Utility function for airline travel in Nepal and its comparison with India

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Abstract: The competition in the airline market provides an airline passenger with ample open choices to evaluate before finalising a travel decision. The final travel decision is an outcome of a consideration of multiple parameters. In the last decade, Nepal has witnessed impressive growth in international and domestic air traffic, which in turn has led to a growth in tourism in Nepal. It has, therefore, become crucial for competing airlines in Nepal to monitor their services and align the same with respect to airline passengers' preferences. We study the domestic airline travel in Nepal to create a utility function for it and compare the performance of one airline with other competing airlines. The model is based on the logarithmic goal programming model and multiple criteria decision-making. This development also provides a unique opportunity to compare utility functions for airline travel across India and Nepal, two neighbouring countries with different socio-economical setups.

Keywords: utility function; goal programming model; revenue management; multiple criteria decision-making; MCDM.

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1 Introduction

Since the late '90s, Nepal has experienced a tremendous rise in its air traffic. In line with its international sector, which has seen a 56% increase in passenger movement in the last decade, the domestic sector has also experienced the same growth trend over the years (Ministry of Culture, Tourism & Civil Aviation, 2017). Currently, the Nepalese domestic airline has primarily nine sectors which are operational, with Kathmandu as a hub for more than 50% of the flights. These sectors are catered to by six major domestic carriers out of a total of 16 players (Tourism & Civil Aviation, 2017). The competition existing within the space provides airline passengers with ample open choices for evaluation before finalising a travel decision. The driving factors for the final decision are one's own preferences with respect to the various elements of airline travel depending upon one's needs and level of required satisfaction. In such a competitive scenario, it becomes crucial for competing airlines to monitor their alignment with the passenger's choices. Also, there will be a number of factors influencing the final airline travel decision of a passenger. Hence, in this paper, we consider the domestic airline travel in Nepal in order to create a utility function for it. This function provides a linear mathematical model to compute the utility function of airline travel in terms of the key attributes influencing a passenger's travel decision. While basic linear models are the same in India and Nepal, the difference is in terms of the weights of different attributes. Understanding the differences in economic conditions of two countries, we wanted to study if the passenger's weights for different attributes are similar. In this paper, we compare the difference between India and Nepal on the preference utility of an 'airline travel decision attribute' by comparing the above mentioned utility function with that of the study done in the Indian context by Dutta and Ghosh (2011). We also categorise the attributes which may be independent of such a context and are largely assignable to the features of air travel.

Since the passenger choice includes multiple attributes, we have applied the multiple criteria decision-making (MCDM) approach along with the logarithmic goal programming model (LGPM). For calculating the normalised individual weights, we have employed LGPM that represents the consensus opinion of the group, or a group of priority vectors by synthesising individual priorities for decision alternatives into a single set of priorities (Bryson and Joseph, 1999). Although there are several other similar MCDM tools available in existing literature, we have used LGPM due to its unique advantages which we will discuss in the forthcoming sections. This paper provides insights into revenue management models through the generation of relative weights for each attribute affecting the final travel decision.

While there are publications (Dutta et al., 2010; Dutta and Ghosh, 2011; Dutta et al., 2015) on developing a utility function with LGPM as an MCDM tool in India in the insurance, railways and airline sectors, not much work has been done in the Nepalese context. The growing trend of domestic airlines in Nepal provides an opportunity to develop such a model. This paper will also be unique in drawing a comparison between the utility function across two countries having different socio-economic setups.

This paper contributes to the following:

1. we apply LGPM to work out a utility function for domestic airline travel in Nepal, as an extension to similar work done in India
2. comparison of the utility function of airline travel in India and Nepal with LGPM
3. to demonstrate the use of LGPM to develop a utility function in airline travel.

The paper is organised as follows. We provide a brief idea of the related literature review for this research in Section 2. In Section 3, we discuss the socio-economic factors differentiating India and Nepal. Section 4 introduces 'utility function' and Section 5 outlines the research methodology. In Section 6, we describe the procedure for developing a utility function for domestic airline travel in Nepal and Section 7 consists of the comparison of the utility function developed for domestic airline travel in Nepal with that of India. Section 8 lays down the limitations and future scope for research related to the paper and Section 9 concludes the paper. The model formulation of LGPM is given in Appendix 1 and an explanation of the 'LGPM' with the help of a small dataset provided in Appendix 2. We have provided the questionnaire used for data collection in Appendix 3. A map of domestic air routes and airports in Nepal and a report on aircraft accidents is provided in Appendix 4 and Appendix 5 consists of a brief idea about tourism in Nepal.

2 Literature review

There are multiple factors influencing the final travel decision of an airline passenger. An individual decision maker has to choose among the sets of alternatives in order to maximise the utility of air travel which depends upon certain attributes. Based on this, the MCDM approach can be fitted perfectly to this airline passenger's choice model as defined by Dyer et al. (1992).

There are several publications illustrating different ways of addressing the MCDM problem. The analytic hierarchy process provides a basis to generate a group priority vector by employing the eigenvector method upon pair wise comparison of weights (Saaty, 1990, 2008). Bryson and Joseph (1999) extended this concept by integrating the LGPM to generate a set of consensus priority point vectors. Wang and Parkan (2006) introduced three approaches: weighted least deviation norm (WLDN), weighted least-square deviation norm (WLSDN), and the weighted mini-max deviation norm (WMDN) to cater to the MCDM problem.

Chang and Yeh (2001) formulated an airline competitiveness evaluation problem with an MCDM approach with a set of 'm' airlines as alternatives to be evaluated on a set of 'n' competitive attributes. They solved this problem with three methods, namely, simple additive weighing (SAW), weighted product (WP), and technique for top order preference by similarity to ideal solution (TOPSIS).

Carrier (2003) has outlined some major characteristics which influence the passenger's choice. One of the elements is the decision window which encompasses various available scheduled departure times and the difference between the desired and actual departure time. The other element brings out the willingness to pay as the major influencer for an airline travel decision.

Pels et al. (2001) described passenger choice of airport and airlines using a nested logit model, for multiple airports in the San Francisco Bay Area. Hess et al. (2005) estimated the issues that arise in the computation of the value of travel-time savings, using mixed logit models. Hess and Polak (2005) also presented an analysis of airport choices by air travellers departing from the San Francisco Bay area, which is a multi-airport region. This analysis was done using mixed multinomial logit models. Telhado Pereira et al. (2007) implemented a stated preferences discrete choice model with respect to consumer airline choices and showed it to be cost effective for the airlines.

