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# The Intention of Bridge Asset Management Implementation in Indonesia

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**Abstract:** The need for effective bridge asset management in Indonesia has become crucial. Currently, the number of bridge assets in Indonesia is continuously increasing, parallel to the rising budget allocations for infrastructure development in the road and bridge sectors to enhance regional connectivity more efficiently. This situation places demands on asset managers to work harder and possess expertise in bridge asset management. However, the reality reveals persistent issues related to the inability of bridge asset managers in various regions to manage their assets effectively. This raises the question of whether asset managers have the intention to implement asset management or what factors might drive their appeal to have an intention towards effective asset management. To address these questions, a survey was conducted involving asset managers and experts to evaluate the current state of bridge asset management in Indonesia. The research findings provide insights into the relationships among factors associated with bridge asset management, such as budget, data, policy, resources, and system, and the intentions of asset managers. The model's solutions show that data and system are anticipated to achieve effective and efficient implementation of bridge asset management. It is hoped that this research will assist asset managers in Indonesia in enhancing their intention towards better bridge asset management.

**Keywords:** bridge; asset; management; intention



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## 1. Introduction

As a developing nation, Indonesia is currently undergoing a period of swift infrastructure development, with a particular emphasis on prioritizing elements such as roads and bridges. These endeavors reflect the government's commitment to enhancing logistical efficiency across different regions. With a large number of road and bridge assets across Indonesia, there is a need for asset managers to provide precise information on the number of assets, their condition, and maintenance plans. The abundance of assets is accompanied by a myriad of challenges, posing a significant concern for researchers striving to devise pertinent solutions. The current nationwide adoption of the road and bridge data management system by the Indonesian government remains underutilized, particularly in the context of decision-making, with a noticeable gap in the effective utilization of bridge-related data. This raises important questions, which this study answers, regarding the factors that contribute to the suboptimal implementation of bridge asset management in Indonesia. Moreover, this research aims to elucidate the motivations underlying the actions of asset managers in Indonesia who have not demonstrated their intention in executing bridge asset management.

The global adoption of bridge asset management practices has surged, with numerous bridge agencies transitioning to sophisticated Bridge Management Systems (BMS) [1]. The overarching goal behind implementing a BMS is to holistically optimize costs throughout a bridge's lifespan, all while prioritizing user safety and safeguarding the asset value of crucial infrastructure [2]. This objective is realized through a meticulous process of data-driven decision-making, leveraging insights gleaned from the condition and performance

metrics of bridges [3]. Thus, the widespread embrace of Bridge Management Systems (BMS) for bridge asset management is not only evident but also underscored by their pivotal role in cost optimization, user safety assurance, and the preservation of infrastructure asset value, all driven by informed decisions rooted in bridge condition and performance data.

Within the realm of successful Bridge Asset Management implementation, government agencies astutely recognize the hurdles embedded in this intricate process, particularly when sculpting an asset management decision-making framework around strategic objectives [4]. Government agencies are grapple with the intricate challenge of catering to diverse stakeholders, each harboring strong opinions shaped by their unique perspectives on asset management. The perpetual focus on short-term budgets further complicates matters, impeding the fulfillment of comprehensive capital investment planning prerequisites crucial for the efficacy of asset management. Furthermore, in the face of mounting pressure to achieve more with finite resources—be it technological, financial, or staff-related—a tangible constraint emerges in meeting the demands inherent in a robust Bridge Asset Management system.

The main aim of bridge management is to find the best strategy that keeps bridges safe while also saving money [5]. This means carefully balancing safety and cost throughout the process. To make Bridge Management System (BMS) deployment more effective, systems and technology can enhance the efficiency and effectiveness of bridge management by providing reliable and objective information [6,7]. This system helps managers make better decisions by considering different factors. Additionally, advanced technologies like Building Information Modeling (BIM) and Unmanned Aerial Systems (UAS) can improve bridge inspections and management, especially with BMS [8–11]. These technologies play a crucial role in making BMS implementation more efficient, particularly in tasks like inspections and data management. Overall, effective asset management relies on supportive systems and technologies that simplify decision-making for managers.

For a successful Bridge Management System (BMS) implementation, significant organizational change is necessary, and having a comprehensive change management strategy is crucial. This strategy should include clear goals, effective communication plans, structured training programs, and strong involvement from stakeholders like bridge engineers, asset managers, maintenance staff, and decision-makers [12]. Their input and engagement greatly improve the system's effectiveness and acceptance. Providing thorough training to bridge staff is vital to ensure they understand and can use the BMS effectively. Moreover, ongoing technical support should be available to address any issues that may arise [12]. In summary, successful BMS implementation relies on thorough organizational change, stakeholder involvement, comprehensive training, and continuous technical assistance.

Asset managers often encounter decision-making challenges due to incomplete information stemming from the absence of a robust national bridge database or Bridge Management System (BMS), coupled with inadequate data on bridge conditions resulting from irregular monitoring practices [13]. To address this issue, a comprehensive deployment plan for the BMS is imperative, delineating specific steps, timelines, and responsibilities [14]. This plan should be tailored to accommodate the unique requirements of the organization [14]. Adequate allocation of resources—financial, human, and technological—is crucial to ensure the effective functioning and sustained operation of the BMS [15]. In summary, enhancing decision-making in asset management necessitates meticulous planning aligned with organizational needs and the provision of ample resources to overcome challenges associated with the absence of a robust national bridge database or management system.

Ensuring seamless integration of the Bridge Management System (BMS) within the organizational framework is imperative. This integration facilitates efficient data sharing, enhances workflow processes, and optimizes operational efficiency [16]. Regular monitoring and evaluation of BMS performance are equally essential. This practice allows for the identification of areas requiring improvement and ensures continued alignment with organizational objectives [16]. Given the dynamic nature of bridge management practices and technologies, regular updates of the BMS are indispensable. This involves incorporating

new advancements, adhering to industry best practices, and drawing insights from prior experiences [16]. Additionally, fostering a culture of knowledge-sharing and collaboration among bridge personnel is paramount. This cultivates effective utilization of the BMS and nurtures key skills such as technical proficiency, communication, leadership, and problem-solving [17]. To summarize, seamless integration of the BMS, ongoing evaluation and updates, and promoting collaboration among bridge managers and staff are fundamental for enhancing operational efficiency and skill development.

Asset management within government agencies presents numerous challenges, including ineffective maintenance practices, misuse of assets, and a lack of familiarity with proper asset management protocols. These issues impact the efficacy, efficiency, and economic management of assets [18]. Additionally, constrained resources pose obstacles to achieving organizational objectives outlined in the agency's vision, mission, and policies. Furthermore, instances of wasteful spending and mismanagement indicate suboptimal utilization of public funds [18]. Moreover, despite government interest in adopting new technologies, the absence of clear implementation guidelines often results in unsuccessful endeavors, underscoring the need for a deeper understanding of factors contributing to successful technology adoption [19]. According to [20], effective bridge management entails three primary processes: comprehending assets, decision-making, and implementing interventions. Asset managers navigate these processes by conscientiously evaluating the operational context, with some seeking to shape this environment through advocating for budget allocations, establishing standards, and defining objectives. In sum, the multifaceted challenges encountered by government agencies in asset management, spanning maintenance, resource allocation, technology integration, and the determinants of successful implementation, underscore the intricate nature of asset management within the public sector.

