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Evaluating the Low Cost Airline's Choice Factors of Airports in India Using Fuzzy MCDM Method

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Abstract:

The current study attempts to evaluate the low cost airline's choice factors of airports in India. The Fuzzy MCDM method has been employed for the above pertaining. The findings of the study exhibits that the airport catchment size, the level of airport's tariff, Incentive for LCA, Operational efficiency of ramp services, exclusive terminal for LCA and supportive attitude of airportare the prime factors of the low cost airline's choice factors of airports in India. The paper fulfills the gap in the literature by identifying the LCA's airport choice factors with special reference to India. Methodically, the paper contributes by developing and demonstrating the application of the Fuzzy based MCDM model for evaluation of the factors for the low cost airline's choice factors of airports.

Keywords: Low-Cost Airport, Low-Cost Airlines, Fuzzy MCDM, Airport Strategic Planning

JEL Classification: C52; C44; C61; R40; R58.

1. Introduction

The post liberalized era has evidenced high growth in national income of India. The real per capita of GDP during 1992-2001 has observed the Compound Annual Growth Rate (CAGR) of 3.9% which has now been increasing at CAGR of 6% during 2001-2016 resulting higher disposable income of Indian citizen (World Bank, 2017). The growth rate of national income and rising disposable income are the key drivers for the growth of aviation industry in India. It has been observed that Indian aviation industry has witnessed a phenomenal growth rate in last two decade. For the period 1990-91 to 2015-16 the domestic passenger has grown at the CAGR of 12.4% (Committee, Report on Civil Aviation Sector, 2012 & AAI, 2017). During the same period international passenger has grown at the rate 8.71% and total passenger traffic has grown at the rate of 11.06% (Committee, Report of Working Group on Civil Aviation Sector, 2012 & AAI, 2017). For the period 2016-17 to 2031-32 the total passengers to be handled at Indian airports is forcasted to grow at Cumulative Annual Growth Rate (CAGR) of 10.3% (AAI, 2017). In 1997-98 the number of aircraft handling the scheduled operations was 106 which has grown to 555 in the September 2017 and is expected to induct 1019 aircrafts by the year 2030 (Committee, Report of Working Group on Civil Aviation Sector, 2012 and AAI, 2017).

The recent trend of economic growth in India is expected to be on high growth trajectory which reveals in tandem growth of aviation sector. However to unleash the future potential of the sector, appropriate capacity enhancement is mandated in right time.

At present, out of 464 airstrips/ airports in India, only 116 are operational (AAI 2017). Recently GOI has announced the construction and development of 200 low cost 'No-Frills'

airports within the budget of USD 7 million to USD 15 million each with the purpose to enhance the regional air connectivity (Ministry of Civil Aviation India 2016). In line with the stated plan, 160 non-functional airports were announced to be developed at a cost of INR 50-100 crore each in partnership with state government under the Union Budget of 2016. As GOI is planning to develop low-cost airports on a massive scale, it is essential to understand the key requirement of Low-Cost Airlines and other key stakeholders in the airport.

Regional airport development is critical for India's economic development and regional integration but it should be given a thoughtful consideration of meeting the needs of key stakeholders. Since 2009, GOI has spent over USD 50 million on eight non-functional airports with intent to develop it as no-frill airports; however, after development, they were unable to attract and retain their airline customer (Reuters 2015). Airports such as Jaisalmer, Sahnewal, Gondia, Mysore, Pondicherry, Kanpur, Juhu, Kolhapur, Sholapur, Akola, Jalgaon, Bhatinda, Pathankot, Malda, Cooch Behar, Warangal&Cuddupa are some of the examples of developed but non-operational airports in India (The Telegraph 2015). The industry experts opine that the above failure has occurred due to lack of a well-structured, demand driven and airline oriented plan in the low-cost airport development (CAPA 2017). *In sum and substance lack of integration of Low Cost Airlines interest in low-cost regional airport development is contributing in existence of developed but non-operational airport in India.*

The current paper attempts to identify and evaluate the low cost airline's choice factors of airports in India using Fuzzy MCDM method. The current study fulfills the gap in the literature by identifying the LCA's airport choice factors with special reference to India.

