# IMPLEMENTATION OF VISUAL ANALYTICS TO ENHANCE BUDGET TRANSPARENCY AND ACCOUNTABILITY IN SURABAYA CITY GOVERNMENT

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## Abstract

Transparency and accountability are fundamental elements of good governance, especially in regional budget management. However, the complexity of budget reports often makes them difficult for the public to understand, posing a significant challenge to financial transparency. This study aims to explore the application of visual analytics as an innovative approach to enhance budget transparency and accountability in the Surabaya City Government. Using a literature review method, this research analyzes 15 academic articles on budget transparency, accountability, and data visualization. The findings reveal that implementing technologies such as e-budgeting, interactive dashboards, and budget transparency applications significantly improves financial information accessibility. Furthermore, integrating the Regional Financial Management Information System (SIMDA) and engaging communities through Musrenbang forums strengthen budget accountability. However, challenges such as low budget literacy among the public and the need for regular data updates must be addressed. This study concludes that visual analytics not only simplifies complex financial information but also strengthens the relationship between the government and society through transparency. Future research should focus on developing a more integrated visual analytics model that includes spatial data for more effective decision-making.

**Keywords:** Good Governance, Budget Transparency, Accountability, Visual Analytics, Surabaya City Government

## INTRODUCTION

Transparency and accountability are two main pillars of good governance (Johnston, 2006). Both play a crucial role in ensuring that every action and decision taken by the government can be accounted for to the public. Transparency and accountability in budget management are closely related, as these two principles are essential to ensuring that budgets are managed effectively, efficiently, and responsibly (Cuadrado-Ballesteros & Bisogno, 2022). This means that information related to the budget from planning to implementation should be open and accessible to the public. When budget information is available to the public, it helps build trust between the government and society. Transparency and accountability enable the public to see how public funds are used and ensure that budget management is carried out properly (Supriyanto & Sasongko, 2025).

One challenge faced by the government is that budget reports are still presented in table or text formats that are not easily understood by the general public (Langella et al., 2023). Although the information may be complete, a non-visual and monotonous format makes it difficult for laypeople to grasp what is actually being reported. Data that is too detailed without simple explanations often leads to confusion. Budget reporting frequently uses complex financial terms, such as "indirect expenditure," "inter-account transfers," or "budget realization." While these terms may be easily understood by professionals in accounting or finance, for the general public, such language becomes a significant barrier to understanding financial reports. Without adequate comprehension, financial transparency cannot achieve its intended purpose. Therefore, the government needs to adopt a new, more interactive approach such as using data visualization or visual analytics—to present financial information in a way that is easily understood by all groups, both within the government and the public (Hagen et al., 2019).

Previous studies by Agliata et al. (2024), Ansari et al. (2022), and Kosack & Fung (2014) have suggested the need for simplification and innovation in the presentation of budget information. With changes in presentation methods, not only can internal government stakeholders better understand budget data, but the general public can also be more engaged in monitoring government financial management. This study aims to propose a visual analytics concept based on a literature review to enhance budget transparency and accountability in the Surabaya City Government.

## LITERATURE REVIEW

### Good Governance Theory

Good governance is increasingly seen as a key factor in ensuring the sustainability of government, as it can create reliability, predictability, and accountability in governance. As a general concept, good governance encompasses three main groups of complementary values. The first group consists of values related to the rule of law, which include compliance with laws, fairness, and the supremacy of law in decision-making and implementation.

### Transparency and Accountability in Budget Management

Transparency and accountability are fundamental elements of the good governance concept applied in the public sector. Transparency refers to the availability and accessibility of information required by the public to assess government actions, particularly in budget management. Accountability, on the other hand, refers to the government's obligation to

explain and account for the decisions and actions taken, especially regarding the use of public funds (Huberts et al., 2008).

**Challenges in Budget Information Presentation**

One of the main challenges in implementing budget transparency is the presentation format of financial information, which is difficult for the general public to understand. Budget reports are often presented in complex tables or texts, using technical financial terms that are only familiar to professionals (Ansari et al., 2022).

