Evaluation of Social Sustainability of Tourism Highway Network

Qiong Wu[1] and Diana binti Mohamad[2]

Abstract

The majority of traffic on tourist routes is generated by tourists, who traverse roadside attractions or beltway corridors, and integrate auxiliary and major road infrastructure with scenic landscapes. However, the transportation and tourism industries face challenges in terms of environmental pollution and poor road safety. The aim of this study is to evaluate the social sustainability of three major tourist highway networks in Shanxi Province, specifically the Taihang, Great Wall, and Yellow River tourist highways. A survey of 300 tourists was conducted to gather information on transportation pathways, covering tourism and transportation management aspects. Statistical analysis was employed to analyze the data, while geographic information systems (GIS) were used to map the highway networks, assess accessibility, and identify potential development locations. The results show how social sustainability is currently performing across Shanxi's three main tourism highway networks. The study also explores the impacts on regional economies and ways of life, as well as initiatives aimed at conserving cultural heritage and environmental sustainability along these roadways. The findings emphasize the importance of achieving a balance among environmental, social, and economic issues to ensure that tourist route networks have positive impacts on surrounding communities and the tourism sector.

Keywords: *Sustainability, Tourism, Highway, Tourist, Socio-Economic, Spatial Efficiency.*

INTRODUCTION

Mobility and Infrastructure of Tourism

Transportation is an essential connecting aspect in the three-body concept of tourism, and it is one of the six aspects of tourist development [1]. Expressways contribute significantly to increased interregional mobility as the primary route for self-driving tourists. Tourism operations have expanded and refined as a result of the progressive development of the fast-forward, slow-travel expressway network, which has included service zones as part of its architecture. Utilizing expressway service areas' growth potential requires evaluating, modernizing, and transforming them into tourism attractions to provide travelers with high-quality, practical, and effective services [2]. The concept has arisen from the tourist environment to enhance the commercial potential available to the tourism sector. The majority of studies examining the effects of the expansion of infrastructure were carried out by experts who considered the opinions of service providers, visitors, tour operators, and workers involved in building infrastructure and determined the various benefits associated with infrastructure projects for tourism. Professionals in tourism, administration, and additional businesses stated in the study that initiatives connected to the tourism infrastructure assist the community [3].

Tourism Network Architecture

Many network architectures in tourist locations have been studied over the past few decades from the viewpoint of supply and demand. From a perspective of supply, several investigations mainly examined the relationships and associations among tourism establishments in tourist areas. From a demand standpoint, the majority of studies focused mostly on travel and modes of transportation for tourists [4].

Economic and Accessibility

---

[1] School of Housing, Building, and Planning, Universiti Sains Malaysia (USM)， 11800 USM Penang, Malaysia. Shanxi Transportation Planning Survey and Design Institute co., LTD. 030032, Taiyuan, China.

[2] School of Housing, Building, and Planning, Universiti Sains Malaysia (USM)， 11800 USM Penang, Malaysia. E-mail: Diana binti Mohamad, diana_mohamad@163.com. (Corresponding author)

The development of the highway and transport systems raises the level of development in the neighborhood by promoting economic growth and facilitating easy access to tourist destinations. Academic studies indicate that the development of fresh tourist destinations in the region as well as the enhancement of current ones depend on the availability of road and transportation infrastructure [5]. The tourism flow, which links travelers' origins and destinations, is the foundation of the tourism business and its activities. The relationship among traveler origins and destinations affects the way regions compete with one another, which has a big impact on the flow of tourists. Understanding the mechanics behind the functioning of tourist networks and the factors that influence tourism flow may be gained through research on these networks. The evolving circumstances and plan formulation of the national and local tourist sectors are linked to the quality, orientation, and geographical pattern of tourism flow [6].

Transportation and Sustainable Impact

A mode of transportation cannot adequately capture the geographical organization of the flow of tourists or their distinct behavioral patterns. For instance, if the primary mode of transportation in the area is the train but only the car-based tourist flow is taken into account, this might lead to erroneous tourism transport planning by the government department. Therefore, it's critical to pinpoint the distinctive tourist flow and examine visitor spatial behavior from the standpoint of a complex transportation network that incorporates a variety of modes of transit [7]. Researcher's interest in relationships with the travel sector has increased. The social accounting matrix, computed average equilibrium, and tourist satellite accounting have all been employed to assess the economic relationships and effects of tourism [8]. The physical, political, and economic social order is significantly impacted by increased connectivity and tourism, which reconfigures economies and leisure areas.

