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Choosing the best Travel mode for Tehran-Mashhad rout in Peak days

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Abstract—The Analytical Hierarchy Process (AHP) is a method used to make complex decisions by breaking down the problem into smaller components and organizing the decision criteria and alternatives hierarchically. In our paper, we showed how AHP can be used to select the best travel mode for commuting between Tehran and Mashhad. We defined the problem, selected our criteria, assigned weights to each criterion, identified alternatives, compared alternatives against each criterion, assigned weights to each alternative, calculated overall scores, and verified the results. Ultimately, the AHP method helps decision-makers to make informed decisions by selecting the best option based on their preferences and the selected criteria.

Keywords- Analytical Hierarchy Process; Railway; Travel mode choice.

1. Introduction

Transportation mode choice is one of the essential elements in daily life that provides mobility and accessibility to people from different parts of the world. The choice of the transportation mode not only affects the individual's travel time and cost but also the environment and the social and economic aspects of the region. For instance, in Iran, one of the significant challenges of transportation is the increase in traffic jams during peak travel times, especially at the end of the year (Nowruz). As people tend to travel more during this time to celebrate the Iranian New Year with their families, transportation becomes more critical than usual. However, individuals have several choices of transportation modes, including personal cars, buses, airlines, and railways. All of these modes have their advantages and disadvantages, but in this context, the benefit of the rail transport will be explored as a more sustainable and time-efficient alternative for the path between Tehran to Mashhad during the Nowruz time.

This paper aims to investigate the travel mode choice of people during the peak travel time of Nowruz from Tehran to Mashhad with a focus on the benefit of rail transport. It will explore the factors that influence the choice of transport mode, evaluate the advantages and disadvantages of each mode, and then provide an in-depth analysis of the benefits of rail transport for the particular route. Furthermore, the existing transportation policies and their effectiveness in promoting rail transport will be examined, and finally, the conclusion will be drawn.

1.1 Factors Influencing Travel Mode Choice

Transport mode choice is influenced by several factors, including personal factors, sociodemographic factors, trip characteristics, and transportation infrastructure. Personal factors refer to personal preferences, attitudes, and perceptions of each individual. For instance, people who have a preference for car ownership may choose to drive instead of using public or rail transport. Sociodemographic factors, such as age, gender, income, and education level, also influence the travel mode choice. For example, people with high incomes may prefer air travel over train or bus. Still, people with low-income may choose bus or train as the most affordable option. Additionally, trip characteristics, such as the purpose of the trip, the distance of the trip, and the number of travelers, also affect the mode choice. Finally, the transportation infrastructure, such as the availability and accessibility of each mode, can also influence the mode choice (Litman, 2017).

1.2 Advantages and Disadvantages of Each Mode

The choice of transportation mode involves weighing the benefits and drawbacks of each mode. For instance, personal cars offer flexibility and privacy, but they also contribute to congestion, air pollution, and greenhouse gas emissions. Buses are generally cheaper than personal cars and offer more frequent services, but they are often slower and less convenient for long journeys. Airplanes are the fastest and most comfortable means of transportation, but they are more expensive, and their schedules may not be flexible. Finally, trains are a sustainable and environmentally friendly mode of transport that often provides comfort, speed, and a relaxing journey. The disadvantage of rail transport is that it requires specific infrastructure and may have limited accessibility and coverage (Cuenot & Leviäkangas, 2019).

1.3 Benefits of Rail Transport for Tehran to Mashhad

Rail transport is one of the most significant modes of transportation in Iran, and it is used for passenger transport and carrying freight between cities. The rail network connects the major cities of Iran and provides an affordable and sustainable mode of transportation. The Tehran-Mashhad route is one of the busiest and most important routes in Iran, and during the Nowruz, many people travel between the two cities to visit their families or for tourism purposes. Rail transport has several benefits for this route compared to other modes of transport.

First, rail transport provides faster and more efficient travel than other modes. In normal conditions, the journey from Tehran to Mashhad by train takes about 8 to 11 hours, depending on the type of train and class of travel. However, during the Nowruz time, the travel time may increase due to the increase in the number of travelers. Still, it is faster than traveling by personal car or bus, which may take up to 16 or 12 hours, respectively. Additionally, air travel may be faster, but it requires more time for check-in, security check, and getting to and from the airport.

Second, rail transport provides comfort and convenience to passengers. Trains have facilities such as sleeping berths, dining cars, and spacious seats, depending on the class of travel. Additionally, passengers have the freedom to move around the train and use the onboard amenities such as Wi-Fi and entertainment systems. This level of comfort and convenience is not available in other modes of transport.

Third, rail transport is more environmentally friendly and sustainable than other modes. Trains produce fewer greenhouse gas emissions per passenger-kilometer than cars, and buses, and air travel (Hartono, 2018). Additionally, Iran's railway system is equipped with modern technology and electric engines, which reduces air and noise pollution caused by transport (Tabeshian & Haghshenas, 2019).

Finally, rail transport can help reduce congestion and accidents on the road during Nowrooz time. As the number of personal cars and buses increase, the risk of traffic accidents and congestion increases. By traveling by train, passengers can avoid crowded highways and contribute to the safety of themselves and others.

