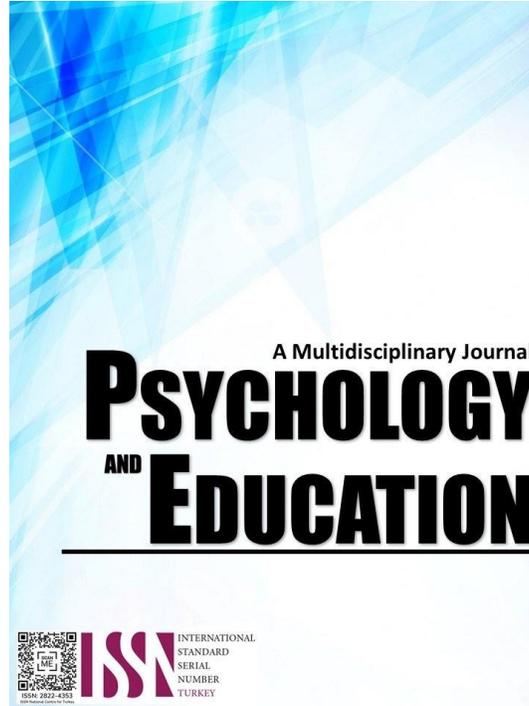


# DATA VISUALIZATION FOR EFFECTIVE COMMUNICATION AND DECISION- MAKING EFFICIENCY IN THE PLANNING AND DESIGN OFFICE



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## Data Visualization for Effective Communication and Decision-Making Efficiency in the Planning and Design Office

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### Abstract

In the ever-evolving landscape of urban development and infrastructure planning, the role of effective communication and efficient decision-making within governmental entities cannot be overstated. This study investigated the role of data visualization in enhancing communication effectiveness and improving decision-making efficiency within the Department of Public Works and Highways (DPWH) Region X – Planning and Design Office, which manages complex datasets as a key player in infrastructure planning and design. Five independent variables were analyzed: experience and engagement with data visualization techniques, organizational culture and support for data visualization, visual design elements, complexity of visualization, and integration of data visualization with other communication channels. Descriptive Correlational and Causal Comparative Research Designs were used in the study. The study encompassed the Planning and Design Division of the Regional Office X, Cagayan de Oro City and 14 District Engineering Offices' Planning and Design Sections, involving professionals such as engineers, architects, and planning and design staff. Statistical analyses, including mean, standard deviation, Pearson Product – Moment correlation ( $r$ ), multiple linear regression and path analysis were employed to analyze the data. Findings revealed statistically significant positive correlations between overall performance and experience and engagement, organizational culture and support, visual design elements and integration of data visualization to other communication channels. Regression analysis highlighted organizational culture and support in terms of leadership support and culture of collaboration, along with visual design elements particularly typography and iconography, and complexity of visualization in terms of experience and proficiency in advance/complex data visualization as key influencers in the overall performance. Finally, Model 4 emerges as the best-fitting structural model, meeting acceptable index standards and providing actionable insights for optimizing planning and design operations. This model is known as Villamor's Model on Data Visualization for Effective Communication and Decision-making Efficiency in the Planning and Design Office at DPWH.

**Keywords:** *data visualization, communication effectiveness, decision-making efficiency, planning and design office, complexity of visualization*

### Introduction

Effective communication and efficient decision-making are crucial for successful outcomes, collaboration, and strategic objectives in urban development and infrastructure planning. The DPWH's Planning and Design Office faces broader challenges in managing large-scale projects, coordinating with diverse stakeholders, and ensuring transparency in decision-making. This study aims to address these communication challenges and contribute to global best practices.

The DPWH, as a key player in the development and maintenance of the nation's infrastructure, assumes a pivotal role in steering the trajectory of progress (DPWH Annual Report, 2021), and the complexity of infrastructure projects necessitates a communication framework that transcends traditional methods. The study explores the potential of data visualization techniques, which combine information science, design, and communication, to offer a visual language that can transcend barriers, enhance understanding, and facilitate informed decision-making processes.

The need for innovative communication approaches within the DPWH is underscored by the complexity of information conveyed in infrastructure projects, which involve numerous stakeholders with varying technical expertise. This necessitates a departure from conventional modes of communication towards more dynamic and inclusive approaches (Garcia et al., 2022).

The study aimed to contribute nuanced insights and practical recommendations that can elevate communication practices within the DPWH's Planning and Design Division. Adopting visual tools could potentially streamline decision-making processes, foster better collaboration, and enhance overall efficiency.