Impacts of Belt and Road Initiative (BRI)

The possible changes that these Belt and Road initiatives (BRI) initiatives are bringing about are also determined by their opinions of them. To determine the effects and durability of the tourism boom prompted by the construction of the cross-border route, it makes use of local perspectives. The tourism sector's beneficial impact on growth is generally emphasized locally, within community frameworks. As global business grows, equally important is its potential to assist the advancement and well-being of local communities in destination regions. Consequently, the idea of sustainability has been included in the development and governance ideas of the tourism industry, and tourism is often promoted as a means of achieving equitable growth for neighboring communities [9]. The improvement of the environmental sustainability of visitor attractions continues to depend on community involvement in the planning process and residents' perceptions and attitudes regarding the effects of infrastructure and tourism development. This is because these factors have a substantial impact on local communities and the environment [10].

Objective of The Study

The purpose of the research was to evaluate these highway networks' present circumstances of social sustainability by considering their implications on community economies, attempts to preserve artistic treasures and sustainable development programs.

The data gathered from 300 tourists concerning transportation routes, as well as statistical analysis and geographic information systems (GIS).

The research aims to comprehend how these highway networks support the general growth and welfare of neighboring communities and the tourism industry.

The intent is to provide an effective approach that integrates social concerns, economic development and conserving the environment to preserve the long-term viability of these networks of tourist routes.

The remainder of this paper is structured as follows: Section 2 determines the literature review; Section 3 describes the methodology; Section 4 discusses the research results and Section 5 provides conclusions, and recommendations for future research.

LITERATURE REVIEW

Study [11] comprised several participants in the tourism sector, including tourists, local government officials of the town, lodging facilities, and tour companies that operate in the area. Participants were provided with 650 questionnaires and an overview of the key study criteria to improve comprehension. After confirming the validity and reliability of the instrument, hierarchical regression was used to analyze the information. Environmental value and tourist resources with standard methods for planning and laying out road networks were evaluated in [12]. First, the accessibility demand of tourist attractions is examined, and the trend and demand projection of tourist traffic and tourist highways were examined. Second, the tourist road planning scheme based on the landscape value was achieved by building the tourism value assessment system and assessing the road network's tourism value. A thorough planning and layout scheme that incorporates the outcomes of the first two steps can satisfy the demand for travel while offering a high-quality travel experience.

Article [13] was to provide a strategic strategy that can support the growth of sustainable tourism in popular tourist locations. To accomplish this, the Analytic Hierarchy Process (AHP) technique and the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis (SWOT) hybrid approach, or A'WOT (AHP-SWOT), were combined. The important strategic aspects were identified using SWOT analysis, and their priority was established using the AHP technique. The impact of Spain's rapid transit infrastructure on the rivalry of the tourist industry was examined in [14]. The network's innovative equipment has been investigated for its potential to boost arrivals and decrease seasonality in tourists. The investigation of the Gini coefficient reveals that while early results indicate a minimal impact on seasonality reduction, this alters as networks grow and become more consolidated. According to the study, a minimum number of connected cities is required for the high-speed network to have a substantial positive impact on visitors and decrease seasonally in tourists.

A multimodal framework for tourism transportation was developed, ecologically friendly transportation was looked at, and creative ways to increase tourist accessibility in outlying locations were discussed [15]. Because of its exceptional natural features, the Białowieża Forest area was chosen for verification as a UNESCO World Heritage site. Heuristic research methods were used to evaluate the model, which was based on public transportation networks, the availability of electric bicycles, and rental cars. Approximately 40% of participants in the research indicated an enormous and extremely strong desire for revolutionary and sustainable mobile technology, such as e-mobility. Because of its special environmental qualities, the Białowieża Forest location was a shining example of the potential for tourist growth. The novel method [16] identifies projects that get public administration funding to optimize resource efficiency and include sustainability considerations in the formulation of tourist strategies. The Multi-objective Optimization model evaluates tourist activities based on stakeholder utility while taking into consideration the effects on the environment, society, and economy. To promote urban attractiveness, the approach was tried in the public sector procurement in Italy. Findings indicated that federal funding was collected more effectively than using multi-criteria methods [17]. The blue development' imperative has prompted the tremendous expansion of the marine and coastal tourist sector in the tourism industry. But as maritime tourism grows, sustainability concerns are brought forward; and these concerns can get worse whether expansion is encouraged even more. These concerns are summarized in [18], which focuses on community-based tourism, cruise tourism, ecotourism, and marine protected areas. It exposes social and environmental inequities in various fields, including skewed access to healthcare and natural resources.

Study [19] was to assess how a relationship is affected by tourism in China's sustainable community-based tourist industry. Four hundred and thirty-three inhabitants of Fanhe village, Guangdong Province, received a questionnaire. The findings led to the creation of a six-factor model with twenty issues that evaluated community competency, social networking, conventional social norms, community cohesiveness, and collective efficacy. The study contributes to an improved understanding of how locals consider social capital connected with community-based tourism as a component of sustainable development by illuminating the multifaceted nature of perceived tourism's social impacts on social capital in the Chinese tourist community.