Previous research has extensively discussed the successful implementation of bridge asset management using various methods, but it has not been specific enough to address asset management practitioners. Only a few studies cited emphasize the significant influence of asset managers in enhancing asset management practices. Nonetheless, the variability in individual asset managers' comprehension of the system has impeded the optimal effectiveness of bridge asset management. This study endeavors to rectify this issue by offering insights into the requisite characteristics of an ideal asset manager essential for the successful implementation of bridge asset management.

A noticeable gap exists in the literature: there is a dearth of research investigating the preferences of asset managers regarding bridge asset management implementation. This deficiency underscores the necessity for comprehensive research endeavors aimed at elucidating the multifaceted factors that contribute to successful implementation. This unexplored dimension emphasizes the exigency for novel research initiatives within the academic sphere.

## 2. Literature Review and Hypothesis Development

Implementing bridge asset management comes with many challenges, as Hooper (2009) points out. Asset management involves key elements like financial aspects (budgets), managing information (data and systems), and developing human resources through training and awareness [21]. The challenges include financial constraints, difficulties in obtaining and verifying data, government policies governing asset management, limitations in human resources, and the tools used for asset management. These challenges show how complex implementing bridge asset management can be.

In infrastructure asset management, the relationship between budget availability and asset management implementation is highly significant [22]. The presence of available budgets alongside asset management plays a crucial role in ensuring optimal conditions in infrastructure asset management and maintenance [23]. Limited budget availability, resources, skilled personnel, and technological capabilities pose challenges to asset management implementation [24]. Budget allocation plays a pivotal role in bridge asset management for bridge maintenance and rehabilitation to ensure integrity and structural

functionality [25]. With this foundation, H1: budgeting becomes one of the critical factors and maintains a significant relationship in the implementation of bridge asset management.

Furthermore, data are one of the critical factors in supporting asset management implementation, where validated data ensure accuracy, completeness, and consistency in the information provided [26]. By validating data, asset managers can make decisions based on reliable information, which is crucial for the effectiveness of infrastructure asset maintenance and management [27]. Data validation plays a critical role in asset management to ensure the reliability and safety of infrastructure assets [28]. The availability and quality of data are essential for effective asset management [29]. The relationship between data and management systems is very close, and this relationship has a real causal impact, as shown in Figure 1. This indicates that the presence of inaccurate data can result in compromised outputs within the bridge management system [30]. H2: Access to accurate and up-to-date data on infrastructure assets is crucial for informed decision-making and prioritization of maintenance and investment activities.

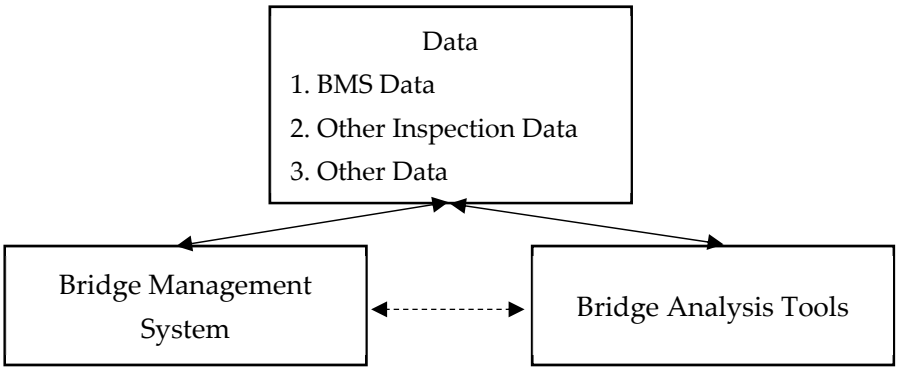


**Figure 1.** The relationship between BMS, data, and analysis tools, Sanford et al. (1999) [30].

The correlation between policy and asset management in infrastructure is crucial for ensuring the long-term resilience and sustainability of our urban environments [31], and is crucial for ensuring the resilience and sustainability of essential infrastructure assets [32]. Policy provides the framework and guidelines for asset management practices, while asset management ensures that infrastructure assets are properly maintained and utilized by policy objectives [33]. The presence of supportive regulatory and policy frameworks can facilitate the implementation of asset management practices [24]. H3: Clear guidelines, standards, and regulations can provide a framework for asset management implementation and ensure consistency across organizations.

Effective and efficient operations in the realm of infrastructure asset management hinge on the vital correlation between human resources and asset management [34]. There is a strong correlation between human resources and asset management in infrastructure [35]. In the infrastructure sector, the effective management and maintenance of assets relies heavily on the pivotal role played by human resource management [36]. The availability of technical expertise and appropriate tools for asset management, such as data management systems, modeling software, and risk assessment tools, can influence the implementation process [37]. H4: Access to these resources can support effective decision-making and analysis in asset management.

The correlation between system and asset management in infrastructure is a critical aspect that ensures the efficient and effective management of physical assets [38]. Infrastructure asset management involves the strategic planning, acquisition, operation, maintenance, and disposal of physical assets such as buildings, roads, bridges, and utilities [39]. The correlation between system and asset management in infrastructure is crucial for effective planning, maintenance, and long-term sustainability [40]. Management systems have been widely applied in various aspects of infrastructure, including pavement, rebuilding of infrastructure, human resources, bridges, traffic, and safety [41].

H5: The system plays a pivotal role, with robust support, in ensuring the success of asset management implementation.

According to the extant body of literature, the execution of asset management, in its overarching scope, can be subject to diverse determinants, including budget availability, data quality, governmental policies, resource availability, and system support. Nonetheless, such determinants may assume a distinctive complexion within the Indonesian context, where practical outcomes have hitherto failed to harmonize adequately with the exigencies of bridge maintenance and rehabilitation. Consequently, this imbues researchers with the impetus to undertake more exhaustive scrutiny of the intricate interplay between these determinants and the proclivities of bridge asset managers in Indonesia vis-à-vis the effective implementation of asset management.

This study also employs the Theory of Planned Behavior, shown in Figure 2, which has not been previously utilized by researchers, to examine the correlation between the intentions of bridge asset managers to adopt bridge asset management in Indonesia. The goal is to ascertain the pivotal factors that impact the intentions of bridge asset managers to ensure the efficacy and precision of bridge asset management in Indonesia.

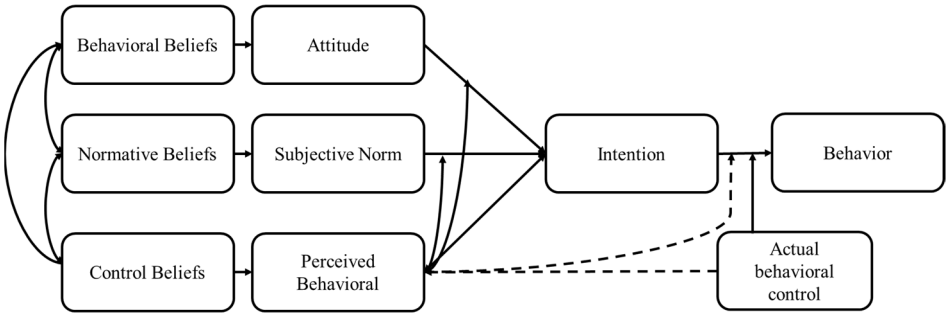


**Figure 2.** Theory of Planned Behavior (Icek Ajzen, 2012) [42].

The Theory of Planned Behavior (TPB) is a well-known framework used to predict and explain human behavior in different areas [42]. It was developed in 1985 as an extension of the Theory of Reasoned Action [43]. The TPB considers factors like personal attitudes, social influences, and perceived control to understand and forecast intentions [44]. It suggests that intentions are influenced by three main factors: attitudes, social norms, and perceived control [45]. Attitudes reflect how someone sees the behavior and its outcomes, social norms involve pressure from others to act or not act, and perceived control relates to someone's belief in their ability to perform the behavior [45]. Together, these factors shape a person's intention to do something. The TPB is widely used in various fields like psychology, sociology, medicine, and environmental studies [46,47]. It has been applied to study behaviors such as recycling and environmentally friendly purchasing [46,47]. Overall, the TPB offers a structured way to understand and predict human intentions, drawing on factors like attitudes, social norms, and perceived control.

