A Discussion on Finding the Opportunity of Intelligent Transportation Systems (ITS) Implementation in Peru Based on Economics

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***Abstract*— The means of transport are major points in a country's infrastructure and economic development, so it is important to analyse its methods and obstacles for further interventions. This study aims to discuss the Opportunity of Intelligent Transportation Systems (ITS) implementation in Peru based on the Economy. The study was subdivided into parts. In the first part briefly reviewed the system of transportation in other countries in comparison with Peru. It further discusses the technologies influencing ITS development, the barriers to ITS implementation as well as Strategies for Implementing ITS in Peru. Three research questions guided that study and an expo facto research design was adopted as the study utilizes secondary data. The study does not consider human participation, rather, kinds of literature and reports of financial status and projections were collected, collated, utilized, and analysed for the study. The study revealed that the worldwide ITS issues is more controlled that that witnessed in Peru as the issue fluctuates between 0 and 100%. Peru has a promising economy which ITS will be implemented with ease. It is concluded that a comprehensive analysis taking into account a range of economic, social, and technological factors will be required to fully understand the potential and challenges of ITS implementation in the country.**

Keywords*— *opportunity, intelligent transportation systems, ITS implementation in Peru, economics

I. INTRODUCTION

Transportation systems play a crucial role in a nation's competitiveness. The system ensures adequate and equitable movement of goods, people, and information and is essential for the growth and development of the economy [1]. By providing reliable and efficient modes of transportation, a nation can increase its competitiveness in international trade, facilitating the movement of goods, and attracting foreign investment. Therefore productivity will increase including investment attractiveness. A well-designed transportation system can stimulate economic growth by providing improved access to markets, resources, and labor, and by reducing the costs of transportation and logistics [2]. Transportation systems are an essential component of a nation's competitiveness and play a crucial role in shaping its economic and social development.

Many countries are discussing Intelligent Transportation Systems (ITS) as a means of improving their transportation systems [3]-[6]. ITS is a rapidly evolving field that is of growing interest to governments, transportation agencies, and private sector organizations around the world. According to Ref. [7], there is a growing recognition of the potential of ITS to improve road safety, reduce congestion, improve air quality, and support the transition to more sustainable transportation systems. As a result, ITS has become a topic of discussion at national and international forums, including conferences, workshops, and research collaborations. Governments and transportation agencies are exploring the potential of ITS to support their transportation planning and policy goals, and private sector organizations are developing new technologies and solutions to meet the needs of the market [8],[9]. The interest in ITS is growing, and the discussions around ITS are likely to continue to increase as countries seek to find solutions to the transportation challenges they face.

Intelligent Transportation Systems (ITS) offer a wide range of benefits for transportation systems and the communities they serve. Some of the key benefits of ITS according to Ref. [10],[11] include: improved road safety, reduced congestion, increased efficiency, improved environmental performance, enhanced mobility, better public transport, and improved quality of life. According to Ref. [12], there are many others that can be realized depending on the specific ITS technologies and applications implemented in a particular transportation system. Overall, ITS has the potential to greatly improve transportation systems and the communities they serve.

In Latin America, countries such as Brazil, Mexico, Colombia and Peru are among those investing in ITS implementation. For example, in Brazil, the government is investing in ITS technologies such as electronic toll collection and traffic management systems to reduce congestion, improve safety, and increase the efficiency of the transportation network [13],[14]. Mexico is also investing in ITS technologies, including intelligent transport management systems and advanced traveler information systems, to improve the efficiency of the transportation network and enhance the overall travel experience for citizens [15]. This development is parallel to the global trend in which countries recognize the importance of ITS and are investing in its implementation to improve the efficiency and sustainability of their transportation systems and to enhance the quality of life for their citizens [1],[16],[17]. Peru is known for its rich history and cultural heritage, including the ancient Inca civilization, and its diverse natural landscapes, ranging from

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the Andes Mountains to the Amazon rainforest. This country also has been developing and implementing this technology.

