Passenger reasons for mobility transition from jet to train and turboprop

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Abstract

Turboprop airplanes and trains have the potential in being more sustainable for short distance travels. This paper focuses on identifying factors that influence passengers in the selection of transport. A questionnaire was developed by 4 experts and used in 3 workshops with 58 aircraft interior design experts. Besides, the answers of 20 passengers were incorporated as well for a holistic view of different stake holders. Results indicated that comfort, efficiency and sustainability are three categories of factors that influence the choice, where the leading factors are space, waiting time, seat and air quality. For traveling less than 250 km the train is the prefered. Twenty seven % has a preference for the turboprop airplanes for a distance of approximately 500 km. Next to the seat, noise is the second major barrier for the choice of the turboprop. Participants also complain about the outdated image of turboprops. This implies that 1) the environmental impact should be presented to the passengers in the selection process to raise their sustainability concerns; 2) in the design of interior for turboprop, seat comfort and noisie reduction are concerns that should be taken into consideration designing the interior. Exciting elements in the design should be considered as well for stimulating a more sustainable way of travel

Keywords: turboprop airplanes, trains, transport, aviation

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Introduction

In 2020 trucks and passenger cars are responsible for two-third of the CO_2 emissions.[1] The aviation sector is responsible for 2.8% of the global CO2 emissions and is one of the fastest-growing polluters with a CO_2 increase of 2.5 times from 2000 to 2019.[1] The train could be an alternative for the air travel for shorter distances as CO_2 emissions are much less if we leave out the construction of the infrastructure. Train stations also have the advantage that they are located in closer vicinity to city centers, However, this is not the case for all countries, e.g. in Brazil train transport is still limited.[2] Federici et al.[3] also demonstrate that in a selected number of cases the high speed train performs even worse than the air transportation due to the environmental impact of the infrastructures, e.g. the construction of tunnels and bridges.

Travelling by jets for short flights (less than 750 km) are polluting as during take-off and landing there is much CO_2 emission.[4] An alternative for jet airplanes could be turboprop airplanes. Turboprop airplanes have lower energy consumption and the use of SAF (Sustainable Aviation Fuel) leads to even lower fuel consumption and a further reduction of CO_2 emissions.[5] We can get even closer to zero-carbon emission as some current cargo turboprops will be changed using hydrogen's conversion kits,[6] which includes a fuel cell and an electric powertrain to replace conventional turboprop engines.

However, a serious issue for the adoption of the turboprop aircraft is the comfort experience of the passenger, primarily because of the noise and vibration inside a turboprop cabin,[7] e.g. the cabin noise of a turboprop can reach 76 dBA on average,[8] which is louder than that in the jet. Even though there are passenger comfort concerns, there could be market interest for turboprops. Embraer forecasts that the 70 to 130-seat airplanes fleet-in-service will increase from 2,700 aircraft in 2016 to 6,710 by 2036.[9] This shows the need for turboprops with a better passenger comfort experience to realize the reduction in emissions.

With the rising societal concern on the greenhouse gas emissions, it can be assumed that the future passengers prefer more sustainable ways of transportation. However, passengers also dislike the noise and vibration of turboprops. There is debate on how passengers make their choices. In an overview of 57 documents on MaaS (Mobility as a service), it was found that the choices for the type of transportation are made based on[10] cost, convenience, discovery/rediscovery of other modes, and personal reflection. According to Brauer,[11] most passengers first select based on convenience, time, and price. In those cases, in which the passenger is indifferent between equally convenient flights, other aspects like comfort and service play a role. It is worth mentioning that in 2004, sustainability was not a major societal concern.

The MaaS system itself might also influence the choices of passengers. It acts as habit intervenor, and over time passengers might make them more conscious of transport choices. Suppose passengers make conscience decisions and MaaS can help with that, then probably three clusters of criteria are of importance: efficiency (e.g. duration, costs), comfort (e.g. point-to-point, interior), and sustainability (environmental impact). For the future development of train interiors or turboprop interiors, it would be interesting to know whether passengers will choose based on sustainability, efficiency, or comfort. In the review of 57 documents[10] it is reported that "users and especially young people, seem to care more about affordability; they are aware of environmental issues, but if the sustainable option is not price-competitive, then they will choose the cheaper option. If MaaS is more expensive than their current travel expenditure, they are less likely to join."

To make the turboprop and train more attractive it is useful to know how passengers nowadays make their choices, which is studied in this paper. Therefore, the research question is: What factors are leading in transport selection and what needs attention to attract more passengers to the train and turboprop?