**Visual Analytics Approach in Budget Reporting**

Visual analytics is a technique that combines data visualization with analytical processes to facilitate the interpretation of complex information. In the context of government budget reporting, the use of visual analytics can transform complex financial data into charts, diagrams, or other visual forms that are more intuitive and easier to understand (Artigas & Chun, 2013).

## RESEARCH METHOD

The data collected were secondary data obtained from various journals in the fields of government, public finance, and information technology, as well as observational data related to the characteristics of these journals. The articles used in the literature review were journals that were available and contained the keywords "Visual Analytics, Budget Transparency, Government Accountability, Local Government Budgeting, Data Visualization in Public Sector." The search was conducted on November 1, 2024, and resulted in 15 articles. The literature review process was carried out as illustrated in the figure below.

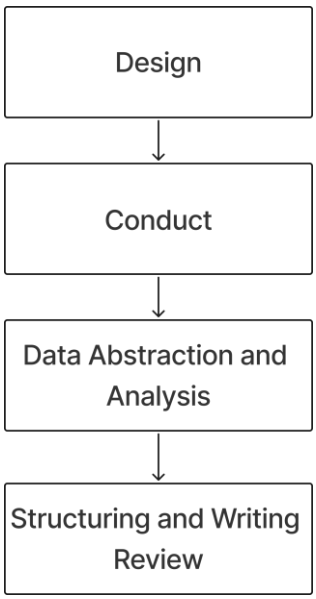


**Figure 1.**
**Literature Review Process**
Source: Snyder (2019)

The initial step in preparing this literature review was to determine the urgency of research on the application of visual analytics to enhance budget transparency and accountability. This study is relevant because budget transparency issues often pose

challenges for local governments, including Surabaya, particularly in ensuring public participation and accountable budget management. In the preliminary study, a literature scan was conducted on transparency, budget accountability, and visual analytics to identify research gaps. An integrative review approach was chosen to identify the relationships between theory, technology, and budget management practices in government settings.

The literature search strategy was designed using keywords such as "visual analytics," "budget transparency," "government accountability," and "Surabaya public budget," with databases including Scopus, SpringerLink, and Google Scholar.

The review process began with testing the search strategy according to the keywords and inclusion criteria to ensure relevant results. The article selection process was carried out in two stages: first, screening abstracts based on relevance to the research questions; second, reading the full articles to confirm their suitability with the research objectives. A total of 25 initial articles were found, which were then filtered down to 15 relevant articles.

The literature analysis was conducted by extracting key information from each article, including core concepts, methodologies used, and relevant findings. This information was grouped into three main themes: (1) visual analytics as a tool to support decision-making, (2) the impact of transparency on public accountability, and (3) the implementation of technology in the government sector. The gathered information was then analyzed thematically to identify patterns, research gaps, and potential contributions to theory and practice.

## RESULTS AND DISCUSSION

### Efforts Undertaken by the Surabaya City Government

The Surabaya City Government has taken various strategic steps to develop innovations in budget reporting that support increased transparency and accountability in regional financial management. One significant initiative is the implementation of an e-budgeting system, which has been a pioneer in the digitalization process of budget management. This system enables all processes, from planning and budgeting to reporting, to be carried out electronically. With integrated and auditable documentation, the potential for irregularities is minimized while accountability is improved.

In addition, the government has also provided an online financial information portal accessible to the public. This portal contains comprehensive data ranging from budget plans to financial realization, presented in a user-friendly format. This initiative is designed to ensure that financial information is available openly and is easy to understand, even for members of the public without a technical background in finance.