The approach [20] discussed how religious tourism pathways serve as pilgrimage destinations and a catalyst for the growth of responsible tourism. It makes use of both personal and statistical data from a questionnaire about pilgrimages Via the Francigena and the Camino de Santiago de Compostela that was submitted in late 2018. According to the research, these pilgrimages emphasize the value of cooperative procedures, which provide more efficient and environmentally conscious policies at places of worship. It promotes social and economic development in the areas where it occurs.

METHODOLOGY

Study Area

The Shanxi Province in northern China is entitled to a vast network of aesthetically pleasing tourist roads that wind across its erratic topography, architectural wonders, and socioeconomically significant areas with the help of China National Highways (CNH). Trekking routes, Buddhist monasteries, and historically significant cities could each be found along the Taihang Tourism, which continues traversing the glorious Taihang Mountains. Along the Great Wall Tourism Highway, which borders historic watchtowers and important defenses like Yanmenguan Pass and Datong's medieval city walls, visitors can discover portions of the well-known Great Wall of China. Following the Yellow River's serpentine course, Yellow River tourism provides availability to the millennia-old Yungang Grottoes as well as views of the magnificent Hukou Waterfall. These roadways are essential for tourism, but they also serve as a vital link in safeguarding Shanxi's cultural legacy, promoting environmentally conscious actions that impact balancing that exists between sustainability and the requirements of visitors, and expanding investments in infrastructure by performing greater traffic from visitors. They are essential for highlighting Shanxi's magnificent environment and fascinating heritage fostering the traveler's knowledge and experience, and achieving socioeconomic and ethnic interaction that contributes to communities on the ground. Figure 1 displays the Tourist region of Shanxi.
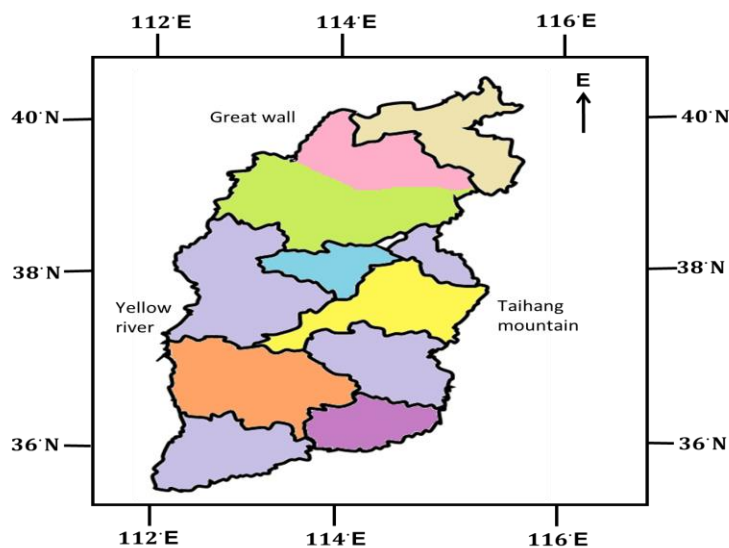

Figure 1: Shanxi province

Data Collection

The study focused on Taihang, the Great Wall, and Shanxi's Yellow River tourism routes. Data were collected from 300 tourists in these three regions regarding the social sustainability of these networks. Investigations and information from tourist and transportation management sources were used to collect this data, which included several facets of public transportation routes. GIS approaches were incorporated to generate maps of roads and highway networks, assess availability levels, and highlight potential expansion sites, while a statistical approach was used to analyze the gathered data. The purpose of the research was to evaluate these highway networks' present circumstances of social sustainability by considering their implications on socio-demographics, patterns in tourist arrivals, highway planning and connectivity, highway network,

transportation, and traffic flow. It emphasizes the significance to finding a healthy equilibrium among problems of society, preserving the environment, and economic expansion to improve the regional economy as well as the business of tourism.

Geographic Information Systems (GIS)

Specialized techniques for collecting, maintaining, analyzing, and interpreting spatial and geographic data are GIS. There are many analogies connecting GIS and constructed spatially rich databases of tourist motion. Its remarkable ability to investigate and demonstrate location and moment is an important resource in knowing and understanding how individuals express themselves in the digital representation of a specific place. GIS can potentially be used for an assortment of major duties when determining the social sustainability of tourism highway networks. An outline of how GIS may be used for this research is provided below:

Computerizing Automobile Systems*: The satellite information and pre-existing highway model files, use GIS software for tracking the significant tourist highway in Taihang, Great Wall, and Yellow River.

Framework Development*: Integrate numerous levels, particularly the aforementioned highways, tourism destinations, preserves of nature, and other prominent sites.

