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Central government role in road infrastructure development and economic growth in the form of future study: the case of Indonesia

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Abstract

Road infrastructure development in a country has been considered an important predictor of economic development and prosperity. Hence applying a systematic analysis approach, this study aims to project the future role of the central government in developing road infrastructure and its significance in the country's economic growth. The main data sources were the literature review and expert opinions in the form of self-administrative surveys and interviews. Besides, the Cross-impact Direct Influence (CDI) matrix was applied to formulate the questionnaire. For the data analysis purpose, MICMAC analysis and Scenario Wizard software were used. The MICMAC analysis results revealed the dominant role of 9 important/key variables in developing the Indonesian road infrastructure. Simultaneously 24 positive states of the important variables what identified via the Scenario-Wizard Method. Findings also depicted stronger consistency among the four scenarios. Whereas Scenario 1 showed the most ideal 9 key features related to Indonesia's road infrastructure developments with a high intensity of concentrating the efforts on planning road infrastructure development in big cities and use of smart and modern technology. Moreover, presenting a group of constructs for developing road infrastructure and resultant economic growth in the country, the current study adds value to the existing literature.

Keywords Scenario-based planning, Future study, Road infrastructure, Economy growth, Central government role

Introduction

For socio-economic development in a country, road infrastructure is important to be considered, which provides access to markets, jobs, and resources (Akpan and Morimoto 2022). For economies and governments all over the globe, road infrastructure is regarded as a key asset (Wagale and Singh 2021). Besides managing these key assets, there is a need for economic brands' cost-benefit analysis based on effective and efficient

decision-making. It further involves various exogenous constructs like climate change impact, environmental costs, social benefits, and tourism attraction benefits (An et al. 2021). Simultaneously, in developing countries context, it can be a challenge as well as can present a lot of opportunities. Whereas with proper planning, governments can substantially influence the development of the country by reducing the poverty level, enhancing resiliency, increasing household income, better health facilities, and education facilities, and enhancing market knowledge among investors (Schweikert et al. 2014).

Moreover, being a critical factor, climate change is anticipated to affect the emerging nations' existing and projected infrastructure more (Streletskiy et al. 2019). Research also shows that when toll roads are constructed,

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the overall region's economic growth is affected (Mejia et al. 2020). For instance, while constructing the toll roads, China spurred its economy, bringing valuable advances in remote areas and leveling the development system all over the country by exploiting the economic capacity (Meijer et al. 2018). Whereas other than climate changes and toll roads, researchers also highlighted the need to explore other factors influencing road infrastructure development, especially in emerging countries (Abdullah et al. 2021; Mhlanga 2021), which the current study aims to explore.

In addition, sound road infrastructure effectively reduced traffic congestion and social disparities in various big cities, including Europe. Hence, road infrastructure development is important for economic prosperity (Veizaj, Islami, and Maliqari 2021). Research also highlights the significance of the transportation system at the national, local, and regional levels for the economic development of a nation (Khanani et al. 2021). The central government can assess the road infrastructure development benefits to attain the required results of economic growth in the country (Liu et al. 2021). So, the significance of road infrastructure development in economic growth is that it efficiently and effectively facilitates transportation systems in the country (Mohamad et al., 2021). Besides, multiple factors such as resources, economic conditions, financing facilities, infrastructure development policies, population growth rate, etc., can be considered while developing the road infrastructure in a country (Horvat et al. 2021; Koval et al. 2021; Liu et al. 2021). Additionally, strategic planning at the central government level is important for developing the overall transportation system to enhance the living standards of a community linked with economic development (Du et al. 2021; Mansoor & Paul, 2022).

Simultaneously, although various attempts have been made to enhance the transportation infrastructure, in Indonesia, the transportation infrastructure is still inadequate to meet the requirements of an emerging economy (Mantoro 2021). Furthermore, low economic growth, hyperinflation, and lack of sustainable national income are among the main reasons for the less developed economy in Indonesia (Istanti 2021). There are many road congestion issues in Indonesian cities, along with the low national transport network scale (Zadry et al. 2022). Also, the number of vehicles on the roads is continuously increasing. The country's development of sound road infrastructure is further projected to lead the national sustainable development. Hence, infrastructure building is very important based on Indonesia's abundance of natural reserves (Hardjosoekarto and Lawang 2021; Nugroho et al. 2021). Researchers also highlighted a dire need to understand the factors influencing the transportation

road infrastructure development in Indonesia (Mantoro 2021), which the current study tried to explore in detail using the scenario-based planning methodology.

