

Dimensions of Satisfactions of Residents on Asphalt Road Projects: An Exploratory Factor Analysis

Randel Dev P. Aparicio, ASEAN Eng.

Engineer II, Project Engineer III, DPWH 2nd District Engineering Office, Surigao del Sur, Philippines

Email of Corresponding Author: apariciordp@gmail.com

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Abstract

This study examined the multidimensional structure of residents' satisfaction with asphalt road projects in the Second District of Surigao del Sur and developed a contextualized framework for their evaluation. Anchored on Expectancy-Disconfirmation Theory and informed by the perceived service quality perspective, the study employed a quantitative, non-experimental, exploratory factor analysis design involving 390 adult residents selected through proportionate stratified sampling. A 39-item questionnaire developed through literature review, key informant interviews, expert validation, and pilot testing was used to collect data. The Kaiser-Meyer-Olkin value of .957 and statistically significant Bartlett's test of sphericity confirmed the suitability of the data for factor analysis. Principal Component Analysis with Varimax rotation and Kaiser normalization retained 38 items with loadings of $\geq .50$ and identified five dimensions: Infrastructure Quality, Safety, and Immediate Project Benefits; Local Economic and Employment Benefits; Stakeholder Engagement, Right-of-Way, and Construction Safeguards; Overall Project Performance and Satisfaction; and Mobility, Accessibility, and Tourism Benefits. These dimensions collectively explained 67.564% of the total variance, demonstrating that residents' evaluations extend beyond physical road conditions to economic, procedural, performance, mobility, and accessibility considerations. The study concludes that resident feedback can complement conventional engineering and project-completion indicators, while the exploratory framework requires further validation. The findings support SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 8 (Decent Work and Economic Growth), and SDG 16 (Peace, Justice and Strong Institutions). The framework contributes to infrastructure, socioeconomic, community, and institutional sustainability by supporting resident-centered evaluation of road quality, accessibility, economic benefits, and participatory project implementation.

Keywords: Asphalt Road Projects, Exploratory Factor Analysis, Infrastructure Quality, Multidimensional Framework, Residents' Satisfaction, Road Infrastructure, Stakeholder Engagement

1. Introduction

Road infrastructure influences mobility, access to services, commerce, safety, and community development. In the Philippines, road infrastructure continues to face challenges involving right-of-way acquisition, financing, local implementation capacity, natural calamities, political intervention, and project management (Navarro & Latigar, 2025). Quality infrastructure is also a national development priority within an inclusive and climate-resilient agenda (Asian Development Bank [ADB], 2024). Thus, road projects should be evaluated not only through physical completion but also through residents' experiences of their quality, safety, accessibility, implementation, and benefits.

Residents' satisfaction with road infrastructure is multidimensional. Completed roads may still receive unfavorable evaluations because of poor maintenance, safety concerns, construction disruptions, accessibility limitations, or insufficient community benefits. Road conditions, safety management, construction conditions, and user satisfaction are important dimensions of road evaluation (Shaaban et al., 2022), while accessibility, road quality, and ancillary facilities also influence infrastructure satisfaction (Zhou et al., 2025). Public service satisfaction similarly reflects accessibility, responsiveness, quality, expectations, and prior experience (OECD/ADB, 2025).

Road improvements can generate benefits beyond mobility, including job creation, formal employment, increased labor income, and improved household welfare (Gertler et al., 2024). However, road projects may also raise concerns regarding public consultation, property impacts, right-of-way acquisition, compensation, and construction safety. Philippine evidence highlights stakeholder concerns related to mobility, environmental preservation, and public consultation (Henry & Fernando, 2026), while policy transparency and resident feedback are important in infrastructure evaluation (Tang and Feng, 2024). These findings demonstrate that residents' satisfaction encompasses physical, socioeconomic, procedural, and functional dimensions.

Persistent implementation and quality challenges in Philippine infrastructure demonstrate the importance of resident-centered evaluation (Navarro & Latigar, 2025). Regional development priorities similarly emphasize quality infrastructure, economic competitiveness, accessibility, responsiveness, and citizen experience (Asian Development Bank [ADB], 2024; OECD/ADB, 2025). These perspectives support assessing whether completed road projects effectively respond to the needs and experiences of their intended communities.

