

Review of Data Visualization Applications in Activity Reports of Istanbul District Municipalities

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ABSTRACT

Our age has resolved critical actions in managerial processes such as storage and retention of data, creating a huge pile of data whose processing and visualization has become valuable for making sense of and expressing it. Visualization provides a powerful representation to extract meaning and discover insights from data, strengthening the narrative that institutions and organizations use in their reports. However, this is not as straightforward as it may seem: visualization is difficult to use and complex to implement, and when applied incorrectly, it creates greater complexity and makes the story it tells multi-layered. Visualization therefore needs to be faithful to its context and appropriate for its target audience, taking the data-to-ink ratio into account.

Within the scope of this study, the data visualization techniques used in the most recent (2024) annual activity reports of the district municipalities of Istanbul, published as open access, were identified and classified through a mixed-methods design combining document analysis and content analysis. A total of 9,742 pages across the reports of 39 municipalities were reviewed (Şile Municipality was excluded, as its 2024 report was unavailable), and the chart types and features used were coded by dual coders with over 90% agreement. The findings indicate that municipalities predominantly rely on basic-level visualizations, particularly first-level chart types such as bar, line, and pie charts, and that tables are largely transferred into reports without formatting or customization. A low data-to-ink ratio, frequent use of three-dimensional and decorative chart elements, and limited use of spatial mapping and interactive presentation techniques were also observed. Errors in the preferred visualization formats and chart types were identified when evaluated against universal design principles. This study is important for examining and evaluating visualization techniques in the annual reports of public institutions, offering a baseline for improving the accessibility and communicative effectiveness of municipal reporting practices.

Keywords: Data visualization, Data-based decision making, reporting, Visual communication in public services, Data analytics in public services

INTRODUCTION

The impact of public administration can be conveyed through carefully and meticulously designed communication methods. Furthermore, communication efforts aimed at promoting transparency, accountability, and participation have been further enriched by the opportunities offered by the digital age. Visual communication tools are frequently used to enhance local government's interaction with citizens, make service processes more understandable, and effectively present its performance to the public (Meijer, 2014). One such tool is the annual activity report. Activity reports not only make performance visible but also serve as a bridge between institutional transparency and accountability. However, it has been observed that moving away from a text-heavy format and designing these reports using effective presentation techniques makes a significant difference in strengthening this communication tool (Tufte, 2001). Reading in digital environments has become quite challenging due to shorter attention spans. Furthermore, as Mangen et al. (2013) noted, the limited interactivity of text—coupled with screen fatigue—results in a limited and shallow cognitive depth compared to traditional reading. Liu (2005) emphasized that texts in digital environments are scanned, leading to a tendency

toward superficial information processing without creating depth of meaning. Comprehensive eye-tracking studies conducted by Nielsen (2025) also revealed that users exhibit scanning behavior rather than reading texts in a systematic manner. This situation necessitates effective data visualization and text structuring strategies, particularly when presenting high-information-density content—such as public documents—in digital environments. Furthermore, the reduction in mental effort directed toward meaning extraction during digital reading negatively impacts long-term information retention (Singer & Alexander, 2017). In this context, redesigning digital reading environments based on user experience and prioritizing structural adjustments that reduce cognitive load have become critical requirements for content effectiveness.

Data visualization simplifies and clarifies the inputs used in data processing tasks that require intense mental effort and focus. It facilitates decision-making processes. Knaflie (2015) defined this as a proven strategy for facilitating data-driven communication among stakeholders and decision-makers. In summary, this technique shapes visual communication by ensuring that tables, charts, and graphs are presented in a simple and effective manner. As Kirk (2016) noted, it must also be used correctly and effectively in communication activities carried out in public administration. Today, the visualization of data included in public institutions' activity reports is not merely an aesthetic choice but also a management strategy directly related to the effectiveness of organizational communication (Few, 2012). In this regard, in addition to the formal quality of data visualization, the suitability of the selected visualization types to the nature of the data and their effectiveness in addressing the target audience must also be considered. Furthermore, the standardization of visualization practices is important for the comparability of reports (Evergreen, 2019).

In Turkey, the preparation of activity reports is mandated under the Public Financial Management and Control Law No. 5018; these documents are prepared to monitor administrative performance, provide accountability to the public, and support institutional development (Supreme Audit Institution of the Republic of Turkey, 2020). As Turkey's largest metropolis, Istanbul—with its 39 district municipalities characterized by diverse socio-economic structures—provides a significant sample for the analysis of these documents. However, systematic analyses in the existing literature regarding how data visualization practices are utilized in these municipalities' activity reports and the quality of such usage remain limited (Yıldız & Yılmaz, 2021).