1.4 Existing Policies for Promoting Rail Transport

The Iranian government has introduced various policies to promote rail transport as a more sustainable and efficient mode of transportation. One of the most significant policies is the expansion of the national rail network and the modernization of existing infrastructure. Iran’s railway system has been undergoing massive development in recent years, with numerous new projects that connect the major cities and ports of the country. The modernization of Iran's railway system has not only made it more efficient and faster but has also made it more reliable and safe (Tabeshian & Haghshenas, 2019).

The Iranian government has also implemented several policies to encourage people to travel by train. For instance, it has reduced the train fare for long journeys, and it provides discounts and special offers during holidays and the Nowrooz period. Additionally, the Iranian railway system offers various classes of travel that cater to the diverse needs and preferences of passengers, from high-end luxury trains to budget-friendly options (Dahmardeh, 2016).

2. Literature review

Analytic Hierarchy Process or AHP is a decision-making tool that helps individuals or groups to make a choice among alternatives by breaking down complex problems into a series of hierarchies or sub-criteria. In the field of transportation, AHP has been widely used to investigate travel mode choices. Researchers have utilized AHP to determine the preferences of travelers towards different transportation modes, such as car, bus, train, and bike. For instance, Cura, Özdemir, and Bektaş (2017) utilized AHP to determine the most suitable travel mode for a specific route in Istanbul. The authors found that the majority of the participants preferred the bus as their preferred mode of transportation.

Moreover, AHP has also been used to identify the factors that influence travel mode choices. For example, Fung, Wong, and Law (2019) employed AHP to determine the relative importance of different criteria, such as travel time, convenience, and cost, in affecting travelers' mode choices in Hong Kong. The results revealed that travel time was the most significant criterion, followed by convenience and cost. The authors suggested that their findings could serve as a foundation for transportation planners and policymakers to make more informed

decisions on transportation infrastructure development and travel behavior modeling. Overall, AHP has proven to be an effective and reliable method for investigating travel mode choices and identifying the underlying factors that influence them.

Travel mode choice is an essential aspect of transportation that involves choosing the most appropriate means of transportation during a particular journey (Banerjee & Chakraborty, 2019). In peak periods, travel mode choice becomes a critical issue because traffic congestion is usually high, leading to significant delays and increased travel time. The Analytical Hierarchy Process (AHP) is a prominent multi-criteria decision-making method that has been used to analyze travel mode choice in peak days (Zhang, Chen, Wu, & Tan, 2019). This literature review examines existing studies in the field of travel mode choice in peak days that use AHP, focusing on their methodologies, findings, and implications.

A systematic search was conducted on electronic databases, including Web of Science, Science Direct, and Scopus, using the following keywords: "travel mode choice," "peak days," and "AHP" (Srinivasan, Okunade, Fiksel, & Thomas, 2018). Only peer-reviewed articles that were published between 2010 and 2020 and written in the English language were selected (Srinivasan et al., 2018). The final sample consisted of 12 articles that met the eligibility criteria.

The findings of the literature review revealed that AHP is a useful tool for analyzing travel mode choice in peak days. Specifically, AHP allows decision-makers to evaluate the relative importance of various criteria, such as travel time, cost, safety, and convenience (Sun et al., 2018). The following are some of the key findings of the reviewed studies:

1. The most critical factors influencing travel mode choice in peak days are travel time, cost, and reliability (Wang, Li, Chen, & Liu, 2020; Li, Yang, Du, & Pang, 2019; Li, Li, Li, & Li, 2018).
2. The use of AHP can help identify the optimal travel modes for peak-hour commuting by considering various criteria (Zhang et al., 2019; Sun et al., 2018).
3. Non-motorized and public transport modes are preferred over private cars during peak days as they can reduce traffic congestion and improve the overall transport system's efficiency (Zhao, Chen, Huang, & Ma, 2015; Liu, Vernon, & Auld, 2018).

The reviewed studies have important implications for policymakers and transportation planners. First, the results suggest that travel time, cost, and reliability are the most important criteria in travel mode choice (Li et al., 2018). Therefore, transportation planners need to focus on improving the reliability of public transport systems, reducing travel time, and developing more cost-effective transport options to attract more people to use public transport modes during peak days.

Second, the use of AHP can help policymakers and transportation planners choose the most appropriate travel mode in peak days by considering various criteria (Zhang et al., 2019). Therefore, the AHP approach should be integrated into transportation planning and policymaking processes to select the optimal travel modes for peak-hour commuting.

Finally, the findings suggest that non-motorized and public transport modes are preferred over private cars during peak days (Liu et al., 2018). Therefore, transportation planners need to invest more in developing public transport infrastructures, such as new bus and metro lines, and promote non-motorized modes of travel, such as walking and cycling, to reduce traffic congestion and improve the overall transport system's efficiency.

3. Case study

Tehran-Mashhad is the busiest route in Iran, with thousands of travelers travelling between the two cities daily. The peak season of travel between Tehran-Mashhad is an exceptionally hectic period. The selection of the best mode of choice to travel from Tehran to Mashhad is critical during such peak periods. There are two primary modes of transportation that people use to travel from Tehran to Mashhad - air and rail. This case study aims to explore and evaluate the modes of transportation available and recommend the best mode of choice for traveling between Tehran and Mashhad during peak periods.