### Research Questions

This study assessed the utilization of data visualization, aiming to enhance communication strategies and improve decision-making efficiency within the context of planning and design processes in the DPWH Region X – Planning and Design Offices. Specifically, this study aimed to address the following research inquiries:

1. What is the level of experience and engagement with data visualization within the Planning and Design Offices, in terms of:
  - 1.1. training and experience;
  - 1.2. confidence and proficiency; and

- 1.3. interest and engagement?
2. What is the level of organizational culture and support for data visualization within the Planning and Design Offices, in terms of:
  - 2.1. leadership support;
  - 2.2. resources and infrastructure; and
  - 2.3. cultural norms and collaboration?
3. What is the level of visual design elements considerations within the Planning and Design Offices, in terms of:
  - 3.1. color and visual contrast;
  - 3.2. layout and composition; and
  - 3.3. typography and iconography?
4. What is the level of complexity of visualization considerations within the Planning and Design Offices, in terms of:
  - 4.1. preference for complexity;
  - 4.2. challenges with complexity; and
  - 4.3. experience and proficiency in advanced/complex data visualization?
5. What is the level of integration of data visualization with other communication channels considerations within the Planning and Design Offices, in terms of:
  - 5.1. ease of integration;
  - 5.2. cross-platform engagement; and
  - 5.3. experience and proficiency?
6. What is the level of overall performance in terms of communication effectiveness and decision-making efficiency within the Planning and Design Offices?
7. Is there a correlation, a significant relationship, between communication effectiveness and decision-making efficiency, and:
  - 7.1. experience and engagement with data visualization;
  - 7.2. organizational culture and support for data visualization;
  - 7.3. visual design elements;
  - 7.4. complexity of visualization; and
  - 7.5. integration of data visualization with other communication channels?
8. Which variables, singly or in combination, best influence communication effectiveness and decision-making efficiency within the Planning and Design Office?
9. What structural model best fits communication effectiveness and decision-making efficiency within the Planning and Design Office?

## Literature Review

In the realm of contemporary planning and design, the efficacy of communication stands as a cornerstone for successful project outcomes (Doe et al., 2018; Johnson, 2020). As the digital landscape continues to evolve, data visualization emerges as a pivotal tool for conveying complex information in a comprehensible manner (Smith & Brown, 2021; Wang & Wang, 2019).

Kennedy et al. (2016) investigated factors affecting user engagement with big data visualizations, emphasizing the importance of design elements that facilitate user interaction and understanding. Their research highlights that well-designed visualizations can significantly enhance user engagement, leading to more informed decision-making processes.

In a comprehensive literature review, Saket et al. (2016) examined user experience-focused evaluations in visualization, identifying key metrics such as memorability, enjoyment, and engagement. Their findings suggest that visualizations tailored to user preferences and cognitive abilities can improve overall user experience and information retention.

Organizational culture and support play a pivotal role in the effective implementation and utilization of data visualization techniques. Edge et al. (2020) conducted a study titled "Workgroup Mapping: Visual Analysis of Collaboration Culture," which examined how visual analytics can elucidate collaboration patterns within organizations. The research highlighted that understanding these patterns through data visualization can inform strategies to foster a culture that supports data-driven decision-making.

Visual design elements play a critical role in enhancing the effectiveness of data visualization and user engagement. Recent studies highlight the importance of design principles, including color, layout, typography, and visual hierarchy, in making data comprehensible and appealing to users. A study by He et al. (2024) explored the interaction between textual and visual elements in circular infographics. The research found that effective placement and clarity of text in conjunction with visual elements such as shapes and colors significantly influenced the viewer's comprehension and retention of the information presented. The study emphasizes that visual design is essential for delivering clear and memorable content.

The complexity of visualization plays a significant role in how effectively data is communicated and understood. For instance, a study by Cui et al. (2021) examined the effects of visual complexity in data visualizations, finding that more complex visualizations, while potentially more informative, can overwhelm users, leading to decreased accuracy in data interpretation. Their research suggests that striking a balance between detail and simplicity is essential for effective communication.

The integration of data visualization with other communication channels has become an increasingly important topic as organizations seek to enhance data-driven decision-making and communication efficiency. A study by McKinley et al. (2021) explored how organizations integrate data visualizations with reports, presentations, and digital platforms. The study found that organizations that adopted an integrated approach were able to convey complex data more effectively, as users could interact with visualizations in real-time, while also accessing textual explanations and insights. This multi-channel integration facilitated better comprehension and more informed decisions.

Effective communication is a critical factor in the success of various organizational and interpersonal endeavors (Smith, 2018). Scholars argue that communication effectiveness is not merely about the transmission of information but also encompasses the comprehension and interpretation of the conveyed message (Davis S. & Miller, B, 2017; Johnson, 2020). In the organizational context, clear and transparent communication has been linked to increased employee satisfaction and productivity (Robinson et al., 2016; Wang & Chen, 2019). Additionally, effective communication plays a pivotal role in leadership, with leaders who exhibit strong communication skills being more likely to inspire trust and commitment among team members (Garcia, 2018; White, 2021).

