



# Investigating the Implementation and Application of Blockchain Technology in Tourism Supply Chain: A System Dynamics Approach

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## ABSTRACT

Presently, the tourism industry confronts a multitude of challenges, such as the mismatch between the quality of services provided and tourists' expectations and the management of tourist identity and security. These challenges can be addressed with the emergence of advanced technologies, including blockchain technology. This research uses the system dynamics approach to investigate the implementation and application of blockchain technology in the tourism supply chain of travel agencies in Isfahan. This research has a practical purpose, aiming to address real-world issues. Additionally, the nature and methodology of the study are descriptive-causal, and the data collection method employed in this research is a survey. At first, based on the existing research literature, the factors influencing the implementation and application of blockchain technology in the tourism supply chain of Isfahan travel agencies were identified. Subsequently, using a judgmental sampling method and gathering opinions from 45 experts, managers, and university tourism professionals, the relationships between the identified factors were determined, and a causal loop diagram was drawn. Then, employing a convenience sampling method and gathering information from 15 selected travel agencies in Isfahan, mathematical relationships between the identified factors were determined, and a stock and flow diagram was designed. The simulation results of this research indicated that the quality of using blockchain technology in the early years of its implementation was not favorable, but it would improve over time. Furthermore, the findings demonstrated a positive correlation between the quality of using blockchain technology with service quality and the level of tourist attraction. The scenarios designed in this research showed that by allocating more resources to employee training and enhancing information technology infrastructure, the quality of using blockchain technology and the quality of the services could significantly improve during the initial years of implementation of blockchain technology.

## Keywords

Keywords: Blockchain technology, Tourism supply chain, Tourist attractions, System dynamics.

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## 1. Introduction

Tourism is a complex and multifaceted industry encompassing many stakeholders, including tourists, tourism service providers, governments, and international organizations (Annamalah, Paraman and Ahmed, 2023). Tourism is one of the most important industries in the world and can contribute to the economic growth and sustainable development of countries (Roodbari and Olya, 2024). The tourism industry in Iran also has the potential to become a tourist destination for domestic and foreign tourists due to its abundant natural and historical attractions, rich history and culture, beautiful natural scenery, and diverse tourist attractions (Akbarian Ronizi, et al., 2023). Government policies to develop the tourism industry, increase tourism facilities and services, and fundamentally develop tourism infrastructure, including airports and hotels, have contributed to the growth of this industry in Iran (Shabankareh, et al., 2023). In addition, more extensive promotional programs have played an important role in attracting foreign tourists to Iran (Khodadadi, 2016). The growth of the tourism industry in Iran has positively effected the country's economy (Seyfi, et al., 2021). This growth has led to new job opportunities in various tourism industry sectors, including hospitality, transportation, handicrafts, and cultural tourism, and increased foreign exchange earnings for the country (Khoshkhoo, et al., 2017).

Isfahan is one of the most significant cities in Iran for attracting tourists and developing the country's tourism industry. Despite its numerous historical, cultural, and natural attractions, the level of tourist attraction in Isfahan has not aligned with the expectations and capacities in recent years (Saghafi, et al., 2023). One of the reasons for this is the various challenges in the tourism sector in Isfahan. One of the most important challenges of tourism in Isfahan is the mismatch of the quality of services provided with the needs and expectations of tourists (Masoud, et al., 2019). This challenge is evident in various aspects of Isfahan city's tourism supply chain, including transportation and insufficient parking spaces, the lack of four- and five-star hotels, difficulties in making reservations at such establishments, inadequate resort quality, and the lack of high-quality intercity restaurants. Additionally, there are issues concerning the poor quality of sanitary facilities and other related amenities (Khoshkam and Rahimi, 2023). The mismatch between the provided service quality and the needs and expectations of customers results in an unpleasant experience and a surge in tourist complaints, giving rise to a negative perception of the tourism industry in Isfahan. This issue contributes to a decrease in tourist satisfaction. It can diminish the overall attractiveness of Isfahan as a tourist destination, leading to a decline in recommendations and positive word-of-mouth. Another challenge within

Isfahan's tourism supply chain is managing tourist identities, ensuring security, and safeguarding personal information (Ghaderi, et al., 2018). Another challenge is managing tourist identities and protecting their security and personal information (Ghorbani et al., 2023). This challenge has become increasingly critical with the rise in foreign tourists visiting Isfahan. There is no comprehensive system to manage tourists' identities in Isfahan. It can lead to issues such as identity theft and fraud, posing significant problems for tourists and ultimately eroding their trust in the tourism industry in Isfahan (Gorji, et al., 2023). To fully realize the potential of tourism in Isfahan, the government and the private sector need to take steps to address these challenges. As the tourism industry is considered a vital part of the economy, contributing to economic growth, job creation, and personal well-being, using new technologies, including those in Industry 4.0, is essential to sustaining its activities (Pereira and Romero, 2017). One of these technologies is blockchain technology (Silva, et al., 2020).

Implementing and applying blockchain technologies in the tourism supply chain can significantly transform it (Rashideh, 2020). A blockchain is a digital ledger in which data is stored in a chain of blocks (Bamakan, et al., 2022). Each block contains time-stamped encrypted data (Xu, et al., 2019). The blockchain is verified and maintained by a network of computers known as nodes. Nodes verify the data and add new blocks to the chain (Komalavalli, et al., 2020). Blockchain offers transparent, secure, reliable, and collaborative solutions as a stand-alone technology or in collaboration with other technologies. (Zutshi, et al., 2021). It means that using and deploying blockchain could help solve problems like the inefficiency in the tourism supply chain, the reliability and transparency of information, fraud, the opportunistic behavior of middlemen, and foreign exchange risks (Fohlin and Ysberg, 2019). For example, implementing blockchain and tracking tourism products and services along the supply chain can help identify and solve the challenges and problems in the tourism supply chain in Isfahan (Prados-Castillo, et al., 2023a). One of the important applications for implementing blockchain in the tourism supply chain is automating the tourism service booking process (Prados-Castillo, et al., 2023b). By using blockchain and automating these steps, the user experience of tourists in the online tourism service market is improved, and the efficiency of the tourism supply chain is increased (Pradhan, et al., 2023). Ultimately, blockchain technology can significantly effect the tourism industry and contribute to economic development, job creation, and personal well-being by promoting transparency, trust, efficiency, and risk reduction (Tan and Saraniemi, 2023).

Literature reviews show that the application of blockchain technology in various industries has been widely studied. However, comprehensive research on the application of blockchain technology in the tourism industry is still in its early stages. It is worth noting that the research conducted on blockchain applications in tourism has largely focused on specific areas or limited use cases. For example, [Önder and Treiblmaier \(2018\)](#) focused on cryptocurrencies, while [Sarhadi et al. \(2023\)](#) addressed the crowdsourcing of blockchain technology in tourism. On the one hand, [Balasubramanian, et al. \(2022\)](#) pointed to the blockchain applications in medical tourism. Also [Balasubramanian, et al. \(2022\)](#) and [Tham and Sigala \(2020\)](#) focused on the application of blockchain in sustainable development.

In the studies conducted, the impact of blockchain technology in the field of tourism has been investigated in areas such as eliminating intermediaries in the tourism supply chain ([Rashideh, 2020](#)), reducing costs ([Aghaei, et al., 2021](#)), increasing transparency ([Treiblmaier, 2022](#)), creating new markets in the field of tourism ([Coita and Ban, 2020](#)) and so on. Also, some studies have addressed the challenges of using blockchain technology, including the lack of cooperation ([Alshahrani and Alshahrani, 2021](#)) and the infrastructure of information and communication technology ([Ølnes and Jansen, 2017](#)). In the studies, only the factors affecting the implementation of blockchain technology in the tourism industry and the benefits of its use were identified. In these studies, a clear picture of how the factors affecting the implementation of blockchain technology communicate with each other and the consequences of the implementation of blockchain technology in the tourism supply chain have not been investigated. According to systemic theory, the elements of a system interact with each other, and a change in one of the elements of the system can affect the entire system ([Safaie, et al., 2023](#)). Therefore, creating a systemic perspective and identifying the communication between factors and their interactions will play an effective role in better understanding the implementation and application of blockchain technology in the tourism supply chain. System dynamics methodology is a research approach that analyses complex relationships and interactions between system elements and their changes ([Khajehpoura, et al., 2024](#)). The system dynamics methodology can be used to understand the long-term and complex effects of blockchain technology in the tourism supply chain in Isfahan's travel agencies due to the lack of a study with a systemic approach and a comprehensive look at the impact and effectiveness of factors affecting the implementation and application of blockchain technology on the tourism industry and the existence of various challenges mentioned of Isfahan's tourism supply chain, including quality mismatch services with the expectations of tourists, identity management of

tourists, maintaining the security of tourists' information. This research aims to investigate the implementation and application of blockchain technology in tourism agencies in Isfahan using system dynamics methodology.

