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Critical to Success Factors Towards the Development of Green Air Transport Systems in Iran

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Abstract: Air transportation is considered as one way to fast, secure and reliable transfer and is a more efficient alternative to long-distance transportation of passengers and goods, etc. Due to growing increase of air travel demand, environmental pollution resulted from it has been increased. The purpose of present study is investigating effective factors on development of green air transport system in Iran and its impact on sustainable development by taking into account the role of macro and politics. In order to data analyze, structural equation modeling based on partial least squares has been applied in PLS. The results of data analysis suggest that developing green air transport system in Iran at confidence level of 95%, affect sustainable development about 0.138. Moreover, the macro and political factors both affect development of green air transport system sustainable development. So that, macro and political factors have a significant impact, respectively at confidence level of 99 and 95%, on the development of green air transport system about 0.681 and on sustainable development, about 0.190.

Key words: Air transportation, sustainable development, green technology, demand environmental, transport

INTRODUCTION

Aircraft, in today civilized societies is one of the necessities of modern life because willingness to comfort and fast travel is an increasing trend in these societies, therefore result in growing demand to use this device. Now a days, reducing the use of fossil fuels and the tendency to use various industries, green technologies and fuels that have lower emissions is much needed and vital. Actually, the countdown of climate changes has started in the world and is developing rapidly. Unprecedented warming of the earth, increase of storms, floods, ice melting in poles and biodiversity destruction are the signs of climate change. Human activities are one of the most important factors to create these climatic changes. Preventing or in other words, managing crisis of climate change, require creating green industries and implementing them in our societies. Creating green industry is one the most important ways to solve environmental crisis. Green industry is an important factor to reduce carbon dioxide and ultimately, reduce greenhouse gases. Transportation include a major share of environmental pollution and air transport is not an exception because air transportation is considered as one way to fast, secure and reliable transfer and is a more efficient alternative to long-distance transportation of passengers and goods, etc.

Due to growing increase of air travel demand, environmental pollution resulted from it has been increased. According to report of International Air Transport Association (IATA), cutting flight times on a global basis by just one minute per flight would reduce carbon emissions by 4.8 million tons (4.4 million metric tons) annually (Boeing, 2014, 2015). Accordingly, investigating effective factors on development of green air transport system in Iran is necessary, so that this country be able to take effective step to reduce greenhouse gas, environmental sustainability and a future with carbon-free transport. Therefore, the purpose of this study is investigating effective factors on development of green air transport system in Iran. Green air transport includes activities to improve aircraft fuel efficiency, developing next generation of efficient air traffic control, developing new technologies and systems engineering processes, a future with carbon-free transport throughout the world. Environmental protection, minimizing side effects of air transport on the environment and sustainability of air transport be considered as one of the primary obligations of aviation industries and airlines.

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Green technology and sustainable development: The term of technology refer to using knowledge to scientific purposes. Green technology includes methods and techniques to produce clean and non-toxic energy. The goals that green technologies looking for are growing rapidly. Some of these goals are sustainable development, reducing waste and pollution, by changing production and consumption patterns, alternative innovation and development to fossil fuels, production of new energies and energy productivity (Pallavi, 2013). Requiring new technologies in today's world is high and undeniable. Technology act as a factor to develop and compete of countries and is one of the most important reasons of backwardness in underdeveloped countries is that these counties do not take advantage modern technologies in their foundation. Technology can play a significant role in welfare, comfort, improving human health, improving safety factor, life expectancy of human beings. However, in some cases, progresses and even backwardness in some human societies can have environmental destructive effects; progress due to this fact that can result in increasing demand and backwardness due to this fact that lack of taking advantage of modern and eco-friendly can result in destructive consequences and impacts to the earth's natural ecosystem.