Implementing asset management involves deciding how to use resources and manage assets [48]. The Theory of Planned Behavior (TPB) can help organizations understand what influences these decisions and resource allocation. For instance, attitudes towards asset management can affect how resources are prioritized and how much investment goes into managing assets [48]. The expectations and opinions of stakeholders, known as subjective norms, can also influence asset management decisions. Another important factor is perceived behavioral control, which reflects how confident someone feels about managing assets effectively and dealing with challenges [44]. Using the Theory of Planned Behavior (TPB) can help organizations understand how attitudes, subjective norms, and perceived control affect decision-making and resource allocation in asset management, highlighting the importance of TPB in improving asset management practices.

In conclusion, the Theory of Planned Behavior offers useful insights for implementing asset management in organizations. By examining attitudes (H6), subjective norms

(H7), and perceived behavioral control (H8) as factors influencing the intentions of bridge asset managers, organizations can grasp how decision-making, resource allocation, and competency development in asset management are influenced. This understanding can guide strategies to encourage positive intentions and behaviors, ultimately enhancing asset management practices' effectiveness.

## 3. Research Methodology

### *3.1. Methodology*

This study endeavors to construct a comprehensive model elucidating the intentions of bridge asset managers and their readiness to implement bridge asset management practices in Indonesia, with a particular focus on national road segments. Employing a mixed-method approach that seamlessly integrates qualitative and quantitative methodologies, we aim to delve deep into the underlying factors shaping asset managers' attitudes, subjective norms, perceived behavioral control, and overall willingness to engage in effective bridge asset management.

In the qualitative phase, insightful interviews were conducted with 14 seasoned senior bridge asset managers at the Directorate General of Highways, each boasting over 15 years of invaluable experience in the field. These interviews, meticulously structured to unearth the nuances of bridge asset management in Indonesia, provided rich data on both challenges and opportunities, laying the groundwork for a robust conceptual framework.

Moving to the quantitative aspect, a meticulously crafted questionnaire was administered to a diverse pool of bridge asset management representatives across Indonesia. This survey, designed to gauge components within the Theory of Planned Behavior model, meticulously assessed attitudes, subjective norms, and perceived behavioral control. Rigorous statistical analyses, including regression analysis, were then employed to uncover intricate relationships between these factors and the propensity to implement bridge asset management practices effectively.

This research methodology extends beyond mere data collection, incorporating a thorough examination of relevant literature, policy documents, and best practices to provide a comprehensive contextual understanding. The strategic utilization of both qualitative and quantitative data not only enriches our insights into the complex dynamics of bridge asset management but also enhances our ability to leverage the Theory of Planned Behavior effectively in improving practices within this critical domain.

The target respondents for this study are bridge asset managers in Indonesia, spread across several directorates and regions. There are 14 sub-directorates in the central office and 33 managers in regional offices directly involved in bridge asset management. Among these, there are also several experienced former managers who are expected to participate in this study, given the limited number of respondents. As the limited sample size may affect the statistical outcomes of the research, it is also important to conduct the interview before and after the questionnaire development to validate whether the actual condition fits with the research output.

Given the limited pool of bridge asset managers, a purposive sampling strategy was adopted, ensuring the selection of respondents based on their relevance and suitability to contribute meaningfully to the study. The questionnaire was distributed online through a dedicated social network group, yielding a robust response from 65 participants across central and provincial offices. Subsequent data analysis, employing multiple regression analysis and Quantitative Comparative Analysis (QCA), unveiled nuanced correlation values among variables and shed light on distinct patterns across different groups, enriching our understanding of the intricate interplay of factors influencing bridge asset management practices in Indonesia.

Data were subsequently analyzed using Multiple Regression Analysis and Quantitative Comparative Analysis (QCA) to determine correlation values among the variables. Multiple Regression Analysis was utilized to quantify the relationships between a dependent variable (Y) and multiple independent variables (X1, X2, X3, . . ., Xn). The objective

was to understand how these independent variables collectively influence the dependent variable [49]. Meanwhile, QCA was applied due to the limited sample size, aiming to elucidate relationships among specific groups, where the outcomes might differ from one group to another [50]. It is concluded that the use of Multiple Regression Analysis to quantify relationships between dependent and independent variables collectively, alongside Quantitative Comparative Analysis (QCA) for evaluating relationships among specific groups, was appropriate given the constraints of a limited sample size.

### *3.2. Theoretical Structure of Frameworks*

Based on an extensive review of relevant literature, it is evident that the implementation of bridge asset management does not always proceed as smoothly as planned. This comprehensive analysis has identified several factors that could potentially influence a bridge asset manager's inclination to engage in asset management. Among these factors are limited budget allocation, insufficiently validated bridge condition data quality, policies lacking full support and effective implementation, a dearth of human resources and tools, and an underutilized bridge management system. In a general sense, these elements present obstacles to the successful execution of bridge asset management. However, it is imperative to ascertain the extent to which these factors impact a bridge asset manager's intent to manage bridge assets effectively. These factors will be integrated into a conceptual research model using the Theory of Planned Behavior, where they are expected to influence the attitude, subjective norms, and perceived behavioral control of individual asset managers, as depicted in Figure 3.

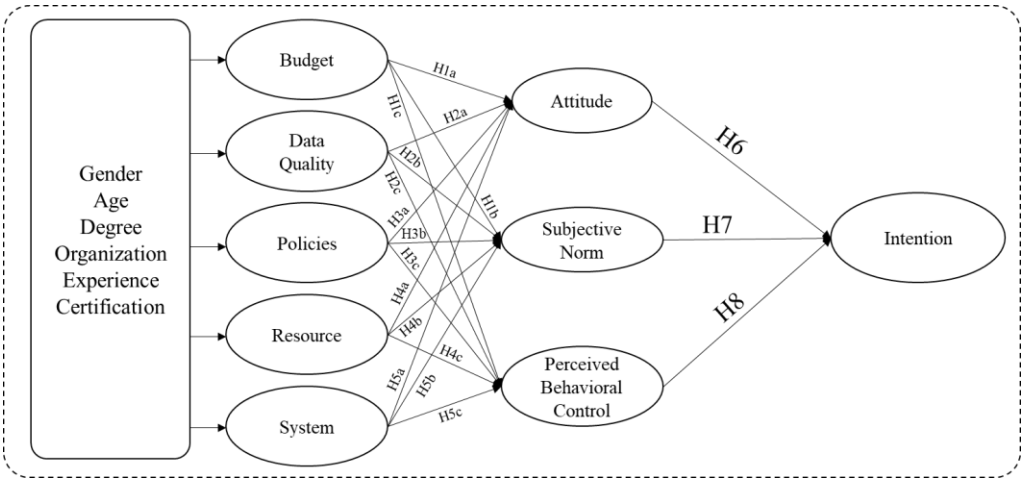


**Figure 3.** Conceptual model.

Five factors influencing the attitude, subjective norms, and perceived behavioral control of bridge asset managers and their inclination to engage in bridge asset management have been identified. These factors serve as the foundation for developing a model that elucidates the influence of a bridge asset manager's intent. The first factor for measurement is the budget availability for bridge asset management. The second is data quality, followed by the impact of policies, the availability of resources (both human and equipment), and the effectiveness of the bridge asset management system used. The forthcoming section details each of the five hypotheses presented in the literature review and hypothesis development chapter.