## 2. Literature review

Nowadays, blockchain technology has digitally transformed the activities of the tourism supply chain. As a result, the tourism industry, which has been facing growing potential for years, seeks to align its supply chain with blockchain technology. By providing new solutions, this technology leads to innovation and digitalization in tourism organizations (Stankov and Filimonau, 2020). One of the important aspects of blockchain in the tourism supply chain is providing superior and reliable services to guests. The potential of this technology can improve business performance and increase the transparency and efficiency of companies (Ioannidis, 2023). Blockchain technology has positively effected business models, tourism services, and companies' supply chain performance. For example, blockchain solutions such as digital identity management, digital payments, and smart contracts can significantly reduce inefficient paper-based processes in the tourism industry. These solutions can also increase transparency and reduce the risk of fraud and error, processing time, and transaction costs for all parties involved. This technology is currently being used in various fields, and numerous studies have also been conducted. For example, Sarfraz, et al., 2023 conducted a study on the impact of sustainable supply chain strategy (SSCS) on sustainable competitive advantage (SCA) in the hospitality and tourism industries using blockchain technology. The findings of this study showed that blockchain technology plays a mediating role in the impact of a sustainable supply chain on competitive advantage. It means that adopting blockchain technology within the framework of a sustainable supply chain strategy can significantly contribute to a sustainable competitive advantage. Rana, et al., 2022 conducted a study to examine the pros and cons of blockchain technology (BC) for the tourism industry in the context of COVID-19's digital acceleration and the shift towards Industry 4.0. This study aimed to investigate the advantages and disadvantages of adopting BC in the tourism industry, as well as potential solutions to overcome challenges. This study conducted a systematic literature review (SLR) to analyze relevant academic articles on BC in tourism. The findings showed that most studies highlight the benefits of BC implementation, showcasing its potential through various models of BC-based systems. Prados et al. (2023a) conducted a study to examine the adoption of blockchain technology in the tourism industry from a sustainability perspective. The study used a

systematic review methodology, descriptive biometric analysis, and network analysis based on co-authorship, co-citation, and keyword analysis criteria. This multifaceted approach provides valuable insights into the research landscape and key points where blockchain penetrates the tourism sector. The findings showed that there is a growing interest in blockchain in academic circles, especially in the fields of sustainable management and supply chain optimization. It suggests that the potential of this technology to help create a sustainable tourism industry is being increasingly recognized. In addition, the analysis of this study suggests that marketing, logistics, and the development of innovative business models have been identified as the main areas where blockchain is gaining traction.

[Corne et al. \(2023\)](#) conducted a study to examine the motivation for adopting blockchain technology in the tourism accommodation sector. The study focused on applying this technology in the context of loyalty programs, online bookings, customer review validation and tracking, and metaverse data security. The study used the Technology Acceptance Model (TAM) for analysis, which considers four key factors: perceived usefulness, perceived ease of use, trust in technology, and perceived social influence. To collect data, researchers used a questionnaire for 100 tourism management graduates. Then, they used fuzzy-set Qualitative Comparative Analysis (fsQCA) to understand the complex relationships between influencing factors and technology adoption intention. The results of this study contribute to a better understanding of the motivational factors for adopting blockchain technology among future tourism accommodation managers. They can provide a basis for policy-making and facilitate the adoption of this technology in the tourism industry.

[Jain et al. \(2023\)](#) also examined the potential of blockchain technology to transform the tourism and hospitality industries. The authors conducted a systematic review of 56 peer-reviewed scientific articles published between 2012 and 2022 to provide a comprehensive overview of the state of research in this area. Through this review, they identified significant gaps in knowledge and awareness of blockchain, particularly regarding measuring the readiness of digital business models to integrate with blockchain. The result of this research is a categorization of research topics and future research directions in the field of blockchain-based smart tourism, presented based on the "Theory, Context, Method" (TCM) framework. Additionally, for a better understanding of the readers, several case studies of the interplay of these three elements are mentioned. [Ratna et al. \(2024\)](#) published an article entitled "Application of Blockchain, Fintech, and Knowledge Management Technologies in the Tourism and Hospitality Industry." The article's main purpose is to provide a new perspective

and explore the opportunities that blockchain, fintech, and knowledge management technologies have created over the past ten years to create new value and innovation processes in the digital tourism and hospitality domains. In this study, a systematic review with a socio-technical approach was used. This paper showed that researchers have explored the benefits and challenges of digital twin technology, fintech, and knowledge management in this industry. This study suggests that using blockchain, fintech, and knowledge management can create new opportunities and markets in the tourism and hospitality industries. [Puri et al. \(2023\)](#) conducted a study to examine the potential and applications of blockchain technology in the tourism industry. In this study, the authors used advanced text extraction and machine learning methods to conduct a comprehensive analysis of 94 papers related to the application of blockchain in tourism between 2017 and 2022. This study uses advanced text mining to predict blockchain-related topics in tourism, which is a leading approach. The article's findings show that there are still many opportunities for research on blockchain applications in the tourism industry.

### 3. Research method

The present study is applied in terms of its purpose, as the results of this study can be used in the tourism industry. It is also descriptive-causal in nature and method, as the factors affecting the implementation and application of blockchain in Isfahan travel agencies were not specified in advance and were identified during the research process. It is a survey in data collection, as the interview tool was used to collect the necessary data. To determine the relationships between the factors affecting the implementation and application of blockchain technology in the supply chain of Isfahan travel agencies, 45 academic experts, managers, and tourism experts were selected by judgmental sampling. Also, to collect the necessary data, information and documents available in Isfahan, travel agencies were used, and 15 travel agencies in Isfahan were selected by convenience sampling. This study used the system dynamics approach to investigate the implementation and application of blockchain technology in the tourism supply chain of Isfahan travel agencies. The system dynamics approach is based on systems thinking and supports the development of simulation models for the holistic assessment of complex systems ([Morovati Sharifabadi and Ziaeiian, 2023](#)). System dynamics modeling is a multi-step process for converting a problem into a quantitative representation and then simulating it ([Shen et al., 2009](#)). The goal of the system dynamics approach aims to identify system variables and their time interactions ([Wolstenholme, 1990](#)). This approach effectively manages the assumptions of system configurations and dynamic structures and enables the management of

changes within subsystems and interactions across the system (Bottero, et al., 2020). The process of conducting this research is shown in Figure 1.



Figure 1. Research implementation steps

As shown in Figure 1, the first step investigated the problem statement and the rationale for the research, given the importance of the tourism industry in the growth and development of the country on the one hand and the existence of challenges such as the mismatch between tourist expectations and the quality of services provided, the management of tourist identity and security. On the other hand, this study has investigated the application of advanced technologies, including blockchain technology, in the tourism supply chain of travel agencies in Isfahan. In the second step, the factors affecting the implementation and application of blockchain in the tourism supply chain of travel agencies in Isfahan were investigated. In the third step, dynamic hypotheses were formulated. Dynamic hypotheses explain the causes and underlying mechanisms of observed behaviors. After defining the dynamic hypotheses, the model boundary diagram was designed. The model boundary diagram specifies the scope of the model by listing the endogenous and exogenous variables, and variables that are not included in the model. The causal loop diagram and the stock and flow diagram were designed in the fourth step. The causal loop diagram serves as a fundamental tool for showing the feedback structure of the system. A positive or negative sign is assigned to each causal link in the diagram. A positive sign indicates that variables change in the same direction, while a negative sign indicates opposite changes (Rebs, et al., 2019). By conducting a series of online and face-



to-face interview sessions with 45 experts, causal relationships between variables were identified, leading to the design of a comprehensive causal loop diagram. After constructing the causal loop diagram, the stock and flow diagram is used to formulate the relationships between the variables under study. The stock and flow diagram allows for examining system behavior over time. The stock and flow diagram was constructed using information obtained from 15 tourism agencies in Isfahan. Mathematical relationships between the variables in the causal loop diagram were determined, and these relationships were further validated and confirmed by experts in the field. Finally, the constructed stock and flow diagram was evaluated with various experiments, and scenarios were presented to provide appropriate solutions for the better implementation and application of blockchain technology in the tourism supply chain of travel agencies in Isfahan.