A. Technologies influencing Intelligent Transportation Systems (ITS) Development

In the conclusions of Ref. [18] and Ref. [19], "Smart Transportation System" and "Intelligent Transportation System" are used interchangeably to describe a system that integrates advanced technologies and services to improve transportation efficiency, safety, and sustainability. However, "Intelligent Transportation System" is the more commonly used term and is widely recognized by the transportation industry and government organizations [20]. Ref. [7] asserted that the term "Smart Transportation System" is sometimes used more broadly to encompass not just advanced technology, but also planning, policy, and management practices that contribute to a more integrated and efficient transportation system. There are several technologies that are influencing the development of Intelligent Transportation Systems, this include:

- Internet of Things (IoT): According to Ref. [1], the integration of Internet of Things (IoT) technologies is a key enabler of ITS. IoT allows the creation of interconnected systems that can share data in real-time, enabling advanced transportation management and control systems.
- Artificial Intelligence (AI): Artificial intelligence (AI) is increasingly being used in ITS to provide advanced decision-making capabilities, such as real-time traffic management, predictive maintenance, and autonomous vehicles [21].
- Big Data: Big data analytics is playing an increasingly important role in ITS, enabling the collection and analysis of massive amounts of data from multiple sources, such as traffic sensors, GPS, and social media, to provide real-time information about transportation systems [22],[23].
- Cloud Computing: Cloud computing is increasingly being used to support ITS, enabling real-time data processing and storage, as well as the development and deployment of advanced ITS applications [24].
- 5G Network: The emergence of 5G networks is expected to play a key role in the development of ITS, providing the high-speed connectivity and low latency required for real-time data transfer and communication between vehicles and infrastructure [25].

These are some of the key technologies influencing the development of ITS, and there are many others that are also contributing to its advancement. The rapid evolution of these technologies is driving the development of new ITS applications and services, which have the potential to transform transportation systems and improve the lives of millions of people around the world.

ITS is currently implemented in various forms in many countries around the world. Some of the common applications and technologies used in ITS include:

- Advanced Traffic Management Systems (ATMS): These systems use real-time traffic data to monitor traffic flow and control traffic signals, reducing congestion and improving safety [19].
- Advanced Traveller Information Systems (ATIS): These systems provide real-time information to drivers about traffic conditions, road closures, accidents, and detours, helping drivers make informed decisions and reducing travel time [26].
- Automated Vehicle Location (AVL) Systems: These systems use GPS and other technologies to track the location and status of public transportation vehicles, allowing transit agencies to improve scheduling and provide real-time information to riders [27].
- Electronic Toll Collection (ETC) Systems: These systems allow drivers to pay tolls electronically, reducing the need for toll booths and improving the efficiency of toll collection [28].
- Connected and Automated Vehicles (CAV): These vehicles use wireless communication and advanced technologies such as sensors, cameras, and artificial intelligence to improve safety, reduce congestion, and enhance mobility [29].

These are just a few examples of ITS implementations, and the technology continues to evolve and expand as new developments emerge. The goal of ITS is to create a safer, more efficient, and more sustainable transportation system, and to improve the overall quality of life for people and communities.

B. The barriers to Implementing ITS

The barriers to implementing ITS in this paper is viewed from two different perspectives which include: Government perspective and Societal perspective

From a government perspective, the barriers to implementing ITS include:

- Funding: ITS projects often require significant financial resources for research and development, infrastructure upgrades, and technology deployments, and governments may struggle to secure the funding necessary to implement these systems [30].
- Regulation: There may be legal and regulatory barriers to the implementation of ITS, such as concerns over privacy, data security, and liability. Governments may need to develop and update regulations to address these issues [31].
- Coordination: ITS often involves coordination between multiple government agencies and departments, and it can be challenging to align these different organizations and stakeholders around a common vision and strategy for ITS [33].

From a societal perspective, the barriers to implementing ITS include:

- Public Awareness: Many people may not be aware of ITS and its benefits, and may be resistant to changes in the transportation system that may affect their daily lives.
- User Adoption: ITS often requires changes in user behavior, such as using new technologies or adopting new transportation options, and people may be reluctant to adopt these changes.
- Technical Challenges: ITS involves the integration of advanced technologies and systems, and there may be

technical challenges in implementing these systems effectively and efficiently.

- Societal Acceptance: There may be concerns about the impact of ITS on employment, privacy, and other societal issues, and it is important to address these concerns and engage with stakeholders to ensure the successful implementation of ITS.

These are just a few of the barriers to implementing ITS, and addressing these challenges will be critical to the success of these systems. Governments and other stakeholders will need to work together to develop solutions that overcome these barriers and ensure the effective implementation of ITS.

C. *Strategies for Implementing ITS in Peru*

Based on the potential of financial resources and capacity to implement ITS, there are several strategies that could be considered to make this a reality. The following strategies as suggested by Ref. [33]-[35] are outlined as follows:

- Public-Private Partnerships: The government could partner with private companies to co-finance and implement ITS projects.
- Prioritization: The government could prioritize ITS projects and allocate resources accordingly, taking into consideration the benefits and potential impact on the transportation system and the wider economy.
- Stakeholder Engagement: The government could engage with stakeholders, including the public, businesses, and transportation organizations, to build support and understanding for ITS and ensure that the needs and priorities of the country are taken into account.
- Research and Development: The government could invest in research and development to advance the technology and knowledge required for ITS implementation.