The identified variables are used to formulate a research hypothesis, drawing on literature from similar research models. Adjustments are made in this study to articulate the hypotheses discussed earlier. Consequently, the research questionnaire is expected to effectively test the validity and reliability of several questions. The relationship between variables and hypotheses is depicted as positive in Table 1 and will be supported by questions derived from the literature review, adjusted to fit the research objectives.

**Table 1.** Hypothesis.

| Variable | Hypothesis | Source |
| --- | --- | --- |
| Budget | (H1a) Budget allocation has a positive effect on attitude.<br>(H1b) Budget allocation has a positive effect on subjective norms.<br>(H1c) Budget allocation has a positive effect on perceived behavioral control | Modified from [22–24,51,52] |
| Data Quality | (H2a) Data quality has a positive effect on attitude.<br>(H2b) Data quality has a positive effect on subjective norms.<br>(H2c) Data quality has a positive effect on perceived behavioral control | Modified from [26–29,51] |
| Policies | (H3a) Policies have a positive effect on attitude.<br>(H3b) Policies have a positive effect on subjective norms.<br>(H3c) Policies have a positive effect on perceived behavioral control | Modified from [24,31–33,51] |
| Resource | (H4a) The resource has a positive effect on attitude.<br>(H4b) The resources have a positive effect on subjective norms.<br>(H4c) The resource has a positive effect on perceived behavioral control | Modified from [34–37,51] |
| System | (H5a) The system has a positive effect on attitude.<br>(H5b) The system has a positive effect on subjective norms.<br>(H5c) The system has a positive effect on perceived behavioral control | Modified from [38–41,51] |
| Attitude | (H6) Attitude has a positive effect on Intention | Modified from [1,24,51] |
| Subjective norms | (H7) Subjective norms have a positive effect on Intention | Modified from [51,53–55] |
| Perceived behavioral control | (H8) Perceived behavioral control has a positive effect on Intention | Modified from [51,53–55] |

In this study, five main variables (Budget, Data Quality, Policies, Resources, and System) serve as predictors, with each having three measurement items that represent their relationship with the dependent variables. There are three dependent variables: Attitude, Subjective Norms, and Perceived Behavioral Control. Each of these dependent variables also includes several modified measurement items derived from relevant research literature.

## 4. Results

### *4.1. Data Collection*

The data collection process for this study employed a questionnaire method, which was meticulously designed based on the theoretical framework aligned with the Theory of Planned Behavior. The questionnaire was specifically tailored for asset managers directly involved in the management of bridges within the jurisdiction of national roads. Each factor influencing Attitude, Subjective Norm, and Perceived Behavioral Control served as a measuring tool to predict a manager's inclination toward bridge asset management. The initial segment of the questionnaire encompassed demographic information about the respondents, including gender, age, education, organizational affiliation, experience, and certification ownership. The second section consisted of various statements derived from Attitude, Subjective Norm, Perceived Behavioral Control, and Intention. These statements were formulated to gauge the intentions of asset managers in effectively administering bridge asset management.

Table 2 presents demographic information for the study's 65 participants. The majority were male (87.69%), with 57 males and 8 females. Regarding age, 63.07% were between 21 and 40 years old, while 32.31% were aged 40 to 60, mainly senior managers, and 4.62% were 60 or older. Educational backgrounds varied: 41.54% held undergraduate degrees, and 55.38% had graduate degrees. In terms of affiliation, 44.62% were with the National Road Implementation Agency and 55.38% were with the Directorate. Work experience was split, with 52.31% having less than 10 years and 47.69% over 10 years. Additionally, 53.85% held certifications, while 46.15% did not.

**Table 2.** Respondent demographics.

| Variable | Category | Frequency | Percentage (%) |
|---|---|---|---|
| Gender | Male | 57 | 87.69 |
| | Female | 8 | 12.31 |
| Age | 21–40 | 41 | 63.07 |
| | 41–60 | 21 | 32.31 |
| | >60 | 3 | 4.62 |
| Education | Undergraduate | 27 | 41.54 |
| | Graduate | 38 | 58.46 |
| Organization | National Road Implementation Agency | 29 | 44.62 |
| | Directorate | 36 | 55.38 |
| Experience | <10 Year | 34 | 52.31 |
| | ≥10 Year | 31 | 47.69 |
| Certification | Certified | 35 | 53.85 |
| | Not Certified | 30 | 46.15 |

In this questionnaire, several questions were presented using a Likert scale measurement (ranging from Strongly Disagree to Strongly Agree) with values ranging from 1 to 5. The questionnaire comprised statements depicting the relationships between factors and Attitude, Subjective Norms, as well as Perceived Behavioral Control. The aim was to capture the intentions of bridge asset managers concerning achieving optimal outcomes in bridge asset management. Responses from participants to the statements presented in the questionnaire are illustrated in Table 3.

**Table 3.** Questionnaire response.

| Variable | Measurement Items | Mean | Sd |
|---|---|---|---|
| Budget (BG) | • (BG-ATT) I need to allocate a budget for the bridge asset management system. The availability of funds will impact my attitude toward bridge asset management implementation. | 4.54 | 0.588 |
| | • (BG-SN) I prefer to allocate a budget for the implementation of a bridge asset management system because the availability of a budget will affect my work environment and behavior to carry out bridge asset management. | 4.34 | 0.713 |
| | • (BG-PBC) I believe the budget allocation for the bridge asset management system will improve the quality of bridge planning and programming results because the availability of the budget will affect my confidence in implementing bridge asset management. | 4.46 | 0.686 |
| Data Quality (DQ) | • (DQ-ATT) I want to improve the data quality for better implementation of the bridge asset management system because good data quality will affect my attitude toward implementing bridge asset management. | 4.82 | 0.429 |
| | • (DQ-SN) I prefer to improve data quality for use in the bridge asset management system because good data quality will affect my work environment and behavior in carrying out bridge asset management. | 4.74 | 0.476 |
| | • (DQ-PBC) I believe that the accuracy of the data collected has a direct impact on the effectiveness of the implementation of bridge asset management because good data quality will affect my confidence in implementing bridge asset management. | 4.71 | 0.491 |
| Policies (PC) | • (PC-ATT) I want to update the policy for better implementation of the bridge asset management system because proper and appropriate policy will affect my attitude toward implementing bridge asset management. | 4.52 | 0.615 |
| | • (PC-SN) I prefer to update the policy for better implementation of the bridge asset management system because the right and appropriate policy will affect my work environment and behavior in carrying out bridge asset management. | 4.38 | 0.7 |
| | • (PC-PBC) I believe that the right policy framework will increase the effectiveness of the implementation of Bridge Asset Management because the right and appropriate policies will affect my confidence in implementing bridge asset management. | 4.52 | 0.562 |

