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Passenger Activities, Postures, Dis(Comfort) Perception, and Needs During Train Travel

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Abstract. This study aims to collect data on the activities, postures, dis(comfort), and needs of train passengers. Observations in the trains and questionnaires completed by train passengers were used. The online questionnaire was completed using the smartphone of the passengers during the train trip. The most often observed activity of the passengers was using a smartphone while travelling. They used a smartphone to listen to music, chat or type, look at a video or picture, and to read. Most passengers reported that they hold a smartphone with both hands and used a smartphone with the right hand also. The thigh support and the armrests of the seat showed the lowest comfort and certainly have room for improvement. Future research could be considered to design the seat to increase passenger comfort while using a smartphone.

Keywords: Train · Smartphone · Discomfort · Activities · Posture

1 Introduction

From 2016 to 2020 the number of smartphone users worldwide continuously increased from 2.5 to 3.5 billion. The Global Digital Report (2019) showed that internet usage via a mobile device has jumped from 26% in 2014 to 48% in 2019. Smartphones can be used in many locations, for example in bed, on the airplane, and on the train. Observations by Kilincsoy and Vink (2018) in the train in the Netherlands showed that smartphone use increased from 12.1% in 2014 to 48.3% in 2018 and the activities that are done using the smartphone differed in duration. Honan (2015) described that smartphone use influences the neck flexion, eye strain, and pain in the arm, wrist, and fingers. More pain and fatigue were reported when the smartphone was used for a long period (Kim and Koo 2016). This might lead to Musculoskeletal disorders (MSDs) or Smartphone Syndrome.

The smartphone is also used on trains and facilitating smartphone use by reducing neck flexion might be a way to attract more passengers on the train, besides creating more comfort. Postures and activities on the train have been studied previously (Branton and Grayson 1967; Bronkhorst and Krause 2004; Groenesteijn et al. 2014; Kilincsoy and Vink (2018). However, the interaction with information and the communication

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technology possibilities have been changing drastically. For example, previous studies by Kilincsoy and Vink (2018) and Kamp et al. (2011) observed passenger activities on the train. But both studies collected several activities: sleeping, reading, talking or discussing, and others. However, the activities of the passenger in the 2018 study on the train changed drastically. Thus, new knowledge on postures and activities is needed to optimize train interiors to facilitate that the traveller can both work and relax optimally. More background knowledge is needed to define which part of the interior should be optimized. The 3 main research questions for this study are: 1) How much smartphone use can be observed in train passengers in Thailand? 2) What activities are performed on the smartphone? 3) How is it linked to posture change and dis(comfort) perception?

2 Methods

To answer above mentioned questions train passengers were observed, and asked to complete questionnaires. This study is based on the methods used by Groenesteijn et al. (2014). The observation focused mainly on the percentage of passengers using a smartphone, while the questionnaires were used to collect the performed activities and tasks while using a smartphone. The researchers collected the data in a sprinter train starting at Nakhonratchasima train station in Thailand in 2020. A pilot test was conducted with 40 paper questionnaires and 18 online questionnaires using a mobile phone. 19 copies were returned of the paper version and 11 were completed. All 18 persons who joined the online questionnaire returned their questionnaire completed. For this reason, the online questionnaire was selected. Based on the pilot nine postures were defined and a tenth 'other' was added (Fig. 1). Five researchers were trained to conduct the research. The researchers started each session by explaining the project objective and benefit to the participant. Then they recorded an observation using an observation form. The main characteristics of the ride were noted (three inputs): train, class, and railway carriage number. Then the total number of passengers, and passengers who use a smartphone were noted by the observers. Then the train passenger was asked to fill in their performed activities, posture, dis(comfort) experience, and their needs in the online questionnaire. They sat on the seat and conducted their normal activities while completing the comfort questionnaire on their smartphone. The global and local discomfort scores were collected using a CR-10 scale (Borg 1982). For each body part, they could rate discomfort on a scale of 1–10 (1 = No discomfort at all, 10 = Extreme discomfort) using a local discomfort map by Corlett and Bishop (1976). The first part of the questionnaire provided the consent form, in which the participants could make their decision to participate or not. After that, they completed the questionnaire and uploaded it by clicking a submit button.

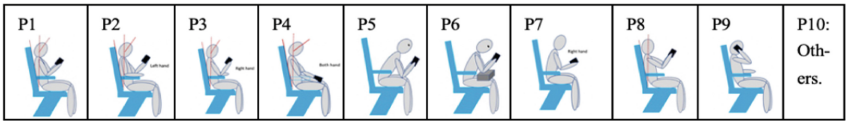

Fig. 1. The corresponding posture related to smartphone use.