The study is primarily anchored on the Expectancy-Disconfirmation Theory developed by Oliver (1980), which explains satisfaction through the comparison between expectations and perceived performance. Residents may therefore evaluate road projects according to whether expectations concerning smoothness, durability, safety, accessibility, convenience, completion, and community benefits are met. The study is also informed by the perceived service quality perspective advanced by Parasuraman et al. (1988), which emphasizes users' perceptions of quality. This perspective is applicable to residents' experiences of road reliability, safety, accessibility, and usability and is consistent with evidence that satisfaction reflects accessibility, responsiveness, quality, expectations, and past experiences (OECD/ADB, 2025).

Exploratory Factor Analysis (EFA) is used in transportation research to organize correlated indicators into meaningful dimensions and support instrument development and validation (Ledesma et al., 2021). Appropriate decisions regarding extraction, factor retention, rotation, loading criteria, and interpretation are essential to obtaining meaningful factor solutions (Goretzko et al., 2021; Ledesma et al., 2021). In this study, Principal Component Analysis was used for extraction and data reduction, while Varimax with Kaiser normalization was used to obtain a simpler rotated solution. Although previous studies have examined multidimensional road-user satisfaction and resident-centered infrastructure evaluation (Shaaban et al., 2022; Zhou et al., 2025), and Philippine research has emphasized stakeholder perspectives in road projects (Henry & Fernando, 2026), limited local evidence exists on the factor structure of residents' evaluations of completed asphalt road projects in the Second District of Surigao del Sur. Thus, the study sought to: (1) determine the suitability of the survey data for factor analysis; (2) identify the factor structure of residents' satisfaction based on retained survey items; and (3) develop a contextualized multidimensional framework for evaluating asphalt road projects.

The study primarily supports SDG 9, Industry, Innovation and Infrastructure, particularly Target 9.1 on quality, reliable, sustainable, and resilient infrastructure. It also relates to SDG 11, Sustainable Cities and Communities, through safe and accessible mobility; SDG 8, Decent Work and Economic Growth, through employment, livelihood, and business opportunities; and SDG 16, Peace, Justice and Strong Institutions, through public consultation, transparency, responsiveness, and stakeholder participation (United Nations, 2015). These alignments reflect regional priorities concerning quality infrastructure, governance capacity, citizen feedback, and responsive public services (ADB, 2024; OECD/ADB, 2025).

The study contributes to infrastructure, socioeconomic, community, and institutional sustainability by examining residents' experiences of road quality, safety, accessibility, socioeconomic benefits, and project implementation. Road improvements can influence employment, livelihood, and household welfare (Gertler et al., 2024), while consultation, transparency, and responsiveness strengthen community and governance dimensions of infrastructure development (Henry & Fernando, 2026; Tang and Feng, 2024). The resulting multidimensional framework may therefore provide a contextualized basis for evaluating asphalt road projects according to the physical, functional, socioeconomic, and procedural dimensions experienced by residents.

2. Material and methods

2.1 Research Design

The study used a quantitative, non-experimental, exploratory factor analysis design to determine the empirical dimensions underlying residents' responses to 39 indicators of satisfaction with asphalt road projects. EFA is commonly applied in transportation research for instrument development and exploration of latent structures among correlated measures (Ledesma et al., 2021). Consistent with methodological guidance, indicators were generated through qualitative inquiry and literature review before their empirical structure was examined through multivariate analysis (Goretzko et al., 2021).

2.2 Locale of the Study

The study was conducted in the Second District of Surigao del Sur, Caraga Region, Philippines, covering Bislig City and the municipalities of Hinatuan, Tagbina, Lingig, and Barobo. These localities were selected because residents had direct experience using or being affected by asphalt road projects implemented within their communities.

2.3 Respondents of the Study

The respondents were 390 adult residents representing different livelihood and socioeconomic groups, including farmers, small business owners, transport operators, professionals, and homemakers. Eligible respondents were at least 18 years old, permanent residents of one of the five localities, had lived in their barangay for at least two years, and had direct experience with the asphalt road project through commuting, livelihood activities, or household impact. Minors, temporary residents, residents of less than two years, and government officials or contractors directly involved in the road project were excluded to minimize potential bias.