#### **4. The proposed model**

Using research literature and expert opinion, the relationships between the factors affecting the implementation and application of blockchain technology in the tourism supply chain of travel agencies in Isfahan were identified, and a causal loop diagram was designed.

##### **4.1. Dynamic hypothesis**

A dynamic hypothesis is a conceptual model the researcher provides based on the key variables of the issue. Dynamic hypotheses involve drawing the main reinforcing and balancing loops using the main variables, facilitating reasoning and knowledge extraction from the developed model. One of the main advantages of dynamic hypotheses is that they increase the readers' understanding of the complexity of the model. The dynamic hypothesis of the current research, the impact of blockchain technology on tourist attractions, is shown in Figure 2 and as follows:

1. Financial resources have a positive effect on blockchain technology.
2. Blockchain technology affects tracking capability.
3. Tracking capability affects transparency in communication and transactions.
4. Transparency in communication and transactions affects service quality.
5. Service quality affects the Tourist satisfaction.
6. Tourist satisfaction affects the tourist attraction.

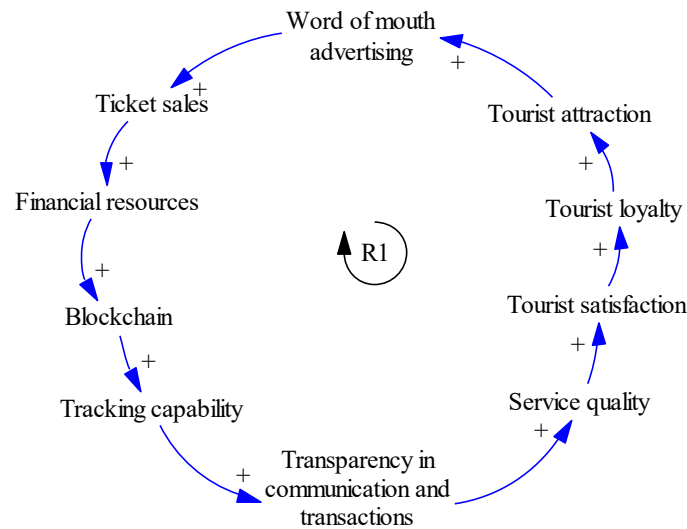


Figure 2. The feedback loops

As shown in Figure 2, blockchain technology can be deployed by allocating sufficient financial resources for the purchase, maintenance, and development of the necessary infrastructure. With the implementation of blockchain technology, the transparency level in transactions and communications with tourists will improve. In other words, with blockchain technology, the level of fraud and forgery in purchases and transactions between tourists and active sectors in the tourism sector, such as hotels, restaurants, and tourist attractions, will be reduced. Transparency in transactions and communications and understanding the needs of tourists will lead to identifying weaknesses in the provision of services by travel agencies. It will significantly help provide quality services to gain customer satisfaction. Tourist satisfaction and loyalty will increase with improved service quality from travel agencies. With increasing tourist satisfaction and loyalty and positive word-of-mouth advertising from them, the rate of tourist attraction will also increase.

**4.2. System’s boundary diagram**

After analyzing the dynamic hypotheses, the indigenous and exogenous variables were created, and the model's boundary diagram was identified. The findings of this examination are summarized in Table 1.

Table 1. Classification of factors into indigenous and exogenous factors

NO	Factors	Description	References
1	Cooperation	Cooperation refers to the extent to which employees are engaged in learning and sharing knowledge to leverage blockchain technology in Isfahan's tourism and travel agencies.	Aghaei et al., (2021); Antoniadis et al., (2020)
2	Top support management	Top support management encompasses the degree of support and efforts managers make in allocating adequate resources, motivating employees, creating suitable training conditions, and enhancing their skill levels to facilitate the adoption of blockchain technology in Isfahan's travel agencies.	Zhu and Kouhizadeh, (2019)
3	Organizational Commitment	Organizational commitment refers to the level of motivation and loyalty of employees to the organization and their deep connection with its goals, values, and mission.	Erol et al., (2022)
4	Employee resistance	Employee resistance refers to the unwillingness of employees in Isfahan's tourism and travel agencies to embrace and utilize blockchain technology.	Agarwal, et al., (2023); Jang, et al., (2023)
5	Skills of employees	Employee skills refer to the level of awareness and understanding they possess regarding the functionality and utilization of blockchain technology within Isfahan's tourism and travel agencies.	Chunmian, et al., (2022); Ozdemir, et al., (2023)
6	Financial resources	Financial resources refer to allocating funds for implementing blockchain technology, which includes upgrading information and communication technology infrastructure, employee training, and other related expenses in Isfahan's tourism and travel agencies.	Barreto, et al., (2019); Ratna et al., (2024)
7	Organizational motivation	Organizational motivation refers to the degree of willingness, interest, and motivation displayed by employees in Isfahan's travel agencies to adopt and utilize blockchain technology.	Chaudhuri, et al., (2023)
8	Blockchain technology	Blockchain technology encompasses implementing and utilizing blockchain technology quality across various segments of the tourism supply chain within Isfahan's travel agencies.	Antoniadis et al., (2020); Salunkhe, et al., (2024)
9	High-speed Internet	High-speed Internet refers to the availability and accessibility of fast and reliable Internet connections that enable blockchain technology's effective use and implementation.	Tang et al., (2019); Živanović and Živanović (2022)
10	Data security	Data security refers to the measures and protocols in place to ensure the protection and confidentiality of tourists' personal	Ozdemir and Erol, (2020)

NO	Factors	Description	References
		information and financial transactions and to prevent unauthorized access or impersonation of tourists within the context of Isfahan's travel agencies.	
11	Service fraud	Service fraud refers to deceptive practices such as the impersonation of tourists, unauthorized use or misuse of their personal information, and unauthorized access to their financial transactions within the context of Isfahan's travel agencies.	<a href="#">Banerji et al., (2021)</a>
12	Trust	Trust refers to the level of confidence and reliance that tourists have in the services provided by Isfahan's travel agencies and their willingness to travel to Isfahan based on that trust.	<a href="#">Veloso, et al., (2019)</a>
13	Transparency in communication and transactions	Transparency in communication and transactions refers to the degree of access that tourists have to information and their awareness regarding prices, financial transactions, travel routes, reservation status, and other relevant details about tourism within Isfahan travel agencies.	<a href="#">Baralla, et al., (2021); Calvaresi, et al., (2019)</a>
14	Service quality	Service quality refers to the standard of services provided to tourists in various areas, including hotel accommodations, services offered in Isfahan hotels, reservations, and overall tourist experience.	<a href="#">Raluca-Florentina, (2022); Veloso et al., (2019)</a>
15	Tourist satisfaction	Tourists' satisfaction refers to their contentment with their travel experiences and the services they receive. It encompasses evaluating various factors, including the performance of tourism organizations and establishments, service quality, meeting tourists' needs and expectations, positive interactions with staff, effective communication, and the overall travel experience.	<a href="#">Pradhan et al., (2023)</a>
16	Tourist attraction	Attracting tourists refers to the process of enticing and generating their interest in visiting the city of Isfahan.	<a href="#">Luo and Zhou, (2021)</a>
17	Tourist loyalty	Tourist loyalty refers to the inclination of tourists to revisit Isfahan, engage in positive word-of-mouth promotion of the city, and demonstrate continued support for the travel agencies and services offered in this destination.	<a href="#">Pérez-Sánchez et al., (2021)</a>
18	Ticket sales	Ticket sales refer to the revenue generated from the sale of tickets to tourists for their travel to Isfahan.	<a href="#">Polukhina, et al., (2019)</a>