Effective decision-making is a fundamental aspect of organizational success, influencing outcomes across various domains (Wang, 2018). Decision-making effectiveness is often associated with the quality of choices made and the efficiency of the decision-making process (Robinson et al., 2019). Scholars emphasize that decision-making involves both rational analysis and intuitive processes, with the optimal approach depending on the complexity and uncertainty of the situation (Taylor, 2021).

## Methodology

### Research Design

This study employed a descriptive-correlational research design to explore the factors influencing communication effectiveness and decision-making efficiency within the DPWH Planning and Design Division/Sections. To unravel the intricate dynamics, Multiple Regression Analysis was employed to identify key variables predicting communication effectiveness and decision-making efficiency. The use of Path Analysis, guided by a causal model, further enhanced our understanding and contributed to the development of a predictive model aimed at elucidating the factors shaping communication effectiveness and decision-making efficiency (Kline, 2015).

The selected research design aligned with the study's objective of investigating relationships among variables and testing hypotheses. Through this approach, the study aspired to construct a predictive model that goes beyond mere correlation, aiming to uncover the nuanced factors that intricately link data visualization techniques, the complexity of data visualization, communication methods, visual design elements, data presentation styles, and ultimately, communication effectiveness and decision-making efficiency.

### Respondents

The respondents for this study were selected from the Regional Office and District Engineering Offices within Region X of the Department of Public Works and Highways (DPWH). To ensure a diverse and representative sample, a stratified random sampling method was applied. Within the Regional Office, participants were drawn from various units, including design engineers, architects and planning engineers and staffs, to capture a broad spectrum of expertise and responsibilities. Similarly, in District Engineering Offices, a stratified random sampling approach was employed, considering the unique characteristics and challenges faced by different districts within Region X.

To determine the appropriate sample size, the Raosoft calculator application was used, resulting in a total of 209 Planning and Design employees participated in the study, with 5% margin of error, 95% confidence level and population size of 454. This approach ensured precision and reliability in the sampling process, adhering to best practices in research methodology (Raosoft Inc., n.d.). By employing a systematic sampling strategy, the study aimed to generate valuable insights that are both statistically robust and representative of the diverse roles and challenges faced by professionals within DPWH Region X.

### Instrument

The study employed survey questionnaires to systematically collect data, evaluating the proficiency, experience and perception on the data visualization techniques, organization culture and support for data visualization, visual design elements consideration, complexity of visualization and integration of data visualization with other communication channels as well as the perceived levels of communication effectiveness and decision-making efficiency with the planning and design office.

For precise measurement, the questionnaire items were rated using a 5-point Likert Scale—a widely recognized scale for assessing opinions, attitudes, and behaviors. The scale offered respondents a spectrum of choices, ranging from "strongly disagree" to "strongly agree," ensuring a standardized and nuanced evaluation of the variables.

To enhance clarity and facilitate efficient data organization, the questionnaire was self-made descriptive survey questionnaires, divided into three main sections. Section 1 collected the demographic information, including participants' respective offices, their roles (planning engineer, design engineer, architect or planning and design staff), and positions (division chiefs, section chiefs, unit heads, team leaders or area engineers). Section 2 encompassed the definition of key terms, including data visualization and advanced data

visualization tools, supplemented with illustrative examples. Section 3 focused on eliciting responses related to the independent and dependent variables, providing a structured and comprehensive approach to data collection.

### **Procedure**

The study was conducted to ensure ethical standards and adherence to research practices. A letter of permission was submitted to the Regional Director of DPWH Region X, followed by a formal letter of consent from the Dean of the School of Business Management and Accountancy (SBMA). The research proposal underwent rigorous ethical review by the Liceo Research Ethics Board, ensuring the study met established standards and prioritized participants' rights, privacy, and well-being.

The data gathering procedure was meticulously designed to capture quantitative insights into communication and decision-making processes within the Planning and Design Division of the Department of Public Works and Highways (DPWH) in Region X. Participants were carefully selected from both the Regional Office and District Engineering Offices using a stratified random sampling method. Ethical considerations were paramount throughout the data gathering process, with inclusion, exclusion, and withdrawal criteria clearly defined to maintain the relevance and validity of the collected data. Informed consent procedures were followed, detailing the purpose of the study, potential risks, benefits, and participants' rights.

A structured survey questionnaire was used as the primary data collection tool, administered electronically to selected participants. This method allowed for efficient data collection while minimizing logistical challenges associated with traditional paper-based surveys. The survey had a defined timeline of 20-35 minutes for completion, ensuring consistency in data collection and reducing response bias.