Moreover, the current study utilizes a scenario-based planning methodology to project the central government's role in road infrastructure development. It is a strategic planning method that helps managers and decision-makers in projecting the future and planning development strategies (Mai and Smith 2018; Mansoor, Awan, & Paracha, 2021). Simultaneously, scenario-based planning operates on two basic principles. In accordance with the first principle, the organizations' external environment and internal characteristics constitute the system. At the same time, the second principle deals with the several features of a particular system and presents multiple future scenarios and possibilities to constitute a strategic planning process (Ehsan et al. 2019). Moreover, it is based on two phases, (i) to develop and apply stimulations to check about future possibilities and (ii) to assess and apply the managerial and decision-making abilities to assess all projected future scenarios (Norton et al. 2019). Besides, researchers of infrastructure development applied future planning as a systematic method to determine simulations for complex adaptive modeling of "road infrastructure resilience to sea-level rise" (Batouli & Mostafavi 2018) and electronic vehicle charging (Márquez-Fernández et al. 2021).

However, the application of scenario-based planning to determine the role of the central government in road infrastructure development for the country's economic growth has not been previously explored. Besides, researchers asserted the need to explore the factors impacting road infrastructure development and the significance of strategic planning by the central government, particularly in the Indonesian context (Setiawan et al. 2022). Hence, the current study aims to apply the scenario-based future planning methodology to determine the key drivers and the extent to which the central government can play its role in road infrastructure development and economic growth of the country, particularly in the context of Indonesia. Thus, the current study aims to answer the following important questions;

- What key factors and driving forces can be used to develop and sustain the road infrastructure in Indonesia?
- How road infrastructure development influences the economic growth of the country.
- Which scenario-based strategic planning would be the best fit with large-and small-scale central government policies for infrastructure development to support the economy of Indonesia?

Research method

Cross-cultural analysis

A qualitative cross-impact analysis has been used based on structural analysis in the current study. To analyze a combination of binary future events, cross-impact analysis is considered a powerful tool (Mehta, Bhattacharyya, and Pandey, 2022). It is also considered a flexible methodology and is mostly used to create and analyze scenarios. It can be united with various methods like multicriteria, Delphi, fuzzy, etc. (Nematpour and Faraji 2019). Moreover, to explore a system's functioning in the future based on its nature, a diverse set of variables needs to be analyzed to access and systematically describe the associations among them (Kahnali and Heyrani 2021). Besides, a well-known method applied to analyze the interrelationships among the existing constructs is known as "cross-impact analysis" (Nematpour et al. 2021).

Structural analysis

Structure analysis is a variant of the original cross-impact analysis method that considers the direct and indirect associations among the constructs/variables (Weimer-Jehle et al. 2020). It can further be conceptualized as a system composed of interrelated constructs. This system further constitutes a network that needs to be analyzed via interrelationships among the variables utilizing interconnection metrics to determine the system's future evaluations (Norton et al. 2019). The association between qualitative and quantitative variables signifies that the system must be structurally identified from the functional perspective. Besides, one of the most significant structural analysis results includes identifying the key variables that control future evolution (Luo et al. 2020).

MICMAC method for structural analysis

MICMAC is a structural analysis technique that is a cross-impact analysis variant (Jasiulewicz-Kaczmarek et al. 2021). "MICMAC analysis involves the development of a graph that classifies factors based on driving power and dependence power and is mostly used to classify the factors and validate the interpretive structural model factors in the study to reach their results and conclusions." (Villacorta et al. 2014, p. 17). The expert panel utilizes this technique to assess key constructs in a system by analyzing a diverse set of existing constructs in a matrix of potential indirect influence and a matrix of direct influence (Villacorta et al. 2014). The impact of every "i" construct on each "j" construct is shown as the product of both as "ij" in each cell of the Matrix of Direct Influence (MDI). These impacts are assigned values varying from 0 to 3. Where "0=no relation between constructs,