Highway Improvement*: GIS could reduce renovation expenses and the ecological effects with promising powerful linkages between recognized tourism destinations.

Resource Assessment*: For increased comfort and security for tourists, consider the most desirable locations for activities that incorporate places to rest, fueling stations, and medical care.

Transit and Highway Collaboration*: To encourage ecologically conscious travel alternates, map and explore train and bus systems to connect them with the roadway network.

Nearest Neighbor Index (NNI)

The Nearest Neighbor Index (NNI) could be used to assess the social sustainability of tourism-associated operations by analyzing the geographical trends and regional distribution of such events along the tourist route networks in Shanxi province. From a geographical perspective, the nearest neighbor index assesses spatial dispersion. To correctly represent the distribution type of the point elements, this approach is utilized to indicate the mutual closeness of each point statistic in the geographical spatial distribution.

$$\bar{r} = \frac{1}{n}\sum_{i-1}^{n} r_i \#(1)$$

$$\overline{r_i} = \frac{1}{2\sqrt{\frac{n}{A}}} = \frac{1}{2\sqrt{D}}\#(2)$$

$$R = \frac{\bar{r}}{\overline{r_i}}\#(3)$$

The formula takes into the following variables: n is the number of highways; D is the point density; A is the geographical territory; R is the closest neighbor index; r is the actual nearest neighbor distance value; and $\overline{r_i}$ is the assumed nearest neighbor separation frequency. Assessing spatial dynamics and the implications for social sustainability is improved by including the NNI study in the examination of Shanxi province's tourism transportation routes.

Statistical Analysis

Statistical research provides the primary framework for the monitoring of the social sustainability of tourism highway networks. The research incorporates statistical methods for analyzing socio-demographics, patterns in tourist arrivals, highway planning and connectivity, highway network, transportation, and traffic flow. The survey data, which was obtained from 300 tourists, were augmented by various sources encompassing modes of transportation and sustainability. To examine certain aspects that could influence overall tourist fulfillment, statistical inference techniques are utilized to distinguish ratings for tourist satisfaction among many traffic routes. GIS-based geographical evaluation examines highway connections, measures connectivity, and indicates potential development sites. The decision attempts to accomplish equilibrium across environmental protection, social equity, and growth in the economy, providing that tourism routes promote both the local population and the industry of tourism.

RESULTS

In this section, we examine the findings encompassing the socio-demographic, patterns in tourist arrivals, highway planning and connectivity, highway network, transportation, and traffic flow analysis. To enhance the knowledge of the socioeconomic effects, practical difficulties, and potential for improving the social sustainability of Shanxi province's tourism route networks.

Socio-Demographic

The individual factors that make up the demographic and socioeconomic variables. Participants have discerned variations in perception contingent upon these characteristics. These features influence travelers' positions on the improvement of tourism. Table 1 shows the socio-demographic profile. The information provided indicates the social background of individuals at the Great Wall, Taihang, and Yellow River, three of Shanxi Province's most frequently visited tourist destinations. In general, the greatest proportion of travelers on all highways are Chinese, with statistics fluctuating from 54.8% to 65.9%. The fraction of international tourists is a significant minority, comprising 34% to 45.1%.

Table 1: Socio-demographic profile

Characteristics	Factor	Tourist places (N=300)		
		Great wall 121 (%)	Taihang 97 (%)	Yellow river 82 (%)
Country of origin	Chinese	73 (60.3)	64 (65.9)	45 (54.8)
	International	48 (39.6)	33 (34)	37 (45.1)
Gender	Male	68 (56.1)	45 (46.3)	37 (45.1)
	Female	53 (43.8)	52 (53.6)	45 (54.8)
Age	Below 20	26(21.4)	37 (38.1)	21 (25.6)
	21-30	33 (27.2)	21 (21.6)	22(26.8)
	31-40	26 (21.4)	19 (19.5)	17 (20.7)
	41-50	21 (17.3)	12 (12.3)	12 (14.6)
	51+	15 (12.3)	8 (8.2)	10 (12.1)
Degree of education	Not formally qualified	17 (14)	11 (11.3)	17 (20.7)
	Intermediate	24 (19.8)	21 (21.6)	21 (25.6)
	Student	23(19)	23 (23.7)	11 (13.4)
	Graduates	36 (29.7)	19 (19.5)	26 (31.7)
	Masters	21 (17.3)	23 (23.7)	7 (8.5)
Relationship status	Married	67 (55.3)	54 (55.6)	39 (47.5)
	Unmarried	54(44.6)	43 (44.3)	43 (52.4)

Language	Chinese	57 (47.1)	41 (42.2)	37 (45.1)
	English	43 (35.5)	23 (23.7)	23 (28)
	Others	21(17.3)	33 (34)	22 (26.8)