Despite general evolution and developing infrastructure concepts in many parts, we can see that the energy sector has retained the same borders in >80 years. In the early 20th century, the industry efforts to meet society's expectations have accelerated. Increasing growth of demand along with changing political, economic, environmental challenges forecasts requiring a change and providing an approach that its infrastructures are appropriate economically and environmentally (Wendy and Janis, 2011). Since, the industrial revolution, five long-waves have emerged in innovation: water, steam, power, mass production and information and communication technologies (Moody and Nogrady, 2010). It is argued that the sixth wave will be resources productivity because the population is growing and lack of resources and high and hazardous pollution of waste and climate change also are increasing. Development without increasing resource consumption requires systematic progress in productivity that are new commercial models which can provide mobility, heating, cooling and lighting with smaller amount of resources and pollution. Air transport is inevitable part of daily life in the modern world. Using fossil fuels is not sustainable as an energy source to air transport. Air transport is one of the main factors to greenhouse gas emissions. Moreover, the price of fossil fuels is increasing and encounters high volatility. Therefore, introducing alternative fuels from renewable resource is necessary; renewable resource such as biofuels from renewable resources that their greenhouse gas emissions is relatively low and have high durability and are cost effective (Hari *et al*., 2015). Sustainable fuels can reduce life cycle of CO_2 emissions by up to 80%. So far, >1,500 passenger flights has been done with biofuels and it is believed that using biofuels can be profitable 80% more than traditional jet fuel in the life cycle (ATAG, 2014a, b). In January 2016, it was announced that United States airlines will purchase 15 million gallons of renewable jet fuel over a 3 years period (Lane, 2016). Boeing is pioneer in International cooperation to find solutions of complex environmental challenges. Protecting the environment and sustainability of air transport are as a part of primary obligations of this company. A new sustainable jet fuel can reduce carbon emissions to commercial air transport. Boeing has focused on sustainable biofuels which can directly combine with conventional oil fuels products and used without any changes to the aircraft. Sustainable air transport biofuels can be produced by organic sources such as plants, algae and inedible bio-based raw materials such as the waste oil, animal fat or municipal solid waste. Since, air transport is a global industry with aircrafts that every day pass through international borders, Boeing believes that a global system to deal with greenhouse gas emissions of air transport is needed. Boeing, completely support the position of ICAO to control emissions of air transport and together with others in air transport industry is working to fulfill these commitments. ICAO demand an international instruction such as developing a CO_2 standard to aircraft, improving traffic control systems to reduce gas emissions related to air travel up to 12% and constant effort to promote commercialization of sustainable alternative fuels. The purpose of all these efforts is achieving carbon neutral and reduces its side effects in commercial aviation by 2020. In October 2013, ICAO general assembly in Montreal agreed on a road map, in which the position of aviation industry moves towards a global market-based approach of climate change. Boeing believes that these conditions of ICAO reflect significant progress with more steps, towards a global approach to transport green house gas emissions. As air traffic grows throughout the world, air navigation and management services should be coordinated. Studies have shown that a modern air traffic management system can improve productivity of all flights up to 12% and reducing fuel consumption and greenhouse gas emissions as well as save time to passengers and crew. Upgrading global infrastructure of air traffic management system enhances operational efficiency and improves support and service delivery of aircraft operations. Utilizing pioneer technology industry