1=weak relations, 2=indicates moderate relations, and 3=strong relations."(Nematpour and Faraji 2019). The technique has some important steps, including collecting inventory constructs, describing the relationship among those constructs, and determining the key constructs. Moreover, analysis has been carried out according to the nature of the data utilizing a direct method that ranks the constructs by describing their direct impact on the other constructs. The MDI matrix elements are formalized in "a kth row and a kth column." Hence, generating (Nematpour et al. 2021);

$$IK = \sum_{j=1}^n MDI(k, j) \text{ and } I_k = \sum_{j=1}^n MDI(j, k) \tag{1}$$

Moreover, the MICMAC chart presents a two-dimensional map with a horizontal and vertical axis representing the dependency and impact, respectively, as shown in Fig. 1 (Chen 2018; Villacorta et al. 2014).

Furthermore, researchers identified five zones of each chart, including;

Influential/input constructs These constructs are recognized with a stronger influence on other constructs in the future. Hence, they are considered as input drivers are determinatives upon which the system depends.

Key/intermediate constructs These constructs are considered unstable in nature and can be highly influential and dependent simultaneously.

Dependent/output constructs These constructs are considered highly sensitive to change due to influential and intermediate constructs based on high dependence and low influence.

Excluded contracts The variables that do not interfere with the system are considered out of the chart based on their low dependence or influence.

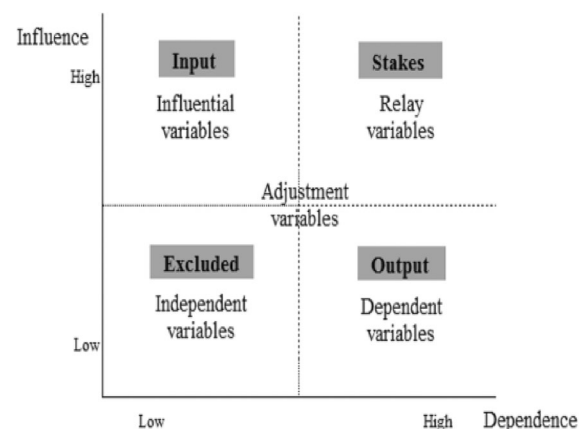


Fig. 1 Influence-dependence chart, adapted from Chen (2018)

Neuter/clustered constructs These variables lie in the centers and tend to join any group of other constructs. Hence, systems cannot make certain projections or decisions about such constructs.

Building scenarios applying cross-impact balance

“Cross-impact Balance (CIB)” is a modern analysis applied to multidisciplinary topics and qualitative systems. CIB’s one of the typical application fields is scenario wizard. The building and construction of scenarios often require the progress of many different fields, i.e., technological, social, economic, political, etc. (Weimer-Jehle et al. 2020). Simultaneously, to develop scenarios, the know-how of various combinations of satisfactory, neutral, and unfavorable prediction variance is important to know about their interrelations. Besides, a peer interaction system approach has been utilized in CIB analysis. In the beginning, important/key factors are identified, which are conceptualized as “descriptors” assessed via applying the MICMAC technique as understanding the qualitative system characterization of the descriptors in the system is important (Jasiulewicz-Kaczmarek et al. 2021). Moreover, Fig. 2 depicts the association between various descriptors. It shows that all the network elements are completely interconnected with the reciprocal one-sided relationship. Besides, an internally consistent way keeps the balance among the web of influences where a system follows a configuration.

The following steps are involved in scenario building via the CIB process;

- i. Use of the MICMAC technique to identify the key constructs, i.e., X1, X2..... Xn.

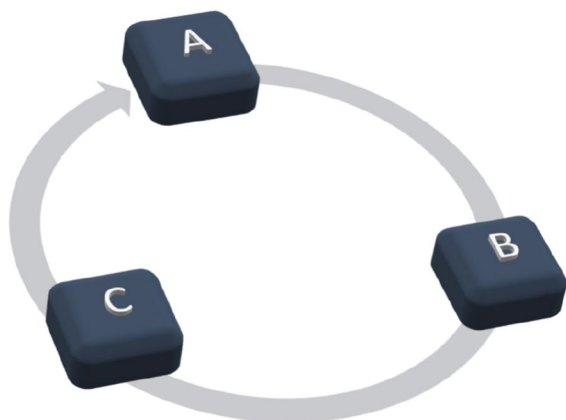


Fig. 2 A simple CIB networks

- ii. Presenting a set of alternative variants based on descriptors’ possible states, i.e.,
 - a. “X1 {xa, xb, xc}2
 - b. X2 {x, xy, xz}3
 - c. X3 {xi, xj} Xn {x1 ... xn}”.....0.4
- iii. Presentation of +3 strongly promoting influence to 3 strongly restricting influence.