Dutta et al. (2010) discussed the development of a utility function for life insurance buyers in India using the logarithmic goal programming approach. Further, Dutta and Ghosh (2011) demonstrated that the same concept LGPM can be used in developing a utility function for domestic airline travel in the Indian context. Once again, Dutta et al. (2015) used the concept of LGPM, to develop a utility function for railway travel in India. Maity and Roy (2014) explored the study of a multi-choice, multi-objective transportation problem using the utility function approach. Later, Maity and Roy (2016) solved the multi-objective transportation problem using revised multi-choice goal programming and utility function approach.

The original work of developing LGPM was done by Bryson and Joseph (1999). Hence, we have applied LGPM to the maximum number of problem areas and maximum number of applications in developing a utility function or combined score to demonstrate that the methodology can be applied to a large number of papers. Table 1 gives the possible applications that have been either published or are in the process of being published.

The annual report of the year 2016–2017 presented by the Civil Aviation Authority of Nepal (CAAN) shows tremendous growth trend between the years 2007 to 2010. During the period between 2010 and 2014, 12 air transportation accidents were reported with a high number of fatalities as described by Basnet (2015) with details in Appendix 4. This caused a decrease in the passenger movement between the years 2011 to 2015. The year wise passenger movement in the domestic airline industry of Nepal is as shown in Table 2. This provides us with a research opportunity to work out a utility function for domestic airline travel in the Nepalese context, as an extension of the research done by Dutta and Ghosh (2011). Similar work has also been done in US airlines (Smith et al., 1992).

Table 1 Applications of LGPM and their publications

Methodology	*Application*	*Country*	*Publication details*
Original	Not mentioned	Not applicable	Bryson and Joseph (1999)
Bryson and Joseph (1999)	Insurance	India	Dutta et al. (2010)
Bryson and Joseph (1999)	Travel airlines	India	Dutta and Ghosh (2011)
Bryson and Joseph (1999)	Travel railways	India	Dutta et al. (2015)
Bryson and Joseph (1999)	Travel airlines	Nepal	Dutta et al. (current paper)

Table 2 Year wise passenger movement

Year	*Passengers (in million)*	*Change (in %)*
2004	0.87	17.1
2005	1.11	26.8
2006	0.88	–20.5
2007	0.91	3.8
2008	1.03	13.1
2009	1.37	32.9
2010	1.55	12.83
2011	1.58	1.85
2012	1.57	–0.55
2013	1.54	–2.10
2014	1.45	–6.35
2015	1.36	–6.34
2016	1.75	22.39

Source: CAAN (2016–2017)

We have also considered the airline travel decision as an MCDM problem and have employed LGPM to generate consensus group priority point vectors. Adding further uniqueness to this paper, we intend to compare the utility functions developed for airlines in India and Nepal, two neighbouring countries with different socio-economic setups. While several researchers have worked on the development of utility functions in airline travel, this is possibly the first time that LGPM has been used for comparing the utility functions of airline travel in two different neighbouring countries in South East Asia.

3 Socio-economic differences between India and Nepal

The price of an airline seat and the demand for the airline travel depend on several socio-economic factors. In this section, we compare the socio-economic factors in India and Nepal. Nepal is among the least developed countries in the world compared to India. Agriculture forms a major part of its economy, and accounts for one-third of gross domestic product (GDP). The service sector constitutes about 53% of GDP. Nepal was hit by massive earthquakes in early 2015, which damaged and destroyed infrastructure, setting back its economic development. According to the Central Intelligence Agency (CIA) World Factbook (https://www.cia.gov/library/publications/the-world-factbook/geos/np.html) 2017 reports, there are 47 airports in Nepal with Kathmandu being the only international airport. A map of Nepal and the possible routes are provided in Appendix 4 and a brief idea about Nepal tourism is provided in Appendix 5.

India is developing into an open-market economy. It has a diverse economy that includes agriculture, large and small scale industries, handicrafts and services. Services are the major source of economic growth in India where the service sector constitutes about 46% of GDP. In 2016 and 2017, economic growth has increased by almost 6% to 7% per year. India's long-term growth is positive because of the increasing integration of India with the global markets.

Although the Nepalese economy is smaller compared to the Indian economy, it is dependent on India. As the service sector contributes the most to GDP, in both the countries, we compare both the economies. The socio-economic differences between India and Nepal are as shown in Table 3.

Table 3 Comparison of socio economic conditions in India and Nepal

	India	*Nepal*
GDP (purchasing power parity) (2017 est.)	$9.447 trillion	$78.55 billion
GDP of official exchange rate (2017 est.)	$2.439 trillion	$24.07 billion
GDP in terms of real growth (2017 est.)	6.7%	7.5%
GDP per capita (PPP) (2017 est.)	$7,200	$2,700
Gross national saving % of GDP (2017 est.)	28.6%	42.1%
GDP Household consumption (2017 est.)	58.7%	76.2%
GDP Government consumption (2017 est.)	11.6%	11.7%
GDP investment in fixed capital (2017 est.)	27.5%	33.8%
GDP in exports of goods and services (2017 est.)	18.4%	9.8%
GDP in agriculture (2017 est.)	16.8%	27%
GDP in industry (2017 est.)	28.9%	13.5%
GDP in services (2017 est.)	46.6%	51.5%
Industrial production growth rate (2017 est.)	7.5%	10.9%

Source: CIA World Factbook (https://www.cia.gov/library/publications/the-world-factbook/geos/np.html) (India and Nepal)

4 Utility function

The airline passenger choice model evidently involves multiple criteria for decision-making. Hence, we presume a linear utility function with the following relationship:

$$U(X) = \sum w_i * x_i + \varepsilon$$

where

x_i level of criteria *i* important for air travel decision

w_i the relative weights assigned to the i^{th} criteria

ε random error.

To decide upon the various criteria significant for the airline travel decision, we had an extensive discussion with one of the airlines of Nepal. After these deliberations, we finally listed down the following criteria/attributes which are the most significant ones for an airline travel decision:

1. passenger fare (PF)
2. availability of tickets (AT)
3. price fluctuation (PRF)
4. departure time of a particular airline (DT)
5. on-time performance (OP)
6. the difference between the actual and desired arrival/departure time (DD)
7. cancellation charges or penalty cost (PC)
8. handling of luggage loss (HL)
9. airline frequency (AF)
10. in-flight services (S).

We have considered these attributes to be independent of each other and exhaustive, for making an airline travel decision. The independence shall be verified by the data collected by checking the presence of a dominant effect of any attribute. The exhaustiveness will be ensured by introducing a constraint that all the weights sum to 1. Hence, we compute the utility score as a linear weighted average of the attributes.

