# Planning and Management of Regional Infrastructure for Tourism Development in Orissa State, India

Dr Dillip Kumar Das

Senior lecturer, School of Civil Engineering and Built Environment, Faculty of Engineering and Information Technology, Central University of Technology, Free State, Bloemfontein, South Africa, email: ddas@cut.ac.za, ph. 0027515073647

## ABSTRACT

Infrastructure is highly imperative for tourism development of a tourism resource rich region, which requires plausible planning and management for the development of such infrastructure. In this article, an attempt was made to comprehend the tourism development of a region by considering the influence of three most essential infrastructures, such as, roads, railway and accommodation. For this purpose an integrated System Dynamics model was developed by integrating the effects of road, rail and accommodation infrastructure to the tourism system. It was observed that there would be a multi-fold increase in the tourist flow and revenue generation from tourist receipts along with increase in tourist satisfaction because of enhanced infrastructure provision under perceived simulated scenario. The article also presents a planning and management plan for development of infrastructure in phased manner based on the acceptable simulation results. Thus, a System Dynamics model having the ability to integrate the influences of various infrastructures on the tourism system provides an appropriate tool to predict the various measured indicators reliably and facilitate plausible policy and decision making in perspective planning and management for tourism development.

Keywords: Infrastructure; Planning and management, System Dynamics modelling; Tourism development; Tourist satisfaction

## INTRODUCTION

Infrastructure provision functions as the nervous system for effective tourism development and the success of tourism destinations in world markets. It influences relative competitiveness of destinations or tourist regions (Enright & Newton, 2004) that focused on destination image or attractiveness (Chon, Weaver & Kim, 1991; Gallarza, Saura & Garcıa, 2002; Hu & Ritchie, 1993). Whilst tourism services in general are recognized as being important elements of destination image or product, the supporting factors or better known as satisfiers and resources (motivators or prime attractions) are factors that provide the foundation for building a successful tourism industry in a region (Enright et al., 2004; Murphy, Pritchard & Smith, 2000). This includes, in particular, the extent and condition of a destination's or region's general infrastructure, and facilitating resources, influencing accessibility and providing accommodation (Butler 1980; Crouch & Ritchie, 1999; Enright et al., 2004).

Based on the dimensions and attributes (Beerli & Martın, 2004) of tourism development, the various types of physical infrastructures that influence tourism development and create an image of the destination or tourism region are general/ basic infrastructure, and tourist infrastructure (Decrop, 2010). The first category, i.e., general infrastructure, essentially forms a part of macro level development that helps in attracting and bringing the tourist to the destinations and other functions. This includes transportation, communication, and health services at broader perspective. The second category of infrastructure, i.e., tourist infrastructure mostly functions at the tourist destination level where the activities take place comprises of accommodation, food facilities, information and entertainment facilities (Beerli et al., 2004). These two categories of infrastructure are though overlapping to each other, vary with dimensions and scale. However, there is an inter-linkage between the two types of infrastructure.

Of all, accommodation, transportation and communication sector can be classified as business factors contributing income generation and employment creation and the service quality, which need to have the characteristics like tangibility, reliability, responsiveness, assurance, and empathy, and are key factors in tourism development (Crouch et al., 1999). Transportation infrastructure in the form of canals, roads, railroads, turnpikes, and airports is one of the original and major objects of the State activity. The goal is to ease the movement of goods, people, and services both within the State or regions and across the State or region lines and accessibility of these infrastructure services facilitates economic development (Handberg, 2002; Khadaroo & Seetanah, 2007) in general and so also tourism development. Accommodation is a fundamental element of tourism industry (Urtasun & Gutie´rrez, 2006). It is the largest and most ubiquitous sub-sector within the tourism economy, accounting for around one-third of total trip expenditure and, forms an essential ingredient of the tourism experience. This sector dominates the market and plays a vital role not only in structural terms but also in terms of contribution to Gross Domestic Product and employment. The choice of accommodation reflects, by and large, the needs and expectations of the tourist and, as a result, both the quantitative and qualitative characteristics of the supply of accommodation services directly influence the type of tourism/tourists attracted to destination areas (Albacete-Sa´ez, Fuentes-Fuentes & Llore´ns-Montes, 2007; Sharpley, 2000).

The most recent developments in information communication technology and consequent e-Tourism applications are contributing largely to the tourism industry in the form of information transfer and dissemination and force strategic implications for businesses in tourist locations and changes in strategic management in organizations (Barnes, 2002; Buhalis, 2004; Pan Li, 2011; Xiaoqiu, Buhalis, and Song, 2003).

On the other hand, a few Scholars, (Boissevain and Theuma 1998; Bramwell 2003) argue that infrastructure requirements for quality tourism, consume more natural resources, and may create environmental degradation acting as a double edged sword. However, despite such negativity, the success of tourism industry is largely dependent upon the appropriate development of infrastructure, and should be a fundamental and integral element of the both overall destination planning process (Sharpley, 2000) and regional tourism development process. Therefore, in this article an attempt was made to explore the planning and management implications of infrastructure development on the regional tourism development in a tourism resource rich region of Orissa State, India. In this context, the most influential parameters under basic transportation infrastructure, such as, road length and rail route length; and under tourism

infrastructure sector accommodation were considered and System Dynamics model was built to understand their supply and demand and level of satisfaction in the region and integrated to tourism system of the region to build an integrated tourism development model. The integrated model was employed to project perceived infrastructure requirements under simulated scenarios and observe their influence on the tourism development in the region in terms of tourist flow to the region, revenue generation and effect of infrastructure development on tourist satisfaction.

## STUDY AREA AND JUSTIFICATION OF ITS CHOICE

The region bounded by the coastal region along the coast of Bay of Bengal and flood plains of Orissa State of India located between the parallels of $17^0$ 49' N and $22^0$ 34' N latitudes and meridian of $81^0$27' E and $87^0$29' E longitudes was chosen as the study area for this investigation. It was delineated based on its homogeneous physical and demographic characteristics, evenly spreading of tourist destinations, location of the settlements (districts) in one axis and the reasonable communicable distance from one end of the study area to the other end. The region contains most of the tourist related resources of the State and has tremendous potential for developing tourism industry due to its rich cultural heritage, availability of religious places, archaeological sites, long and beautiful coastline with natural scenic beaches, wildlife sanctuaries, wild flora and fauna, largest backwater lake (Chilka), immigration of beautiful birds and tortoises (Olive riddle) from far corners of the world, hot springs, waterfalls, etc., in addition to adequate resources and high-grade skill for craft based products. Moreover, the region has fertile land, advantages of irrigation facilities for agriculture and horticulture development, however, it is still economically, socially and physically backward, and. under this situation, it was considered that tourism development can play an important role the development of the region and contribute to the spatial, infrastructural and economic development of the region and therefore chosen for this investigation.