2.4 Sample and Sampling Procedure

Proportionate stratified sampling was used to ensure representation across the five localities. The sample comprised 104 respondents from Bislig City, 78 from Hinatuan, 78 from Tagbina, 65 from Lingig, and 65 from Barobo. With 39 items and 390 respondents, the study achieved a 10:1 respondent-to-item ratio. However, because EFA sample adequacy should also consider factor strength, communalities, and data and model characteristics (Goretzko et al., 2021; Ledesma et al., 2021), the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity were additionally used to assess factorability.

2.5 Research Instrument

The research instrument was developed through a two-phase process. During the qualitative phase, relevant literature was reviewed and Key Informant Interviews were conducted with four engineers who had professional expertise in road projects and were residents of the study area. The interview responses were thematically analyzed and integrated with the literature to generate indicators of residents' experiences and satisfaction. An initial 42-item questionnaire was reduced to 39 items following expert validation, with an average validation score of 4.4. The 39-item questionnaire was pilot-tested with 40 respondents using a Likert-type response format and obtained a Cronbach's alpha of .9578, indicating very high internal consistency. The validated questionnaire was subsequently administered to the 390 study respondents.

2.6 Data Gathering Procedure

The researcher first conducted Key Informant Interviews and integrated the resulting themes with the literature to develop the preliminary instrument. Expert review and validation were followed by pilot testing to assess internal consistency. After securing institutional and local authorization, including approval from the University of Mindanao Ethics Review Committee under Protocol No. UMER-2026-080, the validated questionnaire was administered to qualified respondents. Participants were informed of the study's purpose, voluntary nature, confidentiality safeguards, and right to withdraw without penalty. Data handling complied with Republic Act No. 10173, or the Data Privacy Act of 2012. Completed questionnaires were subsequently checked, encoded, tabulated, and prepared for statistical analysis.

2.7 Data Analysis Techniques

The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity were used to determine sampling adequacy and the suitability of the correlation matrix for factor analysis. Principal Component Analysis (PCA) served as the extraction and data-reduction method, while Varimax rotation with Kaiser normalization was applied to obtain a clearer component structure. Components with eigenvalues greater than 1.0 were retained using the Kaiser criterion, and a factor loading of $\geq .50$ was adopted as the minimum salient loading for item retention and interpretation. This loading criterion was not treated as a statistical significance level. These analytical decisions were explicitly reported to support transparency and replicability (Goretzko et al., 2021; Ledesma et al., 2021). The resulting item clusters were interpreted and labeled according to their substantive content and supporting literature. Because the analysis was exploratory, the extracted dimensions were treated as empirical structures organizing residents' responses rather than causal determinants of satisfaction. Interpretation focused on the salient loadings reported in the rotated component matrix because smaller loadings were suppressed in the statistical output.

2.8 Ethical Considerations

Ethical approval was obtained from the University of Mindanao Ethics Review Committee under Protocol No. UMER-2026-080. Participation was voluntary, and respondents were informed of the study's purpose, confidentiality safeguards, and right to withdraw at any time without penalty. The handling of participants' data complied with Republic Act No. 10173, or the Data Privacy Act of 2012.

3. Results and Discussion

3.1 Factorability and Multidimensional Structure of Residents' Satisfaction

3.1.1 Sampling Adequacy and Suitability for Factor Analysis

The Kaiser-Meyer-Olkin (KMO) value was .957, indicating excellent sampling adequacy. Bartlett's test of sphericity yielded an approximate chi-square value of 14,808.953 with 741 degrees of freedom and was statistically significant ($p < .05$). These results confirmed sufficient correlations among the 39 items and established the suitability of the data for factor analysis. The strong factorability of the data supported the extraction and interpretation of the underlying dimensions of residents' satisfaction. Reporting these diagnostic measures before interpreting the factor solution is consistent with recommendations for transparent EFA practice (Goretzko et al., 2021; Ledesma et al., 2021).