3 Results

3.1 Observation Results of the Main Activities Performed by the Train Passengers

The observation could answer the research question on which percentage of train passengers use a smartphone. The researchers collected the overall number of train passengers, then the number of people who use a smartphone were recorded on the observation form. The results showed that out of 606 train passengers, 57.43% were using a smartphone during the trip. This is a 9.13% increase in smartphone use from the last publication by Kilincsoy and Vink (2018) as shown in Fig. 2.

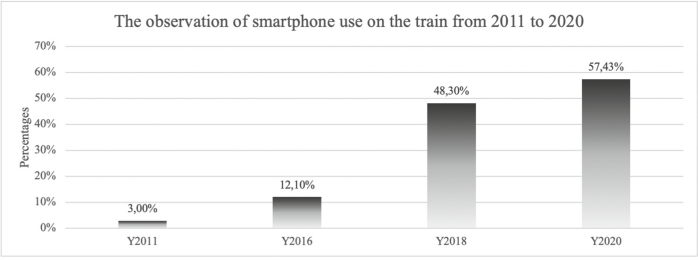

Fig. 2. Smartphone use in the train in several studies from 2011 to 2020.

3.2 The Questionnaire on Activities, Postures, Dis(Comfort), and Needs of the Train Passengers

The questionnaire was completed by 119 passengers who used a smartphone on the train. Mainly female passengers were in the study population (61.2% female, 37.3% male, and 1.5% considered themselves as others). Their reported average height was 164 cm, which varied from 150 cm to 183 cm. The weight varied from 40 kg to 100 kg, with an average of 64 kg. The ages of the participants varied from 18 to 67 years (average 31 years). Their jobs were a low-intensity 64.3%, followed by the moderate-intensity 27.0%, and 8.7% high-intensity. 47.97% of passengers travelled by train to visit their family, while, 20.27% and 18.24% stated that their trip was for holiday and commuting purposes respectively.

3.2.1 Main Activity of the Train Passengers

The passengers used a smartphone for 88.9% of the time and did other activities for the remainder. The last activities they did before answering the questions on the smartphone were listening to music (36.6% of the time), chatting or typing (22.2%), looking at a video or reading (17.9%, 16.1% respectively). For the questions what the passengers did on the smartphone for the whole trip, it was listening to music for 24.4% of the time, 18.9% chatting or typing on the screen. Looking at a video or picture for this groups was 16.9% of the time, and reading 13.39% as presented in Fig. 3.

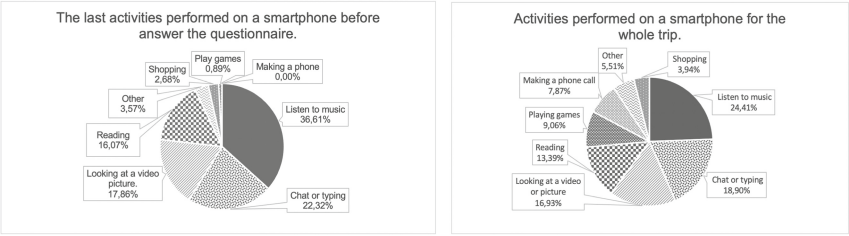

Fig. 3. The last activities performed on a smartphone before answering the questionnaire and activities estimated by the passengers over the whole trip.

The average duration for the main activity was approximately 98 minutes. However, they performed the tasks on a smartphone for 30 to 120 minutes. The minimum time was 10 minutes and the maximum 420 minutes. The travel time for the whole trip was on average 6.48 hours and the duration varied from 2 to 12 hours.

3.2.2 The Postures While Using a Smartphone on the Train

The observed postures while using a smartphone on the train are shown in Fig. 4. This picture include by the last posture before completing the questionnaire, and the posture as estimated for the whole trip. The two most common postures were holding the smartphone in the right hand, and using the armrests for 30.5%, and 23.3%, 26.3%, and 36.4% were using both hands to hold their devices, then using the arm support. Lower percentages were observed for the other postures.