## DATA AND METHODOLOGY

In this investigation survey research methodology followed by System Dynamics modelling was employed. Two types of data, i.e., from secondary sources and primary sources were collected. Secondary data was collected from authentic published and unpublished literatures, reports and documents. Primary data was collected through stratified random sampling survey method by using pre-tested schedules at household level and from individual tourists visiting the region. Survey was conducted from a total number of 300 selected households and 100 individual tourists in three sub regions created for the survey purpose. The data collected were analysed by relevant statistical analysis such as, tabulation, correlation, to identify the major control parameters influencing infrastructure planning and management and tourism development in the region and employed for System Dynamic model development by using POWERSIM software.

## CONCEPT AND THEORY

For this purpose System Dynamics theory based on systems concept (Forester, 1968, 1969) was employed to analyse the tourism and infrastructure functions in the study area. The study area was considered as a system in which infrastructure was interlinked to tourism development in the system (Coyle, 1996; Sterman, Forrester, Graham, and Senge, 1983; Patterson, Tim, Ken, & Egor 2004).

## MODELLING

### Model description

The model was conceptualised based on the influence of two most important basic infrastructure in transportation sector, such as, road sector and railway sector and tourist infrastructure in the form of accommodation on the flow of tourists to the region. Independent System Dynamics sub models for each of the sectors - road, railway and accommodation were developed. Similarly tourism model for tourist arrival in foreign tourist, domestic tourist category leading to total tourists arrival, and revenue generated from tourist receipts because of the tourist expenditure was built independently. The models were developed by considering various major variables influencing them and their causal relationships. The three sub models on road, railway and accommodation infrastructure were integrated to the tourism model developed to build an integrated tourism model. The scope of the model was to observe the satisfaction level of three infrastructures in the system and the influence of these three sectors on the tourist arrival and tourist receipts and tourist satisfaction when integrated to the tourism under normal conditions of infrastructure development as in current scenario and under perceived simulated scenarios of infrastructure development in the projected year. The normal condition was assumed based on the premise that the infrastructure development in the system shall continue following the current trend, where as perceived condition was visualised based on the feasible growth rate in confirmation with the vision of Government of Orissa for infrastructure development in the State, entrepreneurs involved in tourism industry and experts experiences and opinions. The time horizon considered for the model was 25 years, i.e., from 2006 A.D to 2031 A.D. The model was built by considering year 2006 A.D as the base year and 2031 A.D as the projected year. The details of the contents and structures of the sub models and integrated model are described as follows and the causal feedback loop diagram for developing the structure of model is illustrated in the figure 1.

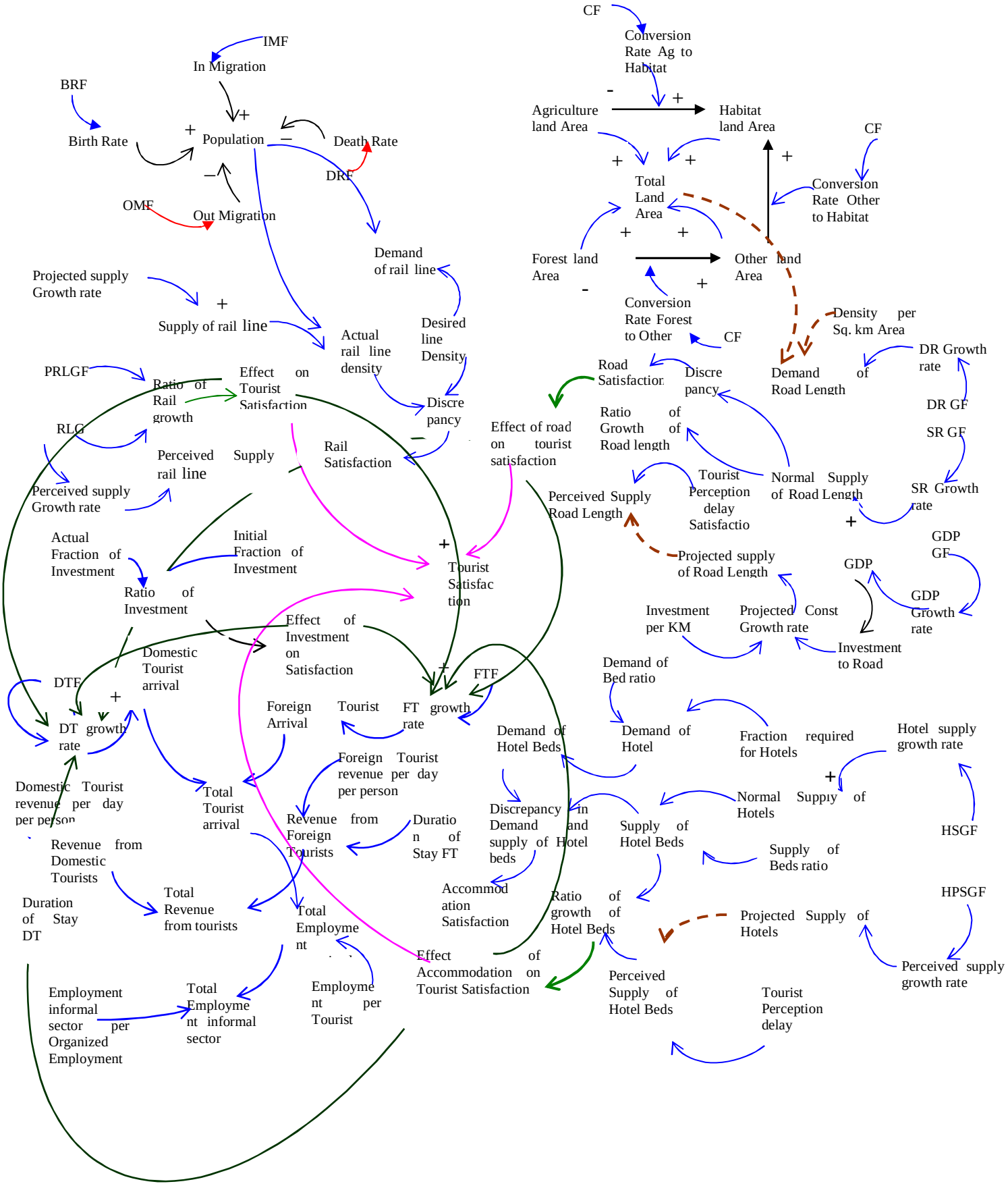


**Fig. 1 Conceptual causal feedback loop diagram for System Dynamics modelling of various subsystems and integrated Tourism System influencing Tourism Development.**