5 Research methodology

We decided to use LGPM as a tool to derive the weights of attributes taken for our utility model. LGPM is used to synthesise individual priorities as collected, into a single set of vector *r* or priority point vectors *w* ($w_1, w_2, \ldots, w_n$) which represent the consensus opinion of the group as a whole. The work of Bryson and Joseph (1999) provides the methodological foundation for us. The objective of the LGPM is to minimise the difference between the ratio of the consensus priority vector (w_i/w_j) and an individual's specified pair-wise comparison for each pair of i and j. So, the idea is mathematically based on minimising the summation of absolute error. The detailed LGPM model is mentioned in Appendix 1 and has also been explained with small data points in Appendix 2.

For implementing our LGPM for the collected set of data (sample size = 106), we used A Mathematical Programming Language (AMPL) (Fourer et al., 1990) with CPLEX 11.2 solver. Although Excel Solver is another option, we choose AMPL because of the following advantages:

a AMPL is model data independent. Hence, the model can be used for similar work with another set of data points.

b It is possible to write the code as we formulate the problem.

c It is model solver independent.

d Further, AMPL provides a platform for relatively easy formulation of a model by using similar algebraic notations as that of various mathematical programs and even ensures the processing by a computer.

e The number of constraints and variables is not restricted.

We used the following methods for data collection.

Kathmandu being the hub for almost every domestic travel in Nepal, we took the inputs from 106 valid respondents (actual passengers) at the Domestic Terminal of Tribhuvan International Airport (Kathmandu). The sample was collected across different times of the day. A primary data collection was done by directly interviewing the passengers at the airport. The experiment was done for a period of six months. The questionnaire (Appendix 3) developed for the study has three parts.

a In part 1, we include the personal and travel details of a respondent. We collected these data to check for the consistency indicator for different clusters (based on age, gender, monthly income, etc.).

b In part 2, we listed the ten attributes mentioned earlier and asked a respondent to rate them on a scale of 1–100 (100 – most important and 1 – least important).

c In part 3, we have asked a respondent to rate different airlines across each of the attributes mentioned earlier, on a scale of 1–10 (10 – most suitable and 1 – least suitable). For our study, we took three existing airlines operating in the domestic space in Nepal.

6 Development of utility function and results

We carried out the implementation of our LGPM model in AMPL to obtain the weights of all attributes. We obtained the un-normalised value of weights (v_i) which we normalised to obtain the weights of the attribute (w_i). The weights of all attributes (normalised) obtained are shown in Table 4.

This reflects that 'passenger fare' and 'departure time' are the top two attributes influencing one's travel decision. 'On-time performance' and 'services' follow the top two in terms of importance. 'Penalty cost' turns out to be the least important attribute with respect to the airline travel decision. 'Airline frequency' and 'price fluctuation' fared better than the 'penalty cost' in the importance list.

So, the utility function of domestic airline travel in Nepal can be written as follows:

$$\begin{aligned} U(X) = {} & 0.1224 \times \text{PF} + .1095 \times \text{AT} + 0.0833 \times \text{PRF} + 0.1187 \times \text{DT} + 0.1111 \times \text{OP} \\ & + 0.1040 \times \text{DD} + 0.0699 \times \text{PC} + 0.0874 \times \text{HL} + 0.0830 \times \text{AF} + 0.1106 \times \text{S} + \varepsilon \end{aligned}$$

In our study, we have asked a respondent to also rate three airlines across the attributes considered. The average score of an airline against each attribute is the 'level' of the airline for that attribute.

Table 4 Weights of attributes

Attributes	*Weights*
Passenger fare (PF)	0.1224
Availability of tickets (AT)	0.1095
Price fluctuation (PRF)	0.0833
Departure time (DT)	0.1187
On-time performance (OP)	0.1111
Difference between actual and desired arrival/departure time (DD)	0.1040
Cancellation charges or penalty cost (PC)	0.0699
Handling of luggage loss (HL)	0.0874
Airline frequency (AF)	0.0830
In-flight service (S)	0.1106

Table 5 Levels of airlines for each attribute

Airlines	*PF*	*AT*	*PRF*	*DT*	*OP*	*DD*	*PC*	*HL*	*AF*	*S*
1	3.42	3.42	3.09	3.22	3.17	3.23	2.97	3.19	3.18	3.38
2	4.00	3.96	3.43	3.72	3.64	3.70	3.08	3.52	3.47	3.96
3	3.86	3.68	3.29	3.62	3.71	3.70	3.11	3.48	3.37	3.91

6.1 Utility score

As per the established utility function of domestic airline travel in Nepal, we get the utility score for three domestic airlines of Nepal as given in Table 6.

Table 6 Utility score of three domestic airlines of Nepal

Attributes	*PF*	*AT*	*PRF*	*DT*	*OP*	*DD*	*PC*	*HL*	*AF*	*S*	*Score*
Weights	0.122	0.109	0.083	0.119	0.111	0.104	0.070	0.087	0.083	0.111	
Airline 1	3.42	3.42	3.09	3.22	3.17	3.23	2.97	3.19	3.18	3.38	*3.244*
Airline 2	4.00	3.96	3.43	3.72	3.64	3.70	3.08	3.52	3.47	3.96	*3.689*
Airline 3	3.86	3.68	3.29	3.62	3.71	3.70	3.11	3.48	3.37	3.91	*3.611*

The market share of the three domestic airlines of Nepal is given in Table 7.

Table 7 Market share of three domestic airlines of Nepal

Airlines	*Market share*
Airline 1	0.249757229
Airline 2	0.389743707
Airline 3	0.360499064

This reflects that Airline 2 and Airline 3 closely compete with each other leaving Airline 1 a little behind. Airline 2 has the best level of ranking across a majority of the attributes listed above for the study and leads in three out of the top four important attributes.

The consistency indicator of the respondents for various clusters is as given in Table 8.