To support more efficient data management, the Surabaya City Government has integrated the Regional Financial Management Information System (SIMDA), developed in collaboration with the Financial and Development Supervisory Agency (BPKP). This system helps ensure data consistency in regional financial management and presents information that can be quickly accessed by stakeholders

**Table 1.**
**Relevant Research**

| No. | Article Author(s) | Article Title (Year) | Research Focus | Visual Analytics Method | Transparency and Accountabi | Main Findings | Constraints or Challenges |
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| | | | | | **lity Indicators** | | |
| 1 | Jesús García-García & María Isabel Alonso-Magdaleno | *Deconstructing Government Budgets through Visual Representation Software* (2021) | Adoption and use of budget visualization tools in local and regional governments in Spain. | DVMI ("¿Dónde Van Mis Impuestos?") and CMI ("Con Mis Impuestos"). | 1. Open and easily accessible budget presentation<br>2. Transparency participation<br>3. Provision of specific data relevant to certain communities | Lack of budget literacy among the public, creating a gap between expectations of the tool and actual use | 1. Organizational issues<br>2. Lack of human resources for data maintenance<br>3. Absence of a transparency strategy<br>4. Low public budget literacy regarding the tool<br>5. Technical challenges in data transfer |
| 2 | Alberto Abella et al. | *The Process of Open Data Publication and Reuse* (2017) | Process of open data publication and its impact on society | Graphical representation of user ecosystem and open data publication workflow | 1. Quality of published government information<br>2. Public engagement<br>3. Data usage rate | Successful use of open data depends heavily on an active and engaged user ecosystem | 1. Data not meeting quality standards<br>2. Limited resources<br>3. 3. Legal challenges related to privacy and intellectual property rights |
| 3 | Natalia Aversano et al. | *Integrated Popular Reporting as a Tool for Citizen Involvement in Financial Sustainability Decisions* (2019) | The role of Integrated Popular Reporting (IPR) as a tool to enhance citizen engagement | Provision of financial information accessible to citizens | Implementation of IPR can significantly increase interaction between citizens and government entities | Effectiveness of e-democracy tools and IPR | |

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| 4 | Albert Meijer | *Governing the Smart City: A Review of the Literature on Smart Urban Governance* (2015) | Smart city governance with a focus on conceptual structures | — | 1. Increased citizen engagement through participation and collaboration<br>2. Use of open data<br>3. More responsive governance | Smart cities require an approach balancing technology and social structures | Lack of understanding of the interaction between social structures and technology |
| 5 | Isabel Brusca & Vicente Montesinos | *Are Citizens Significant Users of Government Financial Information?* (2006) | Use of government financial information by citizens | — | 1. Quality of financial reports<br>2. Use of financial information<br>3. 3. Budget management | Citizens tend to value good budget management, such as high budget execution rates and surpluses when making decisions | Data limitations |
| 6 | Jan van Helden, Christoph Reichard | *Making Sense of the Users of Public Sector Accounting Information and Their Needs* (2019) | Transforming city governance to foster better human collaboration through IT | — | 1. Participation and collaboration<br>2. Open data<br>3. Governance | — | |
| 7 | Alan Freihof Tygel et al. | *"How Much?" is not Enough: An* | Open budget initiatives to improve governmen | — | 1. Open publication of budget data | Smart cities balance technology and social structures | Limitations in evaluating the economic impact and public value of |

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| | | *Analysis of Open Budget Initiatives* (2016) | t transparency and accountability | | 2. 2Public participation | | smart city initiatives |
| 8 | Francesca Manes-Rossi | *New Development: Alternative Reporting Formats: A Panacea for Accountability Dilemmas?* (2019) | Public sector reporting formats through the development of Integrated Popular Reporting (IPR) | — | 1. Information accessibility<br>2. Report clarity and simplicity<br>3. 3. Citizen engagement in political decision-making | Even with open budgets, lack of user engagement often results in mere data catalogs without greater transparency and citizen participation | Diverse data structures make cross-national financial flow comparisons difficult |
| 9 | Jörn Kohlhammer et al. | *Solving Problems with Visual Analytics* (2011) | 1. Analysis of open budget initiatives<br>2. Development of Visual Analytics Methodology: Overview First, Zoom/Filter, Details On Demand | 1. Open publication of budget data<br>2. Public participation<br>3. 3. Effective communication | Identifies key features of open budgets and characteristic attributes to compare initiatives from a user perspective | Data structure diversity | |
| 10 | Wenqiang Cui | *Visual Analytics: A Comprehensive Overview* (2019) | Visual analytics as a multidisciplinary field integrating visualization, algorithmic data analysis, and | — | Public participation and trust | Identifies trends, challenges, and future directions in the field, highlighting rapid growth in visual analytics research | Evaluation of the effectiveness and usability of visual analytics applications |