***Road Sector***

Road is one of the most important infrastructure in the system for both regional and local transportation needs and accessibility, as the entire road transportation system is dependent on the availability of road lengths and their quality, and influence the tourist satisfaction. A System Dynamics model was developed to compute the demand, supply and perceived supply of road lengths and road satisfaction level of the road system in the system. The important control variables considered for developing the model were normal available road length; road construction growth rate, investment in road construction contributed from annual Gross Domestic Product, average cost for construction per unit length of road, time to allocate the fund and construction, minimum requirement and desired road length, and perceived road length. The normal available (supply) road length is taken as a stock variable and is calculated based on the normal construction rate, which is a function of investment as a fraction contributed from Gross Domestic Product of the State and time allocating for the same. Desired road length (Demand) is also a stock variable is taken as a function of minimum requirement of road length per square kilometre of land area. Perceived road length (Stock variable) is a function of the projected investment based on priorities attached to the development of this sector from time to time. The initial road satisfaction (auxiliary variable) of the system is a function of the discrepancy between the demand of road length and supply of road length. Similarly the perceived road satisfaction is a function of perceived supply of road length and demand of road length in the region. The effect of road on tourism development and tourist satisfaction is a function of ratio of growth of road of perceived and normal supply of road length, and tourist perception delay. In this model development, normal available road length, desired road length, projected road length, higher order road length and Gross Domestic Product were considered as level variables. The road construction rate, Gross Domestic product change rate, road length change rate were the rate variables and all others were considered as auxiliary variables. The equations employed for model development are:

Initial Road satisfaction = f (discrepancy between demand and supply of roads)
= f (demand of roads- supply of roads) / demand of roads

Perceived Road satisfaction = f (discrepancy between demand and perceived supply of roads) = f (demand of roads- perceived supply of roads) / demand of roads

Supply of Road Length =Initial road length
$+\int_{t0}^{t}$ (road length*normal construction rate) dt

Perceived Road Length =Initial road length
$+\int_{t0}^{t}$ (road length* perceived construction rate) dt

Demand of road length= Initial demand on road length +
$\int_{t0}^{t}$ (Area * min Km sq. m) * Road length change rate ) dt

Perceived Construction Rate = Perceived annual investment in road /Average investment per Km

Normal Construction Rate = Normal annual investment in road /Average investment per Km

Investment for road construction = f (GDP, time to allocate fund)) = Normal GDP
$=\int_{t0}^{t}$ (Normal GDP* fraction allotted for road construction) d

***Railway sector***

Railway is another essential most sector in the system for national and regional transportation needs and accessibility. At regional level, availability of rail route length is considered essential for regional and local transportation needs. The development of railway in the system was considered as exogenous to the system, as the State does not contribute financially to its development, because it is a subject, which belongs to Central Government. A System Dynamics sub model was developed in order to compute the demand, supply and perceived supply of rail route lengths and satisfaction level of the rail sub system in the system, and effect of rail development on tourist satisfaction and tourism development in terms of tourist flow and tourist receipts. The important control variables considered for developing the model were population, available rail route length, rail route length growth rate, minimum requirement or desired density of rail route length, actual rail route length density, perceived rail route length, tourist perception delay. While supply (available length) was computed based on rail route length growth rate, demand (desired rail route length) was considered as a function of population and rail density as envisaged by the Planning Commission, Government of India, in Vision 2020. Perceived rail line length was the projected rail route length based on priorities attached to this sector from time to time. Rail satisfaction is a function discrepancy in demand and supply position of rail route length and perceived rail satisfaction is a function of perceived supply and demand of rail route length. Effect of rail on tourism development and tourist satisfaction are considered as functions of ratio of rail route length (perceived rail route length to available rail route length), and tourist perception delay. The equations employed for model development are:

Available Rail Line Length = Initial supply +
$\int_{t0}^{t}$ (Initial supply of rail line *Rail Line Growth Rate) dt
Desired Rail Line Length = (Population / 1000000) * Desired Rail Line Density
Perceived Rail Line Length = Initial rail line length +
$\int_{t0}^{t}$ (Initial supply of rail line *Rail Perceived Rail Growth Rate) dt
Discrepancy= (Desired Rail Line Density-Actual Rail Line Density) / Desired Rail Line Density
Gap in Rail Demand and Perceived Supply of Rail line = (Desired Rail Line Length-Perceived Rail Line) / Desired Rail Line Length
Initial Rail satisfaction = f (Gap between demand and supply of roads)
= f (demand of rail line length- supply of rail line length) / demand of rail line length Perceived Rail satisfaction = f (Gap between demand and perceived supply of rail line length)
= f (demand of rail line length - perceived supply of rail line length) / demand of rail line length

***Accommodation sector***

Accommodation is another important sector highly influential for tourism development in the system. This was considered as an endogenous factor, as development of this sector is highly dependent on the tourist flow and their stay in the system; and the tourist stay in the destinations depends on the availability of adequate hotels at affordable costs. The accommodation facilities were taken in terms of hotel beds in organized accommodation facilities. A system Dynamic model was developed in order to compute the demand and supply of accommodation facilities in terms of hotel beds under different categories, satisfaction level of the accommodation facilities in the system, and effect of accommodation sector on tourist satisfaction and tourism development. The important control variables considered for developing the model were total tourist flow, available hotel beds, accommodation growth rate, desired fraction requirement for accommodation and demand of beds ratio, perceived accommodation, perceived growth rate, tourist perception delay. In this model available accommodation, projected accommodation were considered as level variables, where as demand of accommodation was considered as auxiliary variable. While supply (available hotel beds ) was computed based on normal growth rate, demand of hotel beds was considered as a function of tourists arrival and demand of ratio of hotel beds, which was decided based on the standards and hotel occupancy rates envisaged by the entrepreneurs and hoteliers. Perceived accommodation was projected based on priorities attached to this sector from time to time by the government and entrepreneurs. Accommodation satisfaction was a function discrepancy in demand and supply position of hotel beds. Perceived accommodation satisfaction was a function discrepancy in demand and perceived supply position of hotel beds. Effect of accommodation on tourism and tourist satisfaction was considered as a function of ratio of accommodation, (perceived hotel beds to supply hotel beds), and tourist perception delay factor. The equations employed in model development are:

Supply (Available) of Accommodation hotel beds =Initial supply +
$\int_{t0}^{t}$ (Initial supply of accommodation *accommodation growth rate) dt
Demand for accommodation = Tourists per year * Fraction require accommodation
Demand of total hotel beds = Demand for accommodation * Demand of beds ratio
Perceived accommodation (hotel beds) = Initial accommodation (hotel beds)
$+\int_{t0}^{t}$ (Initial supply of accommodation *Perceived accommodation growth rate ) dt
Discrepancy= (Demand of hotel beds-supply of hotel beds) / Demand of hotel beds
Gap in accommodation Demand and Perceived Supply of accommodation = (Demand of accommodation-Perceived supply of accommodation) / Demand for accommodation
Initial accommodation satisfaction = f (Gap between demand and supply of roads)
= f (demand of accommodation- supply of accommodation) / demand of accommodation
Perceived accommodation satisfaction = f (Gap between demand and perceived supply of accommodation)
= f (demand of accommodation - perceived supply of accommodation) / demand of accommodation

**Integrated tourism model**

Tourism industry is one of the most dynamic and complex industries in the system and its various functions are highly interlinked and interdependent to each other. The development of the tourism industry is influenced by various exogenous and endogenous variables of those functions in the system. Initially, tourism system model was developed by taking tourist arrival in both domestic and foreign categories separately. The tourist arrival in both foreign and domestic category in the system were considered as level variables, and were computed based on the normal growth rate experienced in the system. Domestic tourists flow growth rate and foreign tourist flow growth rate were taken as rate variables in this model. The total tourist arrival was an auxiliary variable and computed as the sum of tourist arrival on both foreign and domestic tourists' categories. The duration of stays of tourists in both categories of tourists and per capita tourist expenditures were considered for arriving at the annual (yearly) tourist revenue generation (tourist receipts) in the system. In this model, the effects of road and railway infrastructure under transportation infrastructure; and effect of availability of hotels in the system under accommodation sector were integrated to build the integrated tourism model. The influence of the three sectors of infrastructure was integrated by use of table functions and sensitivity analysis of the model. The table functions were relationships between ratio under perceived conditions and normal conditions and time, which provided non linear relationships close to the real system. They were obtained through discussions with the experts and tourism development decision makers in the system. The values of table functions were finalised after they were discussed, debated, tested and suitably modified following an iterative process based on the observations and past experiences of the experts in the study area. The projected tourist flow and annual revenue from tourist receipts and tourist satisfaction were computed by using the integrated model. The total tourist satisfaction was considered as a function of the effects of roads, railways, and accommodation, on tourist satisfaction. Total tourist satisfaction was computed by assigning different weightages to the effects of these three sectors on tourist satisfaction. The effects of each infrastructure were estimated separately by employing respective sector models, and weightages were assigned according to tourist perception as obtained from the survey of tourists. The equations employed for development of model are:

Domestic tourists = Initial domestic tourist
$+\int_{t0}^{t}$ (Initial domestic tourist *Domestic tourists growth rate ) dt * (∑Effect of Infrastructures)
Foreign tourists = Initial foreign tourists
$+\int_{t0}^{t}$ (Initial Foreign tourist *Foreign tourists growth rate ) dt *( ∑Effect of Infrastructures)
Total tourists per tear = Domestic tourists+ Foreign tourists
Total revenue from domestic tourists = Domestic tourists * Domestic tourist revenue from tourist receipt per tourist per day * Duration of domestic tourist stay
Total revenue from foreign tourists = Foreign tourists *Foreign tourist revenue from tourist receipt per tourist per day * Duration of foreign tourist stay
Yearly revenue = Total revenue from domestic tourists +Total revenue from foreign tourists

Initial infrastructure satisfaction = ∑ (Initial satisfaction level in each sector* w) / ∑ **(**Initial satisfaction level in each sector**)**
Perceived infrastructure satisfaction = ∑ (Perceived satisfaction level in each sector* w) / ∑ (Perceived satisfaction level in each sector)
Tourist satisfaction = ∑ (Effect of infrastructure satisfaction of each sector* w / (∑ (Effect of infrastructure Satisfaction of each sector)
Where w= wieghtages of each sector for contributing to overall satisfaction level

## SIMULATION AND RESULTS

The model build was employed to simulate results based on the time series data available from 1986 A.D to 2006 A.D in the system from the secondary survey and data collected from the primary survey conducted in the system in 2005 A.D. Initially a base year model for the year 2006 A. D was first build and employed to understand the functions of the system. The results of the various variables computed from the model for the base year are demand, supply (availability) and perceived supply in the three categories of infrastructures, such as, road lengths, rail route lengths, accommodation in terms of hotel beds, total domestic tourist arrival, total foreign tourist arrival, total tourist arrival, revenue generation from tourist receipts, satisfaction level of each and infrastructure under normal conditions.

### Validation

The model build was validated by structure verification test, which did not contradict the knowledge of the real system followed by algorithm examination for the correctness of the parameterisation equations. Further, the model was employed to compute outputs from a set of inputs for the year 2006 A.D., which is referred as the base year for the model and up to the year 2009 A.D., for which data for the study area pertaining to a number of variables, such as, supply of road length, rail route length, accommodation, number of domestic tourists, number of foreign tourists and total number of tourist arrival in the system were available for quantitative and behavioural validation. The model results were closely examined and compared to the data available in the real system. It was observed that the model results and real system data were very closely matched with minimum variation, thus making both behavioural and structural validity of the model.

### Simulated projected year model result and management policy recommendations

The projected results of the various indicators of infrastructure development and tourism development in the system were computed by employing the validated model under normal conditions of growth and various simulated conditions by considering the influence of the three variables, i.e., growth in road length, growth in rail route length, growth in accommodation, on the tourism development individually and compositely under various conditions as mentioned in table 1, from the year 2006 A.D up to projected year 2031 A.D. The results were compared and the scenario which provided the optimal result was accepted and chosen for policy recommendations.