The quantitative data was then subjected to rigorous analysis using descriptive and inferential statistical methods. Descriptive statistics were used to summarize key findings and provide an overview of communication patterns and decision-making processes within the division, while inferential statistics, such as regression analysis and correlation tests, explored relationships between variables and derive meaningful insights. This analytical approach allowed researchers to uncover underlying trends and patterns, contributing to a deeper understanding of the factors influencing communication dynamics within the Planning and Design Division.

### **Data Analysis**

Following the administration of the survey to participants from the Planning and Design Offices at the Department of Public Works and Highways (DPWH) in Region X, the analysis phase involved a combination of descriptive and inferential statistical methods.

The data collected for Problems 1, 2, 3, 4, 5, and 6 were summarized using descriptive statistics, including mean and standard deviation. For Problem 7, Pearson-product-moment correlation was used to determine the significance of the relationship between the communication effectiveness and decision-making efficiency (Jones et al., 2019). In addressing Problem 8, Multiple Regression Analysis was employed to discern the most influential variables predicting communication effectiveness and decision-making efficiency. Finally, in addressing Problem 9, Path Analysis was applied to construct a predictive or structural model that most accurately captures the relationship between communication effectiveness and decision-making efficiency within the Planning and Design Division. These statistical techniques aimed to offer a thorough comprehension of the factors influencing these dependent variables, facilitating the development of a predictive model to improve communication and decision-making in these offices.

### **Ethical Considerations**

The study's credibility relies on the validity and reliability of its research instruments. The structured survey questionnaire was used, which underwent rigorous testing to ensure its content validity. Experts in infrastructure planning reviewed the questionnaire to assess its relevance, clarity, and comprehensiveness.

Pilot testing identified potential ambiguities and refining the wording based on feedback from a small sample of 30 participants. Reliability was enhanced through the consistent application of Likert-scale items and multiple-choice questions, allowing for standardized responses and facilitating quantitative analyses. The instrument's reliability was continually monitored through statistical measures to assess internal consistency and coherence. Reliability statistics were conducted to identify unreliable items and remove them from the instrument. Ethical considerations were incorporated into the design, with informed consent statements and assurances of confidentiality.

The study maintained objectivity and honesty in handling data collected on participants' proficiency in data visualization, perceived communication effectiveness, and decision-making efficiency. Raw data was securely stored within the researcher's facility, accessible only to the researcher.

### **Results and Discussion**

The first statement of the problem examined employees' experience and engagement with data visualization techniques in the Planning and Design Offices. The results in the Table 1 showed a Fair level of experience and engagement, with a mean score of 3.45. However, there is room for improvement in areas like staying informed and fostering deeper collaboration. The highest mean score was 3.69, indicating that increasing awareness of trends and advancements could further enhance engagement.

Table 1. Summary of Level of All Sub-variables of Experience and Engagement with Data Visualization Techniques

Sub-variable	Mean	Standard Deviation	Description	Interpretation
1. Training and Experience	3.37	0.57	Neutral	Moderately High
2. Confidence and Proficiency	3.32	0.52	Neutral	Moderately High
3. Interest and Engagement	3.69	0.96	Agree	High
Overall	3.45	0.46	Neutral	Moderately High

Legend: 4.51–5.00 (Strongly Agree, Very High), 3.51–4.50 (Agree, High), 2.51–3.50 (Neutral, Moderately High), 1.51–2.50 (Disagree, Low), 1.00–1.50 (Agree, Very Low)

The second statement of the problem examined the organizational culture and support for data visualization within Planning and Design Offices. In the Table 2 as shows below, employees perceived the culture as moderately high, with a mean score of 3.28. However, there is room for improvement to improve satisfaction levels and strengthen the cultural foundation. The highest mean score was 3.48, indicating that leadership should promote data visualization and innovation, but there is room for improvement in communication and investment in training resources.

Table 2. Summary of Level of All Sub-variables of Organizational Culture and Support

Sub-variable	Mean	Standard Deviation	Description	Interpretation
1. Leadership Support	3.48	0.60	Neutral	Moderately High
2. Resources and Infrastructure	2.81	0.97	Neutral	Moderately High
3. Cultural Norms and Collaboration	3.30	0.65	Neutral	Moderately High
Overall	3.25	0.59	Neutral	Moderately High

Legend: 4.51–5.00 (Strongly Agree, Very High), 3.51–4.50 (Agree, High), 2.51–3.50 (Neutral, Moderately High), 1.51–2.50 (Disagree, Low), 1.00–1.50 (Agree, Very Low)

The third statement of the problem analyzed the importance of visual design elements in data visualization within Planning and Design Offices. Table 3 as shown below found that employees' overall level of visual design elements is Very Important, with a mean score of 4.13. This highlights the significance of typography and iconography in creating effective data visualizations, contributing to readability, accessibility, visual communication, and user experience. The highest mean score of 4.16, interpreted as Very Important, highlights the need for organizations to prioritize design consistency and clarity in their visualization strategies.