and Boeing developed patterns, providing services to airlines in order to estimate real-time, wind direction and receiving temperature data, directly and immediately deliver route's optimized data to aircrafts. Data generated by these applications, to predict more effective route, before starting flying operations and continued improvement of the route during flight operation, allow that proper information to be available to the flight crew and flight management system (Boeing, 2014, 2015). Air transport is considered as a fast, secure and reliable way of transfer and is a more efficient alternative to long-distance transport of passengers and goods compare other devices. One of ICAO environmental goals is minimizing International Air Transport side effects on environment through measures to reduce and greenhouse gas emissions in global climate. The key to success of green air transport is cooperation of all international and national stakeholders. ICAO and Member States in it actively are looking for the performance of a comprehensive strategy to deal with emissions CO_2 from air transportation. ICAO's key activities are: developing and facilitating measures to reduce emissions of CO_2 from international air transport such as aircraft technology, operational improvements, sustainable and alternative fuels to air transport, global market-based measures (Market-Based Market (MBM), its supporting and implementing is through assistance and making capacity to members. Green air transport includes activities to improve aircraft fuel efficiency, developing the next generation of efficient air traffic control, developing new technologies and systems engineering processes to carbon-free future of air transport throughout the world (ICAO, 2014). As a result of increasing demand to air transportation throughout the world and improving efficiency, it is predicted that the contribution of air transport in the future will increased. Therefore, public and political pressure has been more to reduce greenhouse gas emissions. Policy makers and stakeholders of aviation industry are encountering key challenge to reduce greenhouse gas emissions from air transport in addition to maintaining market transport of goods and passengers. Reducing emissions of CO_2 from developing commercial aviation transport can be achieved by five key levers:

- Improving efficiency and productivity of technology through vehicle fuel efficiency
- Improving operational efficiency such as the effects of airline operations (e.g., reducing aircraft weight by removing unnecessary equipment) and air traffic control operations (e.g., fuel efficiency, flight path, altitude, reducing ATC delay, etc)
- Using alternative fuels and fuels that emissions much less CO_2 than traditional jet fuels
- Changing demand towards reduction of travel, according to alternative choices (e.g., video conferencing, virtual meetings, etc)
- Fuel pricing as utilized mechanisms to increase fuel price and reduce demand through relationship between price elasticity of demand

These key levers are using as a base to produce input scenarios in dynamics model of global aviation industry, to evaluate reduction of CO_2 emissions of air transport, to period of 2004-2024 (Sgouridis *et al*., 2011). Since, at high altitude, the speed changes will be optimized, an aircraft can reduce its fuel consumption to some extent (Delgado and Prats, 2012). Satellite Ground Systems of Air Traffic Management (ATM) also play an important role to reduce delay of entry or exit as well as to control fuel costs and carbon emissions which both are important to airlines (Warwick, 2011).

In addition, an optimized system of Air Traffic Management (ATM) is able to reduce aircraft fuel consumption by 10%. On the other hand, communicational and advanced computerized technologies can be used to determine air routes and proper flight time in order to reduce aircraft carbon emissions by Zito *et al.* (2011). Reducing screen size and weight of its wiring, the size of seats can improve aircraft energy efficiency (Tsai *et al*., 2014).

Automation more than Air Traffic Control (ATC) can reduce the influence of climate change on air transport, however, it is anticipated that this improvement will be slowly. Resistance to modernization of ATC is considered as a very important issue. Although, the effects of this resistance are important to increase the yield and network externalities, based on political and organizational challenges, coordination of changes in ATC, according to this fact that determining ATC users experience is very important and difficult (quantitative measurement) to automation risks (in particular using complicated software) is a major obstacle to further progress (Spinardi, 2015). Updating wind is one of the effective factors to optimize flight which contribute saving fuel, reducing workload of flight crew, increasing accuracy and improving the time of flight operations. Automatic up dating wind will provide flight particular data in flight management computer or in loadable formats on FMC, provides. Without updating wind, the flight plan provided to the flight crew can be up to 20 h ahead. Inundating and limited weather data can prevent operation of aircraft in speed, altitude and optimal path (Boeing, 2015). In general it can be said that green air transport, includes many

activities such as working on aerodynamics, engine technology and biofuels as well as Air Traffic Control (ATC). Improving ATC is one advantage that can be performed without having to replace available aircrafts (Green, 2005).

MATERIALS AND METHODS

The research model: According to the outlined subjects in research theoretical principles, conceptual model of present research is conducted as Fig. 1.