Sampling procedure

This study applied MICMAC software and conducted a cross-impact analysis in Scenario Wizard to extract the key factors impacting the development of the transportation infrastructure in Indonesia. A six-phase process is followed in the structure analysis method to construct scenarios, including problem analysis, variables definition, analysis of the relationships, chart analysis, identification of key constructs, and all probable future scenarios to develop a system(Chen 2020). This study was started in July 2021 and was completed in February 2022. Using a purposive sample (non-probability) methodology, a group of experts exhibiting the area of knowledge was selected (Devers and Frankel 2000). In accordance with the researchers, while conducting future projection studies applying scenario-based analysis, the number of experts can vary from 10 to 100. They can further be divided into groups of 2 to 3 (Chen 2020; Jasiulewicz-Kaczmarek et al. 2021). Thus, based on these guidelines, we approached 40 management experts, academicians, administrators, and professionals. However, 29 agreed to participate in the study. Therefore, we requested them to fill out a self-administered questionnaire designed in a cross-impact analysis matrix. In phase II of the current study, the items of the self-administrative questionnaires were identified.

Moreover, various variables were identified based on the experts’ highly knowledgeable views regarding the transportation sector. As the structure analysis of the current study was based on experts’ opinions, we tried to highlight the experts who were rich in transportation infrastructure and economic development knowledge. Moreover, structural analysis was utilized based on experts’ opinions, and various indicators of the variables were highlighted in the context transportation system of Indonesia. Based on the information collected from the experts, a list of 24 variables was identified and finalized, which were later added to the self-administrative questionnaire. It was also made sure that all the experts easily understood the conceptualization of each construct. Moreover, these selected 24 variables belong to six broader fields as macro indicators that greatly influence Indonesian transportation infrastructure. A detailed

description of all five variables and their indicators has been given in Table 1.

Results

Identification of key constructs/variables via cross-impact analysis

To determine the Indonesian role in infrastructure development’s key constructs, we collected 37 variables via the recent literature review and from professionals, academicians, and administrative experts’ opinions via interviews. Out of those 37 constructs, the experts’ panel filtered and re-evaluated constructs and placed those in five main categories. In the next step, all 24 constructs were adapted in the cross-impact 24 X 24=576. Finally, the domain experts validated and evaluated the structure analysis based on the MICMAC (Patidar, Soni, and Soni, 2017). The matrix filtration amount was 64.86, reflecting about 64.86% of the variables’ influence on each other. Moreover, out of 529 metrics-based associations, 123 (21.35%) depicted “no association,” 115 (19.96%) had “weak associations,” 153 (26.56%) reflected “moderate associations,” and the remaining 181 (31.42%) had “strong associations” among each other (see Table 2).

Table 2 Matrix of direct influence MDI

Indicators	Values
Matrix’ size	24
Number of iterations	2
Number of zeros	123
Number of ones	115
Number of twos	153
Number of trees	181
Number of Ps	0
Total	576
Filtrate rate	64.86%

These results extracted from cross-impact analysis utilizing MDI reflect that most of the constructs can significantly improve Indonesian road infrastructure development. The results also revealed that a considerable number of variables had a strong impact on road infrastructure development and are the key constructs in the system. Moreover, as shown in Table 3, the final cross-impact metrics results are presented under the five different categories of the variables, including key, input,