Table 3. Summary of Level of All Sub-Variables of Visual Design Elements

Sub-variable	Mean	Standard Deviation	Description	Interpretation
1. Color and Visual Contrast	4.14	0.49	Agree	High
2. Layout and Composition	4.10	0.52	Agree	High
3. Typography and Iconography	4.16	0.52	Agree	High
Overall	4.13	0.45	Agree	High

Legend: 4.51–5.00 (Strongly Agree, Very High), 3.51–4.50 (Agree, High), 2.51–3.50 (Neutral, Moderately High), 1.51–2.50 (Disagree, Low), 1.00–1.50 (Agree, Very Low)

The fourth statement of the problem analyzed the complexity of data visualization in the Planning and Design Offices, revealing that employees have a fair level of complexity, with a mean score of 3.39 as shown in Table 4. Although they have some experience with advanced data visualization, they are not highly proficient or confident in their abilities. The study also found that participants generally agree that complex visualizations can enhance data understanding but also recognize the challenges associated with managing and interpreting such complexity. The ability to balance information richness with clarity is crucial for effective communication of insights. Future training and tools should focus on improving accessibility of complex visualizations to ensure users can extract meaningful insights without feeling overwhelmed.

Table 4. Summary of Level of All Sub-Variables of Complexity of Visualization

Sub-variable	Mean	Standard Deviation	Description	Interpretation
1. Preference for Complexity	3.48	0.67	Neutral	Moderately High
2. Challenges with Complexity	3.55	0.56	Agree	High
3. Experience and Proficiency in Advance/Complex Data Visualization	3.10	0.82	Neutral	Moderately High
Overall	3.39	0.55	Neutral	Moderately High

Legend: 4.51–5.00 (Strongly Agree, Very High), 3.51–4.50 (Agree, High), 2.51–3.50 (Neutral, Moderately High), 1.51–2.50 (Disagree, Low), 1.00–1.50 (Agree, Very Low)

The fifth statement of the problem revealed that employees in the Planning and Design Offices have a good level of integration of data visualization with other communication channels, with a mean score of 3.59 as shown in Table 5 below. However, there is room for improvement, particularly in accessibility and training on advanced tools. The highest mean score of 4.21, interpreted as Very Important, suggests the need for organizations to adopt multimodal communication strategies that leverage data visualizations across platforms for effective communication.

Table 5. Summary of Level of All Sub-variables of Integration of Data Visualization with Other Communication Channels

Sub-variable	Mean	Standard Deviation	Description	Interpretation
1. Ease of Integration	4.21	0.46	Agree	High
2. Cross-Platform Engagement	4.11	0.49	Agree	High



3. Experience and Proficiency	2.63	0.69	Neutral	Moderately High
Overall	3.59	0.37	Agree	High

*Legend: 4.51–5.00 (Strongly Agree, Very High), 3.51–4.50 (Agree, High), 2.51–3.50 (Neutral, Moderately High), 1.51–2.50 (Disagree, Low), 1.00–1.50 (Agree, Very Low)*

The sixth statement of the problem examined communication effectiveness and decision-making efficiency in the Planning and Design Offices. The results in Table 6 below show a moderately high performance, with a mean score of 3.43, indicating potential for improvement. The study found that Communication Effectiveness was the most effective sub-variable, with respondents generally agreeing. However, Decision-Making Efficiency was rated slightly lower, with a moderately high rating. The results suggest that the Planning and Design Office is meeting expectations, but there are areas for improvement. Strengthening decision-making processes, refining communication strategies, and optimizing resource allocation could enhance efficiency and overall performance, potentially shifting from "Moderately High" to "High" performance.

Table 6. Summary of the Level of All Sub-Variables of Planning and Design Office Overall Performance

Sub-variable	Mean	Standard Deviation	Description	Interpretation
1. Communication Effectiveness	3.59	0.42	Agree	High
2. Decision-Making Efficiency	3.23	0.44	Neutral	Moderately High
Overall	3.43	0.40	Neutral	Moderately High

*Legend: 4.51–5.00 (Strongly Agree, Very High), 3.51–4.50 (Agree, High), 2.51–3.50 (Neutral, Moderately High), 1.51–2.50 (Disagree, Low), 1.00–1.50 (Agree, Very Low)*

The seventh statement of the problem examined the relationship between communication effectiveness and decision-making efficiency in data visualization. The Table 7 below found that experience and engagement with data visualization techniques significantly impact communication effectiveness and decision-making efficiency. Employees who are more confident in using data visualization contribute to overall performance. However, basic training and experience in these techniques did not significantly influence performance. A strong organizational culture and support, including cultural norms, collaboration, and leadership support, are crucial factors. Visual design elements, such as typography and layout, improve communication, while color and contrast have no significant effect. Complexity of visualization did not significantly impact performance. Integration of data visualization with other communication channels positively correlated with performance.