2. Literature Reviewon LCA's airport choice factor

For the above theme extensive review of literature was conducted on major research database. Sources which were reviewed included research articles and papers, newspaper articles, and industry reports. The summary of review on Low-Cost Airline's airport choice factors are furnished below:

The fundamental point with regard to factors affecting the LCA's choice of airport indicates to philosophy that airport should mirror the strategy being practiced by LCA. It requires that airport strategy should fit in with the requirements of the LCA operating model. This involves providing facilities that will allow the LCAs to reduce costs and exploit density economies through high utilisation of aircraft (Pitt & Brown, 2001). This will be reflected in LCAs seeking quick turnaround times between arrivals and departures at airports (normally no more than 25-30 min which will enable them to achieve extra rotations a day), convenient slot times and lack of congestion on the ground and in the sky (which will result in less time spent queuing to take-off or in a stack waiting to land) (Warnock-Smith & Potter, 2005).Another crucial and well documented requirement that will enable LCAs to adhere to their low cost model is to serve airports that have low aeronautical charges and other user costs (Francis, Fidato, & Humphreys, 2003), or at least those that appear favourable and flexible to negotiating airport charges deals (Barrett, 2004a).

Berechman and de Wit (1996) identified that the requirements of the full-service carrier in airport selection varies from LCA for which the criteria varies from airport charges, demand and airport capacity. Adler and Berechman (2001) found that airport quality has a strong influence on airport choice factor of LCA. Gillen and Morrison (2003) also emphasized on the different requirement of LCA which necessitate the airport managers to tailor their strategy to suit their need. Francis, G. et al. (2003) explored that airports attract LCA on basis of hub routes offerings and rely more on aeronautical revenues. Gillen, D. and Lall, A. (2004) endorsed the existence of competition between airports based on LCA requirement and stated that airport tailors its offering as per the need of LCA. Barrett, S.D. (2004) has identified seven factors for airports to attract LCA namely low airport charges, quick turnaround time, single story airport terminal, quick check-in, good catering and shopping at the airport, good facilities for ground transport, and no executive/business lounge. However, the identified

factors need to be verified in the current context of Indian low-cost regional airport development.

The secondary airport is located away from urban area increasing the car rentals to airport resulting an increase in non-aeronautical revenue compensated by a decrease in aeronautical charges levied to LCA (S. Barrett 2004). Airport charges and night curfew influence airport selection decision of LCA (Gardiner, Ison and Humphreys 2005). Eight LCA in Europe were surveyed revealing the differences in airport choice factor of LCAs' and the key result stated the core requirement of LCA has focussed on low-cost services. Lawton, T.C. and Solomko, S. (2005) observed that efficient operating condition is the most required expectation of LCA from the airport decreasing of turnaround time and resulting in higher aircraft utilization rate. Fifteen airport choice factors of which the fundamental factors related to quick and efficient turnaround facilities, convenient slot time and good aeronautical discount were identified (Warnock-Smith and Potter 2005). Chang, et al. (2008) modeled a framework in which airport charges, operations hours, surface transport, terminal floor area, navigational aid and estimated demand for the destination were pertinent factors for LCA choice of airport. LCA seeks to optimize profitability of their network by choosing an appropriate airport (Graham 2013). Graham (2013) reviewed the academic literature pertaining to the relationship between airports and development of LCA and identified that the LCA's choice of airport is determined by its business model. The passengers to secondary airports are willing to endure inconvenient airport location in exchange for a lower fare (Lu and Mao 2015).

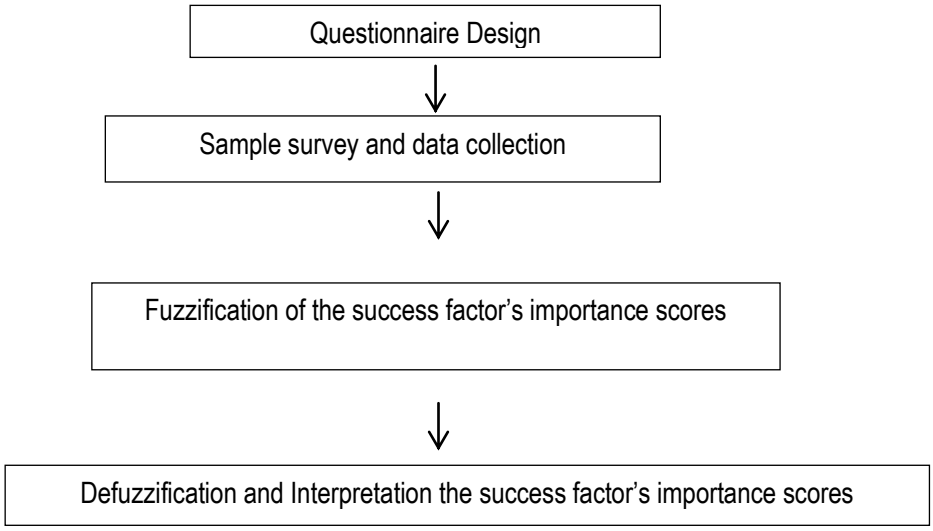
As the most of the literature reviewed contend that airports operating model should mirror the strategy being practiced by LCA keeping in view the rise of LCA. Since there is lack of academic literature to the pertaining to the LCA's airport choice factors in Indian aviation context hence the current study would fulfill the existing gap in the literature.