**Table 3.** *Cont.*

| Variable | Measurement Items | Mean | Sd |
|---|---|---|---|
| Resource (RC) | • (RC-ATT) I want to allocate staff and equipment to implement the bridge asset management system because the availability of resources will affect my attitude toward carrying out bridge asset management. | 4.66 | 0.538 |
| | • (RC-SN) I prefer to allocate staff and equipment to support the implementation of the bridge asset management system because the availability of human resources and equipment will affect my work environment and behavior to carry out bridge asset management. | 4.45 | 0.638 |
| | • (RC-PBC) I believe that defining clear roles and responsibilities for human resources and the availability of tools will improve the implementation of bridge asset management because the availability of human resources and equipment will affect my confidence in carrying out bridge asset management. | 4.62 | 0.604 |
| System (SY) | • (SY-ATT) I want to improve the capabilities of the existing system for better implementation of bridge asset management. The available system will influence my attitude toward implementing bridge asset management. | 4.66 | 0.508 |
| | • (SY-SN) I prefer to update the system for better implementation of bridge asset management because the system that suits my needs will influence my work environment and behavior to carry out bridge asset management. | 4.46 | 0.663 |
| | • (SY-PBC) I believe that a system that fits the needs is very important for the accuracy and effectiveness of bridge asset management because a system that fits the needs will affect my ability to carry out the bridge. | 4.57 | 0.558 |
| Attitude (ATT) | • (ATT1) I would like to implement Bridge Asset Management to improve the durability and longevity of infrastructure. | 4.62 | 0.629 |
| | • (ATT2) Implementing Bridge Asset Management would enhance cost-effectiveness in maintenance and repairs, which is something I'm interested in. | 4.68 | 0.562 |
| Subjective Norms (SN) | • (SN1) I prefer to be supportive in implementing Bridge Asset Management practices as recommended by my colleagues. | 3.8 | 1.064 |
| | • (SN2) I prefer to participate in the implementation of Bridge Asset Management practices as recommended by my superior. | 3.88 | 0.91 |
| | • (SN3) I prefer to support the implementation of Bridge Asset Management as directed by my organization. | 4.23 | 0.786 |
| Perceived Behavioral Control (PBC) | • (PBC1) I believe that putting time and resources will improve the implementation of Bridge Asset Management result. | 4.32 | 0.664 |
| | • (PBC2) I believe that proactive steps are needed to support and contribute to the implementation of Bridge Asset Management | 4.51 | 0.534 |
| | • (PBC3) I believe in the successful implementation of Bridge Asset Management, and I will recommend it to my colleagues and peers | 4.45 | 0.613 |
| Intention | • (INT1) I have the intention to implement the Bridge Asset Management. | 4.62 | 0.521 |
| | • (INT2) I have the intention to recommend Bridge Asset Management to my colleagues, superiors, and organization. | 4.51 | 0.589 |
| | • (INT3) I plan to allocate time and resources to ensure the effective implementation of Bridge Asset Management. | 4.43 | 0.585 |
| | • (INT4) I have the intention to be proactive, support, and contribute to the implementation of Bridge Asset Management. | 4.49 | 0.562 |

Table 3 reveals that respondents generally show agreement with the questionnaire statements, as reflected in average response values ranging from 3.8 to 4.82. Particularly noteworthy is the statement concerning the impact of data quality on attitude, which receives the highest average score and the lowest standard deviation. This suggests a consistent trend among respondents toward prioritizing data quality improvement, indicating a collective willingness to enhance data quality in support of bridge asset management.

To optimize the analysis given the limited number of respondents holding managerial positions in bridge asset management, two analytical approaches will be employed: Multiple Regression Analysis and Quantitative Comparative Analysis (QCA). Multiple Regression Analysis, conducted using SPSS software version 29.0.0.0 (241), will examine relationships between predictors and the dependent variable. This will be demonstrated

through Standardized Coefficients Beta values, where values < 0.05 indicate statistical significance. The goal is to understand the extent to which each predictor contributes to the dependent variable. Concurrently, QCA will be performed using fsQCA software version 3.0 to identify the data configurations most supportive of managerial intentions. This analysis will explore various combinations of factors and variables, providing insights into the configurations aligning best with managerial intentions. Utilizing both methodologies will enrich the analytical process, considering nuanced aspects of the data and ensuring a robust exploration of potential relationships.

### *4.2. Multiple Regression Analysis*

The Multiple Regression analysis results are presented in detail in Table 4, showing the relationship between various predictors and dependent variables in bridge asset management. Budget emerges as the primary determinant for Attitude, showing a moderate positive effect. Policies are the most significant determinant for the subjective norm, while Budget has a weak positive effect. Perceived Behavioral Control is influenced by Budget, Data Quality, and Resource, showing moderately significant positive effects. Finally, Perceived Behavioral Control has the highest impact on Intention, followed by Attitude, albeit weakly, while Subjective Norm shows a weak and non-significant relationship with Intention.

**Table 4.** Multiple regression analysis results.

| Predictors → Dependent Variable | Standardized Coefficients Beta (β*) | Sig. (*p*) | Hypothesis |
|---|---|---|---|
| Budget → Attitude | 0.382 | <0.001 | H1a → supported |
| Data Quality → Attitude | 0.252 | 0.004 | H2a → supported |
| Policies → Attitude | 0.267 | 0.003 | H3a → supported |
| Resource → Attitude | 0.087 | 0.381 | H4a → not supported |
| System → Attitude | 0.105 | 0.376 | H5a → not supported |
| Budget → Subjective Norm | 0.138 | 0.021 | H1b → not supported |
| Data Quality → Subjective Norm | 0.026 | 0.676 | H2b → not supported |
| Policies → Subjective Norm | 0.408 | <0.001 | H3b → supported |
| Resource → Subjective Norm | 0.073 | <0.001 | H4b → supported |
| System → Subjective Norm | 0.091 | 0.007 | H5b → not supported |
| Budget → Perceived Behavioral Control | 0.258 | <0.001 | H1c → supported |
| Data Quality → Perceived Behavioral Control | 0.264 | <0.001 | H2c → supported |
| Policies → Perceived Behavioral Control | 0.005 | 0.944 | H3c → not supported |
| Resource → Perceived Behavioral Control | 0.276 | 0.001 | H4c → supported |
| System → Perceived Behavioral Control | 0.274 | 0.008 | H5c → not supported |
| Attitude → Intention | 0.219 | 0.071 | H6 → not supported |
| Subjective Norm → Intention | -0.065 | 0.536 | H7 → not supported |
| Perceived Behavioral Control → Intention | 0.574 | <0.001 | H8 → supported |

Figure 4 reveals the relationship between various predictors and the dependent variable, Attitude. Budget emerges as the primary determinant for bridge asset managers, showing a moderate positive effect on Attitude. Data and Policies also demonstrate statistically significant positive effects on Attitude, albeit weaker than Budget. Conversely, Resource and System exhibit non-significant effects on Attitude, suggesting a weak and inconclusive relationship.