Table 8 Consistency indicator for various clusters

Clusters	*Number of respondents*	*Consistency indicators*
Age (years)		
Below 25	16	0.4920
25–45	67	0.5937
Above 45	23	0.5705
Gender		
Male	87	0.5915
Female	19	0.4899
Nationality		
Nepalese	96	0.5825
Indian	8	0.4628
Others	2	0.5750
Occupation		
Government sector	22	0.5314
Self-employed	18	0.7787
Student	10	0.6247
Private sector	37	0.5435
Retired	3	0.2866
Home-maker	3	0.5295
Social-service	1	0.4148
Others	12	0.4870
Income (in Rs.)		
Below 15,000	28	0.5462
15,000–30,000	33	0.5603
30,000–45,000	17	0.6493
45,000–60,000	9	0.5434
60,000–75,000	4	0.3843
Above 75,000	15	0.6376

7 Comparison with India and relevance to practitioners

We compare the utility function developed for domestic airline travel in Nepal with that of airline travel in India developed by Dutta and Ghosh (2011). Table 9 compares the weights of each attribute for the Nepalese and Indian studies. It also reflects the relative ranking of the attributes for each country.

Table 9 Comparison of weights of utility function of airline travel

Attributes	*Weights (rank)*	
	Nepal	*India*
Passenger fare (PF)	0.1224 (1)	0.0937 (8)
Availability of tickets (AT)	0.1095 (5)	0.1045 (6)
Price fluctuation (PRF)	0.0833 (8)	0.0637 (9)
Departure time (DT)	0.1187 (2)	0.1210 (2)
On-time performance (OP)	0.1111 (3)	0.1225 (1)
Difference between actual and desired arrival/departure time (DD)	0.1040 (6)	0.1164 (4)
Cancellation charges or penalty Cost (PC)	0.0699 (10)	0.0949 (7)
Handling of luggage loss (HL)	0.0874 (7)	0.1210 (2)
Airline frequency (AF)	0.0830 (9)	0.0519 (10)
In-flight service (S)	0.1106 (4)	0.1098 (5)

On comparing the attributes, we find that 'passenger fare' is the most dominant attribute for domestic airline travel in Nepal. However, the same was among the last three important attributes in the Indian context. It can possibly be inferred that Nepal, being the lesser developed country, the passengers in Nepal are more price sensitive than in India. Hence, airlines operating in Nepal need to pay more attention to their pricing mechanism. In such a price competitive market, in the absence of revenue management software and good knowledge of RM tools, airlines can possibly resort to price wars which may be detrimental to their long-term interest. This may lead to diminishing profits even though sales may be very high. During our interaction with the practitioners in the airline company, we found that the marketing and revenue management department was more interested in keeping the prices low. On further analysis in a price sensitive environment, it was seen that the airline company became a victim of price wars. This company had only small aircrafts with a seating capacity of 29 seats, which was not breaking even at 29, but at higher than 29. This is a perfect fit case where traditional cost cutting is not the solution. During our study, we found that none of the airlines were using scientific methodologies to determine prices. Therefore, airlines with a capacity constraint need to have an appropriate price mechanism to manage their inventory in an environment of random demand. Revenue management as a tool can be very useful in such cases.

'On-time performance' has obtained high weights in both the countries. While it has the highest weights for India, the weights are third highest in the case of the Nepalese study. This strengthens the prime premise that willingness to pay for the price charged by airlines, which is higher than other modes of transport, is based on the amount of time saving an airline offers. When we discussed this with the practitioners, we found that they have the same understanding with regard to on-time performance. 'On-time performance' tends to be the key driver of an airline's success, irrespective of any difference in the socio-economic level of the country. Operational efficiency would play a vital role in ensuring 'on time performance'. The 'turnaround time' minimisation needs to be worked out to develop this competency.

Similarly, 'departure time' has the second highest preference in both – the Indian and the Nepalese context. Passengers tend to choose a flight whose schedule is best suited to their flying needs. Airlines need to span their fleet timings so as to intersect with the convenience of most of the passengers.

The attribute 'handling of luggage loss' is a highly critical attribute in the Indian context but does not derive much utility for domestic Nepalese airline travel. Perhaps with the lower density of traffic, domestic airline travel in Nepal is more efficient in luggage handling than its Indian counterpart. Secondly, we found that Nepal does not have good luggage handing services. It is possible that poor availability of good luggage handing services makes 'luggage handling services' less prominent. The lower probability of loss makes passengers less concerned about the handling of luggage loss.

'In-flight services' appears in the top half of important attributes, in both the contexts. It appears to be the prime hygiene factor for airline travel. Even after the advent of low-cost airlines and paid meals, the importance of in-flight services has retained its importance.

'Availability of tickets' has a slightly higher preference in Nepal than in the Indian context. Passengers in Nepal give higher weightage to the attribute 'availability of ticket' than passengers in India. The same can be attributed to the less developed ticketing mechanisms through offline and online agents.

'Price fluctuation', 'airline frequency' and 'penalty cost' are among the least significant parameters in both contexts. 'Penalty cost', although less significant in both the contexts, has higher weights in the Indian study. Passengers in India prefer to have the flexibility of re-scheduling their travel and might like to book their tickets early, whereas in Nepal, passengers tend to be more certain of their travel and hence give less importance to the penalty cost. Similarly, 'price fluctuation' gets more weight in Nepal due to more price sensitive passengers. This trend was also validated with the 'passenger fare' attribute topping the preference list. Also, 'airline frequency' has more utility weight in Nepal, indicating that the aviation industry in Nepal is less developed than in India. With a limited number of established airline players, the frequency of airlines becomes important.

8 Limitations and scope for further research

The limitations and its scope for further research are listed as follows:

1. The development of utility function for airline travel in Nepal is a follow-up of the work done for airline travel in India by Dutta and Ghosh (2011), the contribution to the literature is limited.
2. While we have been able to show the use of LGPM in last several studies (Dutta et al., 2010; Dutta and Ghosh, 2011; Dutta et al., 2015), the method has a limitation that cross product terms in the utility functions are not considered. This study will be better and more useful if we can consider the effect of cross product of two variables at a time and the effect of square terms.

3 Safety measure was not considered as one of the attributes in this study. As several aircraft accidents have been reported, safety measures can also be considered as one the attributes.

4 In this paper, we have shown the usefulness of the LGPM methodology in airline travel but the comparison is limited to only two different countries (India and Nepal). This type of analysis can also be used to compare the utility function in different sectors or countries. As developing a utility function is an important step in finding the probability of purchase and getting an idea of the market share, this method may be an alternative to well established methods like conjoint analysis. Further research in this direction is necessary to compare the two methods.

5 We have discussed this study with practitioners in the airline industry in Nepal and they think this type of study may be beneficial for introducing a new route. This study can also be extended to examine the interaction effect among similar attributes and their correlation of similarities and differences among the preferences of the attributes across various sectors based on socio-economic levels.