**Table No. 1 Simulation Conditions of Variables influencing Tourism Development**

| Sl No. | Simulation conditions of the Variables | Variation in Conditions |
|---|---|---|
| 1 | Growth in Road Length | Increase from current annual growth rate of 1.0 per cent up to 15.00 per cent |
| 2 | Growth in Rail route | Increase from current rate of 1.4 per cent up to 10.0 per cent |
| 3 | Growth in Accommodation | Increase from current rate of 4.1 per cent up to 15.0 per cent |

The various measured indicators considered for sustainable tourism development are demand, supply and perceived supply of infrastructure, consequent total tourist arrival under different categories (domestic, foreign and total), total annual revenue generation from tourist receipts, satisfaction level of infrastructure under normal and perceived conditions, effect of infrastructure on tourist satisfaction and tourist satisfaction in the system. It was observed that of the several simulations attempted, the simulation condition based on the composite scenario of 5.00 per cent growth rate in road length and rail route length respectively, and 10.00 per cent growth rate in accommodation (hotel beds) provided accepted results, which was treated as the optimal scenario. The results of various indicators, such as, demand and availability of infrastructure, tourist flow in different categories and yearly revenue generation under normal conditions of growth presented in table 2 and figures 2 (a-c); and the accepted simulated results of the above variables are presented in table 3, and fig 3(a-c). The satisfaction levels of each infrastructure under normal and simulated perceived conditions, effect of infrastructure on tourist satisfaction and total tourist satisfaction are presented in figure 4. Table 2 and figure 4 revealed that the satisfaction level of road infrastructure varies from 0.24 to 0.37 and rail infrastructure varies from 0.22 to 0.39, from the year 2006 A.D to 2031 A.D, which are very low signifying lopsided demand in comparison to the supply. However, the satisfaction level at current scenario is 0.95, although it shows an alarming decreasing trend from the year 2016 A.D., manifesting supply under normal growth scenario would not able to meet the higher demand in the near future. The yearly tourist flow under domestic, foreign categories in the normal scenario would be on increasing trend and would reach 15 159 967 numbers and 100389 numbers to a total tourist flow of 15 159 967 number by the year 2031 A.D. Similarly, the yearly revenue generation from tourist receipts would be about 31 069 188 654 in Indian Rupees (621.5 million USD) under the same scenario. However, the simulated scenario revealed that the satisfaction level of road infrastructure, rail infrastructure would improve considerably. The satisfaction level of road infrastructure would be from 0.6 to 0.8 in the projected years from 2006 A.D to 2031 A.D, and similarly satisfaction level of rail infrastructure would be from 0.45 to 0.75 during the same period, thereby reducing the large discrepancy obtained under normal conditions of growth. The accommodation satisfaction level would maintain its current level of satisfaction until 2026 A.D, although it would follow a decreasing trend from 2026 A.D to 2031 A.D as observed from table 3 and figure 4. The integration of the effect of the three infrastructures under perceived conditions to the normal growth process would result in much higher tourist flow and revenue generation from tourist receipts. Table 3 and figure 3 (a-c) revealed that there will be domestic tourist flow of 78 854 718 numbers, foreign tourist flow of 706 814 to a total tourist flow of 79 561 533 in the year 2031

A.D respectively. Under this scenario the flow of domestic tourists, foreign tourists and total tourists would be 5.21, 7.06 and 5.26 times respectively higher than the tourist flow under normal scenarios in the projected year. In tune with this tourist flow there would be a revenue generation of Indian Rupees 163 321 553 489 (3266.4 million USD), which is about 5.25 times higher over the revenue generation under normal conditions in the projected year. Similarly, the effect of perceived infrastructure on tourist satisfaction would be 0.68 and consequently tourist satisfaction would increase from 0.38 to 0.51 (table 3 and figure 4) during the same period.

Thus, it is observed that a simulated scenario with perceived condition, which would be feasible to provide under the constraints of investment from the State and entrepreneurs, there would an appreciable enhancement in the infrastructures in road, railway and accommodation sector. This enhancement would lead to higher tourist flow both in foreign and domestic categories resulting in higher tourist receipts and revenue generation in the system. Therefore, accordingly a management plan needs to be adopted for adequate increase in infrastructure, such as, road length, rail route length and accommodation in terms of hotel beds so that it would lead to significant increase in tourist flow in both domestic and foreign categories and increase in yearly revenue generation as well. Table 4 provides a five yearly management plan in phases from the year 2006 A.D to 2031A.D for gradual increase and development of infrastructure in the discussed three sectors based on the simulated perceived results. The plan revealed that with the gradual increase of infrastructure in the three sectors, the increase tourist flow in all categories to the system and increase in yearly revenue from tourist receipts would become almost double every five years, thereby leading to a significant tourism development in the study area.

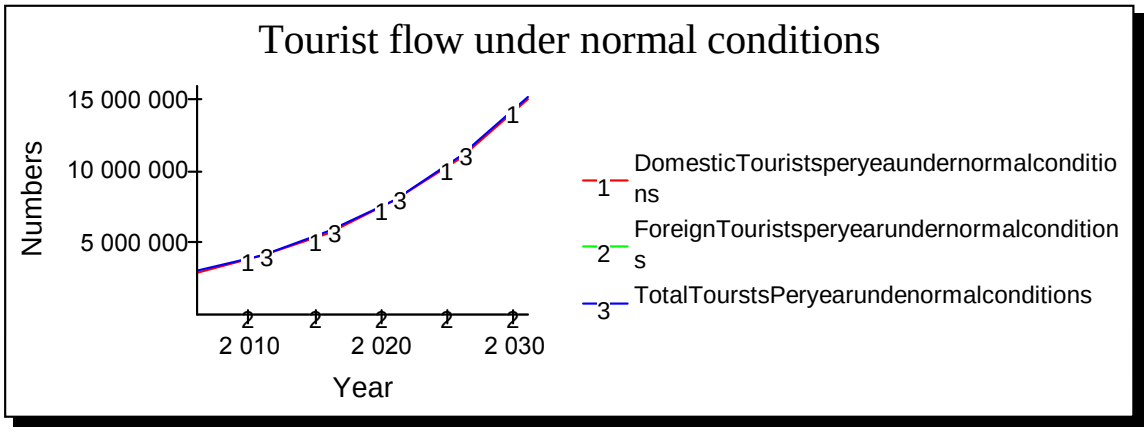


Fig. 2 (a) Projected tourist flow under normal conditions of growth of infrastructure up to 2031 A.D

