

# A Framework for the Communication and Coordination of Mamminasata BRT Services Using Social Network Analysis

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## ABSTRACT

The Mamminasata BRT has not operated since 2020 because its operator, Perum Damri's Makassar branch, has suffered operational losses. This study aims to develop a framework for coordination and communication between stakeholders for the effective operation of the Mamminasata BRT service. Primary data were collected through interviews with 60 respondents representing the 20 stakeholders involved. The Social Network Analysis (SNA) method, combined with the UCINET and Gephi applications, was used to identify and determine the centrality role of stakeholders. The Analytical Hierarchy Process (AHP) was used for the selection of alternative frameworks based on various criteria. The results of the measurement of eigenvector centrality and degree centrality showed that the key player in the network was the Planning Consultant. Closeness centrality showed that Bappeda Kab. Maros was the actor closest to the other actors. The measurement of betweenness centrality showed that the nodes that controlled the network (Facilitators) were Perum Damri Makassar, the Makassar City Transportation Agency, and the South Sulawesi Provincial Transportation Agency. This study proposes a new development framework by combining manual and cloud-based digital methods, which increases the coordination and communication by 17%. This development framework can be used in the revitalization of the Mamminasata BRT project.

**Keywords-***Mamminasata BRT; social network analysis; framework; coordination and communication*

## I. INTRODUCTION

In 2014, the Mamminasata BRT began operating. This central government project was expected to reduce traffic congestion and offer a practical transportation option. However, only 5 of the 11 corridors originally planned were operational. Since 2020, the Mamminasata BRT service has ceased operating due to various challenges, including low load factor. There is still no clear distinction between the main mode and feeder mode, resulting in a lack of integration. During the pre-construction, construction, and operational phases, the

Mamminasata BRT project involved several parties, such as the Ministry of Transportation, the National Development Planning Agency (Bappenas), the South Sulawesi Provincial Transportation Agency, district/city agencies, planners, supervisors, and the Damri Public Corporation. The lack of effective coordination and communication between stakeholders led to sectoral egoism [1]. Inter-agency coordination within the government is one of the fundamental aspects of governance, especially in implementing effective and sustainable policies. In government organizations, coordination is considered very important for creating harmony

and unity of action to achieve predetermined common goals, especially since each agency has different duties, functions, and authorities [2]. The study was conducted to determine the stakeholders involved and their centrality roles. The research location is the planned 11 Mamminasata BRT corridors located in the Makassar, Maros, Gowa, and Takalar (Mamminasata) agglomeration area, as shown in Figure 1.

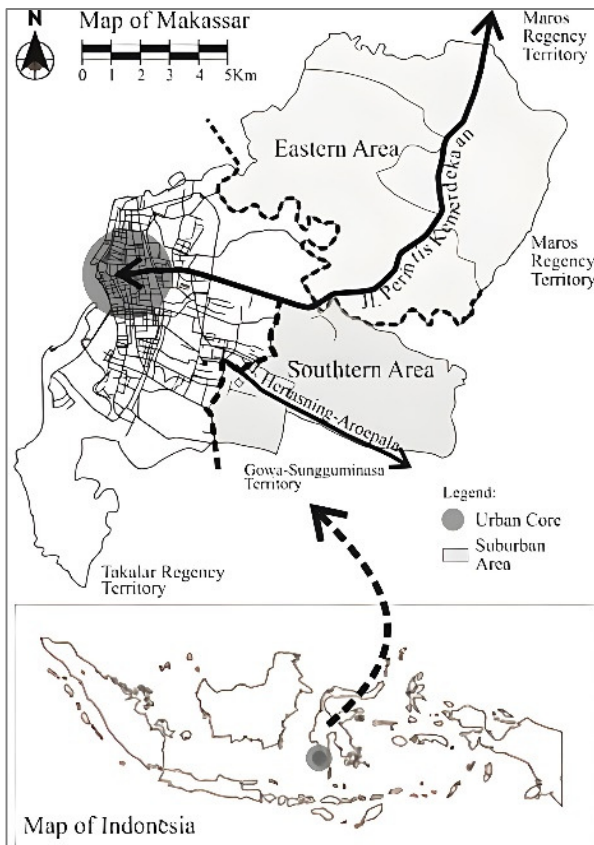


Fig. 1. Research location.

Principles of coordination, such as agreement on objectives, division of roles, loyalty to tasks, and effective information exchange, are key to success in building inter-agency synergy [3]. Joint Decrees (SKB), communication forums, and the use of information technology can also be important tools in facilitating coordination and strengthening accountability in policy implementation. In [4], the South Sulawesi Transportation Agency established communication with Perum Damri Makassar as the operator on an interpersonal basis or through communication between the two agencies using communication media. Interpersonal communication was carried out daily to monitor the progress of the Mamminasata BRT. In addition to Damri, the South Sulawesi Transportation Agency used a group chat-based application with approximately 100 members to monitor the Mamminasata BRT project.

A 2022 study conducted by the American Society of Safety Professionals (ASSP) suggests that consistently optimizing digital SOPs leads to a 25% reduction in workplace incidents

within three years. The optimization of SOP, especially with digital technology, can ensure safer, more accurate, and faster work processes [5]. Digital skills also enable the integration of technology into SOPs, such as automated monitoring and reporting systems, which facilitate data-driven decision-making [6]. SOPs that integrate digital capabilities are essential for improving productivity and safety. Digital tools, such as Application Performance Monitoring (APM) and the Internet of Things (IoT), can increase the accuracy and speed of workflows while reducing errors. Real-time monitoring is made possible by IoT, which also facilitates workflow modifications and reduces human error [7].