The Great Wall and Yellow River highways indicate that the proportion of males is larger than the female ratio based on gender distribution compared to the Taihang highway, providing considerably more weighed transportation. The disparity of demographics is various, ranging with less mature age groups prominent, certainly in the direction of Taihang highway. The level of significance of education achieved varies, and there are distinctive computations of graduates as well as students on all of the driving routes, resulting in tourists hailing from a selection of education-related ethnic groups. A high percentage of travelers on all highways are married, which suggests an orientation favoring family- or couple-oriented travel. The overwhelming majority of those traveling speak Chinese, although there are occasionally tourists who speak English on all travel routes, including the Great Wall. Knowing tourist preferences and routines can be beneficial to establishing concentrated advertising programs, developing infrastructure, and encouraging historic preservation activities across Shanxi Province's touristic pathways.

Highway Planning and Connectivity

In Shanxi province, the Great Wall District, Taihang District, and Yellow River District all implemented tourist highway plans in 2019. It is made up of 699 connecting lines, 203 branch lines, and three major lines. The entire path spans around 13060 kilometers in total. Figure 2 and Table 2 represent the planning of visiting tourist highways. The loop highway network of regional tourism is made up of the tourist route's main line, branch line, and connecting line. Taihang district was rated "high" in terms of broad connectivity based on the total number for roadway miles. The Yellow River, Great Wall, and Taihang areas have tourist highways measuring 4131 km, 4279 km, and 4650 km in length, respectively.

Table 2: Tourist Highways planning

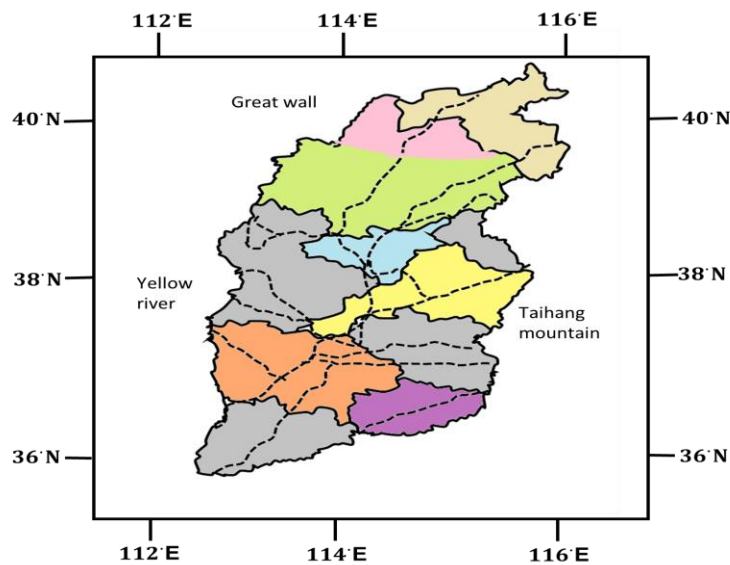| Region	Attributes of roads			
	Length (km)	Main road	Connecting points	Branch road
The great wall	4279	1	256	83
Taihang	4650	1	231	74
Yellow River	4131	1	212	46

Figure 2: Highway connectivity

Year-Basis Tourists Arrival Ratio (%)

The details provided to illustrate the trends of tourists at the Great Wall, Taihang, and Yellow River, three of Shanxi Province's most popular tourist destinations. The changing patterns of visitor arrivals are seen in Table 3 and Figure 3. Considering a significant exclusion of 2019 and 2020 data caused by the COVID-19 pandemic, the following graph shows the annual variations in arrivals of tourists spanning three significant tourism highways in Shanxi Province from 2017 to 2024. The number of visits fluctuated every year which indicating the changes in interest levels and other outside variables like the state of economy and advertising efforts.

Table 3: Tourist arrivals ratio (%) from 2017 to 2019

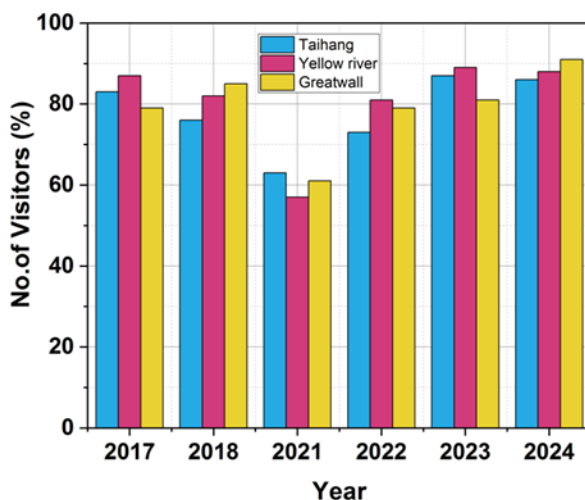| Year	Taihang (%)	Yellow river (%)	Great wall (%)
2017	83	87	79
2018	76	82	85
2021	63	57	61
2022	73	81	79
2023	87	89	81
2024	86	88	91