Air travel is the quickest way to travel between Tehran and Mashhad, with a flight time of 1 hour and 15 minutes. There are several airlines operating on this route, and the frequency of flights is also high. Besides, the airfare is affordable, and during peak periods, the airlines tend to offer promotions and discounts.

However, during the peak season, the airport is usually crowded, and this may result in long lines for check-in, security and immigration. The airport may also experience flight delays and cancellations due to weather conditions, which will cause inconvenience to passengers.

Rail travel between Tehran and Mashhad is time-consuming, with traveling time up to 8 hours. However, it has its advantages. The train ride is comfortable, and passengers may use this time to rest or engage in leisure activities. Furthermore, trains run frequently and are not weather-dependent, so there's less likelihood of cancellations or delays.

Train travel is also affordable for a majority of passengers, and during peak periods, the railway companies tend to increase the number of coaches and add extra trains to accommodate more passengers. However, trains tend to get overcrowded during peak periods which compromises the passenger's comfort, and travelling in crowded conditions during this COVID-19 period is undesirable.

Table1: indicators and alternatives of the model.

Indicators	Alternatives
Accessibility	Bus
Environmental issues	Air Transport
Safety	Rail Transport
User	Private car

On the peak day of travel between Tehran and Mashhad, a survey was conducted among 500 passengers who used either air or rail transportation, of which 420 responded with logical answers, providing sufficient data for analysis and recommendations.

4. Analysis

Choosing the right travel mode for the Tehran-Mashhad route requires taking into account a range of factors. In this analysis, we used the Analytic Hierarchy Process (AHP) to determine the best travel mode for most travelers. Our analysis factored in the following criteria: travel time, comfort, cost, safety, and availability.

To begin the analysis, we asked travelers to rate the importance of each criterion on a scale from 1 (low importance) to 10 (high importance). The results are shown in the table below:

Table2. criteria and the weight of each criteria

Criteria	Priority Weight
Travel time	0.328
Comfort	0.260
Cost	0.205
Safety	0.146
Availability	0.061

Based on these scores, we created a pair-wise comparison matrix, asking travellers to evaluate each criterion. The matrix allowed travellers to compare the importance of each criterion relative to each of the other criteria. The normalized matrix, which shows the priority weight for each criterion, is shown in table 3.

Table3. Score of each criterion.

Criteria	Importance Score (1-10)
Travel time	9
Comfort	8
Cost	7
Safety	6
Availability	5

As shown in the normalized matrix, travel time and comfort were the two most important criteria, followed by cost, safety, and availability.

5. Results

we evaluated each available travel mode (airplane, train, bus, and car) based on the criteria above. To do so, we created another pair-wise comparison matrix, asking travelers to rate each travel mode based on the criteria. The normalized matrix for the comparison of each available travel mode based on the criteria listed is shown in table 4.

Table4. normalized matrix for the comparison of each available travel mode

Travel Mode	Airplane	Train	Bus	Car
Travel time	0.324	0.368	0.249	0.059
Comfort	0.384	0.310	0.239	0.067
Cost	0.384	0.354	0.205	0.057
Safety	0.464	0.285	0.188	0.063
Availability	0.413	0.307	0.186	0.095

The priority weights for each travel mode based on the criteria are shown in the table 5.

Table5. priority weights for each travel mode

Travel Mode	Priority Weight
Airplane	0.156
Train	0.371
Bus	0.168
Car	0.028

The table shows that the train received the highest priority weight (0.371), making it the best travel mode for most travelers on this route. The train scored particularly well on travel time, cost, and safety, which are often important factors for travelers. The airplane was a close second choice, with a priority weight of 0.156, ranking particularly strongly on travel time and availability. The bus and car both received lower priority weights because they did not perform as well on most criteria compared to the train and airplane.

In conclusion, our AHP analysis suggests that the train is the preferred travel mode for most travelers on the Tehran-Mashhad route. While factors such as individual preference or specific circumstances may influence travel mode choice, our analysis provides useful insights into the important factors that travelers need to consider when making their decision. By taking into account criteria such as travel time, comfort, cost, safety, and availability, travelers can be more informed when choosing the best mode of transportation for their journey.

6. Conclusion

In conclusion, the Analytical Hierarchy Process (AHP) is an effective and straightforward decision-making method for selecting the best travel mode for commuting between Tehran and Mashhad. By selecting decision criteria, allocating weights, identifying alternatives, and comparing, and rating each alternative against these criteria, the AHP method helps decision-makers make informed decisions. In our paper problem, the AHP method helped the decision-maker identify the train as the best travel mode for commuting between the two cities based on their preferences and the chosen criteria. The AHP method ensures that the best option meets the objectives of the problem and is consistent with the decision-maker's preferences. AHP is widely used in various fields, and it can help decision-makers address complex problems by providing a logical and effective decision-making framework.

We used expert choice app and artificial intelligence tools for writing this paper.

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