Furthermore, even in large-scale and complex projects in metropolitan locations, the development of cloud technology and digital project management tools enables real-time monitoring, adaptive planning, and fast and coordinated information delivery [8]. To assist in various phases of construction projects, from planning to maintenance, digitization involves the use of technologies, such as Building Information Modeling (BIM), the IoT, Artificial Intelligence (AI), cloud computing, and drones [9]. The application of Information Technology (IT) affects project performance and benefits/is benefitted through knowledge management, organizational innovation, and organizational capabilities. Therefore, all three play a mediating role in the relationship between IT application and project performance [10]. BIM enables all stakeholders in a construction project to work collaboratively through a three-dimensional model integrated with cost and time estimation data, thereby reducing the risk of design errors and project delays [11]. The implementation of digital technology has been proven to accelerate the implementation of underpass projects in Jakarta, with project duration reduced by 19.4%, while for government building projects in Bandung, the acceleration reached 23% of the initial target [12].

The lack of a systematic framework designed to implement project management is due to the absence of methods, strategies, plans, or processes that operate predictably. As a result, stakeholder management becomes irregular [13]. Although many initiatives in the stakeholder management community have made significant progress in improving processes, a formal framework for construction projects has not been fully developed [14]. Enhancing risk management from the outset of a project can be achieved by developing a conceptual model that incorporates the best practices in IT project risk management with PMI guidelines (such as the PMBOK and PMI risk management standards). This model functions as a metamodel that can serve as the foundation for creating risk management models that adhere to the best practices and standards while also enhancing project alignment [15]. Incorporating social and environmental issues into the model, using machine learning algorithms for better land value prediction, is expected to improve its reliability [16]. The objective of the research is to develop a framework for effective coordination and communication between stakeholders. Measurement and mapping of interaction flows are complemented by the analysis of interaction flow patterns, defined as SNA [17]. The latter can be used in various sectors and fields and is considered one of the most powerful methods

for analyzing collaborative relationships and partnerships. Performing network analysis provides a holistic picture of the position of partners in the network and information about the relationships between them [18]. Due to its ability to understand the complexity and full connectivity of networks quickly and cost-effectively, SNA can meet these needs. Mathematically, social networks are very similar to transportation networks because they share basic characteristics [19]. SNA can be used to study the patterns of organizational networks, ideas, and people connected in various ways within an environment [20].

II. RESEARCH METHODS

A. Procedures

Previous research findings describing the central role of agencies/stakeholders were used as a basis for developing a policy in the form of a framework for coordination and communication in order to improve the effectiveness of the Mamminasata BRT service. This research was conducted using several analytical methods, including:

- The pattern of coordination and communication between agencies/stakeholders was analyzed using SNA with UNICET and Gephi software.
- Evaluating the implementation of SOP for government administration and the cloud-based digital project management system framework.
- AHP to determine the criteria and selection of alternative coordination and communication management frameworks.

The data was analyzed using a comparative and contextual analysis approach. Comparative analysis was used to calculate the differences in time and cost efficiency between the pre-digital and post-digital phases [21]. The research flowchart is shown in Figure 2.

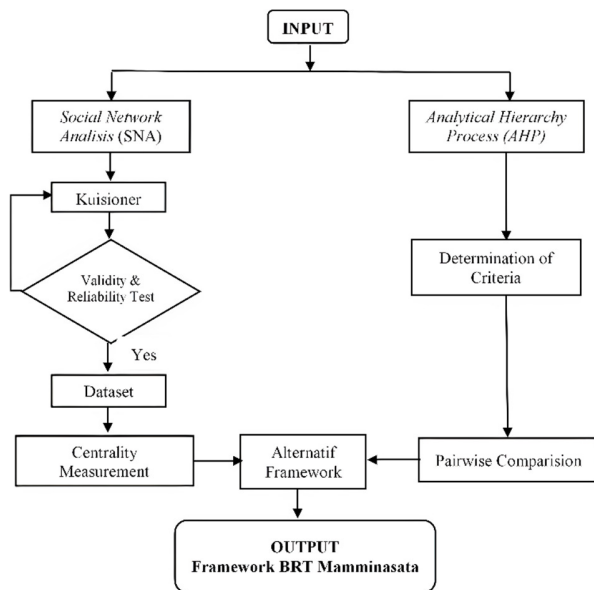


Fig. 2. Research flowchart.

B. Data Collection

Primary data related to the coordination and communication between stakeholders were collected through interviews with more than 60 respondents, representing 20 stakeholders based on their educational background and job positions in the pre-construction, construction, and operational stages. Secondary data were collected from research journals and government records. The list of stakeholders directly involved in the Mamminasata BRT project is presented in Table I.