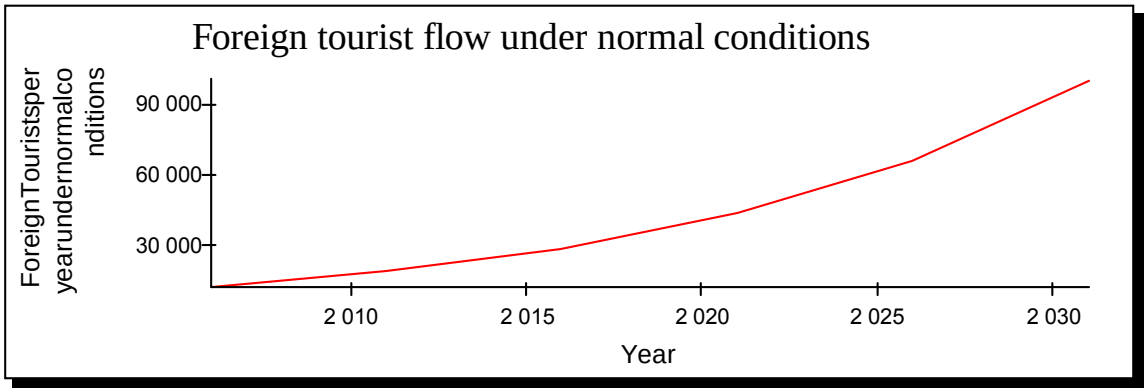


Fig. 2 (b) Projected foreign tourist flow under normal conditions of growth of infrastructure up to 2031 A.D

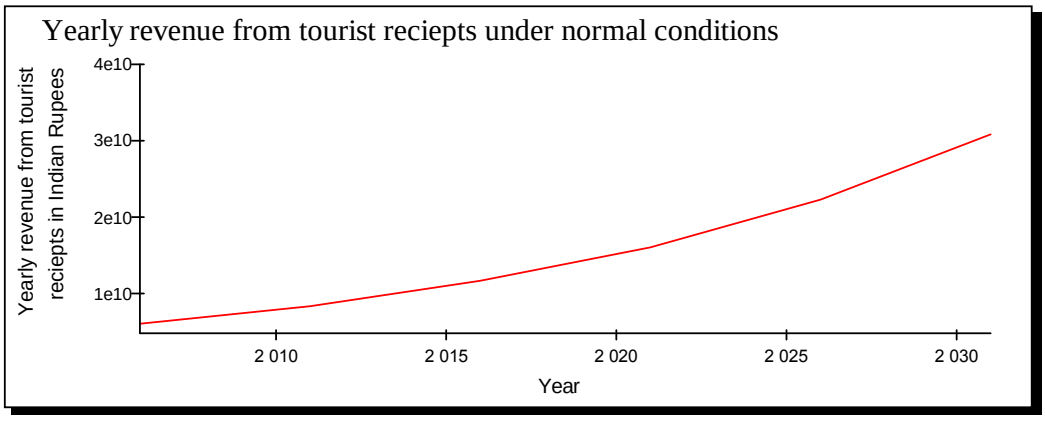


Fig. 2 (c) Projected yearly revenue from tourist reciepts under normal conditions of growth of infrastructure up to 2031 A.D

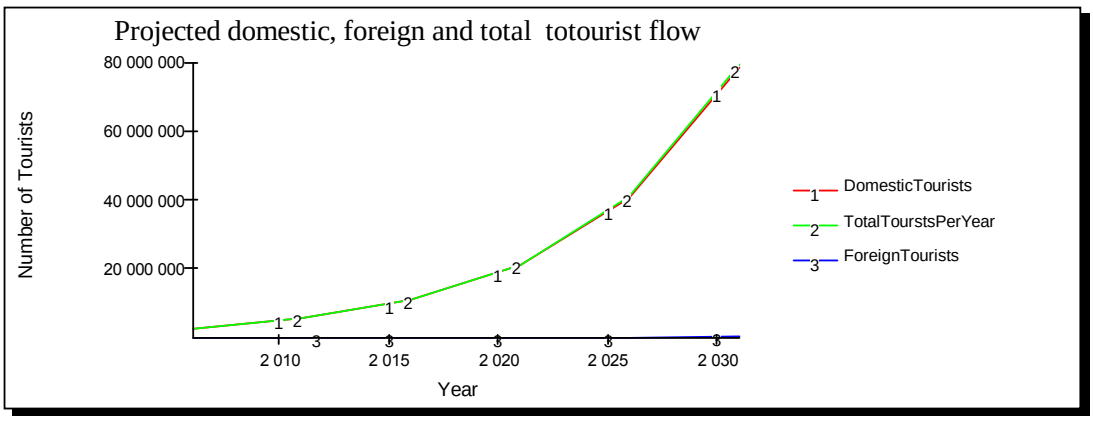


Fig. 3 (a) Projected tourist flow under simulated conditions of percieved growth of infrastructure up to 2031 A.D

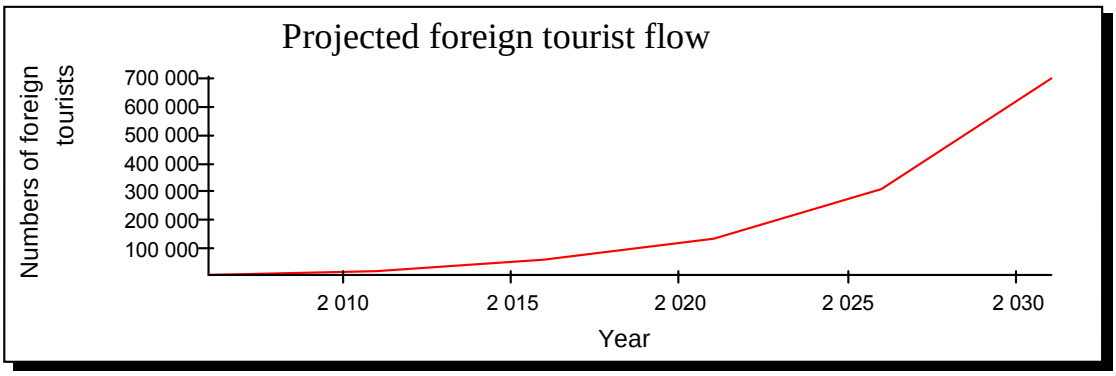


Fig. 3 (b) Projected foreign tourist flow under simulated conditions of percieved growth of infrastructure up to 2031 A.D