9 Conclusions

A linear utility function for domestic airline travel in Nepal is developed in this paper. It is based on the ten critical attributes for a passenger's final airline travel decision, as discussed by one of the airlines in Nepal. In the Nepalese context, this provides a framework for competing airlines to understand the passenger's preference in a better manner and align their offerings with them appropriately. It also provides them with an opportunity to compare themselves with their competitors. We have done the same for three airlines in this report.

In a broader context, the comparison of the utility function for domestic airline travel in Nepal with that of airline travel in India, developed by Dutta and Ghosh (2011), provides significant insights. The parameters like 'on-time performance' and 'departure time', primarily a metric of time effectiveness, have higher weights both in the Indian and Nepalese contexts. We can further strengthen our argument that based on these findings we can say that on time performance and departure time are important parameters in developing the utility function of an airline travel. Also, operational efficiency in terms of 'turnaround time management' and 'scheduling' are important attributes for a passenger who is planning an airline travel. We can also add a parameter 'In-flight services' to this list but as a prime hygiene factor for an airline travel. Further, the difference in the socio-economic conditions of the two countries was reflected strongly as one of the parameters. 'Passenger fare' is most preferred in the Nepalese context while it featured among the last three preferred attributes in the Indian study.

While doing this analysis we have shown that LGPM (Bryson and Joseph, 1999) can be used to develop the utility function in various sectors. Initial work was done to develop a linear utility function in the insurance sector. Further, the concept was used in developing the utility functions of airline travel and railway travel. In this paper, we have developed the utility function for airline travel in the domestic sector in Nepal and through this we have demonstrated the usefulness of the LGPM methodology not only in different sectors, but also in different countries.

References

Aczel, J. and Saaty, T. (1983) 'Procedures for synthesizing ratio judgments', *Journal of Mathematical Psychology*, Vol. 27, No. 1, pp.93–102.

Basnet, S. (2015) 'Air transportation and its impact upon the tourism industry of Nepal', *Case Study: Tribhuvan International Airport*, Tourism Bachelor's degree thesis, Centria University of Applied Sciences.

Bryson, N. and Joseph, A. (1999) 'Generating consensus priority point vector: a logarithmic goal programming approach', *Computers and Operations Research*, Vol. 26, No. 6, pp.637–643.

Carrier, E. (2003) *Modeling Airline Passenger Choice: Passenger Preference for Schedule in the Passenger Origin-destination Simulator (PODS)*, MSc thesis, Massachusetts Institute of Technology, USA.

Central Intelligence Agency (CIA) World Factbook [online] https://www.cia.gov/library/publications/the-world-factbook/geos/np.html (accessed 15 March 2018).

Chang, Y.H. and Yeh, C.H. (2001) 'Evaluating airline competitiveness using multi-attribute decision making', *Omega*, Vol. 29, No. 5, pp.405–415.

Civil Aviation Authority of Nepal (CAAN) (2016–2017) *Civil Aviation Report 2016-17* [online] http://www.caanepal.org.np/publication/CivilAviationLayoutReport_2017.pdf (accessed 15 March 2018).

Dutta, G. and Ghosh, P. (2011) 'Development of utility function for airline travel: a logarithmic goal programming approach', *International Journal of Revenue Management*, Vol. 5, No. 4, pp. 277–289.

Dutta, G., Basu, S. and John, J. (2010) 'Development of utility function for life insurance buyers in the Indian market', *Journal of Operational Research Society*, Vol. 61, No. 4, pp.585–593.

Dutta, G., Ghosh, P. and Kaul, A.W. (2015) 'A logarithmic goal programming approach to develop the utility function for a railway travel', *International Journal of Revenue Management*, Vol. 8, No. 2, pp.153–164.

Dyer, J.S., Fishburn, P.C., Steuer, R.E., Wallenius, J. and Zionts, S. (1992) 'Multiple criteria decision making, multi-attribute utility theory: the next ten years', *Management Science*, Vol. 38, No. 5, pp.645–654.

Fourer, R., Gay, D.M. and Kernighan, B.W. (1990) 'A modeling language for mathematical programming', *Institute for Operation Research and Management Science*, Vol. 36, No. 5, pp.519–554.

Hess, S. and Polak, J.W. (2005) 'Mixed logit modelling of airport choice in multi-airport regions', *Journal of Air Transport Management*, Vol. 11, No. 2, pp.59–68.

Hess, S., Bierlaire, M. and Polak, J.W. (2005) 'Estimation of value of travel-time savings using mixed logit models', *Transportation Research Part A: Policy and Practice*, Vol. 39, No. 2, pp.221–236.

Maity, G. and Roy, S.K. (2014) 'Solving multi-choice multi-objective transportation problem: a utility function approach', *Journal of Uncertainty Analysis and Applications*, Vol. 2, No. 1, p.11.

Maity, G. and Roy, S.K. (2016) 'Solving multi-objective transportation problem with interval goal using utility function approach', *International Journal of Operational Research*, Vol. 27, No. 4, pp.513–529.

Ministry of Culture, Tourism & Civil Aviation (2017) *Nepal Tourism Statistics 2017*, Government of Nepal [online] http://www.tourism.gov.np/uploaded/statistics 2017.pdf (accessed 15 March 2018).

Pels, E., Nijkamp, P. and Rietveld, P. (2001) 'Airport and airline choice in a multiple airport region: an empirical analysis for the San Francisco Bay Area', *Regional Studies*, Vol. 35, No. 1, pp.1–9.

Saaty, T.L. (1990) 'How to make a decision: the analytic hierarchy process', *European Journal of Operational Research*, Vol. 48, No. 1, pp.9–26.

Saaty, T.L. (2008) 'Decision making with the analytic hierarchy process', *International Journal of Services Sciences*, Vol. 1, No. 1, pp.83–98

Smith, B.C., Leimkuhler, J.F. and Darrow, R.M. (1992) 'Yield management at American Airlines', *Interfaces*, Vol. 22, No. 1, pp.8–31

Telhado Pereira, P., Almeida, A., Gomes de Menezes, A. and Cabral Vieira, J. (2007) 'How do consumers value airline services attributes? A stated preferences discrete choice model approach', *Management: Journal of Contemporary Management Issues*, Vol. 12, No. 2, pp.25–40.

Wang, Y.M. and Parkan, C. (2006) 'A general multiple attribute decision-making approach for integrating subjective preferences and objective information', *Fuzzy Sets and Systems*, Vol. 157, No. 10, pp.1333–1345.