NO	Factors	Description	References
19	Knowing the expectations of tourists	Knowing tourists' expectations refers to understanding their needs and desires of tourists about the services they expect to receive during their trip to Isfahan.	<a href="#">Calvaresi et al., (2019)</a> ; <a href="#">Fragnière et al., (2022)</a>
20	Development of tourist attractions	The development of tourist attractions refers to enhancing tourists' awareness of the diverse attractions available in the city of Isfahan. It includes improving the visibility, accessibility, and promotion of key tourist sites, landmarks, cultural and historical destinations, natural landscapes, and other points of interest within the city.	<a href="#">Kwok and Koh, (2019)</a>
22	Attracting investors	Attracting investors involves drawing in both domestic and foreign investors and providing them with opportunities to invest in securing the necessary financial resources for implementing blockchain technology.	<a href="#">Antoniadis et al., (2020)</a>
23	Tracking capability	Tracking capability refers to accurately and transparently recording and tracking information related to travel routes, financial transactions, services provided, and other aspects of the tourism experience.	<a href="#">Valeri, (2020)</a> ; <a href="#">Wong et al., (2024)</a>
24	Travel motivation	Travel motivation refers to individuals' desire and interest in journeying to Isfahan.	<a href="#">Bodkhe et al., (2019)</a>
25	Training	Training involves conducting various courses and programs to educate and familiarize employees with blockchain technology and its functioning. These training sessions aim to equip employees with the necessary knowledge, skills, and understanding of blockchain technology, its applications, and its potential effect on their work.	<a href="#">Erol et al., (2022)</a>
26	Word of mouth advertising	Word-of-mouth advertising refers to the act of tourists from Isfahan sharing positive recommendations, experiences, and endorsements about their visit and encouraging others to travel to this city.	<a href="#">Kathuria and Tandon (2023)</a>
27	Job Satisfaction	Job Satisfaction refers to employees' dedication, interest, and willingness towards their work in Isfahan's tourism and travel agencies.	<a href="#">Raluca-Florentina (2022)</a>
28	Proper advertising	Proper advertising promotes the characteristics of Isfahan, including its historical and cultural attractions, through various advertising mediums. It utilizes different advertising channels such as print media, online platforms, television, radio, billboards, and other relevant promotional channels to convey information about the city's unique features and attractions.	<a href="#">Aghaei et al., (2021)</a>

NO	Factors		Description	References
29	Exogenous factors	Government support	Government support refers to the assistance provided by the government in various areas, including financial support and support in information and communication technology, among others, to facilitate the implementation and adoption of blockchain technology in Isfahan travel agencies. This support can encompass financial incentives, grants, subsidies, tax benefits, and other forms of financial assistance to encourage the implementation and utilization of blockchain technology.	Li et al. (2021); Ozdemir et al., (2020)
30		Use of experts	The use of experts refers to the process of attracting highly skilled and capable individuals in the field of information and communication technology, specifically in the domain of blockchain technology. It involves recruiting and leveraging the expertise of professionals with specialized knowledge and experience in blockchain technology. By engaging these experts, organizations can benefit from their deep understanding of blockchain principles, best practices, and implementation strategies.	Dadkhah et al., (2022)

4.3. Causal loop diagram

Figure 3 shows the causal loop diagram after determining dynamic hypotheses and identifying the model's indigenous and exogenous variables.

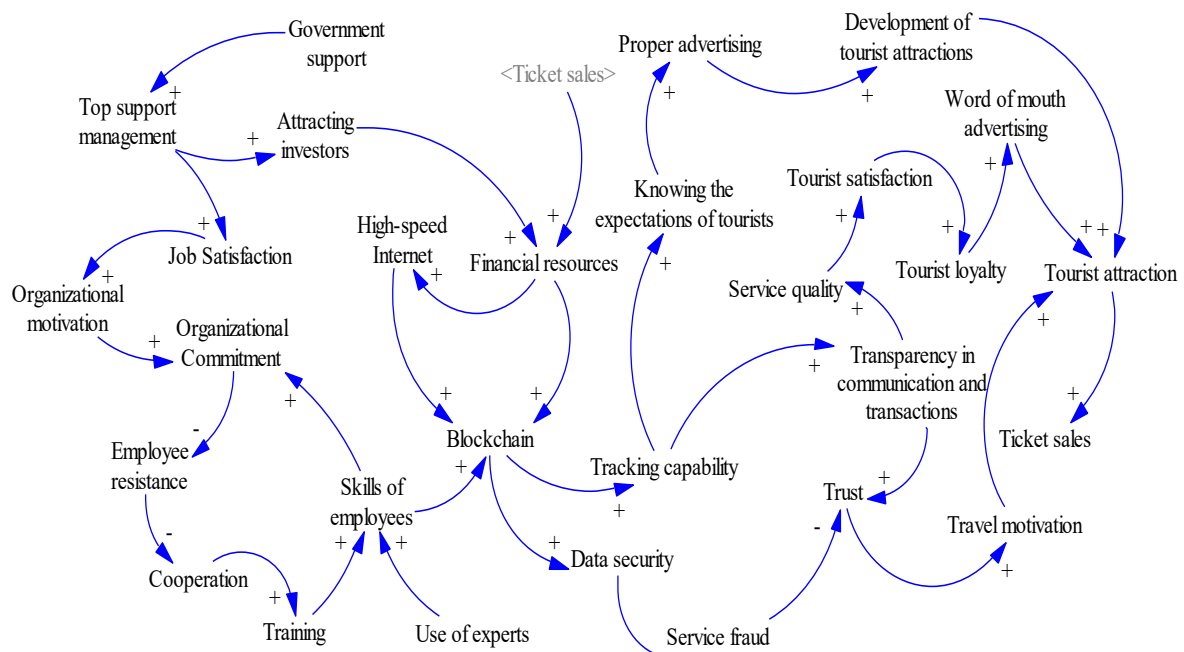


Figure 3. Causal loop diagram

Several feedback loops have been established in the causal loop diagram, which are examined below.

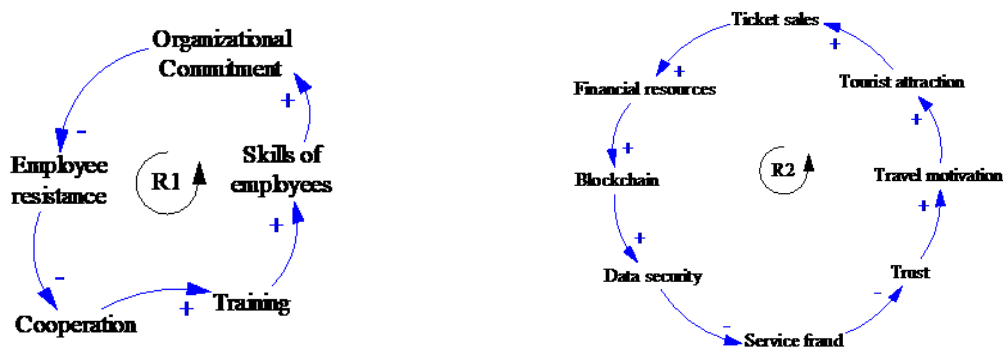


Figure 4. Feedback loops

As depicted in Figure 4 (left), a positive feedback loop is established. Employees' organizational commitment to Isfahan's tourism travel agencies diminishes their resistance to adopting blockchain technology. Minimizing employee resistance enhances their cooperation in learning and training for utilizing blockchain technology. Augmenting employees' training and learning duration elevates their proficiency and expertise in blockchain technology. Heightening employees' knowledge and skills and their awareness of the benefits associated with blockchain technology amplifies their motivation and organizational commitment to their workplace.

A positive feedback loop is illustrated in Figure 4 (right). Implementing encryption algorithms within the blockchain technology platform in Isfahan's tourism travel agencies enhances the security of tourist-related data, such as transactions, identities, and personal information. The improved security of tourist data reduces fraud, impersonation, and misuse of personal information. Decreasing fraud and fraudulent activities elevates trust and motivates tourists visiting Isfahan. Heightened tourist motivation leads to increased visitors attracted to Isfahan and the sales of travel tickets to the city. Ultimately, this results in a rise in available financial resources and consequently promotes utilizing blockchain technology through increased funding allocation.

#### 4.4. Stock and flow diagram

After creating the causal loop diagram, the stock and flow diagram are developed by establishing relationships and mathematical equations among the variables under investigation. In the appendix, we outline several key relationships among variables in the current research. The stock and flow diagram are drawn in Figure 5.