Figure 3: Tourist arrivals from 2017 to 2019

After the epidemic, a varied but commonly expanding number of automobiles could be observed on all roadways starting in 2021. Considering the persisting boundaries on foreign travel, the higher figures for 2023 and 2024 predict an eventual restoration and probably an additional attraction to regional exploration. By using these patterns, tourism managers in Shanxi Province and other relevant stakeholders can adapt their approach to maximize visitor flow and enhance the visitor experience while upholding sustainability and security in an epidemic environment.

Highway Network Efficiency

The three Taihang, Yellow River, Great wall highway network efficiency is compared to the current highway network, the more spatially efficient planned highway network. Table 4 and Figure 4 show the efficiency of the highway system. The portability of the whole spatial organization may be reflected in the average spatial efficiency. The general availability of incomplete spatial data might be investigated using the highest possible spatial effectiveness.

Table 4: Highway Network Efficiency

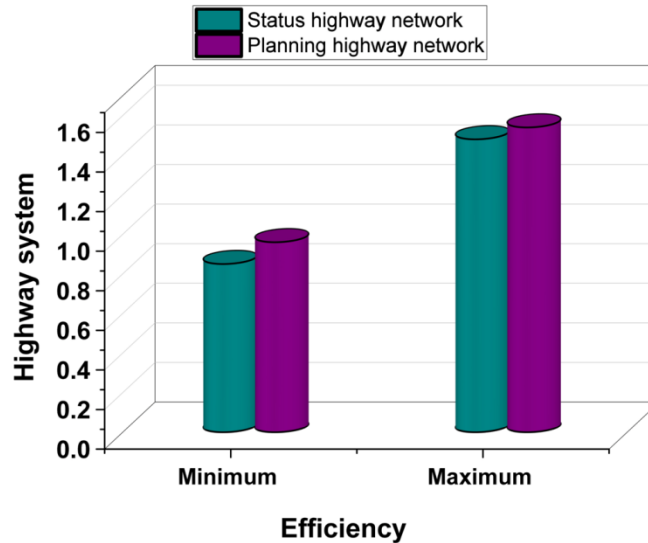| Highway system	Maximum efficiency	Minimum efficiency
Planning highway network	1.54	0.96
Status highway network	1.48	0.85

Figure 4: Efficiency

The metrics for maximum efficiency and average efficiency show gains in the intended network. The connection across the scenic region and the neighboring areas might be strengthened by the planned tourist highway network.

Transportation Based On Road Condition

The three significant tourist places in Shanxi Province Yellow River, Great Wall, and Taihang have the circumstances synthesized in the followings. Table 5 shows the road condition. Each highway's general length is presented, and its state is divided into three groups: good, moderately damaged, and entirely damaged. There are 4131 km of the Yellow River highway; 2650 km in good condition, 1000 km are moderately damaged, and 481 km have been demolished. Conversely, 4279 km of the Great Wall highway, 3100 km are in excellent condition, 850 km are partially impaired, and 329 km are destroyed.

Table 5: Road condition

Highway	Good (km)	Partially damaged (km)	Fully damaged (km)	Total length (km)
Yellow River	2650	1000	481	4131
Great wall	3100	850	329	4279
Taihang	3400	950	300	4650

Across the 4650 km of the Taihang highway, 3400 km are in excellent condition, 950 km are damaged in part, and 300 km have been destroyed. This data displays similarities in roadway issues and maintenance among various roadways, enabling essential insights for strategic planning, and transportation transformation to boost travel reliability and security in the region.

Traffic Flow

Traffic is one important factor that might restrict the expansion of tourism. This article studies the provinces' main arterial routes and highways to assess traffic locations. Based on the strength of the element flow, the 9 cities were categorized into three categories. The primary action directions for each piece in each city were

created using GIS software. Figure 5 presents the traffic flow. The majority of the primary attractions in the three districts are connected by the planned tourism route.
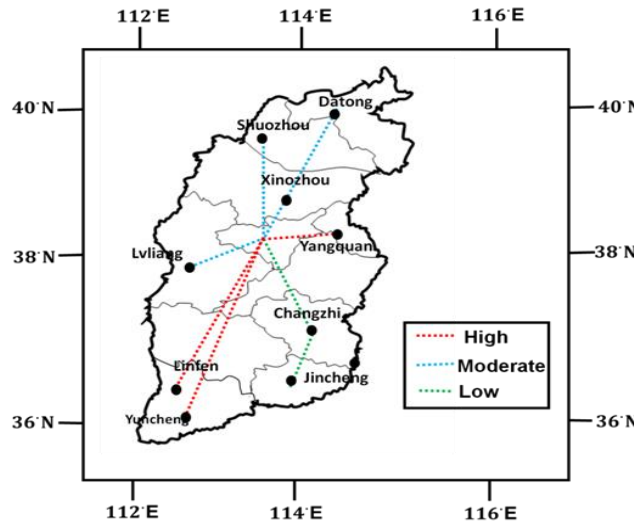