TABLE I. LIST OF STAKEHOLDERS INVOLVED IN THE MAMMINASATA BRT PROJECT

Agency/Institution	Status	Node
Direktorat Angkutan Jalan Kemenhub	Central government	S1
Direktorat Sarana Transportasi Jalan Kemenhub		S2
Balai Pengelola Transportasi Darat Kelas II Sulawesi Selatan Wilayah XIX		S3
Kedepuitan Bidang Koordinasi Infrastruktur dan Transportasi, Kemenko Perekonomian		S4
Direktorat Transportasi, Bappenas		S5
Perum DAMRI Makassar	Local government	S6
Dinas Perhubungan Pemprov Sulawesi Selatan		S7
UPTD Mamminasata Pemprov Sulsel		S8
Badan Perencanaan Pembangunan Pemprov Sulsel		S9
Dinas Perhubungan Kota Makassar		S10
Bappeda Kota Makassar		S11
Bappeda Kab. Maros		S12
Bappeda Kab. Gowa		S13
Dinas Perhubungan Kab. Gowa	S14	
Dinas Perhubungan Kab. Takalar	S15	
DPD Organda Makassar	Company	S16
Universitas Hasanuddin	University	S17
Konsultan Perencana	Private sector	S18
Konsultan Supervisi		S19
Kontraktor Pelaksana		S20

C. Data Analysis

Based on interviews, several variables and indicators were identified as key issues during the pre-construction, construction, and operational stages of the Mamminasata BRT. These include:

- Frequency of information provided and received
- Follow up on suggestions and feedback
- Number of stages in the coordination and communication process
- Duration of stages in the coordination and communication process

There are three outputs generated from social network interaction: the frequency of communication flows received, the frequency of communication flows sent, and the follow-up, response, or solution that can be generated [22]. To examine the flow of information between stakeholders on each issue regarding how stakeholders (individually or as a group) receive or transmit information related to that issue, a 5-point Likert scale was used, as presented in Table II.

TABLE II. LIKERT SCALE

Value	Frequency
0	No information
1	Occasionally
2	Once a month
3	Weekly
4	2-3 times a week
5	Every day

Centrality measures are used to determine stakeholders or nodes that play the most important role in coordination and

communication relationships [19]. Some network properties in SNA include: nodes, edges, average degree, diameter, and average path length. Centrality measures are used to determine the most important actors in a social network, indicating a person's degree of centrality [23]. There are four centrality measures: degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality. The coordination and communication relationship data using a Likert scale, presented in Table III, were then converted into categorical data by grouping them into the dataset.

TABLE III. CORRELATION MATRIX DATA BETWEEN STAKEHOLDERS

NODE	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
S1	0	3	2	2	2	2	1	1	1	0	0	0	0	0	0	0	2	2	2	2
S2	3	0	3	2	2	2	1	2	1	0	0	0	0	0	0	1	3	4	4	4
S3	2	3	0	0	0	4	1	2	1	1	0	0	0	1	1	1	2	4	4	5
S4	2	2	0	0	2	0	0	2	0	0	0	0	0	0	0	1	0	2	0	0
S5	2	2	0	2	0	0	1	1	2	0	0	0	0	0	0	0	1	2	0	0
S6	2	2	4	0	0	0	3	3	0	2	0	0	0	1	1	2	1	2	1	2
S7	1	1	1	0	1	3	0	4	3	2	1	0	0	2	2	1	1	2	1	2
S8	1	2	2	2	1	3	4	0	2	1	1	0	0	1	1	0	0	2	2	2
S9	1	1	1	0	2	0	3	2	0	1	1	1	1	1	1	0	1	2	0	0
S10	0	0	1	0	0	1	2	1	1	0	2	0	0	2	2	2	0	1	1	1
S11	0	0	0	0	0	0	1	1	1	2	0	2	2	1	0	0	1	1	0	0
S12	0	0	0	0	0	0	0	0	1	0	2	0	2	0	0	0	1	1	0	0
S13	0	0	0	0	0	0	0	0	1	0	2	2	0	2	0	0	1	1	0	0
S14	0	0	1	0	0	1	2	1	1	2	1	0	2	0	1	1	0	0	0	1
S15	0	0	1	0	0	1	2	1	1	2	0	0	0	1	0	1	0	0	0	1
S16	0	0	1	1	0	1	1	0	0	2	0	0	0	1	1	0	0	1	0	0
S17	2	2	2	0	1	1	1	0	1	0	1	1	1	0	0	0	0	1	0	0
S18	2	3	4	2	2	2	2	2	2	1	1	1	1	0	0	1	1	0	4	3
S19	2	4	4	0	0	1	2	2	0	1	0	0	0	0	0	0	0	4	0	5
S20	2	4	5	0	0	2	1	2	0	1	0	0	0	1	1	0	0	3	5	0

III. RESULTS AND DISCUSSION

A. Study of the Relationship between Coordination and Communication

Based on Figure 3, the nodes that send and receive the most coordination and communication flows in the network are S18 (Planning Consultant), S2 (Direktorat Sarana Transportasi Jalan Kemenhub), and S8 (UPTD Mamminasata Pemprov Sulsel), S1 (Direktorat Angkutan Jalan Kemenhub), and S6 (Perum DAMRI Makassar). The node with the least frequency of communication and coordination is S12 (Bappeda Kab. Maros).

1) Density

Density is a measure that describes how many edges (connections) exist in a network compared to the maximum possible number of edges. Density measures the density of a network or the level of connectivity between the nodes in that network. Density is computed by:

$$Density = \frac{n(n-1)}{2} \times 100$$

where *n* is the number of nodes

From the measurement results, a density value (matrix average) of 0.2947 and a standard deviation of 0.4559 were obtained. The calculated density was smaller than the standard deviation, and, therefore, categorized as low, indicating that the

network is still sparse (loose), where the communication and roles between nodes are not evenly distributed.

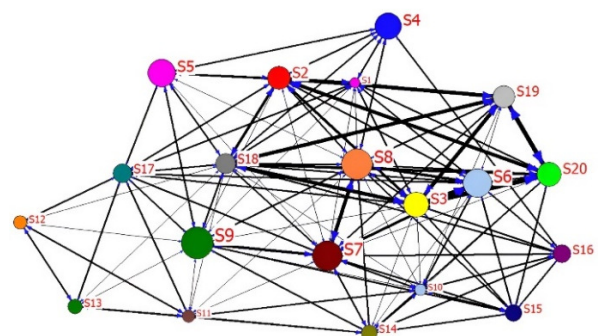


Fig. 3. Sociogram diagram of coordination and communication between stakeholders.

