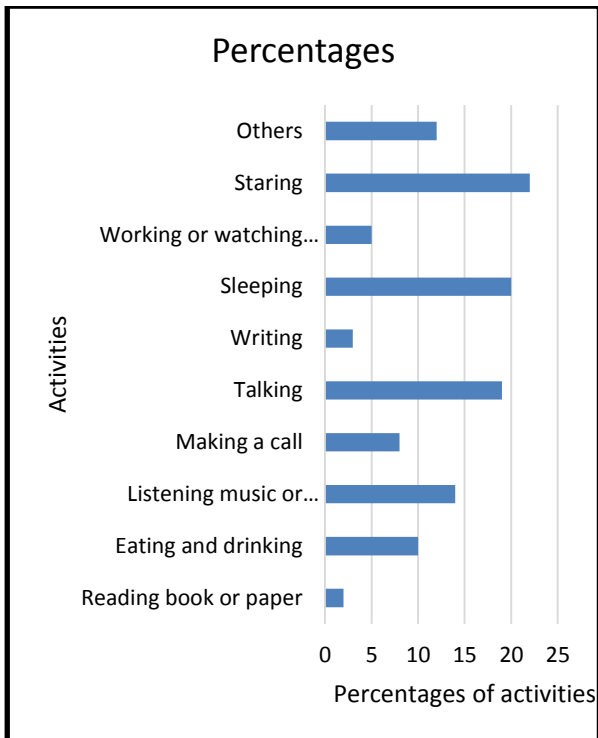


Fig 1 Percentages of activities

For the main activities staring, sleeping, talking and listening music or using mobile phone, the top eight most observed postures are shown in Table 4. Body part position were defined according to Groenesteijn [8] with addition to foot contact.

Table 4 Top eight of observed postures

	Body part position	Stick Diagram
1.	Head upright Trunk backwards Full seat contact Foot contact on floor	
2.	Head upright Trunk upright Full seat contact Foot contact on floor	
3.	Head forward Trunk upright Full seat contact Foot contact on footrest	

4	Head sideward Trunk backwards Full seat contact Foot contact on footrest	
5	Head forward Trunk backward Full seat contact Foot contact on floor	
6	Head sideward Trunk upright Full seat contact Foot contact on footrest	
7	Head sideward Trunk slumped Middle + Front seat contact Foot contact on floor	
8	Head sideward Trunk upright Full seat contact Foot contact on floor	

The posture with the head upright, the trunk backwards, full seat contact and foot on the floor was found in all four activities. In longer observation, sleeping was the activity with highest duration and the second highest is staring.

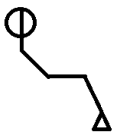
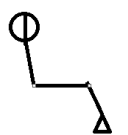

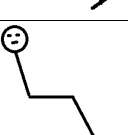
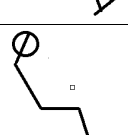
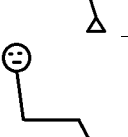
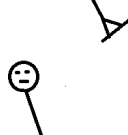
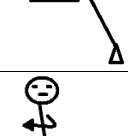
4.2 Resembling Postures and Perceived Comfort for Main Activities

Out of the responses of 50 (13 female and 37 male) passengers who completed the questionnaires, 20 subjects were staring, 11 subjects were sleeping, 2 subjects were listening music and 8 subjects were talking.

Table 4.2 shows the observed posture activity combinations and the corresponding comfort scores. Discrete postures were observed for each activity and comfort scores varied in respect of to the combination of posture and activity. Here in the first posture, staring,

sleeping, talking and listening music or using phone possess comfort 60%, 60%, 70% and 50% respectively. In the second posture staring, sleeping and listening music or using phone have comfort only 40%, 50% and 60% respectively and the rest can be explained as same.

Table 5 Main activities, corresponding postures and comfort score

postures	staring	sleeping	talking	Listening music or using mobile phone
	6	6	7	5
	4	5		6
	7	6	7	
	6.5	5	4	
	6	5		5
			8	
		6		5.5
			5	

5.0 Conclusion

The goals of this study were obtained eventually. Four mainly performed activities: staring, sleeping, talking and listening music or using mobile phone were found. Associated with these four activities, eight different

postures were found based on the variations in head position, back posture and seat pan contact. The posture with the head upright, the trunk backwards, full seat contact and foot on the floor was the observed posture that occurred in all four activities. Sleeping was the activity with longest duration and writing was the activity with shortest duration. The comfort in respect of the performed activities and postures were also determined. The comfort score was highest for talking with the posture of head sideward, trunk slumped, and middle + front seat contact, foot contact on floor.

The research work will be helpful for Bangladesh Railway (BR) to evaluate train environment considering passengers' performed activities, postures and construct ergonomically fit passenger train seat assessing comfort score. In this study along with the described postures and activities, more specification is needed to provide recommendations for train seats and train interior design. The manufacturer should produce train seat in such a manner that it can give comfort to the lion's share of the population. The study will be helpful for providing more features according to performed activities and corresponding postures. The study shows longest duration for sleeping and so special concern should be given for this activity.

6.0 Recommendations

A movable situation often influences the chosen activities. Vibrations and sudden movements of the train have an influence on the comfort feeling of passengers. As the data of this study was collected in running trains, there may be some biasness with vibrations and movements. So the recommendation is to consider the necessary calculation for vibration and movement. There may have some potential activities that passenger want to perform which should be explored. The train seat should be evaluated according to human anthropometry to check if there is any mismatch.

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