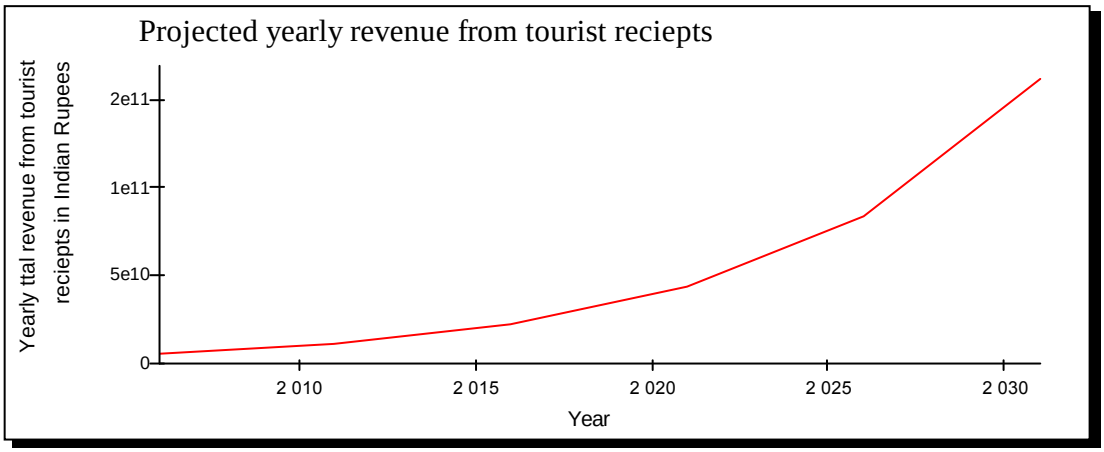


Fig. 3 (c) Projected yearly revenue from tourist reciepts under simulated conditions of percieved growth of infrastructure up to 2031 A.D

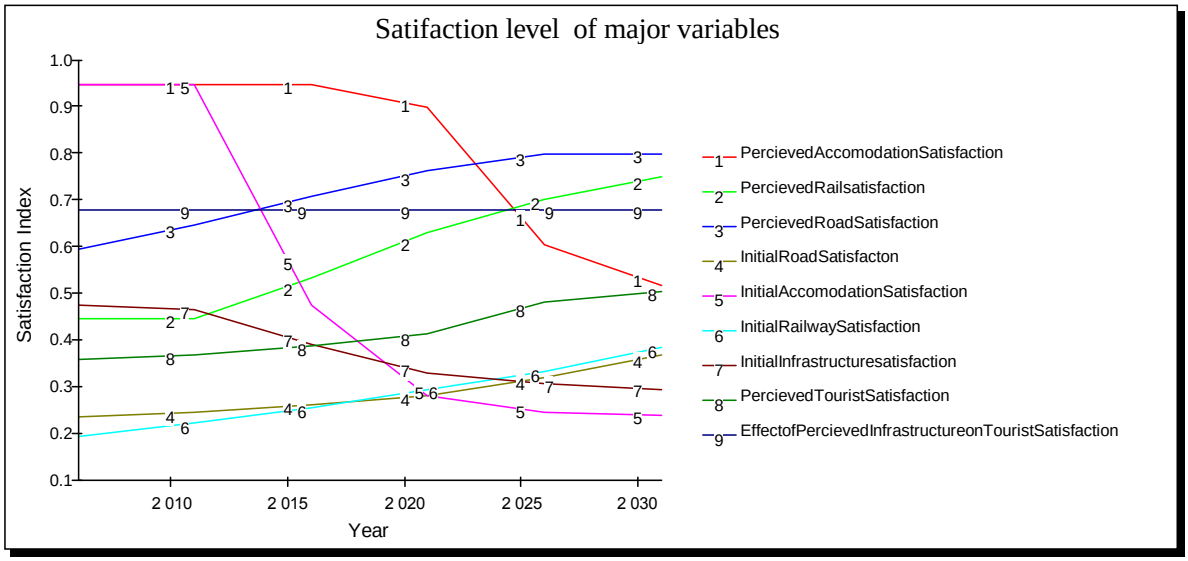


Fig. 4 Satisfaction level of infrastructure under normal and simulated perceived conditions, and effect of perceived infrastructure on tourist satisfaction and total perceived tourist satisfaction

**Table 2**
**Projected Supply, Demand, satisfaction level of various infrastructure and tourist flow and revenue from tourist receipts under normal conditions of growth of infrastructure**

| Year | Available Road Length (Kms) | Available Rail Line Length (Kms) | Available Accommodation (Number of hotel beds) | Demand of Road Length (Kms) | Demand of Rail Line Length (Kms) | Demand For Accommodation (Number of hotel beds) | Initial satisfaction level of roads | Initial satisfaction level of railway | Initial Satisfaction Level for Accomodation | Initial Infrastructure satisfaction | Domestic Tourists per year under normal conditions (Numbers) | Foreign Tourists per year under normal conditions (Numbers) | Total Tourists Per year under normal conditions (Numbers) | Yearly Revenue from tourist receipt under normal conditions (Indian Rupees) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 006 | 70 056 | 647 | 5 296 186 | 107 412 | 2 046 | 2 633 062 | 0.24 | 0.20 | 0.95 | 0.48 | 3 084 500 | 13 220 | 3 097 720 | 6 254 522 634 |
| 2 011 | 74 577 | 692 | 6 090 614 | 112 782 | 2 046 | 5 055 629 | 0.25 | 0.22 | 0.95 | 0.47 | 4 241 187 | 19 830 | 4 261 017 | 8 615 316 546 |
| 2 016 | 79 956 | 741 | 7 004 206 | 118 421 | 2 046 | 9 542 908 | 0.26 | 0.26 | 0.48 | 0.39 | 5 831 632 | 29 745 | 5 861 377 | 11 869 082 137 |
| 2 021 | 86 351 | 793 | 8 054 837 | 124 342 | 2 046 | 18 327 159 | 0.28 | 0.29 | 0.28 | 0.33 | 8 018 495 | 44 617 | 8 063 112 | 16 354 520 768 |
| 2 026 | 93 946 | 848 | 9 263 063 | 130 559 | 2 046 | 35 202 402 | 0.32 | 0.33 | 0.25 | 0.31 | 11 025 430 | 66 926 | 11 092 357 | 22 539 265 300 |
| 2 031 | 102 960 | 907 | 10 652 522 | 137 087 | 2 046 | 67 627 303 | 0.37 | 0.39 | 0.24 | 0.30 | 15 159 967 | 100 389 | 15 159 967 | 31 069 188 654 |