II. Research Problem and Objectives

The growing need to improve mobility and road safety has prompted emerging countries to make considerable improvements to their infrastructure, particularly when it comes to transportation infrastructure modernisation. The experience and problems of implementing intelligent transportation systems (ITS) in Peru, a developing country in western South America, are presented in this study. Several aspects of ITS have been developed in the country and are actively being implemented. Will the introduction of ITS help the Peruvian economy grow? While assessing the prospect of deploying Intelligent Transportation Systems (ITS) in Peru, it is critical to analyze a variety of economic, social, and technological variables, as well as the country's distinct transportation demands and challenges. It is against this backdrop that this paper discussion the Opportunity of Intelligent Transportation Systems (ITS) implementation in Peru based on Economics.

The research questions are:

- What is the trend of ITS issue in Peru in comparison with worldwide?
- What is the impact of ITS from Economics Perspective on:
    - Peru's GDP Growth?
    - Peru's Gross Fixed Capital Formation?
    - Peru's FOREIGN Direct Investment?
    - Peru's balance trade?
- What is the impact of ITS to the government and people of Peru?

III. Method

A. *Research Design*

The study adopted expo facto research designs. Ex post facto study is a category of research design in which the investigation starts after the fact has occurred without interference from the researcher [36],[37]. The design enables the researchers to explore the opportunity for implementing Intelligent Transportation Systems (ITS) based on Peru's Economics without manipulation. A literature review of peer-reviewed articles, reports, and news articles relating to ITS and its implementation in other clients. Secondary data was majorly used to answer and analysed the research questions. The data were majorly sourced from works of literature and government financial reports from 2018 to 2022.

B. *Participants*

The study does not consider human participation, rather, kinds of literature and reports of financial status and projections were collected, collated, utilized and analysed for the study.

C. *Procedure*

The literatures examined were grouped into themes which saw the presentation of the results in tables and graph. The data collection was between 2018 and 2022 and to some extent 2023 which form the projection aspect of the study and processed for statistical analysis. The data was analysed using Graph Pad Prism (v8.4.2).

IV. Results and Discussions

A. *Research Question One? What is the trend of ITS issue in Peru in comparison with worldwide?*

Fig. 1 expresses the trend of ITS issues in Peru in comparison with what is obtainable worldwide. From Fig. 1, it is evident that Peru has more ITS implementation issues when compared worldwide as the year 2019 witnessed the highest implantation issues with a 100% issues recorded whereas the worldwide issue noticed in 2019 was about 65%.

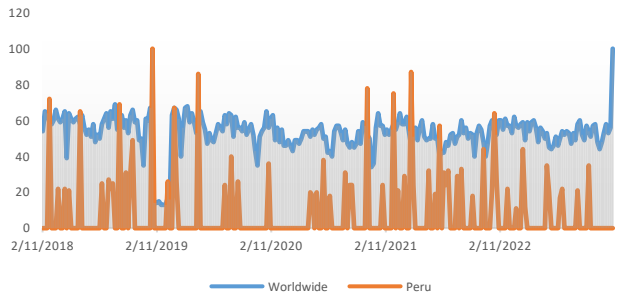

Fig. 1. The trend of ITS issue comparing worldwide and Peru

However, the ITS issues in Peru declined by 60% in 2022 whereas the worldwide issues escalated to about 100%. It could be deduced from Figure 1 that the world wide ITS issues is more controlled that that witnessed in Peru as the issue fluctuate between 0 and 100%.

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B. *Research Question 2: What is the impact of ITS from Economics Perspective on Peru's Gross Domestic Product (GDP)?*

The Gross Domestic Product (GDP) of a country is an important factor to consider when evaluating its ability to implement ITS. In general, a higher GDP can indicate greater financial resources and capacity to invest in transportation infrastructure and technology.