Table 1 Study variables and sub-indicators

Sr. #	Macro-variables	Sub indicators	Labels
1	Socio-cultural	Community participation	VAR1
		Considering state vs. local rules	VAR2
		Public and stakeholder involvement	VAR3
		Carrying capacity of the community	VAR4
2	Economic	Development of action plans	VAR5
		Budget allocations	VAR6
		Investments in research and development	VAR7
		Multidimensional thinking	VAR8
		Financial and economic facilities	VAR9
3	Political and organizational	strengthen planning and modeling	VAR10
		Transportation management	VAR11
		Master plan for road infrastructure development	VAR12
		Improve connections	VAR13
		Attraction for tourists	VAR14
4	Laws and regulations	Safety and security in the transportation system	VAR15
		Establish a commission	VAR16
		Protect trust fund reserves for transportation	VAR17
		Diesel and filter regulations	VAR18
5	Technology and innovation	Investments in technology and innovative practices	VAR19
		Smart growth with innovative procedures	VAR20
		Maintain a comprehensive transportation database	VAR21
6	Infrastructure and spatial	Continue transportation agency head coordination	VAR22
		Continuous investments in the transportation sector	VAR23
		Addressing transportation/land use conflicts	VAR24

Table 3 Direct influence and dependence of constructs

Sr. #	Role	Variables	Items	Matrix of direct influence (MDI)	
				Direct influence	Direct dependence
1	Key	VAR1	Community participation	479	343
2	Key	VAR5	Development of action plans	651	428
3	Key	VAR11	Transportation management	649	411
4	Key	VAR12	Master plan for road infrastructure development	644	402
5	Key	VAR15	Safety and security in the transportation system	630	398
6	Key	VAR19	Investments in technology and innovative practices	621	389
7	Key	VAR21	Maintain a comprehensive transportation database	609	379
8	Key	VAR3	Addressing transportation/land use conflicts	554	366
9	Key	VAR9	Financial and economic facilities	537	320
10	Input	VAR3	Public and stakeholder involvement	452	361
11	Input	VAR6	Budget allocations	430	345
12	Input	VAR7	Investments in research and development	427	339
13	Input	VAR8	Multidimensional thinking	409	233
14	Clustered	VAR2	Considering state vs. local rules	403	261
15	Clustered	VAR10	Strengthen planning and modeling	383	251
16	Clustered	VAR13	Improve connections	377	218
17	Dependent	VAR4	Carrying capacity of the community	213	389
18	Dependent	VAR14	Attraction for tourists	191	372
19	Dependent	VAR17	Protect trust fund reserves for transportation	156	234
20	Dependent	VAR22	Continue transportation agency head coordination	134	209
21	Dependent	VAR 23	Continuous investments in the transportation sector	110	123
22	Excluded	VAR16	Establish a commission	43	81
23	Excluded	VAR18	Diesel and filter regulations	38	73
24	Excluded	VAR20	Smart growth with innovative procedures	27	141

clustered, output, and excluded variables. As shown in Table 3, community participation, development of action plans, transportation management, the master plan for road infrastructure development, safety and security in the transportation system, investments in technology and innovative practices, maintaining a comprehensive transportation database, and addressing transportation/land-use conflicts have been identified as the key constructs playing a vital role in Indonesian road infrastructure development. Likewise, constructs like public and stakeholder involvement, budget allocations, investments in research and development, and multidimensional thinking are considered input variables reflecting the importance of utilizing these key factors to enhance the development of the Indonesian road infrastructure. In addition, considering state vs. local rules, strengthening planning and modeling, improving connections, and continuous investments in the transportation sector have been marked as clustered variables. At the same time, the community's carrying capacity, budget allocations, attraction for tourists, protection trust fund reserves for transportation, and continued transportation agency

head coordination are considered the output constructs. Simultaneously, establishing the commission, diesel, and filter regulations and smart growth with innovative procedures were found to be the least impactful for Indonesian road infrastructure development.

Consistent scenarios building via applying CIB

Once the key variables to develop the Indonesian road infrastructure using cross-impact analysis were identified, we assessed the significance of all the factors in different combinations linked with the system in Scenario Wizard software. Besides a coded rule in the CIB method boss employed to identify the key variables. We found nine key variables impacting the road infrastructure development in Indonesia. In the next step, expert panel members were approached to analyze the descriptors, and a 24×24 matrix was formulated to evaluate the Indonesian road infrastructure development and any projected changes in any descriptor variables. Simultaneously, forthcoming judgments, interactions, and associations of the constructs and structured processes were utilized to build scenarios. Qualitative variances were

defined after compiling the key variables (descriptors) list. This further reflects the characteristics of the key variables reflecting various states to develop the Indonesian road infrastructure development. At the same time, these states are considered “strategic drivers” in developing the road infrastructure in the future at a national level, and this can happen at any time in the system. Moreover, Table 4 depicts the study descriptors and their variables, categorizing the possible states of all the descriptors.