Hypotheses: According to research conceptual model research hypotheses are expressed as follows:

- H_1: development of green air transport system in Iran has a significant impact on sustainable development
- H_2: macro and political factors has a significant impact on development of green air transport system in Iran
- H_3: macro and political factors has a significant impact on sustainable development

Statistical sample: This study has selected 85 members from faculty of higher education center of aviation and airports, Civil Aviation Technology College (CATC), aerospace research institute, experts of transportation management and planning organization, specialized experts of Iran airports company, design, construct and technical expert of aircraft those who work employed in civil aviation organization, experts of flight competence and standard as well as pilots and teachers of aviation in Mahan Air and the questionnaires has been distributed among them. Table 1 has shown the results of descriptive analysis of respondent's demographic statues.

Data collection method: In this study, four critical to success factors towards the development of green air transport systems in Iran has been evaluated. Moreover, the impact of moderating factors in the research conceptual model which is shown in Fig. 1 has been measured and its descriptive results are presented in detail. Standard questionnaire and also researcher made questions have been used to test hypotheses and then expert's views (Delphi method), on the questionnaire have been received and applied in questionnaire. This questionnaire, respectively has used 4, 5, 6, 3, 8 and 1 items to measure equipment, management system, economic efficiency, fuel (Table 2), macro-economic and political factors (Table 3), sustainable development (what is the impact of development green air transport system on sustainable development in Iran).

Table 1: Demographic status of participants (N = 85)

Variables	Frequency	Percent
Gender		
Male	82	96.5
Female	3	3.5
Age (years)		
Under 30	5	5.9
30-40	33	38.8
40 and 50	31	36.5
50 and 60	10	11.8
Over 60	6	7.1
Education		
Bachelor	36	42.4
MA	34	40.0
Phd	15	17.6
Tenure (years)		
<10	16	18.8
10-20	42	49.4
>20	27	31.8
Field of study		
Aerospace engineering	24	28.2
Electrical engineering, electronics and telecommunication	10	11.8
Civil engineering	3	3.5
Energy economy	2	2.4
Other (mechanical engineering, engineering aviation technology, aircraft maintenance engineering, industrial engineering, care flight, MBA, Mathematics and Physics)	46	54.1
Job		
University faculty members	17	20.0
Preeminent expert of aircraft design construct and technic	19	22.4
Pilot, aviation science teachers	33	38.8
Standard of flight	3	3.5
Other (expert in management and planning, flight operations, aircraft inspection)	13	15.3
Position		
Teaching and training	12	14.1
Iran airports and air navigation company	8	9.4
Civil aviation organization	10	11.8
Aviation and airport	43	5.6
Technical competence and standard of flight	12	14.1

Statistical techniques: Structural Equation Modeling (SEM) was used to measure proposed model. In the part of inferential statistics, partial least squares method in Smart PLS v.2 was used to test research hypotheses. PLS is a variance-based approach is that compare to similar structural equation techniques such as LISREL and AMOS, requires less conditions. For example, in contrast to LISREL, the PLS modeling is more suitable to actual applications, especially once that models are more complex and/or data distribution is abnormal; using this approach will be more appropriate. Of course, the main advantage of PLS modeling to LISREL is that it needs a less number of samples; however, relatively high sample size has been used in this study. PLS, at the same time, deal with two models: external model (measurement model) which investigates the relationship between obvious variables and hidden ones and internal model (structural model) which measures the relationship between hidden variables and other hidden variables.

Table 2: Critical to success factors towards the development of green air transport systems in Iran

Items	Effective factors on items
Equipment	
Aircraft technology and design	Changing in aircraft design such as using composites and lightweight structures
	Effective factors compatible with new fuels
	Design wing and fuselage
	Lowering the weight of passenger cabin
System management	
Management of air transport system and infrastructure	Outdated of equipment and aircraft performance
	Improving airports traffic control system
	Designing comprehensive airport with suitable capacity
	Airport infrastructure and quality of runway
	Pilot skills in directing aircraft
Economic efficiency	
Political, social and economic	Codified and strict environmental standards in the field of air transport
	Pricing aircraft services and profit margins of service companies
	The willingness of customers to use economical flights
	The effectiveness of using green technologies in aircraft
	International sanctions to import new aircraft, pieces and equipment
	Research and development of green technology
Fuel	
Alternative aviation fuels and fuel properties	Improving the quality of avgas
	Using biofuels
	Using green diesel