TABLE I. CURRENT STATUS OF PERU'S GDP (HTTPS://TRADINGECONOMICS.COM/)

Markets	**Actual**	**Q1/23**	**Q2/23**	**Q3/23**	**Q4/23**
Currency	3.82	3.87	3.93	3.99	4.05
Stock Market (points)	21695.6	18258	18004	17754	17506
Government Bond 10Y (%)	8.01	7.99	8.12	8.24	8.37
Overview	**Actual**	**Q1/23**	**Q2/23**	**Q3/23**	**Q4/23**
GDP Growth Rate (%)	3.5	0.9	1.1	0.7	1.5
GDP Annual Growth Rate (%)	1.7	2.7	2.3	2.1	2.5
Unemployment Rate (%)	7.1	7.3	7.5	7.8	8
Inflation Rate (%)	8.66	6.97	4.68	2.84	2.5
Interest Rate (%)	7.75	8	8	8	6.5
Balance of Trade (USD Million)	1476.9	-50	105	351	803
Current Account (USD Million)	-3661.8	-4506	-3926	-3930	-3167
Current Account to GDP (% of GDP)	-2.9				-1.5
Government Debt to GDP (% of GDP)	36				37
Government Budget (% of GDP)	-2.6				-2
Business Confidence (points)	42.4	47	49		50
Corporate Tax Rate (%)	29.5				29.5
Personal Income Tax Rate (%)	30				30

The nation Peru has a growing economy, and its GDP has been increasing in recent years. See Fig. 2. However, the specific details of the country's economic situation, such as its level of debt, budget constraints, and the allocation of resources to different sectors, will impact its ability to implement ITS.

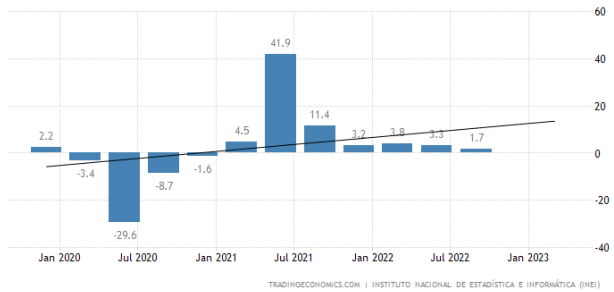

Fig. 2. Gross Domestic Product (GDP) Status of Peru's as at January, 2023 (https://tradingeconomics.com/)

Considering the Gross Fixed Capital Formation (GFCF) of Peru is of importance when discussing the implantation of ITS. GFCF is one of the few strategies that could be considered to support the implementation of ITS in Peru. See Fig. 3. The specific approach will depend on the country's specific economic situation, transportation needs, and other factors. Ultimately, the success of ITS implementation will depend on the ability of the government and other stakeholders to work together to prioritize and allocate resources, engage with the public and other stakeholders, and develop and implement effective and efficient transportation solutions.

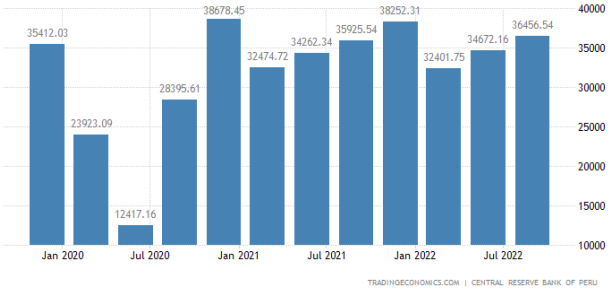

Fig. 3. Gross Fixed Capital Formation (https://tradingeconomics.com/)

Foreign Direct Investment (FDI) is an important source of financing for the development of transportation infrastructure and technology. A higher level of FDI can indicate greater foreign interest in investing in the country and its transportation sector, which could support the implementation of Intelligent Transportation Systems (ITS). In the case of Peru, the FDI level of 2063.00 USD Million is relatively moderate, but still provides an opportunity for investment in transportation and technology. See. Fig. 4.

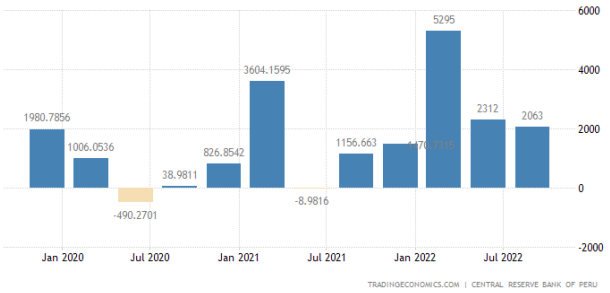

Fig. 4. Foreign Direct Investment (https://tradingeconomics.com/)

However, the success of ITS implementation will also depend on factors such as government policies and regulations, the availability of infrastructure and technology, and the overall level of support from the public and other stakeholders. Overall, while the FDI data provides a useful indicator of foreign interest in investing in Peru, it is only one of several factors to consider when evaluating the potential for ITS implementation in the country. A comprehensive analysis would also need to take into account other economic, social, and technological factors to fully understand the potential and challenges of ITS implementation in Peru.

The balance of trade is an important economic indicator, but it does not directly impact the possibility of implementing Intelligent Transportation Systems (ITS) in Peru. See Fig. 5. The balance of trade refers to the difference between a country's exports and imports, and can provide an indication of the country's overall economic health and competitiveness.