In the next step, judgments were made regarding descriptor X's state x's impact on descriptor Y's state y. This resulted in a “cross-impact matrix in Scenario Wizard Software” with 9 important/key variables and 24 states impacting the Indonesian road infrastructure development system. In the next step, around 5,832 probable compounding scenarios (from $3 \times 2 \times 3 \times 3 \times 2 \times 2 \times 3 \times 3 \times 3 \times 3$) were extracted out of all probable states. These scenarios we have loaded these in the scenario wizard. These further include four with stronger consistencies, 453 with weak, and 276 with nil consistencies. In addition, results revealed the high occurrence of four scenarios in the development of the road infrastructure in Indonesia in the future as a forecast to foster economic growth in the country. Furthermore, various categories were assigned to these four consistent scenarios based on specific features, as shown in Table 5.

In addition, scenario 1, as shown in Table 5, reflected the ideal and desirable conditions and is named the “driving scenario.” Scenarios 2 and 3 reflected the intermediate status with appropriate states. However, scenario 04 was critical, reflecting undesirable status with zero projections of developing the Indonesian road infrastructure in the future. Simultaneously, the consistency values of each possible state are presented in Table 6.

The results reflect the highest consistency value of the master plan at the national level as a significant measure for road infrastructure development in Indonesia. Further, results demonstrate the highest consistency of investment in technology and innovation practices and maintenance of a comprehensive transport database to develop the road infrastructure in Indonesia. Moreover, results revealed the significance of safety and security in the transportation system not only facilitates the local inhabitants to participate in the country's economic growth but also attracts tourists. It is also the state's responsibility is equally important to develop the road infrastructure in the country that can further facilitate prosperity based on economic growth. The development of the action plan has also been found to be an important predictor of road infrastructure development in an emerging nation. It further reflects that it is not necessary to only plan about multiple things, but the execution is equally important. Finally, the participation of

the community has been found to be an important factor that facilitates road infrastructure development in a country and leads to economic growth and prosperity at the societal and community levels.

Discussion

The current study applying the CIB identified four consistent scenarios. The findings presented the significance of Scenario 1 as a driving scenario for the development of the Indonesian road infrastructure based on its influence on the country's economic development. In addition, all 9 key variables identified in this scenario-building research are very important and stable for the Indonesian road infrastructure development with a positive nature. Besides, scenario 1, with the most stable and influential states, includes D3 (concentrating the efforts on planning road infrastructure development in big cities). It revealed that when governments pay more attention to strategic planning for developing the road infrastructure in the big cities, it can facilitate individual and business entities far smooth functioning with easy access to their final destinations. It further presents that road infrastructure development is necessary, especially in large, more populated cities, to help people reach their destinations on time and effectively perform their duties with the least distractions and unnecessary delays. These results can be related to the previous studies, which presented the significance of road infrastructure development in large cities to drive economic prosperity in the country (Lin et al. 2021; Polom 2021).

In scenario 1, the second most influential state was F1 (Use of smart and modern technology). It is a modern era where people rely more on information and communication technology to devise smart solutions to real-life problems (Dalle et al. 2020; Mansoor 2021). Since road infrastructure development is a big economic development in a nation, realizing modern technologies to build roads and keeping this sustainability of the environment is of significant importance. Previous research also reflects the depletion of resources, the use of multiple resources for road infrastructure development, and its negative impact on environmental issues (Batouli and Mostafavi 2018; Schweikert et al. 2014). Hence, the government should pay attention to smart technologies to build road infrastructure while preserving the resources for future developments.