Table 3: Effective factors on moderating component

Moderating component	Effective factors on component
Macro and political factors	Alignment of green aviation industry with the priorities of science and technology
	Using capabilities of knowledge management network (universities, research centers, etc.) to develop green technologies
	Allocation of public funds of research and development to green technologies
	Government's commitment to sustainable development
	The structure of airline industry (competition and monopoly)
	Enforcement of environmental standards and other technology standards creating air hubs
	Sufficient infrastructure of research and development in the aviation industry to develop green technologies

Table 4: The results of AVE obtained from research variables

Variable	Green air transport	Macro and political factors	Sustainable development
AVE	0.523	0.546	1

RESULTS AND DISCUSSION

Convergent validation: Validity of questionnaire has investigated through convergent validity and divergent validity which is specific to structural equation modeling. Convergent validity refers to ability of dimension indices to explain that dimension and divergent validity indicates that the structure of research model should have more correlation with their questions than other structures (Hulland, 1999). This study, to evaluate the validity has used convergent validity by using AVE (Average Variance Extracted) related to research variables and results of this criterion have been shown in Table 4. The criteria to accept AVE is 0.5 (Magner *et al*., 1996) as it is described in Table 2, all AVE, value related to structures are higher than 0.5 and it confirms that convergent validity of present questionnaire is acceptable.

Table 5: The reliability analysis of hidden variables markers

	Variables			
Markers	Green air transport	Macro and political factors	Sustainable development	t-values
Fuel	0.648	-	-	15.586
Management	0.662	-	-	10.981
Politic	0.786	-	-	32.234
Tech.Desi	0.738	-	-	24.910
MO1	-	0.572	-	8.482
MO2	-	0.679	-	16.271
MO3	-	0.753	-	24.536
MO4	-	0.733	-	20.155
MO5	-	0.559	-	11.053
MO6	-	0.667	-	17.725
MO7	-	0.500	-	10.171
MO8	-	0.718	-	16.074
SU	-	-	1	-

The reliability of hidden variables markers: The reliability of each hidden variables markers in PLS is determined by the factor loadings of each marker. The value of each factor loadings in hidden variables markers should be greater than or equal to 0.5 (Falke and Miller, 1992). In Table 5 have shown the factor loadings for research hidden variables markers. As it can be seen in

Table 6: Cronbach's alpha coefficient and composite reliability of research variables

Variables codes	Variables	Scales	No. of indices	Cronbach's alpha	Composite reliability
GATSD	Green air transport	5 point likert	4	0.675	0.802
Macroeco	Macro and political factors	5 point likert	8	0.805	0.854
Sustainable	Sustainable development	5 point likert	1	1.000	1.000

Table 7: The results of testing research hypotheses

Hypothesis No.	Hypothesis	Path coefficient	t-values	Test result
1	Green air transport→Sustainable development	0.138	2.149	Confirming test
2	Macro and political factors→Green air transport	0.681	22.992	Confirming test
3	Macro and political factors→Sustainable development	0.190	2.412	Confirming test