3. Methodology

The importance perception of relating to LCA's airport choice factors is a subjective measurement. When it is measured on the basis of a numerical linguistic variable often results in incomplete, inconsistent, vague and imprecise results (Lupo 2015; Pandey 2016). On the contrary, it would be preferable to furnish interval value judgments rather than crisp value judgment (Chan and Kumar 2007). Since the current measurement encompasses with intrinsic complexity as it is prone to vagueness of human subjectivity, hence Fuzzy set theory render an effective approach to measure the expectation based on an interval-based linguistic variable (Lupo 2015; Pandey 2016).

Therefore the current study employed Fuzzy Multi-criteria Decision Making (MCDM) to evaluate LCA's airport choice factor in India. The study has incorporated the following steps for the attainment of research objective: designing of the questionnaire, a collection of data, fuzzification of importance scores for evaluation of success factors of low-cost airport development and finally its defuzzification and interpretation which is depicted in figure 1.Further, an overview of Fuzzy set theory and principles and the main steps of the research process are detailed.

Figure 1: Research Process of Fuzzy MCDM



3.1. Fuzzy Set Theory and linguistic-fuzzy evaluation scales

The concept of the fuzzy set was propounded by Zadeh (1973) with the purpose to measure the human judgments or preferences more pragmatically by the help of linguistic terms. As the preferences expressed by human cannot be estimated with an exact numerical value, hence interval based linguistic term are used to describe the desired value (Zadeh1973; Bellman and Zadeh 1970; Zadeh 1975; Hwang and Yoon 1981; Liang and Wang 1991; Hsu and Chen 1997; Chiadamrong 1999; Chien and Tsaia 2000; Chen 2001; Enrique 2004).

A fuzzy set is a set without a crisp, clearly defined boundary and contains elements with only a partial degree of membership (Mathworks 2012). Mathworks (2012) defines a membership function (MF) as a curve that explains how each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1. The concepts of a linguistic variable can be quantified by fuzzy numbers using suitable membership functions.

In the current research linguistic variable were used to represent the experts' assessment of the LCA's airport choice factors and positive triangular fuzzy numbers were employed to measure the linguistic variable as indicated in Table 1.

The previous literature has already established the basic arithmetic operations on fuzzy numbers. If $A_1 = (l_1, m_1, u_1)$ and $A_2 = (l_2, m_2, u_2)$ are representing two distinct triangular fuzzy numbers then their algebraic multiplication operations can be expressed by equation 1.

$$A1 \otimes A2 = (l1, m1, u1) \otimes (l2, m2, u2) = (l1l2, m1m2, u1u2) \qquad \text{Equation 1.}$$

Table 1: Linguistic variables for measurement of airport choice factors

Not at all important	(0.0, 1.0, 2.0)
Slightly Important	(1.0, 2.0, 3.0)
Moderately Important	(2.0, 3.0, 4.0)
Very Important	(3.0, 4.0, 5.0)
Extremely Important	(4.5, 5.0, 5.0)

The two main steps below shall describe the proposed method to conduct the current study:

Step 1: Data Collection and Sampling Framework: A questionnaire was designed on the basis intensive review of literature which contains seven Dimension and 32 success criteria for the development of low-cost airport which are indicated in Figure 2.

The data was collected from the expert team comprising of the senior executives employed with the LCA's in India. The survey was conducted throughout the month of December 2017 by employing purposive sampling method. A sample of 160 executives was undertaken for the study which is adequate for study in line with Norman and Streine (2003) who have stated that the adequate sample size to be five-fold of number of variables.