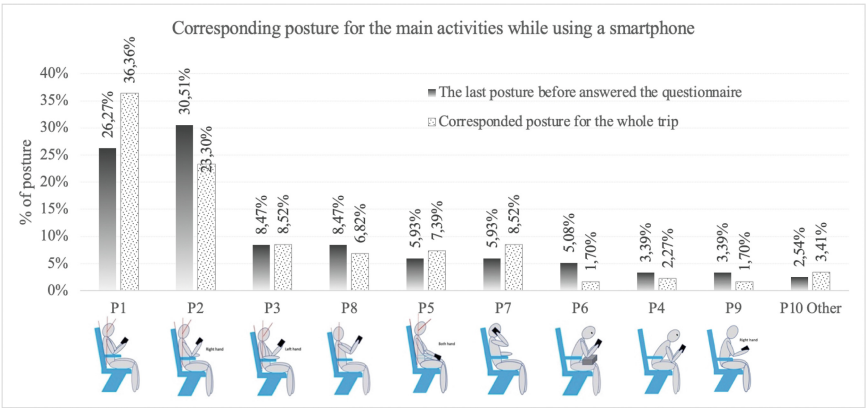

Fig. 4. Corresponding postures while using a smartphone on the train.

The passengers preferred to hold a smartphone with the right hand, and 20% used the armrests when listening to music. 10% held the devices with both hands, and put their elbows on the arm supports for chatting or typing, and assumed the same posture for 5.83%, and 5.00%, for listening to music, and reading, respectively. The corresponding posture and the performed activities of train passengers are shown in Table 1.

Table 1. The postures and the performed activities of train passengers (%).

Main activities	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
										
Listen to music	5,8	20,00	1,67	1,67	1,67	0,00	1,67	2,50	1,67	2,50
Chating or Typing	10,00	1,67	2,50	1,67	1,6	1,67	0,00	2,50	0,83	0,00
Looking at a video	2,50	4,17	2,50	0,00	2,50	0,83	0,0	2,50	0,00	0,83
Reading	5,00	2,50	1,67	0,00	2,50	0,0	0,0	0,00	0,00	0,83
Playing games	0,00	0,83	0,00	0,00	0,00	0,	0,00	0,00	0,00	0,00
Other	1,67	0,83	0,00	0,00	0,00	0,00	0,00	0,83	0,00	0,00
Shopping	1,67	0,00	0,83	0,00	0,0	0,00	0,00	0,00	0,00	0,00
Making a phone call	0,00	0,00	0,00	0,00	0,00	0,00	3,33	0,00	0,00	0,00

3.2.3 Dis(Comfort) Perception

Overall comfort and discomfort experience while using a mobile device on the train was 5.6 and 5.7 on a scale from 1 to 10 respectively. The seat pan was rated with the highest comfort score: 6.0. The upper backrest, lower backrest followed by a score of 5.8 and 5.6 respectively. For thigh support comfort score was lowest: 4.4. The comfort perception of legroom, armrests, and headrest were 4.99, 5.00, and 5.15.

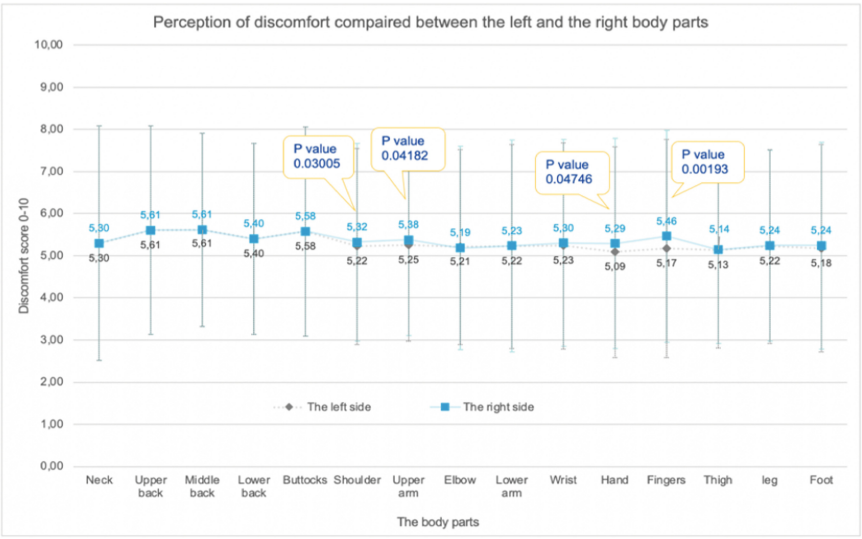

Fig. 5. Discomfort per body part for left and the right side of the human body.