In addition to that, the third leading state that affects the development of road infrastructure in Indonesia was found to be G1 (Application of technological tools to keep track records of transportation modes and transporters' history). Keeping the significance of the previous point, the results of the current study revealed that technological tools could also be applied to track records

Table 4 Possible states of descriptors

Descriptors		Variables
A. Community participation	A1. Participation and interest at the societal level	A2. societal efforts to extract mutual benefits from road infrastructure development in the country
B. Development of action plans	B1. Long-term smart strategic planning	B2. Plan the road infrastructure development while keeping the sustainability elements in consideration B3. No strategic planning
C. Transportation management	C1. Efficient management of the transportation system by utilizing available resources	C2. keeping track of the complete traffic load C3. Selective transportation management system
D. Master plan for road infrastructure development	D1. Initiation of a megaproject for road infrastructure development	D2. identifying key areas with the utmost need for road infrastructure development D3. concentrating the efforts on planning road infrastructure development in big cities
E. Safety and security in the transportation system	E1. Installation of security cameras at prescribed locations after identification of needs	E2. Strict measures for all travelers, along with the quality of roads and transportation systems E3. Relying on local transporters and traditional transport system
F. Investments in technology and innovative practices	F1. Use of smart and modern technology	F2. Efficient allocation of resources F3. Additional means of road infrastructure development
G. Maintain a comprehensive transportation database	G1. Application of technological tools to keep track records of transportation modes and transporters' history	G2. record-keeping of long-route transportation means G3. Poor- and low-quality database maintenance system
H. Addressing transportation/land use conflicts	H1. identification of the existing transportation system in the country and resolving the existing conflicts	H2. clearly defined transportation policies H3. Poorly established transportation system based on power
I. Financial and economic facilities	I1. Investment of the national government to enhance the quality of roads	I2. Investments for enhancement of the road infrastructure and local transport facilities I3. No financial and economic facilities

Table 5 More consistent scenarios for developing Indonesian road infrastructure

Scenario 1	Scenario 2	Scenario 3	Scenario 4
A2	A2	A3	A1
B2	B3	B1	B2
C1	C2	C2	C4
D3	D3	D3	D2
E2	E3	E3	E3
F1	F3	F3	F1
G1	G1	G1	G3
H2	H1	H2	H1
I2	I2	I3	I2

of the translational modes and transportation histories on existing roads to further project the development of strong road infrastructures to cater to the need of existing transporters as well as prospected transporters. These results can further be related to the findings of previous studies that suggested the continuous increase of traffic on the roads and the issues of congestion in big cities which can be sorted out by keeping track records of the transporters and transportation mods (Euchi and Kallel 2021; Nama et al. 2021). That can further be utilized by the governments to effectively and efficiently project the needs of road developments in various areas.

Additionally, E2 (Strict measures for all travelers along with the quality of roads and transportation systems), H2 (Clearly defined transportation policies), and I2 (Investments for enhancement of the road infrastructure and local transport facilities) were also found as key indicators of road infrastructure development in Indonesia. These constructs present the significance of laws and regulations in the country and the level of investments to provide local transport facilities to the masses in the country. Moreover, the security measures while traveling in the country are deemed important to further

attract tourists, which is a great source of earning foreign exchange (Hardjosoekarto and Lawang 2021). These findings further depict that the country's stronger in formulating policies and regulating laws are more apt to develop the road infrastructures to facilitate the public at a large scale.

Besides, B2 (Plan the road infrastructure development keeping the sustainability elements into consideration) and C1 (Efficient management of the transportation system by utilizing available resources) are also revealed as key indicators of road infrastructure development. These findings further reflect that considering the limited availability of non-renewable resources, the principles of sustainability should be implemented while building the road infrastructure in the country while efficiently and effectively utilizing the available resources. Moreover, since developing nations are available with scarce resources and facilities to convert those resources into end products are limited (Zebra et al. 2021), smart technologies should be applied to gain the maximum benefits from those available resources.

Finally, results revealed the potential importance of A2 (societal efforts to extract mutual benefits from road infrastructure development in the country). It further reflects that in addition to the government representatives' and official bodies' efforts to build road infrastructure in the country, the collective efforts at societal levels are important. It further shows the individuals' perceptions of the societal image where they consider themselves a part of this society and try to preserve the existing resources and make collective efforts to develop society as a whole. For that, they not only financially participate in building infrastructures in the local areas but also take the responsibility of protecting existing infrastructures. All these constructs are positive indicators of developing road infrastructure in Indonesia and can be applied in any developing nation.