2) Eigenvector Centrality

Eigenvector Centrality determines the most connected (popular) nodes in a network with high eigenvector values in the network. These are the nodes with high eigenvector centrality and are connected to other nodes with high eigenvector centrality. As displayed in Table IV, S18 (Planning Consultant) has the highest eigenvector value, whereas S12 (Bappeda Kab. Maros) has the lowest.

TABLE IV. CENTRALITY MEASUREMENT WITH DIGITAL FRAMEWORK

ID	Degree	Betweenness	Closeness	Eigenvector
S18	16	21.757	22	0.319
S7	15	15.583	23	0.305
S8	13	7.329	25	0.291
S3	12	3.539	26	0.287
S6	12	4.866	26	0.276
S20	12	6.887	26	0.271
S2	11	3.798	27	0.254
S1	11	4.625	27	0.244
S14	10	3.94	28	0.236
S9	11	6.398	27	0.233
S10	10	5.288	28	0.216
S19	8	0.322	30	0.213
S5	8	1.865	30	0.184
S17	7	1.776	31	0.164
S15	6	0.56	33	0.142
S4	6	1.183	32	0.135
S16	6	1.661	32	0.132
S12	6	0.998	32	0.13
S11	6	1.064	32	0.125
S13	6	1.561	33	0.114

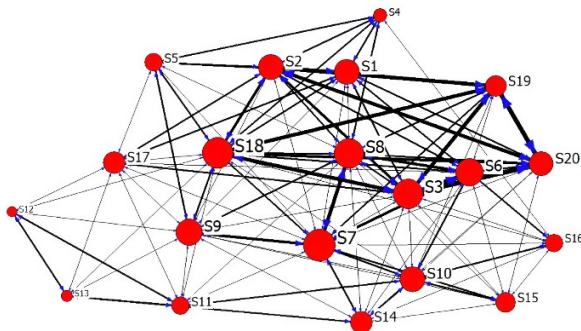


Fig. 4. Eigenvector centrality sociogram diagram.

3) Degree Centrality

Degree Centrality analysis is conducted to determine the level of connectivity of a node with its nearest nodes and identify the key players in the network that can influence other nodes.

4) Closeness Centrality

Closeness Centrality measures the distance between nodes and the speed of information transfer between nodes. The shorter the path between nodes, the faster information can be received and transmitted. As illustrated in Table IV, the node with the highest closeness centrality score or with the shortest path is S12 (Bappeda Kab. Maros), and the lowest is S6 (Perum Damri Makassar).

5) Betweenness Centrality

Betweenness Centrality analysis is conducted to determine the nodes that connect two or more separate groups of nodes. Edges with the highest betweenness centrality values have the potential to become connecting nodes (Facilitators) that maintain the network's integrity. In Table IV, it is evident that the nodes in the network that are the controllers (Facilitators) or have the highest betweenness centrality value are S6 (Perum Damri Makassar), S10 (Dinas Perhubungan Kota Makassar), and S7 (Dinas Perhubungan Pemprov Sulsel).

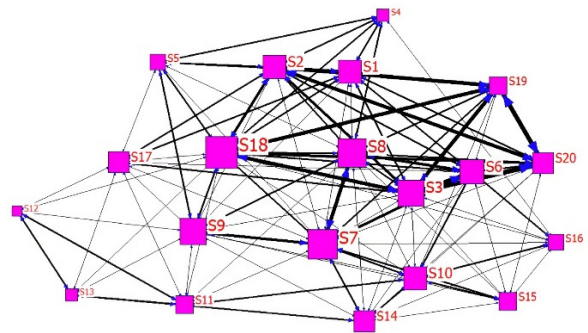


Fig. 5. Degree centrality sociogram diagram.

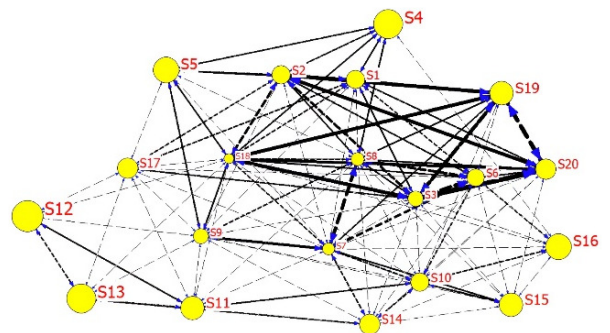


Fig. 6. Closeness centrality sociogram diagram.

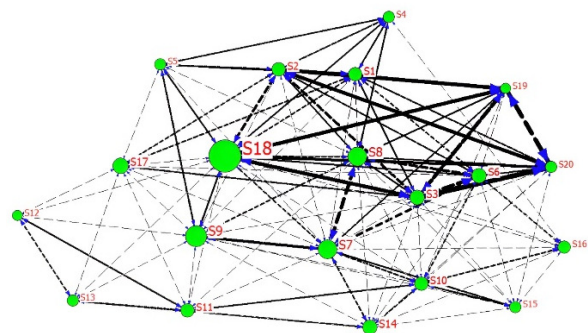


Fig. 7. Betweenness centrality sociogram diagram.