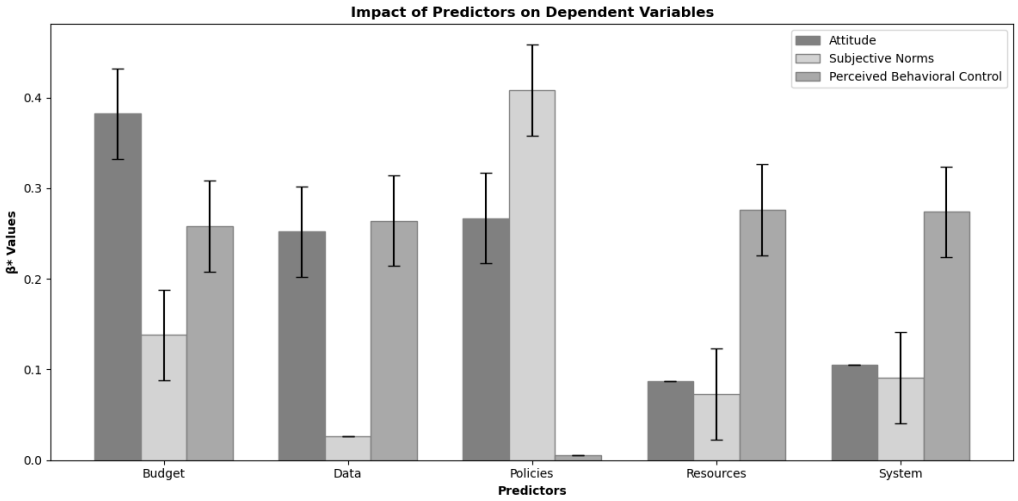


**Figure 4.** Predictors influencing Dependent Variables.

In determining the subjective norm of a bridge asset manager in Figure 4, Policies emerge as the most significant determinant, showing a strong positive relationship. Resources also have a significant positive effect, though moderately weaker than Policies. Budget and System demonstrate statistically significant but weak positive effects on the subjective norm. However, Data has a non-significant and very weak influence on subjective norms.

According to Figure 4, Perceived Behavioral Control is influenced by three predictors: Budget, Data Quality, and Resource. These show moderately significant positive effects on Perceived Behavioral Control, indicating that increases in these factors are associated with increased control perception. System also demonstrates a moderately strong positive effect on Perceived Behavioral Control. However, Policies have a non-significant and very weak influence, suggesting they do not significantly affect Perceived Behavioral Control.

Based on the analysis in Figure 5, the predictor with the highest impact on Intention is Perceived Behavioral Control, showing a robust positive relationship with Intention. Attitude demonstrates a non-significant but weakly positive relationship with Intention, indicating a slight potential contribution. Subjective Norm, however, shows a non-significant and weak negative influence on Intention, suggesting a weak and non-significant relationship.

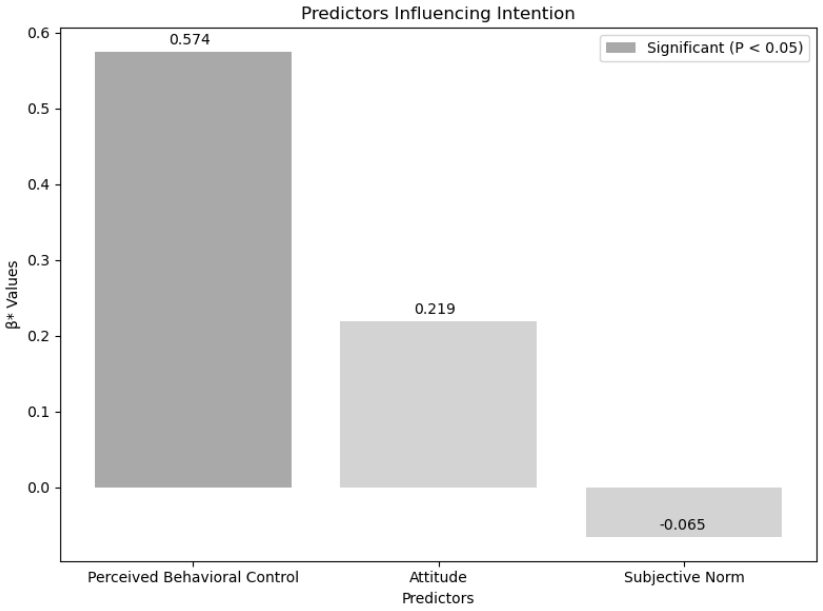


**Figure 5.** Predictors influencing Intention.

### *4.3. QCA*

To determine the most optimal model configuration that yields the highest values for coverage and consistency, calculations were conducted using the fsQCA application with truth table analysis on the parsimonious and intermediate solutions. In this computation, Intention serves as the output variable incorporating Budget, Data Quality, Policies, Resources, and System as factors. Additionally, Attitude, Subjective Norm, and Perceived Behavioral Control are included as causal conditions, with the results presented in Table 5. According to [56,57], the categorization of causal conditions into core or peripheral configurations is based on the parsimonious solution and intermediate solution; core conditions are those present in both parsimonious and intermediate solutions, while peripheral conditions are eliminated in the parsimonious solution and only appear in the intermediate solution. Thus, this approach defines causal coreness in terms of the strength of evidence relative to the outcome, rather than connectedness to other configurational elements.

**Table 5.** All factors towards intention.

| **Config.** | **Solution** | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** |
| Budget | x | | o | | x | x | x | x | x | x | x | o | x | o | o | x | o | x |
| Data | O | O | O | O | O | X | X | X | X | O | O | | | O | | X | X | O |
| Policies | | o | | x | x | x | x | o | x | o | o | x | o | o | o | x | o | o |
| Resources | o | o | o | x | | x | x | | x | o | o | o | o | | o | x | o | x |
| System | O | O | O | X | X | X | | X | X | O | O | X | O | O | O | O | X | O |
| Attitude | O | O | O | X | X | O | X | X | O | X | O | O | O | O | O | X | X | O |
| Subj. Norm | | | | X | X | | O | O | O | X | X | O | O | O | O | X | O | O |
| PBC | X | X | O | X | X | X | X | X | | | | X | X | X | O | O | O | O |
| Consistency | 0.971 | 0.961 | 0.937 | 0.850 | 0.849 | 0.883 | 0.887 | 0.908 | 0.909 | 0.986 | 0.964 | 0.947 | 0.975 | 0.977 | 0.929 | 0.967 | 0.995 | 0.992 |
| Raw Cov. | 0.273 | 0.305 | 0.716 | 0.172 | 0.171 | 0.175 | 0.157 | 0.164 | 0.161 | 0.177 | 0.224 | 0.193 | 0.224 | 0.267 | 0.576 | 0.154 | 0.156 | 0.186 |
| Unique Cov. | 0.001 | 0.009 | 0.094 | 0.011 | 0.007 | 0.003 | 0.007 | 0.005 | 0.001 | 0.004 | 0.003 | 0.003 | 0 | 0.004 | 0.001 | 0.005 | 0.004 | 0.004 |

Note: O = core causal condition (present). o = peripheral causal condition (present). X = core causal condition (absent). x = peripheral causal condition (absent). Blank spaces indicate "do not care".

According to the results of the fsQCA calculations presented in Table 5, the core conditions that emerge are Data Quality and System, along with Attitude, Subjective Norm, and Perceived Behavioral Control, as indicated in the solution column. This occurrence is due to these condition configurations appearing in both parsimonious and intermediate solutions. Based on Table 5, two dominant patterns emerge for solutions that an asset manager can employ in bridge asset management, namely solutions three and fifteen. The third solution exhibits the highest coverage value at 71.6%, coupled with a consistency value of 0.961. This finding indicates that Budget, Data, Resources, and System positively influence the Intention of bridge asset managers, with Data and System serving as core conditions. Additionally, both Attitude and Perceived Behavioral Control contribute to this positive influence. Another notable solution is found in the 15th configuration, which has a coverage value of 57.6% and a consistency value of 0.929. In this configuration, Budget, Policies, Resources, and System exhibit positive influences, along with Attitude, Subjective Norm, and Perceived Behavioral Control, on the Intention of bridge asset managers.