Method

To study the reasons why passengers choose transportation by train, turboprop, or jet aircraft and what should be changed to stimulate the

use of train or turboprop , a questionnaire was developed and used in several workshops. The elements included in the questionnaire were the results of a one-hour meeting with four experts (experts were defined as: senior persons that work in the aircraft interior design and manufacturing industry and have at least 8 years of experience in the industry). Consecutively, the questionnaire was used in three workshops of an hour with 38 experts (16 in the 1st, 11 in the 2nd, and 11 in the 3rd workshop) on aircraft interior design with the topic of how passengers could be attracted to the turboprop and train. All participants were asked to complete an informed consent. Before starting the discussion in the workshop, a questionnaire was completed by the participants with questions on when to use which vehicle and what should be improved to attract more passengers. During the discussion in the workshop, a whiteboard was used where participants could write down their comments. Notes were made on how many times an item are mentioned. This could be as a written comment, on a whiteboard, or as a spoken comment after the workshop.

Twenty passengers were asked to complete the questionnaire; this was in addition to the expert's possible less 'neutral' view. Descriptive statistics (percentages) were used to see what the preferences are for different transport modes over a certain distance (250, 500, and 1,000 km), what the reason are behind those preferences, and what should be changed to attract more passengers to the train and turboprop. A T-test was used to see if there is a significant difference between experts and passengers ($p<.05$), and to see if there are significant differences between space in the vehicle, air quality, seat comfort and cues in importance for the travel choice.

Results

Out of the 58 participants in the workshops, 2 participants explained in their informed consent that they did not want their data to be used in scientific research. So, the data of 56 participants were used. Six of the 36 workshop participants were younger than 30 years, 17 between 30 and 50 years old and 13 were older than 50 years (27 males; 7 females; 2 others). Seven of the other participants were younger than 30 years, 5 between 30 and 50 years old and 8 were older than 50 years (14 male, 6 female). The data of the 56 participants showed that for travel distances of around 250 km the train is preferred (Figure 1) if the price and beverage service is are the same. At 500 km jet, turboprop, and train all have approximately one-third of the preference. For 1,000 km the jet gets the most votes. In the discussion, 5 attendees mentioned that in practice the train is more expensive than a low-cost airplane also for 250 km, which does influence the choice significantly.

Figure 1 Preference for transportation type for 250, 500 and 1,000 km if the price and beverage service are the same according to 56 participants. So, 77% prefers the train for travels of around 250 km, 44% for travels of around 500 km and 79% prefers the jet airplane for travels of around 1000 km.

If we look at the elements that play a role in travel choice, we see that in only 19 out of the 56 participants mention sustainability (Figure 2). Comfort and point-to-point are more often the reason for choosing the type of transportation. No significant differences between age groups, and the two research groups were found (the expert group and the other travelers), also for the other findings no significant differences were found.

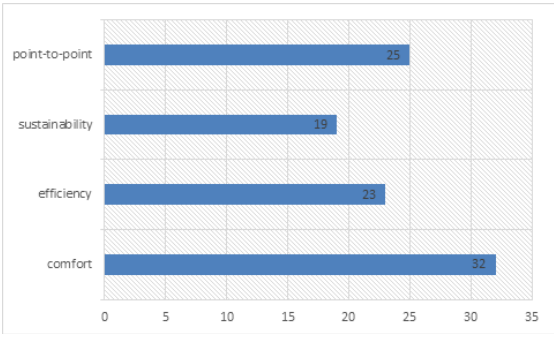

Figure 2 Elements playing a role in the choice for the type of travel according to 56 participants. (Participants could tick more boxes).

Elements of the interior that play a role in the choice are shown in Figure 3. In fact, all four elements space, waiting time, seat and air quality play an important role as all scores are 7 or higher. Air quality seems least important, and it seems to be important to avoid queues and reduce waiting times. The only significant difference found was between air quality and queues/waiting time. For the questions "If you want me to travel more by turboprop the following has priority…" noise and seat comfort were mostly mentioned. For the same question referring to the train, the seat was also important (Figure 4). For the open question 'what has priority to be improved to fly a turboprop instead of a jet?': 8 participants mentioned space (legroom, luggage space, etc.), 7 mentioned noise, 5 mentioned costs, 5 mentioned a better connection and interestingly 5 mentioned that it should be more attractive. One participant of these five stated: "the turboprop has an old fashion image, improve it and make it attractive".