3.1.2 Extracted Factor Structure and Variance Explained

Five components were retained and collectively explained 67.564% of the total variance. After Varimax rotation, the first component accounted for 23.038%, the second for 15.232%, the third for 10.523%, the fourth for 10.137%, and the fifth for 8.634%. Using the predetermined loading criterion of $\geq .50$, 38 of the 39 items were retained. Item 12 did not meet the criterion and was excluded from the interpreted structure. The five-dimensional solution explained a substantial proportion of the observed response structure, with each dimension represented by multiple indicators. The $\geq .50$ loading threshold served as an item-retention criterion rather than a statistical significance level. Explicit reporting of loading criteria, excluded items, and potential cross-loadings is consistent with current EFA guidance (Ledesma et al., 2021).

3.2 Dimensions of Residents' Satisfaction with Asphalt Road Projects

3.2.1 Infrastructure Quality, Safety, and Immediate Project Benefits

The first factor contained 16 retained items with loadings ranging from .508 to .739 and explained 23.038% of the total variance. The indicators reflected road-surface uniformity and visibility, accident reduction, durability, maintenance, rainy-condition performance, construction safety, and selected temporary employment and income benefits. These results indicate that residents evaluate physical road quality together with safety and immediate community benefits. This dimension is consistent with evidence that road conditions, safety management, and construction conditions are important elements of infrastructure evaluation (Shaaban et al., 2022). Zhou et al. (2025) likewise included road network accessibility, road quality, and ancillary road facilities as core indicators within a resident satisfaction-based infrastructure framework. The factor, therefore, reflects a broad perception of infrastructure quality in which engineering performance, safety, and visible short-term community benefits are evaluated jointly.

3.2.2 Local Economic and Employment Benefits

The second factor consisted of eight items with loadings ranging from .614 to .764 and explained 15.232% of the total variance. The indicators represented increased rental and property values, greater customer access, increased household and business income, employment opportunities, reduced transport costs, and livelihood opportunities for drivers, mechanics, technicians, and other residents. The findings show that residents consider local economic and employment outcomes when evaluating asphalt road projects. This finding is consistent with the broader development role of transport infrastructure. Gertler et al. (2024) found that better road quality can support the creation of formal-sector jobs, increase labor income, and improve household welfare. The Asian Development Bank (2024) likewise identifies connectivity and quality infrastructure as important foundations of economic competitiveness and inclusive development. In the study area, the economic value of the road is therefore reflected not only in travel efficiency but also in perceived benefits to livelihoods, businesses, and property.

3.2.3 Stakeholder Engagement, Right-of-Way, and Construction Safeguards

The third factor contained five items with loadings ranging from .558 to .771 and accounted for 10.523% of the variance. The indicators involved clear explanations of right-of-way acquisition and restrictions, public consultation, compensation for affected properties, and safety measures during construction-related traffic congestion. These findings demonstrate that residents' evaluations incorporate procedural fairness and safeguards during project implementation. The dimension highlights the governance component of infrastructure delivery. Right-of-way acquisition and implementation constraints remain documented issues in the Philippine transport infrastructure (Navarro & Latigar, 2025). In a Philippine road-widening case, Henry and Fernando (2026) found distinct stakeholder perspectives concerning mobility, environmental preservation, and public consultation, underscoring the importance of understanding affected communities during project planning and implementation. OECD/ADB (2025) likewise identifies user surveys and feedback mechanisms as important evidence for governments seeking to improve public services and responsiveness. The results suggest that consultation, clear communication, equitable treatment, and construction-phase safeguards form a recognizable dimension of residents' satisfaction.

3.2.4 Overall Project Performance and Satisfaction

The fourth factor comprised five items with loadings ranging from .508 to .791 and explained 10.137% of the variance. Its strongest indicators concerned whether the asphalt road project met residents' expectations and whether they were satisfied with the project overall. Community benefits, timely project completion, and a smooth, defect-free road surface were also represented, indicating an overall evaluation of project accomplishment and performance. This result is consistent with Expectancy-Disconfirmation Theory, which explains satisfaction as an evaluation of whether actual performance meets or exceeds prior expectations (Oliver, 1980). Recent evidence from Southeast Asia on public services similarly notes that satisfaction may reflect accessibility, responsiveness, quality, expectations, and past experiences (OECD/ADB, 2025). The factor indicates that residents integrate perceived road condition, timely delivery, community benefits, and expectation fulfillment when forming an overall judgment of the project.