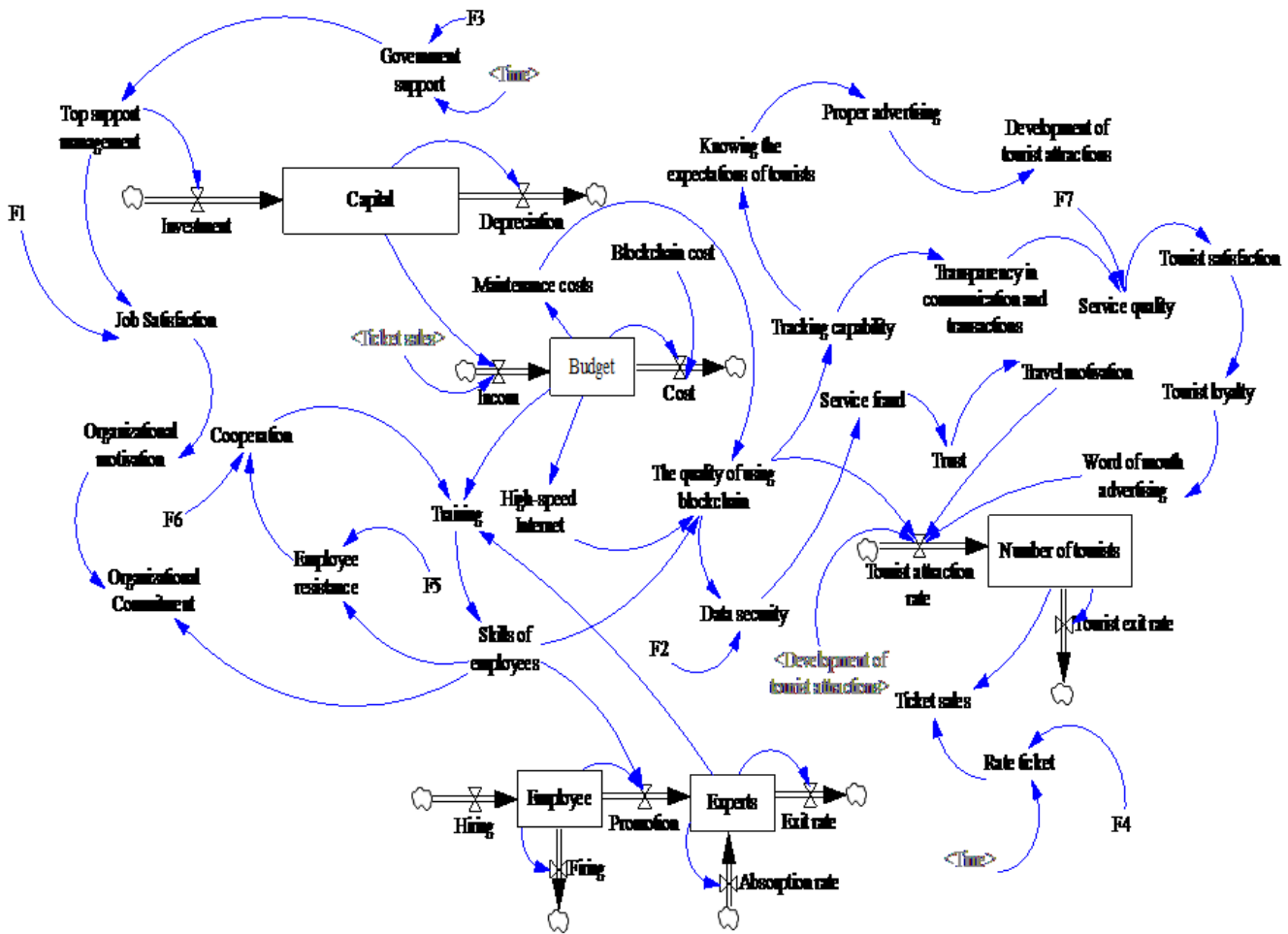


Figure 5. Stock and flow diagram

As shown in Figure 5, the stock and flow diagram comprises 44 variables, of which 5 are stocks, 10 are flows, and 29 are auxiliary variables. Stock and flow variables describe the current state of a system and can be quantified or measured at a specific moment. [Sterman, \(2002\)](#) suggests that stock and flow variables are typically quantitative. Based on those above, the variables examined in this research, such as capital, budget, number of tourists, employees, and experts, can be directly counted or measured at any given time. Furthermore, these variables change input and output flows. It is worth noting that the stock and flow variables considered in this research have received validation from experts. For the simulation of this study, a ten-year time horizon was considered in 12-month intervals.

### 5. Model validation

The model's validation process is conducted in three distinct phases.



### 5.1. Model structure evaluation test

The model structure evaluation test ensures that the structure of the designed model is consistent with existing knowledge. This study approved and designed the model structure based on the research background and the opinions of academic experts, managers, and tourism experts.

### 5.2. Parameter evaluation test

The parameter evaluation test ensures that the values assigned to the variables match their actual values. Since the variables in this study were derived from the research field, relevant literature, documents, records of 15 travel agencies in Isfahan, and expert opinions, the values provided in the relevant documents and research are consistent.

### 5.3. The limit condition test

This test determines whether the model behaves logically under extreme conditions. To this end, the value of one of the factors affecting the implementation of blockchain technology and its application in travel agencies in Isfahan in the model is driven towards zero, and the behavior of other factors is investigated. If the behavior of other factors is logical, this test is accepted and approved. In this study, the income variable was driven towards zero, and the behavior of some of the variables affected by it was investigated, as shown in Figure 6.

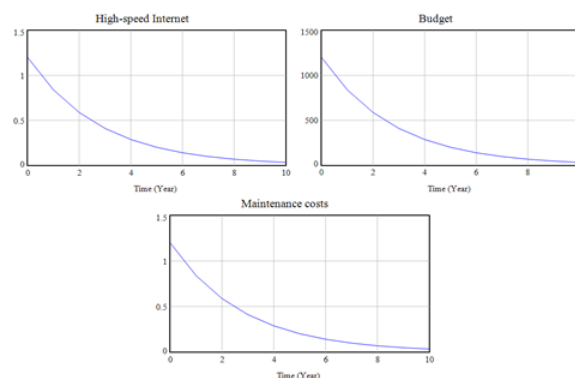


Figure 6. Model testing and validation

As shown in Figure 6, as the income approaches zero, the variables of broadband internet, budget, and maintenance costs will move towards zero.

### 5.4. Behavior reproduction test

This test will compare the simulation results with actual data to verify the correctness of the model's behavior. The figures' findings demonstrate how well the researched variable may be replicated. The results are shown in Figure 7.

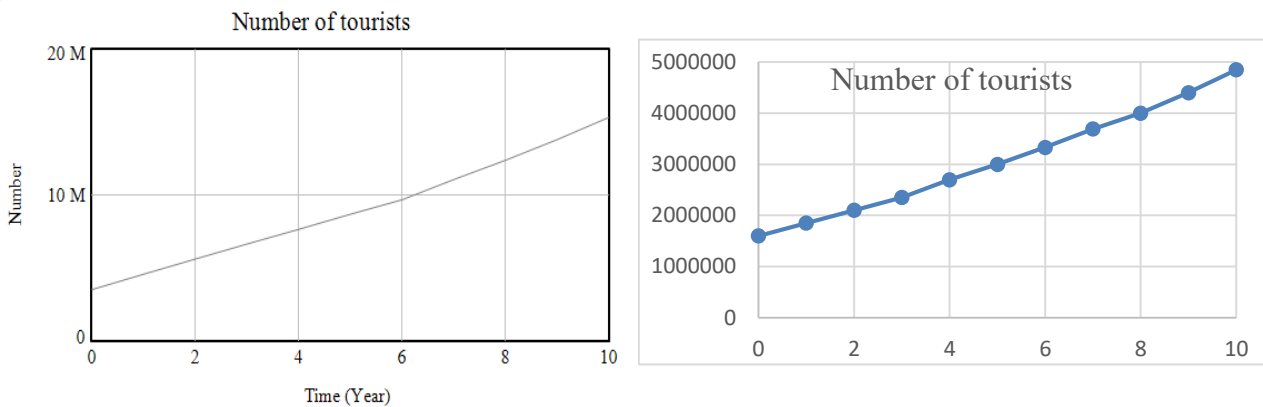


Figure 7. Comparison test with reference behavior

## 6. Simulation results

In this section, the simulation of the behavior of the key variables affecting the implementation of blockchain and its application in travel agencies in Isfahan is investigated.

### 6.1. Implementation and evaluation of policies

This section investigated the results of the simulation and analysis of three scenarios. In this study, three scenarios were evaluated. The first scenario investigated the increase in budget allocation to education and its effect on other key model variables. In the second scenario, attracting capital and increasing investment in technological infrastructure, including maintaining blockchain technology and broadband internet, were evaluated. The third scenario investigated the effect of simultaneously increasing the budget allocated to education, attracting capital, and increasing investment.

#### 6.1.1. The policy of increasing the amount of investment in the tourism sector

Figure 8 shows the behavior of the key variables affecting the implementation and application of blockchain technology in the tourism supply chain of travel agencies in Isfahan when the budget allocation is increased.