Step 2: Method Utilized for Fuzzification and Defuzzification of Success Factors Importance Score

For a ranking of fuzzy numbers graded mean integration representation method was explored by Chen and Hesieh (1998). Further, Chou (2003) has identified a canonical representation of multiplication operation on two triangular fuzzy numbers by graded multiple integration representation methods. Chou (2006) applied inverse function arithmetic representation for multiplication operation of multiple trapezoidal fuzzy numbers and the framework was employed to solve MCDM problem by Chou (2007). Chien-Chang (2012) developed a fuzzy MCDM model for evaluating the service quality of the airports where the service quality criteria and importance weight both were transformed into a triangular fuzzy number.

This paper constructs fuzzy MCDM model for evaluating the LCA's airport choice factor of utilizing a canonical representation of TFN based on graded mean integration method which is in line with the study of Chien-Chang (2012). Later the defuzzification of the scores is done using Inverse Arithmetic representation method. By employing the graded mean integration method a TFN $Y_1 = (c_1, a_1, b_1)$ is represented utilizing Equation 2. The same representation is employed on all importance scores obtained from executives and then the average of the respective criteria is aggregated.

$$P(Y1) = \frac{1}{6}(c1 + 4a1 + b1) \qquad \text{Equation 2.}$$

The normalized weight of respective criteria is obtained by employing equation 3, where w_{in} represents the importance scores of i^{th} success factor (i=1,2,.....w) rendered by the n^{th} respondent (n= 1,2,.....n) and AW_i represents the aggregate normalized weight of i^{th} success factor.

$$AWi = \frac{\sum_{n=1}^{N} win}{\sum_{i=1}^{I}\sum_{n=1}^{N} win} \qquad \text{Equation 3.}$$