Table 7. Correlations between Communication Effectiveness and Decision-Making Efficiency, Experience and Engagement, Organizational Culture and Support, Visual Design Elements, Complexity of Visualization, and Integration of Data Visualization

Variables	r	p	Remarks
Experience and Engagement	.181**	.009	Significant
Training and Experience	.051	.463	Not Significant
Confidence and Proficiency	.168*	.015	Significant
Interest and Engagement	.220**	.001	Significant
Organizational Culture and Support	.349**	.000	Significant
Leadership Support	.351**	.000	Significant
Resources and Infrastructure	.207**	.003	Significant
Cultural Norms and Collaboration	.402**	.000	Significant
Visual Design Element	.188**	.007	Significant
Color and Visual Contrast	.082	.242	Not Significant
Layout and Composition	.166*	.017	Significant
Typography and Iconography	.235**	.001	Significant
Complexity of Visualization	-.072	.302	Not Significant
Preference for Complexity	-.093	.182	Not Significant
Challenges with Complexity	-.043	.535	Not Significant
Experience and Proficiency in Advance/CDV	-.036	.601	Not Significant
Integration of Data Visualization with OCC	.149*	.031	Significant
Ease of Integration	.201**	.004	Significant
Cross-Platform Engagement	.118	.090	Not Significant
Experience and Proficiency	.025	.720	Not Significant

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

The eight statement of the problem investigated which variables, singly or in combination, best influence communication effectiveness and decision-making efficiency. The regression analyses as shown in the Tables 8 and 9 below revealed that several factors such as Organizational Culture and Support, Visual Design Element and Complexity of Visualization significantly influence the overall performance of the Planning and Design Office in terms of communication effectiveness and decision-making efficiency.

Organizational culture and support significantly impact performance, with leadership support and collaboration being key drivers. Visual design elements, particularly typography and iconography, also contribute to overall performance. However, complexity of visualization, particularly with advanced proficiency, may hinder communication and decision-making efficiency. The analysis found a negative relationship between complexity and performance, with about 28% of the variation explained by these predictors, confirming



the model's statistical significance.

Table 8. Multiple Regression Analysis on Communication Effectiveness & Decision-Making Efficiency and: Experience and Engagement, Organizational Culture and Support, Visual Design Elements, Complexity of Visualization, and Integration of Data Visualization

Predictors	Unstandardized Coefficient		Standard Coefficient	t	p
	B	SE B	β		
Intercept (Constant)	1.866	.257		7.273	.000
Experience and Engagement					
Training and Experience	-0.71	.058	-0.95	-1.216	.225
Confidence and Proficiency	.033	.067	.041	.493	.623
Interest and Engagement	.115	.060	.165	1.932	.053
Organizational Culture and Support					
Leadership Support	.162	.056	.240	2.892	*.004
Resources and Infrastructure	-.049	.066	-.084	-.748	.456
Cultural Norms and Collaboration	.216	.050	.347	4.317	*.000
Visual Design Element					
Color and Visual Contrast	-.111	.079	-.123	-1.412	.160
Layout and Composition	.057	.098	.068	.585	.559
Typography and Iconography	.158	.047	.205	3.348	*.001
Complexity of Visualization					
Preference for Complexity	-.047	.055	-.072	-.861	.391
Challenges with Complexity	-.001	.069	.001	.015	.988
Experience and Proficiency in Advance/CDV	-.120	.034	-.242	-3.489	*.001
Integration of Data Visualization with OCC					
Ease of Integration	.099	.098	.103	1.008	.315
Cross-Platform Engagement	-.053	.088	-.059	-.605	.546
Experience and Proficiency	.035	.058	.055	.604	.546

R<sup>2</sup> = .280, F-value = 19.772 p-value = 0.000

Table 9. Multiple Regression Analysis on Communication Effectiveness & Decision-Making Efficiency and the Independent Variables Experience and Engagement, Organizational Culture and Support, Visual Design Elements, Complexity of Visualization, and Integration of Data Visualization