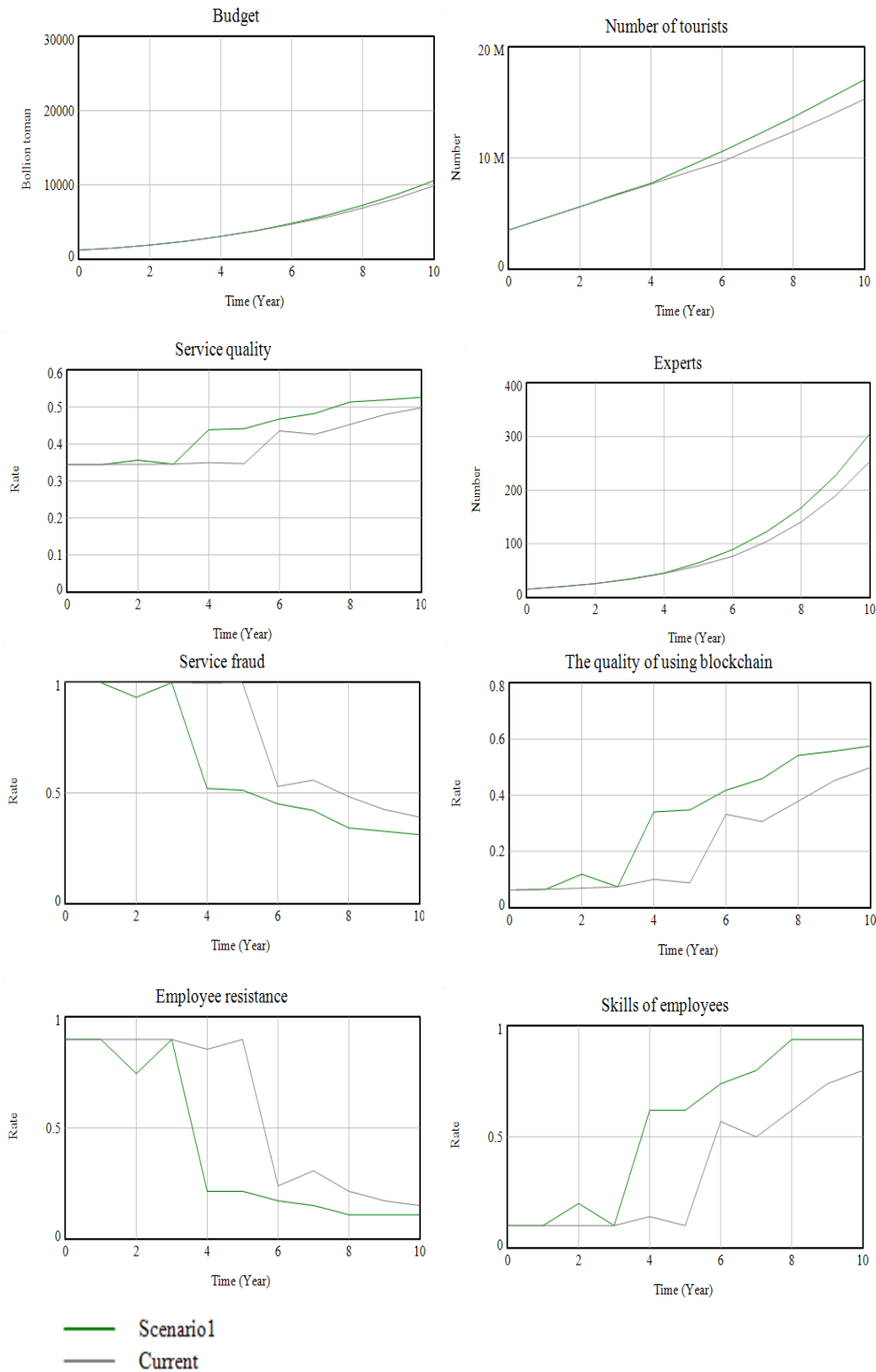


Figure 8. The results of the policy of increasing budget allocation to training

As shown in Figure 8, increasing the budget allocated to education will significantly improve the number of experts in this field and the quality of use of blockchain technology. In addition, employee skills will reach its maximum level in the fifth year. The number of tourists will also change in an increasing trend. The budget amount will change with a smaller slope and an increased budget allocation to education. Employee resistance to forgery and fraud in services provided to tourists will also change in a fluctuating manner in the early stages of the simulation and will decrease significantly over time. By increasing the budget allocated to education for the implementation of blockchain technology, the quality of services provided to tourists exhibits a gradual change with a low slope and fluctuates over time. Specifically, during the middle of the simulation period, the service quality experienced a decline followed by an increase. The fluctuating pattern in service quality is attributed to the evolving nature of innovation in utilizing blockchain technology over time. Despite the increase in budget allocated to employee training, the quality of utilizing blockchain technology also displays fluctuations, particularly in the initial years. The fluctuating behavior of blockchain utilization quality can be attributed to factors such as information and communication technology infrastructure and the time-consuming learning process for employees when adapting to blockchain technology.

#### *6.1.2. The policy of increasing capital attraction and allocating funds to technology infrastructure*

Figure 9 shows the behavior of the key variables affecting the implementation and application of blockchain technology in the tourism supply chain of travel agencies in Isfahan, focusing on attracting capital and increasing investment in technological infrastructure.

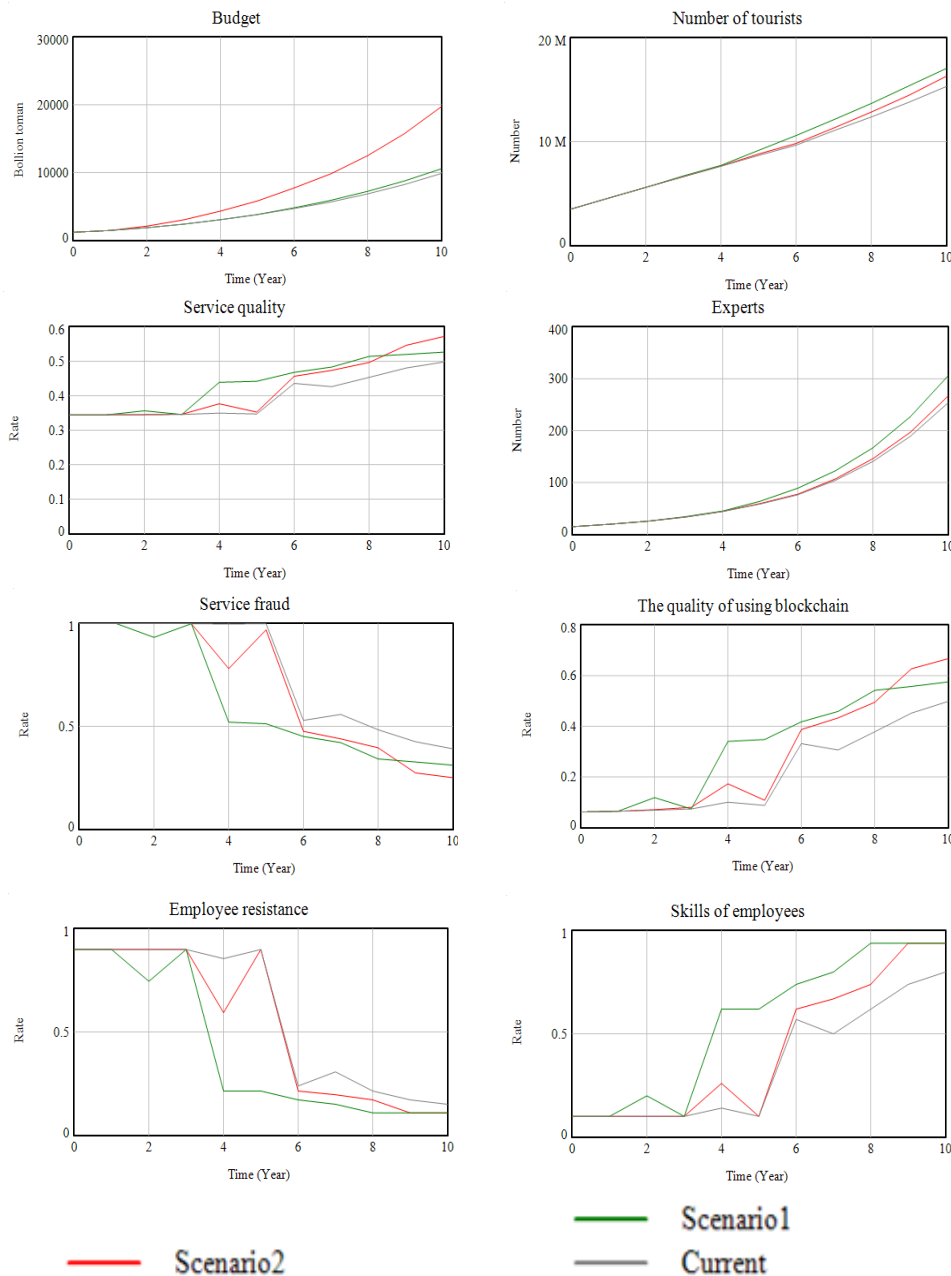


Figure 9. The results of the policy of increasing capital attraction and allocating funds to technology infrastructure

As shown in Figure 9, by attracting capital and increasing investment in technological infrastructure, the number of tourists attracted, experts in the field of blockchain technology, and budget will grow exponentially and with a significant slope. Also, with attracting capital and increasing investment in technological infrastructure, employee resistance, forgery, and fraud in the services provided will decrease significantly from about the third year. Employee skills and the quality of use of blockchain technology and services will also grow significantly from the third year of the simulation period.