Figure 5: Traffic flow

The accessibility of the picturesque location will be impacted by the terrain. The Taihang District's generally level landscape allows for better attraction connections. But the Yellow River region is a home to several mountains, which are known to make tourism less accessible. Yuncheng was Taiyuan's first traffic-flowing connecting city, whereas Changzhi was Jincheng's. Taiyuan was the first city to link with other cities. It is evident that Taiyuan is a significant transportation center, and due to its proximity, Lvliang has the highest membership degree. The center's directionality determined the primary direction of traffic flow.

Factors of Social Sustainability wsith Statistical Interpretations

The evaluation of social sustainability along with Taihang, Great Wall, and Yellow River routes identifies different areas of strength and need for development. Table 6 depicts the social sustainability. While Taihang Highway performs admirably in terms of tourist involvement (0.85) and contributions to the environment (0.85), it makes only mediocre attempts in terms of administration of impact on the environment (0.55) and conservation of cultural assets (0.60). The Great Wall Highway stands out for its excellent infrastructure and mobility (0.75) and robust attempts to converse of cultural assets (0.75), despite its contributions to the Environment (0.65).

Table 6: Social sustainability

Factor	Taihang	Great wall	Yellow River
Tourist involvement	0.85	0.65	0.80
Influence on the neighborhood	0.70	0.75	0.68
Contributions to the Environment	0.85	0.65	0.80
Conservation of cultural assets	0.60	0.75	0.62
Administration of impact on the environment	0.55	0.50	0.58
Infrastructure and Mobility	0.70	0.75	0.65
Cooperation in the Tourism Sector	0.80	0.70	0.78
Public Perception	0.75	0.72	0.78

The Yellow River Highway has a high level of tourist involvement (0.80), contributions to the environment (0.80), and public perception (0.78). It does confront difficulties with the conservation of cultural assets (0.62) and environmental impact management (0.58). On all highways, there is considerable interaction among the tourism industry, which benefits nearby towns. Generally speaking, improving the management of the environment and preservation initiatives could further boost these roads' sustainability profiles, even while supporting economic growth and beneficial community advantages

DISCUSSION

The finding evaluates the social sustainability of the Taihang, Great Wall, and Yellow River tourist highway networks in Shanxi province by traffic flow, road condition, tourist arrival ratio, transportation, highway planning and connectivity. With statistical analysis and GIS, the researchers mapped the network, assessed convenience, and recognized probable areas for enhancement. The works emphasize the importance of these highways to the flow of transport associated with tourism, their implementation as a suitable relation crossways attraction and attractive landscapes. But in addition to this reasonable perk, the research also emphasizes the widespread tribulations that comprise contaminants in the surroundings and suspect immediate motivating security. The study reveals that facilitating the majority of traffic on the highway is traveler-correlated; emphasizing their essential responsibility in between roadside attraction and scenery views, while also prominence continuing ecological contamination and road safety issues.

CONCLUSION

The study evaluates the social sustainability of the Taihang, Great Wall, and Yellow River tourist highway networks in Shanxi province. The research involved 300 tourists to assess their current state and identify potential areas for development. With statistical analysis and GIS, the researchers mapped the network, assessed convenience, and recognized probable areas for enhancement. The findings underscore the necessity of balancing environmental, social, and economic factors in developing tourist highway networks. The improved spatial efficiency of the planned highway network demonstrates potential for positive impacts, including better connectivity, enhanced tourist satisfaction, and a reduced environmental footprint. To ensure that these tourist routes positively affect surrounding communities and the tourism sector, it is essential to continue focusing on sustainable practices. This involves further efforts in environmental conservation, improving road safety, and supporting local economies through tourism. Establishing such equilibrium will help sustain the long-term viability and attractiveness of Shanxi's tourist highways, benefiting the region and its visitors. Using statistical analysis and GIS tools, accessibility and development opportunities were identified through spatial efficiency analysis, revealing planned highway network improvements for improved connectivity and sustainable tourism growth. This study emphasizes the pivotal role of integrated planning and sustainable practices in enhancing the overall effectiveness and societal benefits of tourism highway networks in Shanxi Province.

REFERENCES

Chen, S., Xi, J., Liu, M. and Li, T., 2020. Analysis of complex transportation network and its tourism utilization potential: a case study of Guizhou expressways. Complexity, 2020(1), p.1042506.