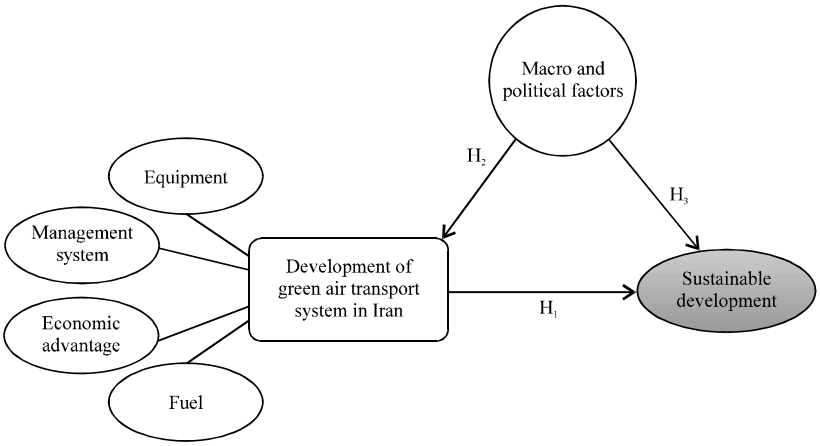

Fig. 1: Research conceptual model (resource the researcher)

the above table, all values of related to hidden variable which are highlighted are >0.5. Therefore, it can be said measurement model has sufficient reliability in the field of hidden variables markers. In this table, t-values are also shown to markers. These values generally are as reliability parameters related to confirmatory factor analysis because relationship between markers and hidden variables has already been identified. As it can be seen, all values are out of interval (1.96-1.96) and significant. As a result, research instrument has appropriate validity.

Reliability of model: To measure reliability of the model, composite reliability and Cronbach's alpha have been discussed. Cronbach's alpha coefficient indicates the ability of question to explain their dimensions. As well as composite reliability coefficient indicates correlation of questions in a dimension to each other to proper evaluate of goodness of fit. The results are shown in Table 6 and Fig. 1, as it can be seen, Cronbach's alpha coefficient of all variables in this study is more than minimum value of 0.6 (Nunnally, 1978) and 0.65.

Goodness of fit model: Model fitting also uses Goodness of Fit (GOF) index. This index calculates by the following equation:

$$GoF = \sqrt{\text{Average Com} \times \text{average } R^2}$$
$$= \sqrt{0.689 \times 0.277} = 0.436$$

If this index is equal to or <0.1, the model is weak, if this value is 0.25-0.36 the model is medium and in the case of values >0.36, it is strong (Latan and Ghozali, 2012). The GOF to research model is 0.436 which represents strong Goodness of fit.

Testing hypotheses: The results of testing hypotheses are presented in Table 7. It should be considered that hypothesis confirm, at significance level of 0.05, if t-value is out of interval (1.96, -1.96). Figure 2 shows the research model in the case coefficients are standard and in Fig. 3, the research model has been shown in the case coefficients are significant. The results of data analysis indicate that the impact of development of green air transport system in Iran, at the confidence level 95% (t = 2.149), on sustainable development is 0.138. As well as, macro and political factors affect both development of green air transport system and sustainable development. So that, the significant impact of macro and political factors in the confidence level of 99% (t = 22.992) on the development of green air transport system is 0.681 and this value at confidence level of 95% (t = 2.412) is 0.190 on sustainable development.