A favourable balance of trade, where exports are greater than imports, can provide a boost to the economy and provide additional resources for investment in various sectors, including transportation. However, the actual balance of trade is often subject to fluctuations based on various factors, such as changes in commodity prices, shifts in consumer demand, and economic and political uncertainties. In the case of Peru, the actual balance of trade for November and December was lower than the consensus forecast, indicating a lower level of

exports relative to imports. However, it is worth noting that these fluctuations are normal and do not necessarily reflect a long-term trend.

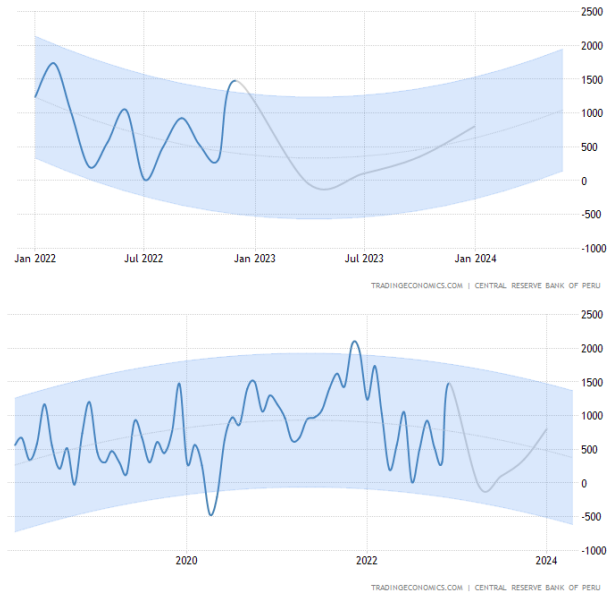

Fig. 5. Forecast of Peru Balance of Trade (https://tradingeconomics.com/)

C. *Research Question 3: What is the impact of ITS to the government and people of Peru?*

The implementation of Intelligent Transportation Systems (ITS) in Peru is likely to have an impact on the country and its people. The benefits of ITS include improved safety, reduced congestion, increased mobility, and more efficient use of resources, which can have a positive impact on the lives of Peruvian citizens. For example, a more efficient transportation system could lead to reduced travel times and increased accessibility to job opportunities, healthcare, and education. However, as with any new technology or infrastructure project, there may also be potential drawbacks. For example, the implementation of ITS may require significant investment and resources, which could have a direct impact on government spending and potentially limit funding for other important projects and initiatives. Additionally, there may be concerns about privacy and security related to the collection and use of data generated by ITS systems. The implementation of ITS in Peru is likely to have both positive and negative impacts, and it is important for the government and relevant stakeholders to carefully consider these factors as they plan and implement ITS initiatives. There are several barriers to the implementation of Intelligent Transportation Systems (ITS) from both government and societal perspectives.

It is generally believed that the success of ITS implementation depends on a number of factors, including public awareness, user adoption, and societal acceptance. In order for ITS to be successfully implemented in Peru, it will be important to engage with the public and other stakeholders to build support and understanding of the benefits of ITS. This may involve educating the public about ITS, addressing concerns and answering questions, and involving stakeholders in the design and implementation process. It will also be important to ensure that ITS is designed and implemented in a way that meets the needs and priorities of the Peruvian people and supports the country's transportation and development goals. This may involve considering the specific challenges and opportunities in the Peruvian context, and working to develop solutions that are tailored to the country's unique needs and circumstances. The success of ITS implementation in Peru will depend on the ability of the government and other stakeholders to effectively engage with the public, build support, and implement systems that meet the needs and priorities of the country and its people.

However, the success of ITS implementation in Peru will depend on a range of factors, including government policies, infrastructure and technology, public support, and the availability of financial resources. While a favorable balance of trade could support the economy and provide additional resources for investment in transportation, it is not a direct indicator of the potential for ITS implementation.

V. Conclusion

To determine the possibility of ITS implementation in Peru, it is important to consider a range of economic, social, and technological factors, as well as the specific needs and challenges of the country's transportation sector. This involves conducting a comprehensive analysis of the transportation system, engaging with stakeholders, and identifying and prioritizing potential ITS projects based on their potential impact and feasibility. While the GDP, GFCF, FDI and the Balance of Trade provides useful information about the economy, it is not the only factor to consider when evaluating the potential for ITS implementation in Peru. A comprehensive analysis taking into account a range of economic, social, and technological factors will be required to fully understand the potential and challenges of ITS implementation in the country.

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