Predictors	Unstandardized Coefficient		Standard Coefficient	t	p
	B	SE B	β		
Intercept (Constant)	2.127	.324		6.562	.000
Organizational Culture and Support	.306	.045	.452	6.746	.000
Visual Design Element	.192	.056	.216	3.404	.001
Complexity of Visualization	-.145	.050	-.197	-2.919	.004

Notes: R<sup>2</sup> = .212, F-value = 18.344 p-value = 0.000

*Predictive Equation (using sub-variables):*

Communication Effectiveness and Decision-Making Efficiency = 1.866 + Leadership Support (.162) + Cultural Norms and Collaboration (.216) + Typography and Iconography (.158) + Experience and Proficiency in Advance/Complex Data Visualization (-.120)

The study found that organizational culture and support significantly influence communication effectiveness and decision-making efficiency. A supportive organizational culture improves communication and decision-making processes. Effective visual design also contributes to communication and decision-making effectiveness. However, complexity of visualizations can hinder performance. The R<sup>2</sup> value of 0.212 indicates that approximately 21% of the variation in overall performance is explained by the independent variables, with an F-value of 18.344 and p-value of 0.000 confirming the statistical significance of the model.

*Predictive Equation (using independent variables):*

Communication Effectiveness and Decision-Making Efficiency = 2.127 + Organizational Culture and Support (.306) + Visual Design Element (.192) + Complexity of Visualization (-.120)

The ninth and last statement of the problem identified the best model for communication effectiveness and decision-making efficiency in Planning and Design Offices. Four structural models were tested and validated using the structural equation approach. Model 4, the fourth, was found to be the best fit, with values less than 2 and p-value less than .05. The model met acceptable indices standard units criteria, with a coefficient of less than .05, as shown in Table 10.

Table 10. Fit Indices Result for the Model 4 (Best Fit Model)

Standard Indices	Standard Value Per Criterion	Model Fit Value
CMIN/DF	<2	.673
P-Value	>.05	.672
NFI	>.95	.994
TLI	>.95	1.015
CFI	>.95	1.000
GFI	>.95	.995
RMSEA	<.05	.000

Legend:  
 CMIN/DF – Chi-Square Minimum/ Degrees of Freedom  
 CFI - Comparative Fit Index  
 RMSEA - Root Mean Square Error of Approximation  
 NFI - Normed Fit Index  
 TLI - Tucker-Lewis Index  
 GFI - Goodness of Fit Index

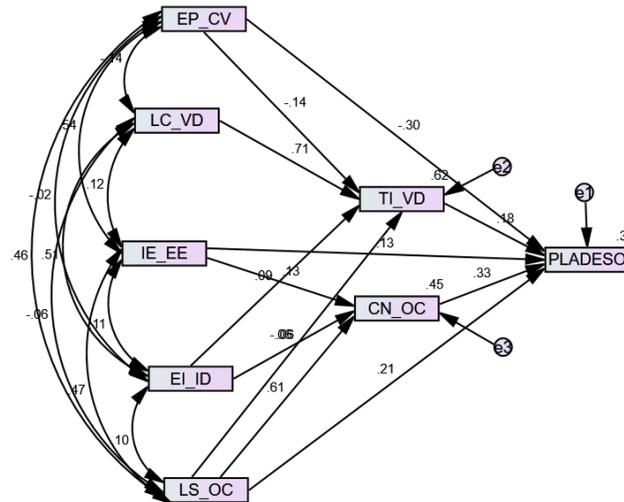


Figure 1. The Structural Model 4 or the Best Fit Model for the Overall Performance/ Communication Effectiveness and Decision-Making Efficiency of Planning and Design Division

Legend:  
 TE\_EE – Experience and Engagement with Data Visualization Techniques - Training and Experience  
 CE\_EE – Experience and Engagement with Data Visualization Techniques - Confidence and Proficiency  
 IE\_EE – Experience and Engagement with Data Visualization Techniques - Interest and Engagement  
 LS\_OC – Organizational Culture and Support for Data Visualization - Leadership Support  
 RI\_OC – Organizational Culture and Support for Data Visualization - Resources and Infrastructure  
 CN\_OC – Organizational Culture and Support for Data Visualization - Cultural Norms and Collaboration  
 CV\_VD – Visual Design Elements - Color and Visual Contrast  
 LC\_VD – Visual Design Elements - Layout and Composition  
 TI\_VD – Visual Design Elements - Typography and Iconography  
 PC\_CV – Complexity of Visualization - Preference for Complexity  
 CC\_CV – Complexity of Visualization - Challenges with Complexity  
 EP\_CV – Complexity of Visualization - Experience and Proficiency  
 EI\_ID – Integration of Data Visualization with Other Communication Channels - Ease of Integration  
 CP\_ID – Integration of Data Visualization with Other Communication Channels - Cross-Platform Engagement  
 EP\_ID – Integration of Data Visualization with Other Communication Channels - Experience and Proficiency  
 PLADESCO – Planning and Design Office Overall Performance /Communication Effectiveness and Decision Making Efficiency