Discomfort perception per body part showed that the upper back and middle back had the highest scores (5.6), followed by the buttocks, the right fingers, the lower back, and the right upper arm (5.6, 5.56, 5.4, and 5.4). Figure 5 illustrates the comparison of discomfort between the left and the right body parts. The Wilcoxon signed-rank test showed a significant difference for the shoulder, upper arm, hand, and fingers ($P < .05$). The right side showed a higher level of discomfort than the left side.

3.2.4 The Train Passengers' Needs Related to Comfort During Smartphone Use

On the general question "Which improvements are needed for comfortable smartphone use?" The Wi-Fi and charger score highest. 21% of the passengers preferred to have Wi-Fi and a charger. 18% mentioned that they needed a better seat pan, for example by increasing the softness and the width of the seat or by changing the cover material to reduce slipping while seated. 17% mentioned the cleanliness inside the train and physical problems like maintaining the same posture over time. Also, passengers mentioned improvement of the armrests such as by installing armrests between the two seats and improving the width and softness of the armrests. Additionally, the high level and the size of arm supports was mentioned by 15% of passengers. 12% of them preferred to have a headrest, and 12% needed more legroom.

4 Discussion

Kamp et al. (2011) found three main activities while people travelled by train: reading, talking/discussing, and relaxing. Seven years later Kilincsoy and Vink (2018) observed three tasks, smartphone use, staring/sleeping, and reading from paper. Groenesteijn et al. (2014) found 3 main activities: staring/sleeping, relaxing, and watching. The corresponding postures of the last study are presented in Fig. 6. Although smartphone use was not one of the main activities, the passengers held the smartphone with both hands or in the right hand, while using an armrest. This result is comparable with a previous publication by Gold et al. (2012), who found that 46.1% of the subjects use a smartphone with both hands, and 36.2% use a mobile phone on the right hand.

In this study, the main activity was using a smartphone. This may have been influenced by the rapid change of information and technology leading up to 2020. However, the other activities not related a smartphone use were the same as previous publications, for example, sleeping, watching or observing, and relaxing. But there was some decrease in percentages for some of these, such as sleeping, shopping, and eating on the train.

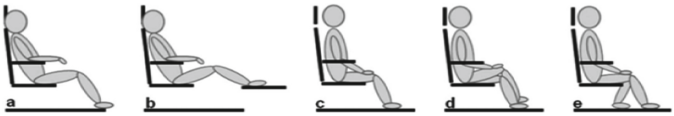

Fig. 6. Significant postures for sleeping (a and b), relaxing (a) and watching (c/d/e): studied by (Groenesteijn et al. 2014)

During smartphone use, upper back and middle back have the highest discomfort score. Udomboonyanupap et al. (2020) showed that passengers using a smartphone on

the airplane mentioned highest discomfort in the neck. An explanation could be that the heights of the participants were completely different. The average height of this study was 164 cm, while in the airplane study it was 175 cm. Moreover, the main activities in this train study were mainly listening to music (36.6%) and then neck flexion is not needed most of the time.

The results of this study indicate that comfort can also be linked to the armrests. For the two main postures observed, passengers used armrests while holding the devices. (Gustafsson et al. 2017) have reported ergonomic recommendations for texting on a smartphone. A forearm support was preferred while typing, to avoid the neck bending forward and during fast typing when using a small device. Van Veen et al. (2014) reported that discomfort decreases significantly for the neck with forearm support, but arms and hands were not significantly different. It was also because participants were able to adjust the height level of arm support to fit the participant's anthropometry and bring the screen closer to eye height.

Thigh support of the train seat in this study was also an issue. It was too high and the seat pan was too long. When passengers were sitting on the seat and they tried to put their feet on the floor it created more pressure on the thighs. This result is in alignment with Zenk et al. (2012), who reported that when there is too much load at the front of the seat, discomfort increases. Moreover Vink and Lips (2017) found that out of all body parts in the buttock, the area contacting the front area of the seat pan had the highest sensitivity levels, significantly higher than other areas in the buttock.

5 Conclusion

The main activity observed among 606 train travelers is using the smartphone. The smartphone is used for listening to music, chatting, looking at videos, pictures, and reading. Passengers report two main body postures during a train trip in which they use a smartphone. They preferred to use a smartphone with both hands, and resting their arms on the arm support. Also, passengers used frequently the right hand to hold a smartphone. In the seat, the thigh support and the armrests showed the lowest comfort score. These results might be useful for redesigns for train seats to increase passenger comfort, now that the activities they do have changed.

A limitation of this study was that some passengers preferred to sleep or were unwilling to answer the questionnaire. In future research it would be ideal to observe the duration of all of the other activities as well.

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