B. Evaluation of Framework Implementation among Stakeholders

1) Cloud-Based Digital Framework for Coordination and Communication among Mamminasata BRT Stakeholders

Based on Figures 8 and 9, the sociogram diagram produced using the Digital and Development Framework shows a density value greater than the standard deviation, indicating a dense network in which the communication and roles between nodes are evenly distributed. The centrality measurements in Tables IV and VII show that the highest eigenvector centrality and degree centrality key player is S18 (Planning Consultant). Closeness centrality demonstrates that the node with the shortest path is S12 (Bappeda Kab. Maros). Betweenness centrality exhibits that the node that acts as a controller (Facilitator) is S18, which also functions as a node that maintains the network so that it does not break.

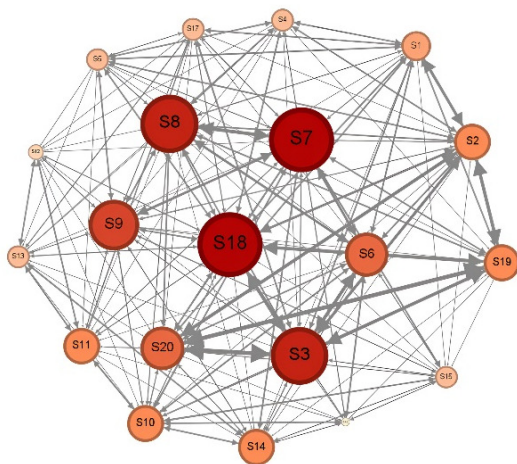


Fig. 8. Sociogram with cloud-based digital framework.

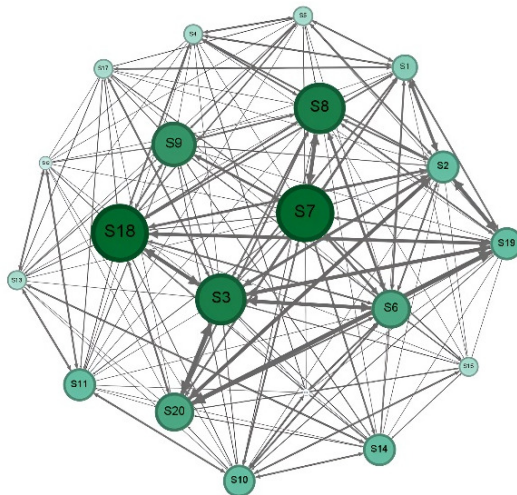


Fig. 9. Sociogram with development framework.

Based on Table V, the density value continues to increase along with the standard deviation, indicating that the network is becoming denser (more concentrated), where communication and roles between nodes are distributed evenly. Based on Table VI, the application of alternative frameworks resulted in a significant increase in the number of edges, using the Digital framework by 86% and increasing by another 17% using the development framework.

TABLE V. DENSITY

Alternative	Standard deviation	Density	Description
Framework Manual	0.4559	0.2947	D < SD
Framework Digital	0.5000	0.5053	D > SD
Framework Development	0.4919	0.5895	D > SD

TABLE VI. DENSITY COMPARISON

	Framework manual	Framework digital	Framework development
Number of Edges	386	718	840
Ascension		332	122
%		86%	17%

TABLE VII. CENTRALITY MEASUREMENT WITH DEVELOPMENT FRAMEWORK

ID	Degree	Betweenness	Closeness	Eigenvector
S18	17	15.299	21	0.299
S7	17	11.448	21	0.309
S8	16	9.343	22	0.297
S10	14	5.325	24	0.272
S3	14	4.879	24	0.274
S9	13	6.427	25	0.233
S20	13	4.161	25	0.255
S6	13	3.298	25	0.259
S1	12	2.459	26	0.24
S2	12	2.12	26	0.245
S14	11	3.915	27	0.206
S17	9	2.029	29	0.172
S5	9	1.231	29	0.181
S15	9	0.672	29	0.187
S19	9	0.672	29	0.203
S16	8	1.511	30	0.159
S12	7	1.054	31	0.128
S13	7	1.033	31	0.121
S4	7	0.944	31	0.14
S11	7	0.852	31	0.127

2) Selection of Alternative Frameworks for Coordination and Communication Networks among Mamminasata BRT Stakeholders

This framework was developed to achieve more effective coordination and communication by combining manual and cloud-based digital framework methods. The framework development flowchart is presented in Tables IX and X.

Based on the evaluation of the manual framework, the implementation of the cloud-based digital framework, and the development of a new framework model for coordination and communication between stakeholders, four criteria were produced, namely the number of edges, density value, process duration, and number of activities in the process. These criteria were then analyzed using the AHP with the Expert Choice application, as displayed in Figure 10. Changes in criterion weights affect the ranking of choices, where a visual comparison of alternative performance across criteria and changes in the priority (weight) of a particular criterion affect the overall priority (ranking) of alternatives, as portrayed in Figure 11.

Based on Table VIII, the measurement results reveal that the criterion with the highest value is the number of edges at 0.350 with a consistency value (CR) of 0.04 below 10% (0.1), which is acceptable. The measurements presented in Table XI show that the Framework Development alternative has the highest value of 0.570 with a consistency value (CR) of 0.02, below 10% (0.1).