6.1.3. *The policy of increasing budget allocation to education and attracting capital and increasing investment in technology infrastructure*

Figure 10 shows the behavior of the key variables affecting the implementation of blockchain technology and its application in travel agencies in Isfahan when the budget allocated to education is increased, the amount of investment from investors is increased, and the budget is allocated to technological infrastructure.

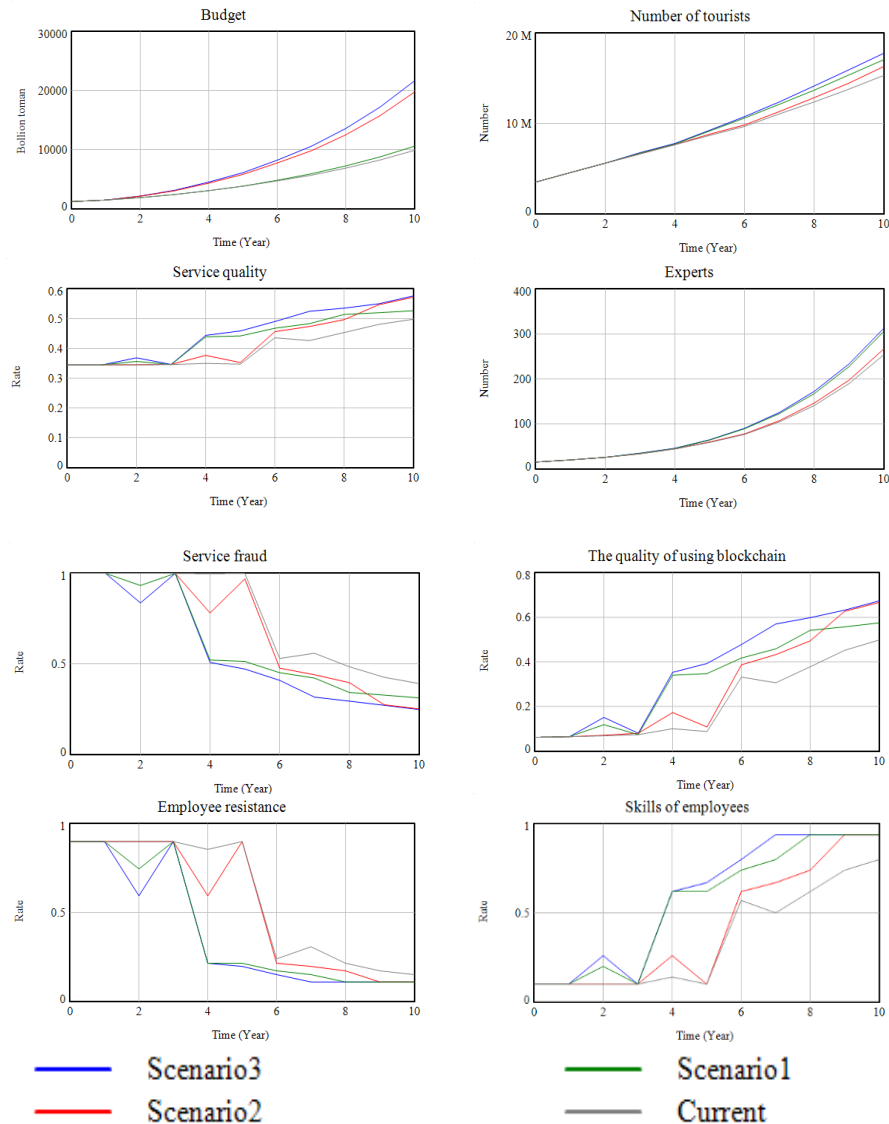


Figure 10. The result of the policy of increasing budget allocation to education and attracting capital and increasing investment in technology infrastructure

As shown in Figure 10, with the simultaneous increase in the budget allocated to education, attracting capital, and increasing investment in technological infrastructure, the number of tourists attracted, budgeted, and experts in the field of blockchain technology will grow significantly. Also, the level of changes in employee resistance, forgery, and fraud in services

provided to tourists will fluctuate in the early years and decrease significantly over time. On the other hand, the number of variables, such as the quality of blockchain use, employee skills, and services, will change increasingly and increase to a certain extent.

## 7. Discussion

The tourism industry plays a significant role in the development of deprived areas and the economic, cultural, and social progress of different societies. Given the potential in the tourism industry, the number of domestic and international tourists attracted to different cities of the country, including Isfahan, is far from the desired level for several reasons, including the mismatch of the quality of services provided with the needs and expectations of tourists, the management of tourists' identities and the protection of personal information, the lack of sufficient knowledge of tourist attractions among tourists, the complexity and time-consuming nature of the reservation process. In recent years, the service and manufacturing industries have also made significant progress with the development and progress of information and communication technologies. Therefore, new technologies, including blockchain technology, can transform the tourism industry and improve its performance.

The purpose of this study is to present a simulation model for implementing and applying blockchain technology in travel agencies in Isfahan. This study identified the factors affecting the implementation and application of blockchain technology in the tourism industry based on the literature and research background. In the continuation, the identified factors were confirmed based on the opinions of academic experts, managers, and experts specializing in tourism. In continuation, using the system dynamics approach, the model of the implementation and application of blockchain technology in travel agencies in Isfahan was investigated.

The simulation of system dynamics in this research showed that allocating financial resources, developing technological infrastructure, and the knowledge and skills of employees are among the most effective factors in implementing blockchain technology as best as possible. The research is consistent with the findings of the studies conducted by (Ratna et al., 2024). Due to the lack of sufficient skills and knowledge of employees and their resistance to adopting blockchain technology, the quality of using it in the early years is unfavorable and will grow over time. By training employees and using experts specialized in blockchain technology, in addition to increasing the skills and abilities of tourism travel agencies in Isfahan, it is possible to reduce their resistance to adopting blockchain technology. In other words, with the increase in the knowledge and skills of employees, their understanding of the benefits and benefits of

using blockchain technology will increase, and their possible resistance to accepting this technology will decrease. Also, the results of this research showed that if blockchain technology is established, the quality of services provided to tourists will improve for various reasons, including improving the level of security of tourists' personal information and knowing their expectations and needs through sharing. The experiences of tourists in the context of blockchain technology will improve the facilitation of transactions and reservations of accommodation and hotels, transparency in prices, and a better understanding of the matching of quality and price provided by travel agencies.

It should be noted that due to the time-consuming process of fully deploying blockchain technology and the quality of its use, the quality of services grew with a slight slope in the early years. With the passage of time and the improvement of the quality of blockchain technology, the quality of service will also grow significantly. Tourist attractions and financial resources will grow significantly as the services provided by travel agencies in Isfahan improve. This research examines three scenarios to provide solutions for the best possible use of blockchain technology and its application in travel agencies. The findings from the first scenario showed that by allocating more funds to the training of employees, their skills and ability to use blockchain technology in the early years grew significantly. The ten-year simulation will reach its maximum in the fifth year of the course. With the increase in the skill level and ability of the employees, their resistance to the adoption of blockchain technology will decrease significantly in the initial years. It will reach its minimum in the fifth year of the simulation period. The results of this section showed that the employees' resistance has decreased to a certain extent and will not reach zero. Also, by improving the quality of blockchain technology, fraud and forgery in the services provided to tourists will decrease over time, which aligns with the findings of audio studies by [Banerji et al. \(2021\)](#). In addition, with the increase in budget allocation for staff training, the number of tourist attractions, budget, and experts in this field in travel agencies in Isfahan will grow significantly. Due to the better mastery of blockchain technology, the value of the various variables in this research will change with a slight slope in the early years and with a significant slope from the middle of the simulation period.