Table 6 Each possible state' value consistency

Descriptors	Possible sates	Value consistency
Master plan for road infrastructure development	D3	432
Investments in technology and innovative practices	F1	420
Maintain a comprehensive transportation database	G1	401
Safety and security in the transportation system	E2	374
Financial and economic facilities	I2	342
Addressing transportation/land use conflicts	H2	325
Development of action plans	B2	297
Transportation management	C1	271
Community participation	A2	233

Conclusion

Road infrastructure in a country has been considered an important predictor of the economic growth of the country as well as of the region (Varnavskii 2021). Besides, road infrastructure has a wide influence on cultural, economic, environmental, political, and social situations (Setiawan et al. 2022). Hence, to reap the benefits and advantages of a country's sound and well-managed road infrastructure, it is very important to strategically plan the road infrastructure development. More specifically, road infrastructure building is of utmost importance in the most populated cities for the smooth functioning of the travel system, as it facilitates individuals to perform their routine tasks efficiently and effectively without time delays to reach various destinations (Meijer et al. 2018). Moreover, since the road infrastructure reflects the level of economic development of a country, it further attracts tourists from various places to visit such countries and becomes the source of earning foreign exchange.

The current study revealed contextual associations among 24 road infrastructure development variables through a CIA-based scientific framework. Adding to that, fuzzy MICMAC analysis based on CIA desserts was applied to construct an integrated model for evaluating the interactions among numerous road development-oriented variables in the Indonesian infrastructure. Performing a consolidated analysis, 9 key constructs were identified, and all possible scenarios of all these 9 key variables were generated via a cross-impact algorithm. These variables include a master plan for road infrastructure development, investment in technology and innovative practices, maintaining a comprehensive transport database, safety and security, and transportation system, financial-economic facilities, addressing transportation/land-use conflicts, development of action plans, transportation management, community participation.

Implications and Limitations

There are some practical and policy implications for developing road infrastructure. Some important factors related to the development of the Indonesian road infrastructure are identified by the current study. These factors can further be considered as the main determinants of economic development in the country linked with infrastructure development. Besides, the results show the significance of strategic planning for developing roads to attract tourists. It should be prioritized by the combined effort of the Indonesian Ministry of Infrastructure Development and the Indonesian Ministry of Cultural Heritage and Tourism. Moreover, as discussed earlier, the key variables found highly influencing the development of road infrastructure should be given importance to utilize

their benefits in infrastructure development in the form of economic growth and prosperity in the country.

Furthermore, safety and security measures should be considered on priority bases to facilitate transporters to travel freely all over Indonesia. Moreover, digital technologies at large should be utilized in sustainable ways of constructing war infrastructure, keeping the non-renewable resources preserved for upcoming generations, and providing them with the best infrastructure facilities that can further lead to the economic development and prosperity of the country. There is also a need to provide high-quality local transport services with ease of access to the workplaces to the masses so that a level of trust can be built and individuals' skills and experiences can be utilized in the best possible manner without wastage of time and procedural delays. Besides, several long-term strategies can be devised and implemented to develop road infrastructure to enhance the area's beauty and ease of traveling to attract tourists to such destinations. The existing roads can be modified for that purpose, and facilities should be provided on the roadsides.

Moreover, there are certain limitations of the current study. For instance, regardless of identifying and highlighting the associations among the constructs, the "MICMAC and Scenario Wizard analysis" is dependent upon the expert panel's knowledge and skills. As a result, the findings can be biased based on variable skills and knowledge of the experts. Hence, it is recommended that future researchers use a multidisciplinary team so that diverse results can be found. Additionally, the emphasis of this study is on the development side of broad infrastructure to facilitate the transporters and attract tourists to such countries with highly developed road infrastructure to facilitate the traveling needs of the individuals; however, researchers did not focus on the demand. Therefore, future researchers can consider the demand side for the availability of road infrastructure and modern means of transportation. Finally, the available facilities, procedures, and policies for infrastructure building and development can be analyzed and compared to identify the shortcomings in the system to make the transportation system more apt and successful in the country's economic development in the future.

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Author contributions

All the authors contributed equally.

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Availability of data and materials

Data will be available on demand.

Declarations

Competing interests

There is no competing interest among the authors or with any third party.

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