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| | | | analytical reasoning | | | | |
| 11 | Francisco Artigas, Soon Ae Chun | *Visual Analytics for Open Government Data* (2013) | Exploration and visual analysis of open government data | ArcGIS Explorer Desktop, Google Fusion Tables, and Google Chart Tools | 1. Availability of spatial and tabular data that can be accessed and analyzed by the public<br>2. Use of visualization tools | Understanding and gaining insights from complex data | Challenges in integrating various data formats from different sources |
| 12 | Florian Windhager et al. | *Linked Information Visualization for Linked Open Government Data: A Visual Synthetics Approach to Governmental Data and Knowledge Collections* (2016) | Open data initiatives and how information visualization supports them | Visual Ontology | 1. Open access to data<br>2. Public participation<br>3. Data visualization quality | Linking various visualizations allows users to gain a more holistic view of government data | 1. Data diversity<br>2. Presentation standards<br>3. Cognitive complexity |
| 13 | R. Maciejewski, T. Ropinski, & A. Vilanova | *A Survey on Visual Analysis Approaches for Financial Data* (2016) | Visual analysis approaches for exploring financial data, aiming to collect task requirements from | Standard charts (2D & 3D), line charts, candlestick charts | 1. Open access to data<br>2. Public participation<br>3. Data visualization quality | Trends in data sources, automation techniques, visualization, interaction methods, and evaluation | Limited access to real-world financial data for researchers, ownership issues restricting information sharing |

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| | | | financial analysts and categorize existing visualization techniques | | | | |
| 14 | Evert A. Lindquist | *Visualization Practice and Government Strategic Investments for More Democratic Governance* (2018) | How visualization tools and techniques can support democratic governance | Use of information dashboards, infographics, simulations, and performance logic models | Sustainable data | 1. Visual tools tend to support government's instrumental needs<br>2. Great potential to expand visual tools toward openness and accountability, but implementation remains limited to politically safe areas | Challenges in convincing leaders and officials to adopt visual approaches |
| 15 | Kishore Singha, Peter Best | *Anti-Money Laundering: Using Data Visualization to Identify Suspicious Activity* (2019) | Use of visualization techniques to detect money laundering activities | Prototype application called AML2ink | Data openness | Visualization techniques can significantly enhance analytical capabilities in detecting money laundering activities | Complexity of data to be analyzed, and the need for high-quality data to produce effective visualizations |

**Table 2.**
**Classification of Articles Based on Research Focus**

| Research Focus Group | Article | Use of Visual Analytics |
|---|---|---|

| | | |
|---|---|---|
| **Budget Transparency** | García-García & Alonso-Magdaleno (2022); Tygel et al. (2016); Kohlhammer et al. (2011); Artigas & Chun (2013) | DVMI, CMI, interactive analytics (zoom/filter), geospatial tools (ArcGIS Explorer). |
| **Public Participation** | Aversano et al. (2019); Manes-Rossi (2019); Lindquist (2018); Meijer & Bolívar (2016) | Popular tables/charts (IPR), visual dashboards, infographics, simulations. |
| **Urban Governance** | Meijer & Bolívar (2016); Van Helden & Reichard (2019); Windhager et al. (2016) | Open data technology, visual ontology for linking data, integration of spatial/tabular data. |
| **Financial Analysis** | Brusca & Montesinos (2006); Singh & Best (2019); Cui (2019) | Standard charts (2D/3D, candlestick), interactive clustering for identifying financial data trends. |

Source: Processed Data, 2024

Articles in the budget transparency group written by García-García & Alonso-Magdaleno (2022); Tygel et al. (2016); Kohlhammer et al. (2011); Artigas & Chun (2013) use visualization tools such as dashboards (e.g., DVMI and ArcGIS Explorer) to facilitate understanding of budget data by presenting information openly and providing public access to financial data, thus improving public accessibility. García-García & Alonso-Magdaleno (2022) emphasize the importance of budget literacy to improve transparency, as well as integrating spatial and tabular data to provide deeper insights (Artigas & Chun, 2013). Challenges faced include low levels of public budget literacy and limited technical and human resources to use and develop such visualization tools.