In the analysis phase using QCA, a more in-depth investigation is also conducted regarding the preferences of a manager in implementing bridge asset management. In this stage, data are categorized into three detailed scopes. First, a comparison is made between Certified Bridge Asset Managers and Non-Certified Bridge Asset Managers. The term "Certified" here refers to asset managers who have obtained certification in the field of bridge expertise. Second, a comparison is made between Bridge Asset Managers with less than 10 years of experience and those with more than 10 years of experience. Last, a comparison is made between Directorate-level Bridge Asset Managers (central) and Bridge Asset Managers at the National Road Agency (regional). The results of these comparisons aim to identify the factors that tend to influence the intention of a bridge asset manager to effectively implement bridge asset management.

Certified bridge asset managers exhibit nearly uniform values for coverage and consistency across each predictor. Specifically, the coverage values for Attitude, Subjective Norm, and Perceived Behavioral Control are 90.5%, 70.9%, and 82.1%, respectively, with corresponding consistency values of 0.801, 0.843, and 0.904, as illustrated in Table 6. The model for Certified Asset Managers, developed through the Quine–McCluskey algorithm, highlights robust relationships between key predictor variables (Attitude, Subjective Norm, and Perceived Behavioral Control) and Intention. Conversely, in the model for Non-Certified Asset Managers, it is evident that only Attitude tends to influence Intention, with a coverage value of 88.41% and a consistency value of 0.764. This comparison underscores the nuanced differences in the factors influencing the intention of certified versus non-certified bridge asset managers in the context of bridge asset management.

**Table 6.** Certified (a) vs. non-certified (b) bridge asset managers.

| Variable | Solution | | | | | |
|---|---|---|---|---|---|---|
| | **1a** | **2a** | **3a** | **1b** | **2b** | **3b** |
| Attitude | O | | | O | | |
| Subjective Norm | | O | | | O | X |
| Perceived Behavioral Control | | | O | | X | O |
| Raw coverage | 0.904 | 0.709 | 0.821 | 0.884 | 0.305 | 0.408 |
| Consistency | 0.801 | 0.843 | 0.904 | 0.764 | 0.834 | 0.909 |

Note: O = core causal condition (present). X = core causal condition (absent). Blank spaces indicate "do not care".

In Table 7, it is evident that managers with more than 10 years of experience show Attitude as the dominant predictor, exerting a remarkably high influence on Intention, supported by a high raw coverage of 93.2% and a consistency level of 0.808. On the other hand, managers with less than 10 years of experience indicate that all three predictor variables—Attitude, Subjective Norm, and Perceived Behavioral Control—play significant roles in predicting Intention. The respective coverage values for these predictors are 85.7%, 67.6%, and 81.4%, each with consistency values above 0.75. This suggests a nuanced relationship between experience level and the influencing factors on the intention of bridge asset managers, emphasizing the varying dynamics within different experience cohorts.

**Table 7.** Experience (a) vs. less experience (b) bridge asset managers.

| Variable | Solution | | | | | |
|---|---|---|---|---|---|---|
| | **1a** | **2a** | **3a** | **1b** | **2b** | **3b** |
| Attitude | O | | | O | | |
| Subjective Norm | | O | X | | O | |
| Perceived Behavioral Control | | X | O | | | O |
| Raw coverage | 0.932 | 0.295 | 0.425 | 0.857 | 0.676 | 0.814 |
| Consistency | 0.808 | 0.787 | 0.934 | 0.757 | 0.758 | 0.847 |

Note: O = core causal condition (present). X = core causal condition (absent). Blank spaces indicate "do not care".

As explained in Table 8, bridge asset managers at the Directorate (central) level tend to have high values for the predictor's Attitude and Perceived Behavioral Control to Intention. The respective coverage values for these predictors are 90.7% and 83.8%, with consistency values surpassing 0.8. These findings illustrate significant and consistent relationships with Intention, underscoring their reliability in forecasting this dependent variable. Conversely, bridge asset managers at the National Road Agency (regional) level emphasize the dominance of Attitude as a predictor of Intention, with a coverage value of 88.1% and a consistency value of 0.757. This suggests a nuanced variation in the influential factors on the intention of bridge asset managers based on their organizational roles within the central or regional structure.

**Table 8.** Directorate vs. National Road Agency bridge asset managers.

| Variable | Solution | | | | |
|---|---|---|---|---|---|
| | **1a** | **2a** | **1b** | **2b** | **3b** |
| Attitude | O | | O | | |
| Subjective Norm | | | | O | X |
| Perceived Behavioral Control | | O | | X | O |
| Raw coverage | 0.907 | 0.838 | 0.881 | 0.315 | 0.454 |
| Consistency | 0.805 | 0.87 | 0.757 | 0.837 | 0.921 |

Note: O = core causal condition (present). X = core causal condition (absent). Blank spaces indicate "do not care".

From the QCA calculations, measurements of the variables Attitude, Subjective Norm, and Perceived Behavioral Control towards Intention were conducted. Table 9 observed that Attitude dominates the intention of a bridge asset manager at 89.52%. However, its consistency value is slightly lower compared to Perceived Behavioral Control, with values of 0.783 (below 0.8) for Attitude and 0.872 for Perceived Behavioral Control. On the other hand, Subjective Norm exhibits the lowest coverage value at 69.97%, with a consistency value of 0.803. This condition indicates that the perceived behavioral control of asset managers has a strong influence on their inclination to implement bridge asset management, emphasizing its pivotal role in shaping intention.

**Table 9.** Attitude, Subjective Norm, and PBC towards Intention.

| Variable | Solution | | |
|---|---|---|---|
| | **1a** | **2a** | **1b** |
| Attitude | O | | |
| Subjective Norm | | O | |
| Perceived Behavioral Control | | | O |
| Raw coverage | 0.895 | 0.699 | 0.825 |
| Consistency | 0.783 | 0.803 | 0.872 |

Note: O = core causal condition (present). Blank spaces indicate "do not care".

### *4.4. Interview*

The interviews conducted with multiple experts in bridge asset management in Indonesia strongly corroborate the findings of the data analysis. Overall, respondents voiced a predominantly negative sentiment regarding the state of bridge asset management in the country, highlighting significant shortcomings. Chief among these are persistent challenges in funding, leading to inadequate support for essential bridge asset management activities. This funding gap not only affects the quality of bridge condition data but also exacerbates the uneven distribution of bridge inspection expertise across different regions, notably favoring the western areas.

A clear consensus emerged among respondents on the urgent need for coherent policies that delineate the responsibilities of bridge asset managers and provide them with standardized operating procedures. Moreover, the relatively nascent nature of the bridge asset management system in Indonesia necessitates comprehensive adaptation efforts among all stakeholders, especially the bridge asset managers themselves.

Financial constraints loom large in the effective management of bridge assets, with current priorities skewed towards road construction and preservation, leaving bridge asset management underfunded and undervalued. This disparity in funding priorities hampers the implementation of proactive maintenance strategies, leading to a reactive approach that may inflate intervention costs in the long run.

Another critical issue identified is the dearth of resources for bridge asset managers, resulting in suboptimal intervention programming and a heavy reliance on central management for both human and technical support. This centralized approach not only hinders regional autonomy but also leads to redundant efforts and delays in bridge condition validation.

The current programming tool, while pivotal for cost planning and intervention prioritization, is still in its developmental stages, limiting its effectiveness in guiding annual programming decisions. Manual programming using spreadsheet lacks the sophistication needed to optimize resource allocation, often resulting in disproportionate budget allocations for corrective maintenance at the expense of preventive measures.