The findings from the second scenario showed that by attracting capital and allocating funds to information technology infrastructure, including high-speed Internet access and maintenance costs related to blockchain technology, the quality of using blockchain technology increased. It will be improved if this research finding is consistent with the findings of the studies conducted by [Nuryyev et al., 2020](#)). Other results obtained from the second scenario include:



- Increasing the amount of budget for tourism travel agencies in the city of Isfahan,
- Improving the quality of services provided to tourists,
- Increasing the rate of attracting tourists,
- Reducing the resistance of employees to accepting blockchain technology due to the development of technological infrastructure and facilitating the use of blockchain technology
- It is reducing fraud and forgery in the services provided

The results of the comparison of the two investigated scenarios showed that attracting capital and increasing investment will have a significant effect on the number of budget changes compared to the implementation of the first scenario (increasing budget allocation to education). Also, the change in the quality of blockchain use in the second scenario (budget allocation to the development of technological infrastructure) is greater than in the first scenario (increase in the budget allocation to education). In other words, the results of this section show that providing suitable infrastructure for the use of blockchain technology is a priority. Other results obtained from the comparison of the two scenarios include the significant effect of training on the development of employee's skills and the reduction of their resistance to accepting the use of blockchain technology in travel agencies in Isfahan to attract capital and increasing the amount invested in the development of technology infrastructure.

The findings from the third scenario showed that with the increase in budget allocation to education and capital attraction and the increase in investment in technology infrastructure, the quality of using blockchain technology will grow significantly compared to the implementation of the previous two scenarios. Also, employees' skills and knowledge will reach their maximum in a shorter period. Among the other results of this department the minimization of employee resistance and fraud in the services provided to tourists in a shorter period can be mentioned.

In general, the results of this research show that the use of blockchain technology will significantly affect tourist attractions and budgets. On the other hand, the results of this research showed that training employees, increasing their skill and knowledge level, and developing technology infrastructure are of particular importance in order to make better use of blockchain technology.

## 8. Conclusion

This research presents the simulation model for implementing and applying blockchain technology in travel agencies in Isfahan using the system dynamics approach. This study first identified the factors affecting the implementation and application of blockchain technology in the tourism industry. Then, they were approved by academic experts, managers, and experts in

the field of tourism. In the following, the causal loop diagram and the relationship between the identified factors were examined based on the design of dynamic hypotheses. Based on the causal loop diagram, a stock and flow diagram was designed, and quantitative relationships were established between the variables and factors affecting the implementation and users of blockchain technology in travel agencies in Isfahan. This research showed that implementing blockchain technology significantly increases the quality of tourism services, the amount of tourist attractions, and financial resources. According to the findings of this research regarding the effect of two factors, employees' skills, and information technology infrastructure, on the enhancement of the quality of using blockchain technology, it is recommended that future studies employ system dynamics simulation to investigate the dynamic interactions and mutual effects of these factors.

Furthermore, it is suggested that future research explore other factors that influence the adoption of blockchain technology in the tourism supply chain and present a wider range of models in this field. Additionally, it is recommended that the application of blockchain technology in various types of tourism, such as religious tourism, sea tourism, sports tourism, and others, be investigated in future research. Finally, it is suggested that the application of other technologies of the fourth industrial revolution, such as the Internet of Things, cyber-physical systems, and digital twins, in the tourism industry should be investigated in future research.

### Disclosure statement

No potential conflict of interest was reported by the author(s).

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## Appendix

- (01) Absorption rate= INTEGER (0.3\*Experts)  
Units: Dmnl
- (02) Blockchain cost= 0.27  
Units: Billion toman
- (03) Budget= INTEG (Incom-Cost)  
Units: Billion toman
- (04) Capital= INTEG (Investment-Depreciation)  
Units: Billion toman
- (05) Cooperation= (DELAY II(F6(Employee resistance), 0.5, 0.8))\*(0.4)  
Units: Dmnl
- (06) Cost=Blockchain cost+0.3\*Budget  
Units: Billion toman
- (07) Data security= F2(The quality of using blockchain)  
Units: Dmnl
- (08) Depreciation=0.02\*Capital  
Units: Billion toman
- (09) Development of tourist attractions= 0.85\*Proper advertising  
Units: \*\* Dmnl \*\*
- (10) Employee= INTEG (Hiring-Firing-Promotion)  
Units: Number
- (11) Employee resistance= F5(Skills of employees)  
Units: Dmnl
- (12) Exit rate= 0.001\*Experts  
Units: Dmnl
- (13) Experts= INTEG (Absorption rate+Promotion-Exit rate)  
Units: Number
- (15) Firing= 0.01\*Employee  
Units: Dmnl
- (16) Government support= F3(Time)  
Units: Dmnl
- (17) "High-speed Internet"= 0.001\*Budget  
Units: Billion toman
- (18) Incom=Ticket sales+Capital  
Units: Billion toman
- (19) Investment= 100\*Top support management

Units: \*\* Billion toman \*\*

(20) Job Satisfaction= F1(Top support management)

Units: Dmnl

(21) Knowing the expectations of tourists= 0.75\*Tracking capability

Units: Billion toman

(22) Maintenance costs= 0.001\*Budget

Units: Billion toman

(23) Number of tourists= INTEG (Tourist attraction rate-Tourist exit rate)

Units: Number

(24) Organizational Commitment= (0.75\*Organizational motivation)+(0.6\*Skills of employees)

Units: Dmnl

(25) Organizational motivation= 0.8\*Job Satisfaction

Units: Dmnl

(26) Promotion= 0.01\*Employee\*Skills of employees

Units: Dmnl

(27) Proper advertising= 0.7\*Knowing the expectations of tourists

Units: Dmnl

(28) Rate ticket= F4(Time)

Units: Dmnl

(29) Service fraud= 1/Data security\*0.1

Units: Dmnl

(30) Service quality= 0.3+F7(Transparency in communication and transactions)

Units: Dmnl

(31) Skills of employees= IF THEN ELSE(Training<0.03, 0.1, IF THEN ELSE(Training>0.03:AND:Training <=0.04, 0.14, IF THEN ELSE(Training>0.04:AND:Training<=0.05, 0.2, IF THEN ELSE (Training>0.05:AND:Training<=0.06, 0.26, IF THEN ELSE(Training>0.06:AND:Training <=0.07, 0.33, IF THEN ELSE(Training>0.07:AND:Training<=0.08, 0.41, IF THEN ELSE (Training>0.08:AND:Training<=0.09, 0.5, IF THEN ELSE(Training>0.09:AND:Training <=0.1, 0.57, IF THEN ELSE(Training>0.1:AND:Training<=0.2, 0.62, IF THEN ELSE (Training>0.2:AND:Training<=0.3, 0.67, IF THEN ELSE(Training>0.3:AND:Training <=0.5, 0.74, IF THEN ELSE(Training>0.5:AND:Training<=0.7, 0.8, IF THEN ELSE (Training>0.7:AND:Training<=0.1, 0.86, 0.94))))))))))

Units: Dmnl

(32) The quality of using blockchain= ("High-speed Internet"\*0.1+Maintenance costs\*0.1+10\*Skills of employees)

Units: Dmnl

$$(33) \text{ Ticket sales} = \text{Number of tourists} * \text{Rate ticket} * 0.1$$

Units: Billion toman

$$(34) \text{ Top support management} = 0.6 * \text{Government support}$$

Units: Dmnl

$$(35) \text{ Tourist attraction rate} = ((\text{Development of tourist attractions} * 1e+06) + (\text{Travel motivation} * 1e+06) + (1e+06 * \text{Word of mouth advertising})) + (\text{The quality of using blockchain} * 1e+06)$$

Units: \*\* Dmnl \*\*

$$(36) \text{ Tourist exit rate} = 0.02 * \text{Number of tourists}$$

Units: \*\* Dmnl \*\*

$$(37) \text{ Tourist loyalty} = 0.8 * \text{Tourist satisfaction}$$

Units: Dmnl

$$(38) \text{ Tourist satisfaction} = 0.2 + 0.85 * \text{Service quality}$$

Units: Dmnl

$$(39) \text{ Tracking capability} = 0.8 * \text{The quality of using blockchain}$$

Units: Dmnl

$$(40) \text{ Training} = (\text{Cooperation}) * 0.001 * \text{Budget} * (10 * \text{Experts} * 0.0003)$$

Units: Billion toman

$$(41) \text{ Transparency in communication and transactions} = 0.2 + 0.7 * \text{Tracking capability}$$

Units: Dmnl

$$(42) \text{ Travel motivation} = 0.3 + \text{Trust} * 0.5$$

Units: Dmnl

$$(43) \text{ Trust} = 1 / \text{Service fraud} * 0.1$$

Units: Dmnl

$$(44) \text{ Word of mouth advertising} = 0.4 + 0.75 * \text{Tourist loyalty}$$

Units: Dmnl