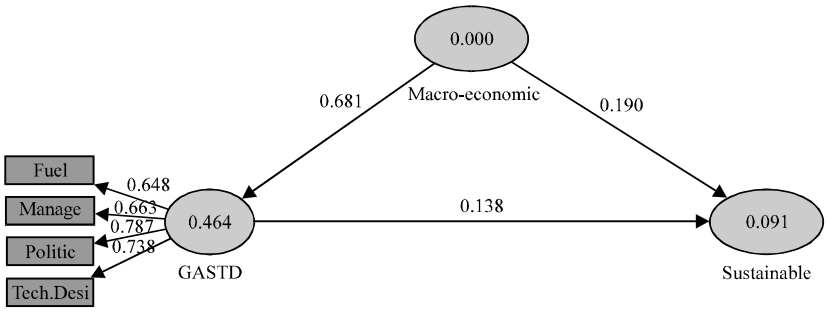

Fig. 2: The research model in estimating standard

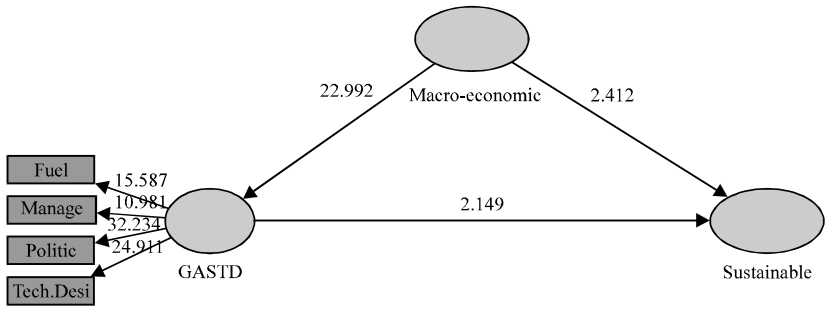

Fig. 3: The research model in significant parameters

Table 8: The results of ranking by using the friedman test

Variables	Component	Mean rank	χ^2-statistic	p-values
Technology and design	Changing in aircraft design such as using composites and lightweight structures	2.72	25.643	0.000
	Effective factors compatible with new fuels	2.76		
	Design wing and fuselage	2.38		
	Lowering the weight of passenger cabin	2.14		
System management	Outdated of equipment and aircraft performance	3.81	60.930	0.000
	Improving airports traffic control system	3.31		
	Designing comprehensive airport with suitable capacity	2.76		
	Airport infrastructure and quality of runway	2.44		
	Pilot skills in directing aircraft	2.68		
Political component	Codified and strict environmental standards in the field of air transport	3.92	72.525	0.000
	Pricing aircraft services and profit margins of service companies	2.89		
	The willingness of customers to use economical flights	2.75		
	The effectiveness of using green technologies in aircraft	3.31		
	International sanctions to import new aircraft, pieces and equipment	4.55		
	Research and development of green technology	3.58		
Alternative fuels	Improving the quality of avgas	2.16	9.961	0.007
	Using biofuels	1.99		
	Using green diesel	1.84		
Moderating component	Alignment of green aviation industry with the priorities of science and technology	4.47	21.928	0.003
	Using capabilities of knowledge management network (universities, research centers, etc.) to develop green technologies	4.19		
	Allocation of public funds of research and development to green technologies	4.58		
	Government's commitment to sustainable development	4.94		
	The structure of airline industry (competition and monopoly)	4.27		
	Enforcement of environmental standards and other technology standards	5.03		
	Creating air hubs	3.89		
	Sufficient infrastructure of research and development in the to develop green technologies	4.35		

Ranking criteria: In this study, each of the components related to variables were ranked by using the Friedman test. The results of this ranking are shown in Table 8.

CONCLUSION

Safety, willingness to comfort and fast travel has result in growing demand of air travels. Iran also,

according to its geo-strategic and geopolitical can play a special transit role as the main transport regional pole. Requiring changes in order to reduce using fossil fuels and the tendency to use various industries, green technologies and fuels that have lower emissions is much needed and vital. Green industry is an important factor to reduce carbon dioxide and ultimately, reduce greenhouse gases. Therefore, using an integrated system based on an efficient model is essential. The key to success green air transport is cooperation of all stakeholders at international and national level. Several effective Factors on development of green Air transport are aircraft technology, operational improvements, alternative fuels, improving and developing productivity of new technologies consistent with sustainable development, improved air traffic management system, automatic Updating wind, weather information and many factors that are described in detail in the text. Moreover, the impact of macro and political factors on development of green air transport system in Iran and sustainable development were discussed and evaluated according to proposed model in the paper. The results of data analysis show that the impact of development of green air transport system in Iran, at the confidence level 95% (t = 2.149), on sustainable development is 0.138. As well as, macro and political factors affect both development of green air transport system and sustainable development. So that, the significant impact of macro and political factors in the confidence level of 99% (t = 22.992) on the development of green air transport system is 0.681 and this value at confidence level of 95% (t = 2.412) is 0.190 on sustainable development.

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