Other articles, such as those by Aversano et al. (2019); Manes-Rossi (2019); Lindquist (2018); Meijer & Bolívar (2016), generally emphasize the use of visualization tools such as tables, charts, and visual ontologies to enhance public participation in monitoring public budget management. Aversano et al. (2019) stress the role of Integrated Popular Reporting (IPR) in supporting community involvement in decisions related to financial sustainability, while Manes-Rossi (2019) proposes simplifying financial reports to encourage public participation. However, challenges include the complexity of traditional reports, limited interaction between technology and social structures, and gaps between reporting and participation initiatives.

Articles by Meijer & Bolívar (2016); Van Helden & Reichard (2019); Windhager et al. (2016) examine how governance is improved through visualization tools such as dashboards, infographics, and simulations to support greater transparency and collaboration between government and the public. According to Lindquist (2018), potential challenges for visual tools in governance include diversity in data formats, limited resources, and organizational resistance to technology-based changes.

Articles in the data quality and visual analytics technology group, such as those by Artigas & Chun (2013); Cui (2019); Singh & Best (2019), generally highlight the role of visualization technologies such as 2D/3D graphics, application prototypes, and analytics tools in increasing public trust in public data and providing deeper insights into data quality, including data sustainability, visualization accuracy, and accessibility of public budget data.

**Research Gaps**

In the context of implementing visual analytics to improve budget transparency and accountability in the Surabaya City Government, several gaps need to be addressed in research. Although many studies discuss the use of visualization tools such as dashboards to present budget data, few explore how these tools can be integrated with spatial and tabular data to provide deeper insights for decision-making at the city government level. Additionally, while many articles highlight the importance of budget information openness, few discuss how to improve public budget literacy, even though better public understanding of budget data can strengthen the effectiveness of transparency.

Furthermore, the sustainability and maintenance of budget visualization tools remain challenges that are rarely discussed. Future research could focus on developing strategies for maintaining and updating visualization tools to ensure that displayed data is always relevant and up to date. In terms of public participation, although visual analytics has been proven to enhance engagement, research on the long-term effectiveness of these tools in sustaining public participation is still lacking.

Another underrepresented aspect is the evaluation of the impact of visualization tools on decision-making and budget accountability in the Surabaya City Government. Further studies could examine how visual analytics not only facilitates budget understanding but also influences improvements in transparency and accountability within the budget decision-making process. This research aims to address these gaps by contributing to the development of more effective visual analytics models, improving public budget literacy, and ensuring that budget visualization tools can deliver long-term benefits in enhancing budget transparency and accountability in Surabaya City Government.

**Framework Development**

In this context, budget visualization will replace complex financial terminology with more visual and easily understandable representations. For example, instead of solely using numerical graphs and tables, bar charts, pie charts, and flow diagrams can be used to illustrate comparisons and relationships among various budget categories, such as employee expenditure, goods and services spending, and financing receipts and expenditures.

Additionally, interactive dashboards will allow users to explore budget data in greater depth according to their needs, for example, by selecting sectors or programs they wish to study further, without being overwhelmed by excessive data or difficult technical terms. This visualization approach not only helps simplify information but also improves budget transparency and accountability, enabling the public to see and evaluate how the budget is allocated for each sector or program.

This model should leverage visual analytics techniques such as trend analysis or geospatial mapping to depict the geographical distribution of budget spending, as well as to show the progress and achievements of each program and activity in real-time. In this way, it is expected that the more simplified and interactive budget visualization concept will help improve public understanding of government budget use, thus more effectively achieving the goal of information openness.