TABLE VIII. CRITERIA EVALUATION MATRIX

No	Criteria	Priority weight
1	Number of edges	0.350
2	Density	0.322
3	Process duration	0.216
4	Number of processes	0.112
		Inconsistency (CR) = 0.04

TABLE IX. DIGITAL FRAMEWORK DEVELOPMENT FLOWCHART

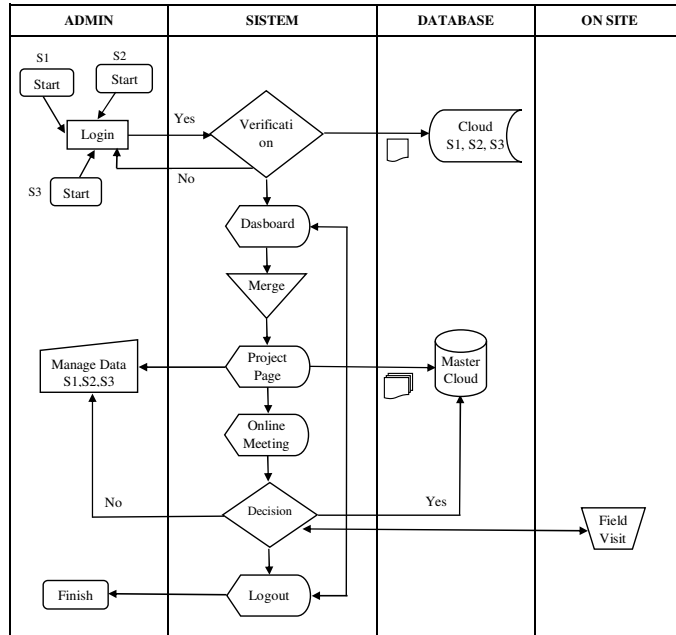


TABLE X. STAGES OF DIGITAL FRAMEWORK DEVELOPMENT

NO	PROCEDURE DESCRIPTION	STAGES				BOOK QUALITY		
		ADMIN	SYSTEM	DATABASE	ON SITE	EQUIPMENT & SUPPLIES	TIME	OUTPUT
1	Several stakeholders/nodes log into the system for coordination and communication regarding the Mamminasata BRT project.					Assignment letter, computer & communication tools	1-2 minutes	Account and password
2	Dinas Perhubungan Susel as the responsible party, conducts verification for entry into the system. If rejected, log in again.					Account & password, ID card	2-3 minutes	Log in to the system
3	Stakeholder representatives included in the system will be provided with data updates and information related to the progress of the Mamminasata BRT project from the database.					Data and documents	30-60 minutes	Update data & information
4	Several stakeholders who have joined the system are making improvements and ensuring the completeness of the data and information presented in the system dashboard.					Data and documents	2-3 hours	Update data & information
5	Stakeholders manually input data and then enter it into the project page system in real time into the database.					Data and documents, results of internal meetings	1 day	Update data & information
6	The system administrator invites stakeholders to an online meeting to discuss project updates and policies.					Data and documents	1-2 days	Minutes of the meeting
7	Conducting field visits as a follow-up to online meetings					Desktop computer, manual folder, vehicle	1 day	Minutes of the visit
8	Results of the visit: if the policy is approved, the data and documents are stored in a database (by the respective person in charge/agency). If not, return to the agency and report to the leadership.					Data and documents, results of field visits	1-2 hours	Documents, databases
9	Stakeholders requested Logout to exit the system. Coordination and communication were completed and will be carried out again periodically.					Report	1-2 minutes	Coordination report
Total Processing Time (Maximum)							<b>4 days, 6 hours, 7 minutes</b>	

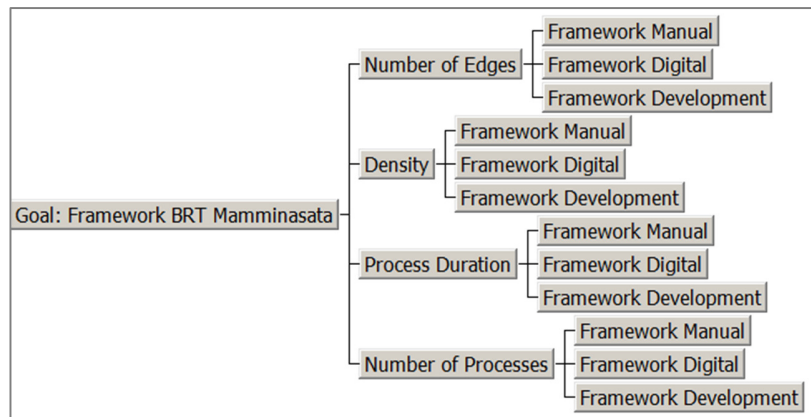


Fig. 10. Criteria hierarchy.