Appendix 1

Logarithmic goal programming model

In goal programming, we minimise under achievement and over achievement from the required goal. Bryson and Joseph (1999) suggested that minimising a linear objective function with two variables summed over indices is identical to minimising the logarithms of their product computed over the same indices. Therefore, in LGPM, we minimise the logarithms of the product of under achievement and over achievement. This has also been explained in Dutta et al. (2010) and Dutta and Ghosh (2011).

We define the indices, parameters and sets of the model as follows:

I set of first criterion $I = (1, 2, 3, i \ldots Imax)$ indexed by i

J set of second criterion $J = (1, 2, 3 \ldots j \ldots Jmax)$ indexed by j

L link or pair of criteria (i, j) where $i \in I$ and $j \in J, j \neq i$

T set of decision makers indexed by t, $T = (1, 2 \ldots t \ldots Tmax)$

a_{ij}^t the specified value of the decision-maker t for the pair of attribute (i, j) where $t \in T$ and $(i, j) \in L$

p_{ij}^t the specified value generated by the methodology given t for the pair (i, j) where $t \in T$ and $(i, j) \in L$

q_{ij}^t another specified value generated by the methodology given t for the pair (i, j) where $t \in T$ and $(i, j) \in L$

v_i is the un-normalised decision variable of LGPM

w_i is the normalised decision variable or the weights of different attributes.

The objective of a linear goal programming model (LGPM) is to generate a group mean priority point vector $w = (w_1, w_2, \ldots, w_N)$ such that while comparing each pair of criteria i and j, the difference between the decision-makers specified as a_{ij}^t and the ratio (w_i/w_j) is minimised.

We have to define two real numbers $p_{ij}^t \geq 1, q_{ij}^t \geq 1$ such that

$$\left(w_i/w_j\right)*\left(p_{ij}^t/q_{ij}^t\right)=a_{ij}^t,$$

where p_{ij}^t and q_{ij}^t both cannot be greater than 1.

Then, $p_{ij}^t=q_{ij}^t=1$ implies that $(w_i/w_j)=a_{ij}^t$, $q_{ij}^t>1$ implies that $(w_i/w_j)>a_{ij}^t$, and $p_{ij}^t>1$ implies that $(w_i/w_j)>a_{ij}^t$.

Therefore, if $p_{ij}^t=q_{ij}^t=1$ for each pair of criteria i and j, then the set of point estimates provided by the decision-maker t is consistent; otherwise the data are inconsistent and our problem then is to minimise the product $\prod_{i\in I}\prod_{j\in J}p_{ij}^t q_{ij}^t$.

But we need to focus on the entire set of pairwise comparison values (Aczel and Saaty, 1983). Therefore, our problem is to minimise the product for all respondents $t \in T$ and each value of $(i, j) \in L$.

Thus the problem is to minimise:

$$\prod_{t\in T}\prod_{i\in I}\prod_{j\in(i,j)\in L}p_{ij}^t q_{ij}^t$$

Thus, we have the following linear goal programming problem where the decision variables are the un-normalised vector (v_1, v_2, …, v_N) and we minimise the logarithm of their product.

Subject to

$$\ln(v_i)-\ln(v_j)+\ln\left(p_{ij}^t\right)-\ln\left(q_{ij}^t\right)-\ln\left(a_{ij}^t\right)\quad\forall\quad t\in T;(i,j)\in L$$

$$\left(\frac{1}{K}\right)\sum_{i\in I}\sum_{j\in J}\left(\left(\ln\left(p_{ij}^t\right)+\ln\left(q_{ij}^i\right)\right)-\ln\left(\Theta^t\right)\right)=0\quad\forall\quad t\in T$$

where $K = N * (N - 1)$; $I = \{1, 2, …, N\}$ and all variables are non-negative.

The optimal solution of this problem results in the un-normalised vector $v = (v_1, v_2, …, v_N)$, which can then be normalised to give our normalised consensus priority point vector $w = (w_1, w_2, …, w_N)$ where $(v_i/v_j) = (w_i/w_j)$ for each (i, j).

Appendix 2

Logarithmic goal programming model

In this section, we explain the model with small data points. We explain the LGPM with the help of a small dataset implemented on the MS Excel Solver.

We reduced our 106 responses across ten attributes into only ten responses across those attributes so that we could run the model in MS Excel for a simpler explanation of the model. For this, we took an average of the first ten responses and considered that as a single response. Similarly, we moved along to generate ten such responses (as shown in Table A1).

Table A1 Small data points for ten responses for model explanation

Responses	*PF*	*AT*	*PRF*	*DT*	*OP*	*DD*	*PC*	*HL*	*AF*	*S*
1	95.5	89.7	66.1	85.3	82.2	82.5	57.6	66.6	74.7	86.0
2	83.2	80.5	52.0	87.3	86.8	84.8	49.5	60.6	67.6	77.1
3	93.7	82.7	58.7	92.0	83.6	81.4	55.2	59.7	58.3	84.0
4	86.7	93.1	66.6	88.1	87.9	80.4	50.0	74.6	51.0	83.0
5	91.2	75.5	59.0	86.4	83.6	79.9	46.8	57.1	46.9	84.4
6	91.6	78.7	66.9	93.1	82.3	69.5	62.2	63.6	59.7	81.4
7	90.2	79.0	68.1	94.4	88.1	83.6	53.5	63.1	53.6	82.5
8	95.0	80.2	63.0	93.1	88.1	66.8	57.3	68.7	63.7	88.9
9	91.8	66.6	50.0	78.2	70.1	38.7	31.3	75.8	57.5	81.3
10	75.8	78.1	48.0	71.0	65.6	62.8	33.3	58.6	58.3	70.1

Then, we will follow the steps as devised for LGPM implementation.

Step 1: Individual priority matrix a_{ij}^t

We calculated the a_{ij}^t matrix for each respondent for each attribute where a_{ij}^t is the ratio of response to the i^{th} attribute with respect to the response to the j^{th} attribute by the t^{th} respondent. Therefore, we get a matrix of order of ~10 × 45 (no. of respondents × no. of comparison ratios for each attribute = 106 × $^{10}C_2$ = 106 rows × 45 columns). Here, for ease of explanation, we have taken only ten respondents so the matrix is of order of 10 × 45.

Here, $a_{ij}^t = a_i^t / a_j^t$, for each t = 1 to 10, j = (i + 1) to 10 for all i = 1 to 9

For example: $a_{12}^1 = 95.5 / 89.7 = 1.065$

Table A2 is the a_{ij}^t matrix for i = 1 (as a reference).