Experts observe that this situation limits asset managers to mainly engaging in corrective maintenance, where a significant portion of the budget is allocated to bridges classified as severely damaged or critical. In this scenario, the allocation for preventive bridge maintenance is sacrificed for more extensive interventions. Such management practices raise concerns among experts as they may lead to inflated bridge intervention costs in the future.

Quality data emerges as a recurring concern among experts, exacerbated by the absence of certified bridge inspectors and a lack of comprehensive understanding of bridge damage among asset managers. This data deficiency undermines the efficacy of bridge asset management practices and underscores the urgent need for standardized inspection procedures and certification protocols.

To address these multifaceted challenges, experts unanimously advocate for the establishment of guidelines governing bridge asset management needs, encompassing standards for human resources, equipment, systems, and data. Clear leadership directives are deemed essential to ensure coherence and accountability at both central and regional levels, fostering a unified approach towards achieving the goals of the asset management program.

From the expert point of view, it can be concluded that though Indonesia grapples with numerous obstacles in the implementation of bridge asset management, there is a clear path forward through enhanced funding, capacity building, policy formulation, and system refinement. By addressing these challenges head-on, Indonesia can pave the way for more effective and sustainable management of its vital bridge infrastructure.

## 5. Discussion

The intention of asset managers is influenced by attitude, subjective norms, and perceived behavioral control, underpinned by crucial factors: budget, data quality, policies, resources, and systems. This discussion aims to unveil correlations between variables and factors to address the gap between expectations and asset management implementation. Multiple Regression and Qualitative Comparative Analysis (QCA) results will be presented. Multiple Regression will reveal relationships between variables through Standardized Coefficients Beta (β*) and significance values ($p$). Findings highlight a strong correlation between a manager's intention and perceived behavioral control, reinforced by QCA results, emphasizing the manager's belief in their ability to execute asset management tasks. This underscores the pivotal role of perceived behavioral control in shaping intentions.

Perceived behavioral control is reinforced by three factors strongly connected to asset manager intentions: budget, data quality, and resources, supported by expert statements. Budget allocation reflects managerial priorities, influencing asset management positively. Poor data quality undermines manager confidence, while resource availability fosters effective asset management. Additionally, policies should align with target achievements to support manager attitudes. It is supported by several references that budget allocation reflects bridge owners' and managers' priorities, influencing service levels and life cycle costs [58]. Adequate funds specifically allocated for bridge asset management positively impact managers. Poor data quality can lead to erroneous decisions, inefficient resource allocation, and increased risks, affecting managers' confidence in executing asset management [3]. Knowledge, skills, organizational culture, and support are crucial for effective asset management, highlighting the importance of staff competence and organizational environment [59]. it can be concluded that effective bridge asset management hinges on budget allocation aligned with priorities, sufficient funding, high data quality to avoid errors and risks, and a supportive organizational environment fostering staff competence and a positive culture.

However, the Multiple Regression analysis indicated that Attitude and Subjective Norms do not align with asset manager intentions, influenced by budget inadequacies, data quality issues, and unclear policies. Subjective Norms inversely relate to intentions due to outdated policies and resource shortages, reflecting the need for updated guidelines and improved resources.

QCA identifies key conditions triggering asset manager intentions, with solutions emphasizing budget, data quality, resources, systems, Attitude, and Perceived Behavioral Control. Two dominant patterns emerge: voluntary asset management without policies but with adequate resources, and policy-adherent asset management irrespective of data conditions. These patterns reveal a lack of clear guidelines and uneven data quality.

Certified managers exhibit more supportive attitudes, subjective norms, and perceived behavioral control than non-certified counterparts, suggesting a need for certification alignment with managerial needs. Experienced managers and those in the Directorate rely on attitude and perceived behavioral control, while regional managers lean on attitude due to resource constraints.

To bolster their commitment to asset management, managers should prioritize initiatives aimed at enhancing their perceived control over operational tasks. This can be achieved through targeted investments in training and resource allocation, bolstering their confidence in executing asset management duties proficiently. Moreover, advocating for sufficient budgetary allocations dedicated to asset management endeavors is paramount, as it underscores the tangible benefits of adequate funding on operational outcomes. Simultaneously, managers must prioritize the maintenance and enhancement of data integrity, recognizing its pivotal role in informed decision-making processes. Furthermore, advocating for updated policies and guidelines reflective of contemporary best practices can provide managers with a structured framework for strategic decision-making. Additionally, acquiring relevant certifications and accumulating practical experience in asset management can significantly augment managers' competence and credibility in the field. By pursuing these avenues, managers can fortify their intention for proficient asset management, contributing to the overarching success of organizational asset management initiatives.

## 6. Conclusions

The current state of bridge asset management implementation in Indonesia falls far short of expectations, indicating a pressing need for improvement. Several key factors contribute to this deficiency. Firstly, there's a noticeable lack of commitment among asset managers to effectively execute bridge asset management strategies. This can be attributed to the poor quality of data that fails to accurately reflect field conditions, coupled with a limited understanding of the bridge asset management system among these managers. Furthermore, the scarcity of asset managers, along with inadequate resources, knowledge, and experience in asset management, exacerbates the situation. Budgetary constraints further hamper efforts to bolster resource capacity and support activities related to bridge asset management.

Research findings suggest that the willingness of bridge asset managers to oversee assets is heavily influenced by their perceived behavioral control. To enhance asset managers' willingness to implement bridge asset management, it is imperative to ensure that the budget is allocated according to the needs. Furthermore, managers need to validate data in accordance with applicable guidelines. Additionally, to maintain consistency in asset management, managers need to provide periodic training to their teams. Lastly, managers must comprehend the systems utilized in bridge preservation programming data processing to ensure that the system outputs can be utilized appropriately for the required bridge maintenance.

Moreover, the attitudes and subjective norms of asset managers have not yet provided the necessary impetus for effective bridge asset management. This is due to their lack of confidence in the outcomes of the asset management process and limited knowledge about

the assets under their purview. Insufficient human resources with reliable competencies further hinder the development of the asset manager's work environment.

Enhancing data quality and system robustness are pivotal in influencing asset managers' intention to engage in bridge asset management. Additionally, available resources must be augmented by screening managers with adequate experience and certifications. Establishing an optimal environment for effective bridge asset management is crucial, with particular emphasis on the development of human resources and the provision of necessary tools.

Recognizing the significance of bridge asset management knowledge is essential to prevent undesirable outcomes such as bridge failures. This underscores the importance of receiving high-quality data and utilizing a superior asset management system to bolster asset managers' intention to engage in bridge asset management.

Furthermore, the study proposes a novel hypothesis, suggesting that effective implementation of bridge asset management requires appropriate measures such as data validation, enhancement, and regular updates to both data and systems. Conducting regular socialization sessions on utilizing the bridge asset management system can enhance the capabilities of existing resources, leading to more accurate bridge preservation program results aligned with actual bridge conditions.

To improve bridge asset management in Indonesia, several practical steps can be taken. Firstly, allocate budget resources according to needs, addressing constraints and supporting necessary activities. Second, implement procedures to validate data quality based on relevant guidelines, enhancing decision-making confidence. Third, provide regular training sessions to enhance managers' understanding of bridge asset management systems and maintain consistency. Fourth, ensure managers comprehend the utilized systems, enabling effective utilization of outputs for maintenance. Fifth, screen managers based on experience and certifications to ensure competency. Sixth, focus on developing human resources, providing necessary training and support. Lastly, establish an optimal environment conducive to effective management, emphasizing human resource development and providing necessary tools and support. Through these actions, organizations can address deficiencies and improve bridge asset management intention and effectiveness in Indonesia.

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