Bhattarai, K., Conway, D., Bhattarai, K. and Conway, D., 2021. Impacts of economic growth, transportation, and tourism on the contemporary environment. Contemporary Environmental Problems in Nepal: Geographic Perspectives, pp.563-662.

Mamirkulova, G., Mi, J., Abbas, J., Mahmood, S., Mubeen, R. and Ziapour, A., 2020. New Silk Road infrastructure opportunities in developing tourism environment for residents a better quality of life. Global Ecology and Conservation, 24, p.e01194.

Amen, M.A., Afara, A. and Nia, H.A., 2023. Exploring the link between street layout centrality and walkability for sustainable tourism in historical urban areas. Urban Science, 7(2), p.67.`

Kanwal, S., Rasheed, M.I., Pitafi, A.H., Pitafi, A. and Ren, M., 2020. Road and transport infrastructure development and community support for tourism: The role of perceived benefits, and community satisfaction. Tourism Management, 77, p.104014.

Wu, S., Wang, L. and Liu, H., 2021. Study on tourism flow network patterns on May Day Holiday. Sustainability, 13(2), p.947.

Pityulych, M.I. and Feier, A.Y., 2022. Rural Tourism: Diversification and Modernisation of Tourist Infrastructure (on the Materials of the Transcarpathian Region). НАУКОВИЙ ВІСНИК, 8(4), pp.79-87.

Bargeman, B. and Richards, G., 2020. A new approach to understanding tourism practices. Annals of tourism research, 84, p.102988.

Kim, S., Kang, Y., Park, J.H. and Kang, S.E., 2021. The impact of residents' participation on their support for tourism development at a community-level destination. Sustainability, 13(9), p.4789.

Saarinen, J., 2019. Communities and sustainable tourism development: Community impacts and local benefit creation in tourism. In A research agenda for sustainable tourism (pp. 206-222). Edward Elgar Publishing.

Baloch, Q.B., Shah, S.N., Iqbal, N., Sheeraz, M., Asadullah, M., Mahar, S. and Khan, A.U., 2023. Impact of tourism development upon environmental sustainability: a suggested framework for sustainable ecotourism. Environmental Science and Pollution Research, 30(3), pp.5917-5930.

Liu, Z.G. and Zhang, T.T., 2020, May. Layout Planning Methods of Tourism Road Considering Tourism Value and Traffic Demand. In International Conference on Transportation and Development 2020 (pp. 186-200). Reston, VA: American Society of Civil Engineers.

Saha, J. and PAUL, S., 2020. Sustainable tourism development strategies using SWOT-AHP on newly developed coastal tourism destinations. Romanian Review of Regional Studies, 16(2).

Martín, J.M.M. and Fernández, J.A.S., 2022. The effects of technological improvements in the train network on tourism sustainability. An approach focused on seasonality. Sustainable Technology and Entrepreneurship, 1(1), p.100005.https://doi.org/1 0.1016/j.stae.2022.100 005

Hye, Q. M. A. (2008). Aggregate Import Demand Function for Pakistan: Analysis in the Form of Old and Relatively New Cointegration Techniques. International Journal of Economic Perspectives, 2(4).

Szymańska, E., Panfiluk, E. and Kiryluk, H., 2021. Innovative solutions for the development of sustainable transport and improvement of the tourist accessibility of peripheral areas: The case of the białowieża forest region. Sustainability, 13(4), p.2381. https://doi.org/10 .3390/su13042381

Arbolino, R., Boffardi, R., De Simone, L. and Ioppolo, G., 2021. Multi-objective optimization technique: A novel approach in tourism sustainability planning. Journal of Environmental Management, 285, p.112016. https://doi.org/10.1016/j.jenvman.2021.112016

Li, X., Abbas, J., Dongling, W., Baig, N.U.A. and Zhang, R., 2022. From cultural tourism to social entrepreneurship: Role of social value creation for environmental sustainability. Frontiers in Psychology, 13, p.925768. https://doi.org/10.3389/fpsyg. 2022 .9 25768

Leposa, N., 2020. Problematic blue growth: A thematic synthesis of social sustainability problems related to growth in marine and coastal tourism. Sustainability Science, 15, pp.1233-1244. https://doi.org/10.1007/s11625-020-00796-9

Zhang, Y., Xiong, Y., Lee, T.J., Ye, M. and Nunkoo, R., 2021. Sociocultural sustainability and the formation of social capital from community-based tourism. Journal of Travel Research, 60(3), pp.656-669.

Romanelli, M., Gazzola, P., Grechi, D. and Pollice, F., 2021. Towards a sustainability‑ oriented religious tourism. Systems Research and Behavioral Science, 38(3), pp.386-396