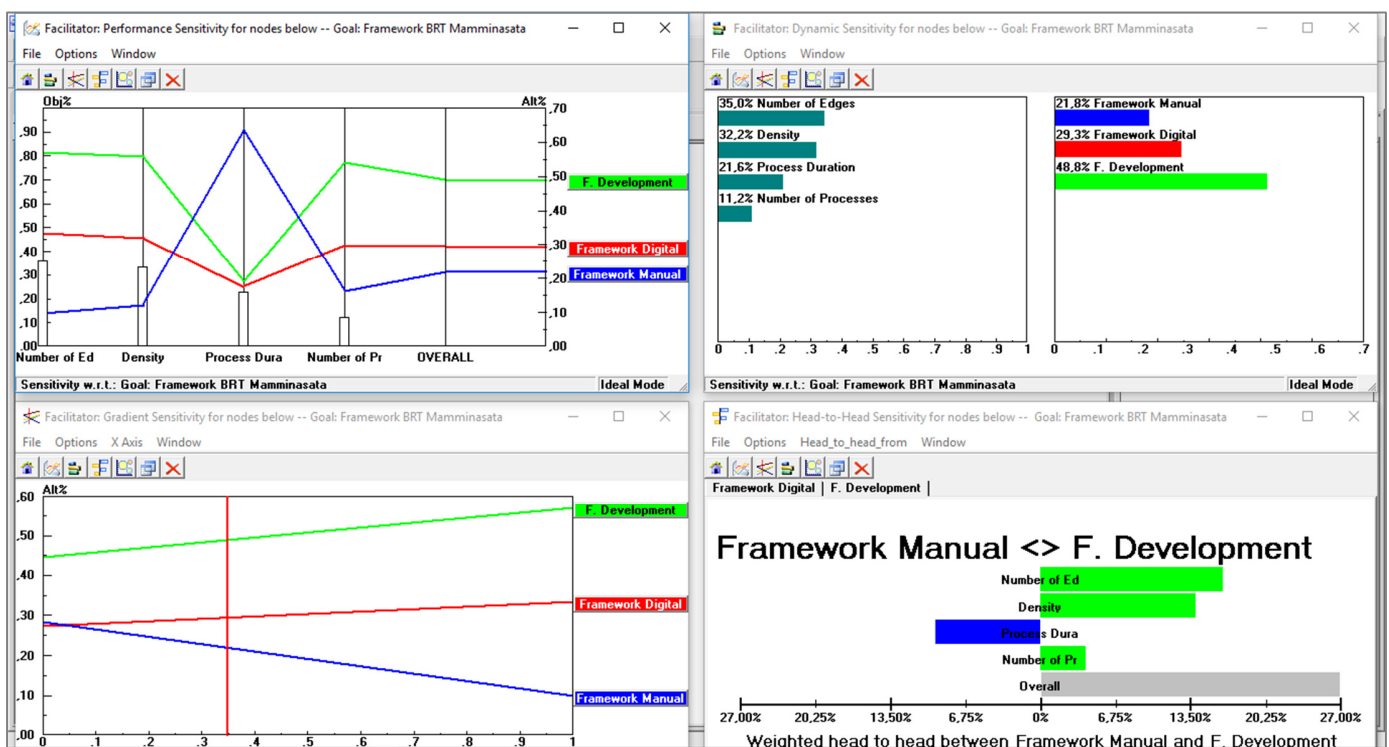


Fig. 11. Alternative performance sensitivity graph.

TABLE XI. ALTERNATIVE SELECTION MATRIX

No	Alternative	Weight value
1	Framework development	0.570
2	Digital framework	0.333
3	Manual framework	0.097
Inconsistency (CR) = 0.02		

IV. CONCLUSION

The density measurement results are categorized as low network connections. The highest energy vector centrality and degree centrality measurements indicate that the key player in the network is S16 (Planning Consultant). Closeness centrality indicates that the node with the shortest path, where the communication time and distance with other nodes are the

fastest, is S12 (Bappeda Kab. Maros). Betweenness centrality measurements indicate that the nodes that control the network (Facilitator) are S6 (Perum Damri Makassar), S10 (Dinas Perhubungan Kota Makassar), and S7 (Dinas Perhubungan Pemprov Sulsel), which also function as nodes that maintain the network from breaking. The implementation of coordination and communication procedures using a cloud-based digital project management framework and a development framework led to notable improvements. Measurements of 20 stakeholders showed an 86% increase in the frequency of relationships (edges) (from 386 to 718), while the development framework model continued to grow by 17%. The density value continues to increase, higher than the standard deviation, which demonstrates that the network is becoming denser (more concentrated), where the

communication and roles between nodes are evenly distributed. The Analytical Hierarchy Process (AHP) analysis results propose a new development model for the framework that combines manual and cloud-based digital methods, offering a short and integrated process, more frequent and effective interactions, cost and coordination efficiency, and real-time updates. This new development framework has the potential to become a technical guideline regulation for the revitalization of the Mamminasata BRT project.

The current transportation analysis method is considered expensive, time-consuming, and requires precise data for reliable results, whereas the Social Network Analysis (SNA) method is fast, cost-effective, and efficient for analyzing transportation networks, both in the planning stage as well as for improving service effectiveness. Future research can be conducted for projects involving agencies from several countries.