To visualize budget accounts comprehensively and transparently, various types of visualizations can be applied according to the type of data and information to be conveyed.

**Table 3.**
**Visualization for Each Budget Account Category**

| Budget Category | Visualization Type | Description | Visualization Dimension |
|---|---|---|---|
| **Revenue** | Bar Chart | Comparing contributions from various revenue sources. | X-axis: Revenue Sources, Y-axis: Revenue Amount (in rupiah). |
| | Pie Chart | Showing the proportion of each revenue source to total revenue. | Proportion of each revenue source category. |
| **Government Expenditure** | Pie Chart | Showing the proportion of budget for expenditure types (personnel, goods/services, capital, social assistance). | Proportion of each expenditure category. |
| | Stacked Bar Chart | Displaying the amount of expenditure per category within one bar. | X-axis: Expenditure Categories, Y-axis: Expenditure Amount (in rupiah). |
| **Financing** | Bar Chart | Comparing financing receipts and expenditures (e.g., loans vs debt repayments). | X-axis: Financing Types, Y-axis: Financing Amount (in rupiah). |
| | Line Chart | Showing changes in financing over time. | X-axis: Time (month/year), Y-axis: Financing Amount (in rupiah). |
| **Budget Realization** | Bar Chart | Visualizing the percentage of budget realization (revenue, expenditure, financing). | X-axis: Budget Category, Y-axis: Realization Percentage (%). |
| | Progress Bar Chart | Showing budget realization percentage with a simple visual format. | Bar length indicates the realization percentage. |
| **Priority Programs & Activities** | Bar Chart or Line Chart | Showing budget allocation for priority programs. | X-axis: Program/Activity, Y-axis: Allocation Amount (in rupiah). |
| | Flowchart | Illustrating progress of each program from planning to evaluation. | Nodes: Program Status, Flow: Fund flow or progress at each stage. |
| **Integrated Total Budget** | Interactive Dashboard | Integrating various budget visualization elements for dynamic analysis. | Interactive elements with filters and drill-down details. |
| | Geospatial Map | Showing budget distribution by region (e.g., infrastructure per subdistrict). | Geographic area representation with budget data per location. |

Source: Processed Data, 2024

With these various types of visualizations, budget data can be presented clearly and attractively, making it easier for stakeholders to understand budget allocation, monitor realization, and evaluate transparency and accountability in budget management at the Surabaya City Government. These visualizations should also be designed to be interactive and easy for the public to understand, strengthening community engagement in budget oversight.

## CONCLUSION

1. The Importance of Budget Transparency and Accountability
   Transparency and accountability are fundamental elements of good governance. These principles ensure that the use of public funds is carried out effectively, efficiently, and responsibly, while also fostering public trust in the government. However, the often complex presentation of budget information poses a significant challenge, hindering public understanding of budget allocation and utilization.
2. The Role of Visual Analytics
   Visual analytics facilitates the interpretation of complex financial data through various visual representations such as charts, diagrams, and interactive dashboards. This technology not only simplifies information for the general public but also supports data-driven decision-making within government institutions. Previous studies have shown that budget data visualization can increase public engagement in oversight and enhance accountability.
3. Research Gaps
   Although many studies discuss the benefits of visual analytics, there is still a lack of integration between spatial and tabular data to enable better decision-making at the local level. In addition, low public budget literacy remains a barrier affecting the effectiveness of transparency. Other challenges include limited technical and human resources for the development and maintenance of visualization tools, as well as the lack of impact evaluation of these tools on government accountability.

**Recommendations**

To address these challenges, the government should:

1. Develop more interactive and integrative visual analytics models, incorporating geographic data and real-time program progress.
2. Improve public budget literacy through education and training on the use of budget visualization tools.
3. Ensure the sustainability of visualization tools with regular data updates and efficient maintenance strategies.
4. Measure the impact of visualization on transparency and decision-making through long-term evaluations.

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