3.2.5 Mobility, Accessibility, and Tourism Benefits

The fifth factor contained four items with loadings ranging from .570 to .706 and accounted for 8.634% of the total variance. The indicators represented improved tourism and access to markets and businesses, reduced travel time, greater travel convenience, reliable movement of people and goods, and improved access to social services. The results establish mobility and accessibility as a distinct dimension of residents' satisfaction. The finding reflects the fundamental function of transport infrastructure in connecting households, economic centers, markets, schools, health facilities, and other essential destinations. ADB (2024) emphasizes connectivity and quality infrastructure as foundations of inclusive economic development, while Zhou et al. (2025) identify road-network accessibility and road quality as foundational indicators in resident-centered infrastructure assessment. Residents in the study area recognize reduced travel time, improved convenience, and expanded access as important outcomes of asphalt road development.

3.3 Multidimensional Framework for Residents' Satisfaction

The exploratory factor analysis generated five dimensions: Infrastructure Quality, Safety, and Immediate Project Benefits; Local Economic and Employment Benefits; Stakeholder Engagement, Right-of-Way, and Construction Safeguards; Overall Project Performance and Satisfaction; and Mobility, Accessibility, and Tourism Benefits. Together, these dimensions accounted for 67.564% of the total variance and provide a contextualized multidimensional representation of residents' evaluations of completed asphalt road projects in the Second District of Surigao del Sur. The resulting framework demonstrates that residents' satisfaction extends beyond the physical condition of asphalt roads to include safety, economic opportunities, stakeholder treatment, project accomplishment, mobility, and accessibility. However, the framework represents an exploratory measurement structure rather than a causal model. Accordingly, the identified dimensions describe patterns in residents' responses but do not establish that any individual dimension causes or significantly predicts overall satisfaction.

4. Conclusion & Recommendations

The study established that residents' satisfaction with asphalt road projects in the Second District of Surigao del Sur is multidimensional. The data were suitable for factor analysis, with a KMO value of .957 and a statistically significant Bartlett's test of sphericity. Using Principal Component Analysis and Varimax rotation with Kaiser normalization, 38 of the 39 survey items met the $\geq .50$ loading criterion and formed five dimensions: Infrastructure Quality, Safety, and Immediate Project Benefits; Local Economic and Employment Benefits; Stakeholder Engagement, Right-of-Way, and Construction Safeguards; Overall Project Performance and Satisfaction; and Mobility, Accessibility, and Tourism Benefits. Collectively, these dimensions explained 67.564% of the total variance, demonstrating that residents evaluate asphalt road projects through physical, economic, procedural, project performance, and mobility-related considerations.

Local government units, public works agencies, project engineers, and contractors may supplement conventional engineering and project-completion indicators with structured resident feedback covering road quality and safety, economic and employment effects, stakeholder consultation and right-of-way processes, project completion and expectation fulfillment, and mobility and accessibility outcomes. The identified dimensions may also serve as an initial basis for refining a contextualized assessment instrument and supporting quality and resilient infrastructure, accessible mobility, inclusive economic opportunities, and transparent and participatory project implementation. Future research should validate the five-dimensional structure using another sample, examine the complete loading matrix and communalities, assess the reliability of each dimension, apply additional factor-retention procedures when available, conduct confirmatory factor analysis, and examine whether the validated dimensions are associated with or predict residents' overall satisfaction.

The study was exploratory; therefore, the five extracted dimensions represent an initial factor structure that requires further validation using another sample. The proposed structure also requires further examination of the complete loading matrix, communalities, reliability of each extracted dimension, and additional factor-retention procedures such as scree-plot examination or parallel analysis when available. Consequently, confirmatory factor

analysis is needed to determine whether the identified five-dimensional structure remains stable before it is used for subsequent predictive examination of residents' overall satisfaction.

5. Compliance with ethical standards

The author declares no conflict of interest. This study received no external funding. Ethical approval was obtained from the University of Mindanao Ethics Review Committee under Protocol No. UMER-2026-080; participation was voluntary, informed consent was obtained, and data were collected through non-invasive methods, with confidentiality maintained and no identifying information disclosed. The authors acknowledge the participating residents of the Second District of Surigao del Sur and the University of Mindanao for their involvement in the study.

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