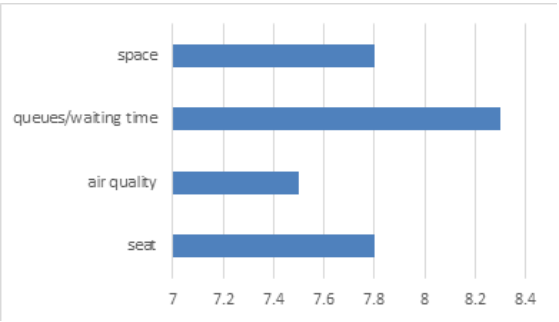

Figure 3 Answer to the question "for my travel ……. in the vehicle is of importance (1= not important at all; 10=of extreme importance). The difference between air quality and queues /waiting time is significant. (t-value = 2.52; p-value = .0066)

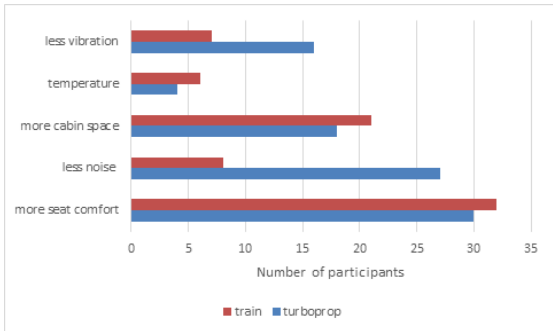

Figure 4 The number of participants answering "what should be improved to take more often the ….". It is clear that seat comfort has priority for both cases and less noise is needed to get more passengers to travel by turboprop.

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Discussion

Regarding the research question of what needs to be improved to attract more passengers to the train and turboprop, the seat and space seem to play an important role. This is not surprising as the seat's importance in travel is mentioned in previous studies.[12] Physical space is also mentioned before.[13] For the turboprop, the noise needs to be improved. This is in alignment with the study of Mansfield et al.,[14] which mentions that turboprop aircraft were considered noisy and therefore less comfortable than turbojets.

An element that is mentioned by five participants in the open questions, that the turboprop should be more exciting to avoid the image of being outdated is worthwhile considering. Liang et al.,[15] found in car interior research that interior elements that are interesting, dynamic, vigorous, and recreational relate to excitement, which might be good for turboprop interiors as well. However, further study is needed on what elements create excitement and comfort, if the noise can be reduced or changed into a nicer frequency, or if other elements could mask and/or compensate for the noise. It is worth looking into noise reduction as Lewis et al.,[16] found that passengers can be distracted from lack of legroom by gaming, but they could not be distracted from the discomfort caused by the sound of a crying baby. It's also worthwhile to look at the styling of the interior. McMullin[17] showed in her study that passengers liked the seats more in the sky interior of a Boeing 737 than in the traditional interior of a Boeing 737, while the seats are the same.

In some vehicles (e.g. BMW cars) drivers can choose between sport (fast), comfort (convenient), and eco (sustainable) (Figure 5). It might be good for choosing a type of travel to introduce a choice among sustainable, comfortable, or efficient travel plans. This way passenger can become more aware of their choice. The fact that passengers are not aware of the environmental impact of their journey during booking, because it's not clearly visualized, or that an alternative mobility choice is not yet shown during booking can be an explanation to the lesser importance of sustainability during the choice process as sustainability is rising in importance in public opinion. Also in the pre-study of our research with 4 experts, the importance for travel choice resulted in point-to-point, efficiency, comfort, and sustainability being most important. Point-to-point and efficiency could be combined as it is both related to faster travel.

Figure 5 In some cars, it is possible to adapt it to the preference of the driver by choosing between sport, comfort, and eco.

This study also has its limitations. The questions were asked without being in the context of the vehicle. Experiencing the three transport modes (rail, turboprop and jet) after each other prior to the workshop might be better to evaluate the user experience. Also, there is much variation in interiors and the answers are strongly dependent on what type of seats, airplane or train the participants used and how connections were and whether the participants have a train station or airport nearby. Research showed that there was a clear preference for one out of four very different aircraft seats[18] and even a small change in pitch or seat width has influence on comfort.[2] So, the seat itself might have much influence.

Nevertheless, the study indicates that the distance plays an important role in choosing the transport system, which is not a surprise. Choosing the most sustainable transport system does not have the priority for many participants in this study. Perhaps passengers should be tempted to choose the more emission friendly travel. As stated by Hendrikx[4] under the 750 km it might be interesting to stimulate more train and turboprop use. However, the train might take too much time for over 500 km and building high speed trajectories might create much emission.[3] Perhaps the turboprop (especially, the hydrogen version) might be an alternative for this range. However, turboprops have the disadvantage of noise, which is affirmed by other studies.[14] Reducing this problem or perhaps create more comfort in another way or by other making the interior more 'sexy' might attract more passengers.

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Conflict of interest

The Authors declares that there is no Conflict of interest.

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