The structural equation modeling for Communication Effectiveness and Decision-Making Efficiency of the Planning and Design Offices (PLADESCO) is represented by the following predictive equations:

$$PLADESCO = 0.71(LC\_VD) + 0.18 (TI\_VD);$$

$$PLADESCO = 0.13 (EI\_ID) + 0.18 (TI\_VD);$$

$$PLADESCO = 0.9 (IE\_EE) + 0.33 (CN\_OC);$$

$$PLADESCO = -.06 (EI\_ID) + 0.33 (CN\_OC);$$

$$PLADESCO = -.30 (EP\_CV);$$

$$PLADESCO = 0.13 (IE\_EE); \text{ and}$$

$$PLADESCO = 0.21 (LS\_OC).$$

This best-fitting model can be called “Villamor’s Model on Communication Effectiveness and Decision-Making Efficiency in the Planning and Design Office in DPWH”.

## Conclusions

The study concludes that while employees demonstrate a good level of interest and engagement in data visualization, there remains room for improvement in their overall experience and proficiency. Comprehensive training and deeper collaboration are necessary to enhance awareness of current trends and strengthen confidence in utilizing data visualization effectively. Efforts to further increase employees' confidence and proficiency would likely contribute to improved overall performance.

Organizational culture and support within the Planning and Design Offices are perceived as moderately high, yet further investments in leadership support, resources, and training could foster a more collaborative and data-driven environment. Strengthening leadership engagement and promoting a culture of collaboration could enhance communication effectiveness within the organization.

The importance of visual design elements, particularly typography and iconography, is evident in enhancing communication. This highlights the need for consistency and clarity in visual presentations, ensuring that data visualization strategies are effectively designed to improve comprehension and engagement.

Employees possess a basic understanding of complex visualizations, but proficiency levels vary. The negative correlation between visualization complexity and performance suggests that excessive complexity hinders communication and decision-making efficiency. Simplifying complex visualizations, ensuring accessibility, and providing training on advanced techniques can improve their effectiveness.

While the integration of data visualization with other communication channels is generally perceived as good, further enhancements are possible. Improving accessibility and tools for seamless integration across platforms—such as emails, social media, and presentations—can enhance communication effectiveness and decision-making efficiency.

The overall performance of the Planning and Design Office is acceptable, with communication being a key strength. Employees generally perceive communication as effective, contributing to operational efficiency. However, decision-making processes require refinement to further enhance effectiveness. Strengthening decision-making strategies, refining communication approaches, and optimizing resource allocation could lead to higher levels of productivity and efficiency.

Organizational culture and support, leadership support, cultural norms and collaboration, and visual design elements—particularly typography and iconography—have the most significant influence on communication effectiveness and decision-making efficiency. Conversely, visualization complexity negatively impacts performance, emphasizing the importance of simplification and effective design. Additionally, leadership and a strong organizational culture are key drivers of success, highlighting the need for a more collaborative and supportive work environment.

Regression analysis identified organizational culture and support, visual design elements, and visualization complexity as highly significant predictors of overall performance. A supportive organizational culture and well-designed visual elements positively impact communication effectiveness and decision-making efficiency, whereas excessive complexity hinders performance.

Structural Model 4 was determined to be the best-fit model for explaining communication effectiveness and decision-making efficiency. The predictive equations derived from the model emphasize the positive influence of leadership support, visual design elements, and organizational culture. Specifically, leadership support (LS\_OC), typography and iconography in visual design (TI\_VD), and cultural norms and collaboration (CN\_OC) are significant drivers of performance. The model highlights the critical role of leadership, collaboration, and design clarity in enhancing communication and decision-making within the organization.

To address these findings, the study recommends the adoption of Villamor's Model on Data Visualization for Effective Communication and Decision-Making Efficiency in the Planning and Design Office, which provides a structured approach to data presentation and decision-making. Increasing employee engagement and proficiency through specialized training programs, leadership support, and resource allocation will further enhance performance.

Strengthening organizational culture by integrating visualization tools across communication channels and prioritizing clarity in design while avoiding excessive complexity can also improve decision-making. Additionally, advanced data visualization skills should be developed among District Engineers and their teams to ensure more effective communication and analysis.

Lastly, future research should expand to other regions and government agencies, such as the Department of Information and Communications Technology and the Department of Transportation, to gain broader insights into the impact of data visualization on governance and industry sectors. Implementing these recommendations will help foster a more efficient, data-driven work environment within DPWH Region X.

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