Table A2 Individual priority matrix a_{ij}^t for i = 1

Responses	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}	a_{17}	a_{18}	a_{19}	a_{110}
1	1.065	1.445	1.120	1.162	1.158	1.658	1.434	1.278	1.110
2	1.034	1.600	0.953	0.959	0.981	1.681	1.373	1.231	1.079
3	1.133	1.596	1.018	1.121	1.151	1.697	1.570	1.607	1.115
4	0.931	1.302	0.984	0.986	1.078	1.734	1.162	1.700	1.045
5	1.208	1.546	1.056	1.091	1.141	1.949	1.597	1.945	1.081
6	1.164	1.369	0.984	1.113	1.318	1.473	1.440	1.534	1.125
7	1.142	1.325	0.956	1.024	1.079	1.686	1.429	1.683	1.093
8	1.185	1.508	1.020	1.078	1.422	1.658	1.383	1.491	1.069
9	1.378	1.836	1.174	1.310	2.372	2.933	1.211	1.597	1.129
10	0.971	1.579	1.068	1.155	1.207	2.276	1.294	1.300	1.081

Step 2: Group priority vector w_i from the individual priority matrix a_{ij}^t

a Now we define two real numbers p_{ij}^t and $q_{ij}^t \geq 1$ such that

$$\left(w_i/w_j\right)*\left(p_{ij}^t/q_{ij}^t\right)=a_{ij}^t \qquad (1)$$

Both p_{ij}^t and q_{ij}^t cannot be greater than 1 for the same (i, j).

Ideally, $(w_i/w_j) = a_{ij}$ but it is not practically possible. There are two cases:

1. $(w_i/w_j) > a_{ij}$: In this case, $(p_{ij}^t / q_{ij}^t) < 1$ to equate equation (1), hence $q_{ij}^t > p_{ij}^t \geq 1$ or $q_{ij}^t > 1$.

   To keep the equation of $(p_{ij}^t / q_{ij}^t) < 1$ always valid, we get the value of $p_{ij}^t = 1$.

2. $(w_i/w_j) < a_{ij}$: In this case $(p_{ij}^t / q_{ij}^t) > 1$ to equate equation (1), hence $p_{ij}^t > q_{ij}^t \geq 1$ $p_{ij}^t = 1$.

   To keep the equation of $(p_{ij}^t / q_{ij}^t) > 1$ always valid, we get the value of $q_{ij}^t = 1$.

So, either we have p_{ij}^t or q_{ij}^t as a variable and the other one being equal to ideally one. Therefore, our target is to minimise the product of p_{ij}^t and q_{ij}^t over all t's, for all combinations of i and j.

Now, we do not have the w_i vector known as we will get this value by getting the optimal solution by using the Excel Solver. Therefore, to solve this we introduce the v vector and calculate the $a_{ij}^t * (v_j / v_i)$ matrix to calculate the value of p_{ij}^t and q_{ij}^t.

The value stated in Table A3 has been calculated by Excel Solver after optimising for the w_i vector.

Table A3 $a_{ij}^t * (v_j / v_i)$ matrix for $i = 1$

Responses	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}	a_{17}	a_{18}	a_{19}	a_{110}
1	0.841	0.859	0.982	0.942	0.863	0.852	0.906	0.754	0.899
2	0.817	0.951	0.836	0.777	0.732	0.864	0.868	0.726	0.873
3	0.896	0.949	0.893	0.908	0.858	0.872	0.992	0.948	0.903
4	0.736	0.774	0.863	0.799	0.804	0.891	0.735	1.003	0.845
5	0.955	0.919	0.926	0.884	0.851	1.001	1.009	1.147	0.875
6	0.920	0.814	0.863	0.902	0.983	0.757	0.910	0.905	0.911
7	0.902	0.787	0.838	0.830	0.805	0.866	0.903	0.993	0.885
8	0.936	0.896	0.895	0.874	1.060	0.852	0.874	0.880	0.865
9	1.089	1.091	1.029	1.061	1.769	1.507	0.765	0.942	0.914
10	0.767	0.939	0.936	0.937	0.900	1.170	0.818	0.767	0.875

b Computation of p_{ij}^t and q_{ij}^t matrix:

$$a_{ij}^t*\left(v_j/v_i\right)>1 \text{ then } 1/q_{ij}^t=1 \ \& \ p_{ij}^t=a_{ij}^t*\left(v_j/v_i\right)$$

(This is case 2 as discussed above).

$a^t_{ij} * (v_j / v_i) < 1$ then $p^t_{ij} = 1$ & $1/q^t_{ij} = a^t_{ij} * (v_j / v_i)$

(This is case 1 as discussed above).

Or, we can compute the matrix individually as follows:

p^t_{ij} matrix is computed by considering that if

$a^t_{ij} * (v_j / v_i) > 1$ then $p^t_{ij} = a^t_{ij} * (v_j / v_i)$ else $p^t_{ij} = 1$.

Table A4 p^t_{ij} matrix for $i = 1$

Responses	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}	a_{17}	a_{18}	a_{19}	a_{110}
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
3	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
4	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.003	1.000
5	1.000	1.000	1.000	1.000	1.000	1.001	1.009	1.147	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.060	1.000	1.000	1.000	1.000
9	1.089	1.091	1.029	1.061	1.769	1.507	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.170	1.000	1.000	1.000

Similarly, q^t_{ij} matrix is computed by considering that if

$a^t_{ij} * (v_j / v_i) < 1$ then $1/q^t_{ij} = a^t_{ij} * (v_j / v_i)$ else $1/q^t_{ij} = 1$.

Table A5 q^t_{ij} matrix for $i = 1$

Responses	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}	a_{17}	a_{18}	a_{19}	a_{110}
1	1.188	1.165	1.019	1.062	1.159	1.174	1.103	1.326	1.113
2	1.224	1.052	1.197	1.287	1.367	1.158	1.152	1.378	1.145
3	1.117	1.054	1.120	1.101	1.165	1.146	1.008	1.055	1.108
4	1.359	1.293	1.159	1.251	1.244	1.122	1.361	1.000	1.183
5	1.047	1.089	1.080	1.131	1.175	1.000	1.000	1.000	1.144
6	1.087	1.229	1.159	1.109	1.018	1.321	1.099	1.105	1.098
7	1.108	1.270	1.193	1.205	1.243	1.154	1.107	1.008	1.130
8	1.068	1.116	1.118	1.144	1.000	1.174	1.144	1.137	1.156
9	1.000	1.000	1.000	1.000	1.000	1.000	1.306	1.062	1.094
10	1.304	1.066	1.068	1.068	1.111	1.000	1.223	1.304	1.143

With these formulations in an Excel Solver and with

$$\text{Objective function} = \text{Minimise}\left(\ln\left(p_{ij}^{t} * q_{ij}^{t}\right)\right) \text{ for all values of } i,\ j \text{ and } t.$$

We get the normalised consensus priority vector w_i vector where $(w_i/w_j) = (v_i/v_j)$ for each (i, j).