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#### REFERENCES

- [1] *Final Report Feasibility Study of BRT in Makassar*. Jakarta, Indonesia: Ministry of Transport Republic of Indonesia, 2022.
- [2] M. T. Al Nahyan, A. Sohal, Y. Hawas, and B. Fildes, "Communication, Coordination, Decision-making and Knowledge-sharing: A Case Study in Construction Management," *Journal of Knowledge Management*, vol. 23, no. 9, pp. 1764–1781, Nov. 2019, <https://doi.org/10.1108/JKM-08-2018-0503>.
- [3] Nurlinah, Haryanto, and M. Chaeroel Ansar, "Comparative Study of Social Welfare Programme Effectiveness Perception in Peri-urban and Rural in Indonesia," *Asia Pacific Journal of Social Work and Development*, pp. 1–18, Apr. 2024, <https://doi.org/10.1080/29949769.2024.2342794>.
- [4] E. N. Piniano and M. Iwanami, "Investigating Optimism about and Impediments to BIM Implementation in Construction Safety Management: Asian Perspectives," *Practice Periodical on Structural Design and Construction*, vol. 29, no. 3, Aug. 2024, Art. no. 04024039, <https://doi.org/10.1061/PPSCFX.SCENG-1458>.
- [5] A. J. Van Deursen and J. A. Van Dijk, "The Digital Divide Shifts to Differences in Usage," *New Media & Society*, vol. 16, no. 3, pp. 507–526, May 2014, <https://doi.org/10.1177/1461444813487959>.
- [6] R. Nurrohman, M. Syah, and A. Alfathir, "Optimizing SOP Design to Improve Safety and Operational Efficiency through the Integration of Digital Skills at PT. XYZ Samarinda," *Martabe Jurnal Pengabdian Kepada Masyarakat*, vol. 8, no. 2, pp. 511–526, Feb. 2025.
- [7] B. Succar and M. Kassem, "Macro-BIM Adoption: Conceptual Structures," *Automation in Construction*, vol. 57, pp. 64–79, Sept. 2015, <https://doi.org/10.1016/j.autcon.2015.04.018>.
- [8] S. Azhar, "Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry," *Leadership and Management in Engineering*, vol. 11, no. 3, pp. 241–252, July 2011, [https://doi.org/10.1061/\(ASCE\)LM.1943-5630.0000127](https://doi.org/10.1061/(ASCE)LM.1943-5630.0000127).
- [9] M. Hemmati and H. Hosseini, "Effect of IT Application on Project Performance Focusing on the Mediating Role of Organizational Innovation, Knowledge Management and Organizational Capabilities," *Engineering, Technology & Applied Science Research*, vol. 6, no. 6, pp. 1221–1226, Dec. 2016, <https://doi.org/10.48084/etasr.769>.
- [10] B. Hardin and D. McCool, *BIM and Construction Management: Proven Tools, Methods, and Workflows*, 2nd ed. Hoboken, NJ, USA: John Wiley & Sons, 2015.
- [11] M. Manullang and R. Rini, "Optimalisasi Manajemen Proyek Konstruksi Berbasis Teknologi Digital: Studi Efisiensi Biaya dan Waktu pada Pembangunan Infrastruktur Perkotaan," *All Fields of Science Journal Liaison Academia and Society*, vol. 5, no. 2, pp. 113–125, Aug. 2025, <https://doi.org/10.58939/afosj-las.v5i2.796>.
- [12] J. T. Karlson, "Project Stakeholder Management," *Engineering Management Journal*, vol. 14, no. 4, pp. 19–24, Dec. 2002, <https://doi.org/10.1080/10429247.2002.11415180>.
- [13] A. Akintoye, *Public-Private Partnerships: Managing Risks and Opportunities*, 1st ed. Chichester, UK: John Wiley & Sons, Incorporated, 2007.
- [14] Y. Wang, Y. Yao, Y. Zhang, and L. Xiang, "A Framework of Stakeholder Relationship Analysis for an Urban Regeneration Project Based on Social Network Analysis: A Dynamic Perspective," *Journal of Urban Planning and Development*, vol. 148, no. 4, Dec. 2022, Art. no. 04022035, [https://doi.org/10.1061/\(ASCE\)UP.1943-5444.0000861](https://doi.org/10.1061/(ASCE)UP.1943-5444.0000861).
- [15] V. Anantatmula and P. Rad, "Linkages Among Project Management Maturity, PMO, and Project Success," in *2013 International Conference on Engineering, Technology and Innovation and IEEE International Technology Management Conference*, The Hague, Netherlands, June 2013, pp. 1–12, <https://doi.org/10.1109/ITMC.2013.7352602>.
- [16] M. Idris, M. Ramli, R. U. Latief, and S. H. Aly, "A Model for the Economic Feasibility Assessment of Urban Road Development in Agglomeration Areas based on Land Value Changes," *Engineering, Technology & Applied Science Research*, vol. 15, no. 3, pp. 23486–23498, June 2025, <https://doi.org/10.48084/etasr.10946>.
- [17] E. Otte and R. Rousseau, "Social Network Analysis: A Powerful Strategy, Also for the Information Sciences," *Journal of Information Science*, vol. 28, no. 6, pp. 441–453, Dec. 2002, <https://doi.org/10.1177/01655515020280601>.
- [18] D. Z. Grunspan, B. L. Wiggins, and S. M. Goodreau, "Understanding Classrooms through Social Network Analysis: A Primer for Social Network Analysis in Education Research," *CBE—Life Sciences Education*, vol. 13, no. 2, pp. 167–178, June 2014, <https://doi.org/10.1187/cbe.13-08-0162>.
- [19] I. H. El-adaway, I. S. Abotaleb, and E. Vechan, "Social Network Analysis Approach for Improved Transportation Planning," *Journal of Infrastructure Systems*, vol. 23, no. 2, June 2017, Art. no. 05016004, [https://doi.org/10.1061/\(ASCE\)IS.1943-555X.0000331](https://doi.org/10.1061/(ASCE)IS.1943-555X.0000331).
- [20] A. Sapountzi and K. E. Psannis, "Social Networking Data Analysis Tools and Challenges," *Future Generation Computer Systems*, vol. 86, pp. 893–913, Sept. 2018, <https://doi.org/10.1016/j.future.2016.10.019>.
- [21] C. R. Kothari, *Research Methodology: Methods and Techniques*, 2nd ed. New Delhi, India: New Age International, 2024.
- [22] H. Doloi, H. Purwoto, M. Yuniza, S. A. P. Rosyidi, and J. Soemardjito, *Assessment of Policy Coordination and Communication in the Development of the Makassar–Parepare Railway Line*. Caulfield East, Australia: The Australia-Indonesia Centre., 2023.
- [23] M. Mincer and E. Niewiadomska-Szynkiewicz, "Application of Social Network Analysis to the Investigation of Interpersonal Connections," *Journal of Telecommunications and Information Technology*, no. 2, pp. 83–91, June 2012, <https://doi.org/10.26636/jtit.2012.2.1268>.