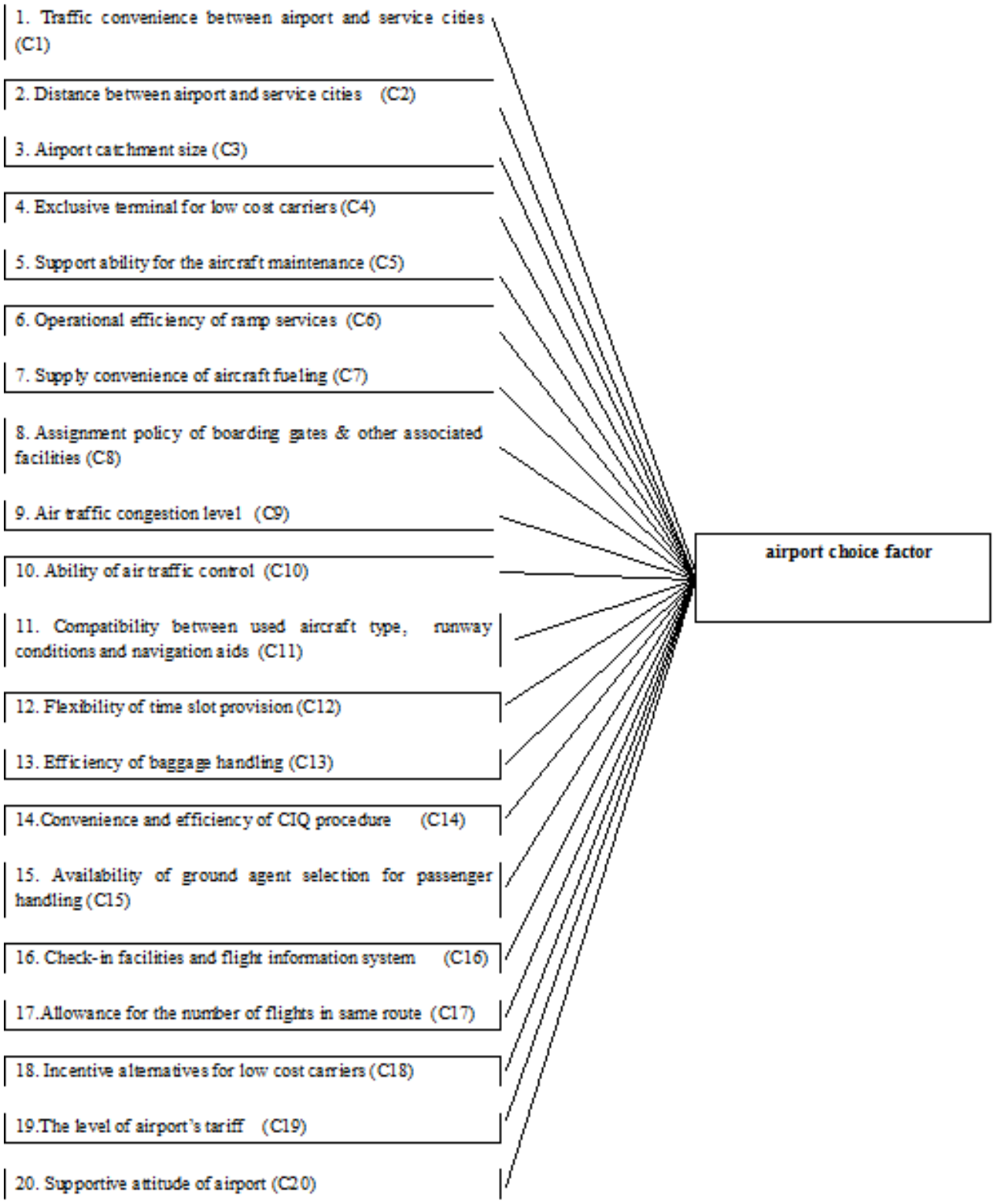


Figure 1: Analytical Hierarchical Structure for LCA's airport choice factors

4. Findings and Discussion

Based on the Fuzzy MCDM method, the results summarized in Table 2 indicates the evaluated construct for the LCA's airport choice factors in India. Out of the twenty factors, the five most important factors are airport catchment size, the level of airport's tariff, Incentive for LCA, Operational efficiency of ramp services, exclusive terminal for LCA and supportive attitude of airport with score of 4.4, 4.35, 4.25, 4.23, 4.2 and 4.2 respectively. All of the factors are directly contributing either to operational efficiency of airlines and facilitates in lowering cost.

The moderately important factors included Efficiency of baggage handling, Air traffic congestion level, Compatibility between used aircraft type, runway conditions and navigation aids, Flexibility of time slot provision, convenience and efficiency of CIQ procedures, check-in facilities and flight information system, availability of ground agent selection for passenger handling, allowance for the number of flights in same route and ability of air traffic control with the respective scores of 4.19, 4.13, 4.1, 4.09, 4.06, 4.06, 4.04, 3.99 and 3.97. All of the factors lying in this category are contributing directly to maintain the operational efficiency of the LCA.

The less importance was rendered to factors supportability for the aircraft maintenance, distance between airport and service cities, supply convenience of aircraft fueling, traffic convenience between airport and service cities and assignment policy of boarding gates & other associated facilities with importance scores of 3.85, 3.8, 3.7, 3.5 and 3 respectively.

Table 2. Evaluation result of the Low-Cost Airline's airport choice factor in India.

1. Traffic convenience between airport and service cities	3.5
2. Distance between airport and service cities	3.8
3. Airport Catchment Size	4.4
4. Exclusive terminal for low cost carriers	4.2
5. Support ability for the aircraft maintenance	3.85
6. Operational efficiency of ramp services	4.23
7. Supply convenience of aircraft fueling	3.7
8. Assignment policy of boarding gates & other associated facilities	3
9. Air traffic congestion level	4.13
10. Ability of air traffic control	3.97
11. Compatibility between used aircraft type, runway conditions and navigation aids	4.10
12. Flexibility of time slot provision	4.09
13. Efficiency of baggage handling	4.19
14. Convenience and efficiency of CIQ procedure	4.06
15. Availability of ground agent selection for passenger handling	4.04
16. Check-in facilities and flight information system	4.06
17. Allowance for the number of flights in same route	3.99
18. Incentive alternatives for low cost carriers	4.25
19. The level of airport's tariff	4.35
20. Supportive attitude of airport	4.2

5. Conclusion

The current paper identifies and evaluates LCA's airport choice factors in India using Fuzzy MCDM method. The findings of the study point that the airport catchment size, the level of airport's tariff, Incentive for LCA, Operational efficiency of ramp services, exclusive terminal for LCA and supportive attitude of airport are most pertinent factor for LCA to choose the airport.

This paper furnishes the evaluated LCA's airport choice factors for airport development in India which fulfills the gap in the literature by integrating the stakeholders view in low-cost regional airport development. Methodically, the paper contributes by developing and demonstrating the application of the Fuzzy based MCDM model for evaluation of the current objective.

As to contribute to future research in this domain, comprehensive functional success factors need to be explored and included in the evaluation model. Also, some more strategic critical factors related to airport development should be explored through expert interview which may be included in the further study.

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