Table A6 Priority consensus vector for small set of data

PF	*AT*	*PRF*	*DT*	*OP*	*DD*	*PC*	*HL*	*AF*	*S*
0.1358	0.1073	0.0807	0.1191	0.1101	0.1013	0.0698	0.0858	0.0801	0.1099

Appendix 3

Questionnaire for airline travel decision in Nepal

Hi!

We at Indian Institute of Management, Ahmedabad (IIMA), are conducting a study to know the factors you would consider when choosing an airline to travel in Nepal.

Your name: ________________________________

Your date of birth: ___________________________

Your occupation (tick one):

☐ Student

☐ Executive

☐ Self employed

Your monthly household income (tick one):

☐ < 10,000

☐ 10,000–20,000

☐ 20,000–30,000

☐ 30,000–40,000

☐ 40,000–50,000

The factors considered by people while choosing an airline to travel in Nepal are as listed below. Indicate the importance of each factor in influencing your decision to buy tickets in a particular airline in Nepal. Indicate the importance on a scale of 1 (least important) to 100 (most important).

Serial no.	*Attribute name*	*Importance (1–100)*
1	Passenger fare (PF)	
2	Availability of tickets (AT)	
3	Price fluctuation (PRF)	
4	Departure time (DT)	
5	On-time performance (OP)	
6	Difference between actual and desired arrival/departure time (DD)	
7	Penalty cost (PC)	
8	Handling of luggage loss (HL)	
9	Airline frequency (AF)	
10	In-flight service (S)	

Rate the following airlines across each of the above mentioned attributes on a scale of 1 (least suitable) and 10 (most suitable).

Attributes	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Airline 1										
Airline 2										
Airline 3										

Appendix 4

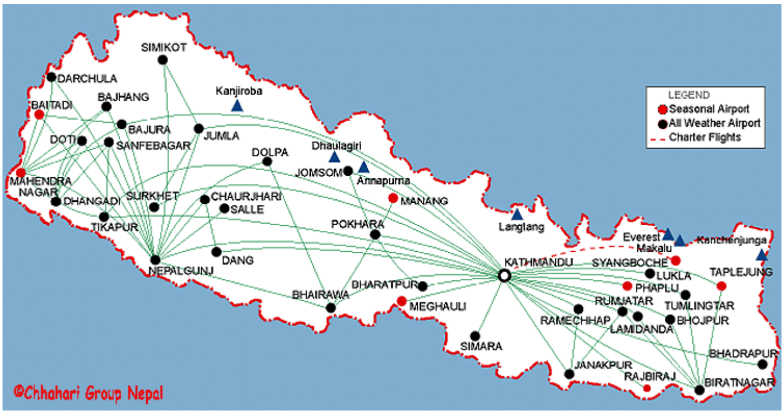
According to the CIA World Factbook (https://www.cia.gov/library/publications/the-world-factbook/geos/np.html), 2013 reports, Nepal has 47 airports with Kathmandu being the only international airport and a hub for domestic airline travel in Nepal. A map of Nepal airports is given in Figure A1 and the domestic flight routes in Nepal are given in Figure A2.

Figure A1 A map of Nepal airports (see online version for colours)

Source: Google images of Nepal airports

Table A7 shows the total number of aircraft accidents and fatalities that occurred in Nepal during the period from 2005 to 2014. The table clearly shows that during the period between 2005 and 2014 a total of 16 aircraft accidents (Basnet, 2015) were reported. During the period 2010 to 2014, a total number of 12 aircraft accidents were reported with very high number of fatalities. This was the major reason for a high decrease rate in the passenger movement in the domestic airline travel in Nepal.

Figure A2 Domestic air routes in Nepal (see online version for colours)



Source: Google images of domestic air routes in Nepal

Table A7 Aircraft accidents and fatalities from the year 2005 to year 2014, Nepal

Year	*No. of aircraft accidents*	*No. of fatalities*
2005	1	0
2006	2	9
2007	0	0
2008	1	18
2009	0	0
2010	3	36
2011	3	25
2012	2	34
2013	3	0
2014	1	18

Source: Basnet (2015)

Appendix 5

Nepal tourism

Tourism is one of the largest industries in Nepal. The tourism industry in Nepal is economically important as it is one of the major sources of foreign exchange in Nepal. Nepal tourism offers its rich culture, pilgrimage destinations, national parks and reserves. In addition to this there are also places in Nepal known for adventure sports. The tourism industry in Nepal can be categorised into three major areas: cultural and natural tourism, pilgrimage destinations and adventure sports.

- *Cultural and natural tourism:* The UNESCO World Heritage Sites in Nepal are Lumbini and seven monuments of Kathmandu valley that constitute the cultural tourism and Chitwan and Sagarmatha National parks that constitute natural tourism. The other popular national parks in Nepal include Shivapuri and Langtang National Parks. There are many other natural reserves in Nepal that form a major part of its tourism.
- *Pilgrimage destinations:* Nepal is known for its ancient pilgrimage sites. Janakpur, Halesi Mahadev, Baraha Chhetra, Tengboche and Pathibhara are some of the places of pilgrimage in East of Nepal. Lumbini, Kathmandu Valley, Manakamana, Tansen, Muktinath, Gorkha and Gosainkunda are in Central Nepal and Khaptad Ashram and Swargadwari are in West Nepal. One of the holy Hindu pilgrimage destination in Nepal is Pashupatinath, the temple of Lord Shiva. Another religious destination that is most visited in Nepal is Lumbini, the birth place of Lord Buddha.
- *Adventure sports:* Nepal is also a well-known destination for adventure sports like mountaineering, rafting, kayaking, trekking, canyoning, etc. Nepal offers many mountaineering and trekking options like the Annapurna and the Everest Region, the areas near Dhaulagiri, Lamjung, Jomsom and Mustang, in the Western region, and the areas surrounding Jumla and Rara Lake, in the Midwestern administrative division. Mt. Everest is one of the major tourist attractions in Nepal, which is most visited by tourists and mountaineers. Other sports like rafting, kayaking, boating and canyoning can be experienced at Pokhara, the lake city of Nepal. Air sport options like paragliding are also available in Pokhara and other cities.