**Table 3**
**Projected perceived supply, satisfaction level of various infrastructure, tourist flow, revenue from tourist receipts, and tourist satisfaction under simulated conditions**

| Year | Perceived Road Length (Kms) | Perceived Rail Line Length (Km) | Perceived Accommodation (Number of beds) | Domestic Tourists (Numbers) | Foreign Tourists (Numbers) | Total Tourists Per Year (Numbers) | Yearly Revenue From Tourist Receipt (Indian Rupees) | Perceived Road Satisfaction | Perceived Rail satisfaction | Perceived Accommodation Satisfaction | Effect of Perceived Infrastructure on Tourist Satisfaction | Perceived Tourist Satisfaction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 006 | 70 056 | 647 | 5 296 186 | 3 084 500. | 13 220 | 3 097 720 | 6 254 522 634 | 0.60 | 0.45 | 0.95 | 0.68 | 0.38 |
| 2 011 | 82 217 | 809 | 7 944 279 | 5 918 384 | 29 414 | 5 947 798 | 12 038 467 718 | 0.65 | 0.45 | 0.95 | 0.68 | 0.39 |
| 2 016 | 96 567 | 1 010 | 11 916 418 | 11 162 783 | 64 167 | 11 226 951 | 22 786 689 815 | 0.71 | 0.53 | 0.95 | 0.68 | 0.41 |
| 2 021 | 113 501 | 1 263 | 17 874 627 | 21 418 591 | 142 772 | 21 561 363 | 43 904 476 544 | 0.77 | 0.63 | 0.90 | 0.68 | 0.43 |
| 2 026 | 133 483 | 1 579 | 26 811 941 | 41 096 921 | 317 669. | 41 414 591 | 84 647 811 273 | 0.80 | 0.71 | 0.61 | 0.68 | 0.48 |
| 2 031 | 157 061 | 1 974 | 40 217 912 | 78 854 718 | 706 814 | 79 561 533 | 163 321 553 489 | 0.80 | 0.75 | 0.52 | 0.68 | 0.51 |

**Table 4**
**Perceived five yearly increase of infrastructure and consequent increase in tourists flow and yearly revenue generation from tourist receipts**

| Phases | Year | Perceived increase in road length (Kms) | Perceived increase in rail length (Kms) | Perceived increase in accommodation (Number of hotel beds) | Increase in Domestic Tourists (Numbers) | Increase in Foreign Tourists (Numbers) | Increase in total tourist (Numbers) | Increase in yearly revenue from tourist receipts (Indian Rupees) |
|---|---|---|---|---|---|---|---|---|
| | 2 006 | - | - | - | - | - | - | - |
| Phase I | 2 006-11 | 12161 | 162 | 2648093 | 2833884 | 16194 | 2850078 | 5783945076 (115.67 ) |
| Phase II | 2 011-16 | 14350 | 201 | 3972139 | 5244399 | 34753 | 5279153 | 1074822210 (211.48) |
| Phase III | 2 016-21 | 16934 | 253 | 5958209 | 10255808 | 78605 | 10334412 | 21117786730 (422.35) |
| Phase IV | 2 021-26 | 19982 | 316 | 8937314 | 19578330 | 174897 | 1985228 | 40743334730 (814.86) |
| Phase V | 2 026-31 | 23578 | 395 | 13405971 | 3775797 | 389145 | 38146942 | 78673742213 (1573.47) |

(Note: values in brackets are in million USD)

## CONCLUSION

Tourism development of a region essentially depends on a host of parameters both exogenous and endogenous to the system; however, infrastructure plays the most important role as satisfiers and encourages the tourist to visit a tourist region. At the regional level it is apparent that the road and rail transportation and accommodation are vital, which provides efficient infrastructure system directly influencing to tourist in their decision to visit the destinations. In addition to this accommodation also plays equally important role. In this investigation understanding the importance of the three sectors of infrastructures and their influence on tourism development of the considered region, an integrated System Dynamics model was established by incorporating the effect of road, rail and accommodation infrastructure to the tourism system and various indicators, such as, satisfaction level of infrastructures, supply, demand and perceived supply of infrastructure, and consequent tourist flow, revenue generation from tourist receipts and tourist satisfaction were computed for projected years. It was observed that by integrating the influence of enhanced road infrastructure, rail infrastructure and accommodation infrastructure under a simulated perceived composite scenario, there would be significant increase in the tourist flow in both domestic and foreign categories and also substantial increase in revenue generation from tourist receipts. Further, improvements in the satisfaction level of the three types of infrastructures were also marked although there would a slight reduction in satisfaction level in accommodation sector in the later periods of projected years from 2026 A.D to 2031 .D, yet it would be higher than the satisfaction level under normal conditions of growth. This also would lead to higher effect of on tourist satisfaction and consequently the tourist satisfaction also would improve and follow an increasing trend. Thus, this analysis manifest that

significant tourism development would be experienced, if road infrastructure, rail infrastructure and accommodation infrastructure of a tourism resource rich region are enhanced in combination in appropriate proportions. Further, an infrastructure development management plan was derived based on the simulated results obtained from the integrated System Dynamics model. The development management plan was prepared by considering five phases, each phase constituting five years from the base year 2006 A.D to the projected year 2031 A.D., which revealed that with a gradual increase of infrastructure supply in phases from phase–I (year 2006-2011) to phase-V (year 2026-2031), the study area would experience appreciable increase in the tourist flow and consequent increase in revenue generation from tourism in addition to reasonably high level of tourist satisfaction.

It is also to note that there are several other variables and control parameters, which influence tourism development in a region. More importantly, it is also understood that the qualitative aspects of the three considered infrastructures, are equally important and they do influence tourism development. However, the modelling in this investigation was confined to the quantitative aspects, such as, road length, rail route lengths and accommodation in terms of hotel beds only, keeping the qualitative aspects out of the scope of this investigation. Notwithstanding these qualitative parameters require further investigation.

Understanding of the complexities of the tourism system because of involvement of several dynamic control parameters, and in order to facilitate appropriate decision making to harness the potential of tourism development offered by a region, there is a need for an appropriate predictive model. It is observed from this investigation that System Dynamics model with its ability to integrate several control parameters-infrastructures and their influences on the tourism system provides an appropriate tool to predict the various measured indicators reliably and facilitate plausible policy and decision making and managerial decisions in perspective planning and management for tourism development.

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