This study examines the data visualization practices included in the 2024 annual reports of Istanbul's district municipalities from formal, functional, and content-related perspectives. In particular, they were evaluated in terms of visualization types and design principles. The aim is to assess the effectiveness of information presentation in the reports and to identify the current state and shortcomings. Thus, existing practices regarding local governments' information presentation strategies were analyzed, with the goal of contributing to more high-quality reporting approaches in the context of institutional transparency and citizen engagement.

METHOD

The methodological framework of the study is based on a mixed-methods research approach. First, the 2024 activity reports of the district municipalities were collected. During the data collection process, the reports of 39 district municipalities were individually reviewed and obtained. A total of 9,742 pages were examined. At the time of the study, only one municipality had not uploaded its 2024 activity report to its website. The Şile Municipality, for which no 2024 activity report was available, was excluded from the scope of the study, and the research was conducted based on the activity reports of 39 municipalities. Data visualization practices in the reports were evaluated using document analysis to conduct a systematic analysis. Document analysis is a powerful technique based on the systematic examination of written materials, enabling the assessment of the structural and content-related aspects of official documents published by institutions (Bowen, 2009). At this stage, the activity reports of all district municipalities in Istanbul were examined using content analysis, and the types of visualizations (graphs, tables, maps, etc.) were categorized (Neuendorf, 2017). Coding was performed during the categorization process. The coding was based on the principles of content analysis. Content analysis enables the systematic identification of specific patterns, units of meaning, or themes within a text and is also an effective approach for analyzing the communicative power of visual elements (Krippendorff, 2018). As a result of the content analysis, both descriptive and inductive categories were established. Thus, the quantitative data presented statistically measured the frequency and distribution of each visualization technique's use. The

analysis process was conducted using dual coders to enhance the reliability of the qualitative data, achieving over 90% coder agreement.

In the second phase, qualitative analysis methods were applied to evaluate the effectiveness of the visualization practices. The validity of the study was ensured through a three-pronged validity strategy (triangulation), clear category definitions, and the classification of document samples based on sampling (Patton, 2015). The analysis encompassed not only the numerical quantity of the visuals included in the report but also their ability to convey meaning and their level of informativeness. In this context, an evaluation was conducted based on Tufte's (2001) principles of "graphical excellence" in data visualization (data-to-ink ratio, multi-dimensional display, explanation of causal relationships, etc.). Furthermore, in line with the principles of data storytelling proposed by Knaflie (2015), the visualizations were examined for their narrative coherence and effectiveness in conveying information. In this context, the study aims not only to present a formal inventory but also to develop a critical perspective on the role of visualization in public administration communication.

FINDINGS

Table 1 presents an overview of the general status as reflected in the activity reports of the district municipalities.

Municipality	Number of Page	Format	Chart Types
Arnavutköy	262	Çevirmeli Kitap	Doughnut, Bar, Table
Avcılar	334	PDF	Table, Bar
Bağcılar	246	PDF	Table, Bar, Map, Pie
Bahçelievler	368	PDF	Table, Pie, Doughnut, Bar
Bakırköy	252	PDF	Map, Table
Başakşehir	206	PDF	Table, Bar, Pie
Bayrampaşa	276	PDF	Bar, Table, Doughnut, Map
Beşiktaş	204	PDF	Table, Pie, Bar
Beylikdüzü	466	Çevirmeli Kitap	Table, Map, Doughnut, Bar
Beyoğlu	280	PDF	Table, Pie
Büyükkçekmece	260	PDF	Table, Bar, Map, Pie
Çatalca	378	PDF	Table, Pie, Map, Bar
Esenler	220	PDF	Table, Bar, Pie
Esenyurt	192	PDF	Table, Bar, Pie, Map
Eyüpsultan	262	PDF	Table, Bar, Pie
Fatih	460	PDF	Table, Bar, Pie
Gaziosmanpaşa	369	PDF	Table, Bar, Pie, Map
Güngören	160	PDF	Map, Table

Kağıthane	322	PDF	Map, Table, Pictogram, Bar
Küçükçekmece	446	PDF	Table, Bar, Cluster, Doughnut
Sarıyer	238	PDF	Table, Bar, Pie
Silivri	290	PDF	Table, Bar, Pie, Map
Sultangazi	250	PDF	Table, Pie
Şişli	236	PDF	Table, Bar, Pie, Doughnut, Map
Zeytinburnu	330	PDF	Table, Bar, Pie, Map
Adalar	100	PDF	Table, Bar, Pie
Ataşehir	178	PDF	Table, Bar, Pie, Doughnut, Map
Beykoz	206	PDF	Table, Pictogram, Map
Çekmeköy	232	PDF	Table, Bar
Kadıköy	255	PDF	Table, Bar, Pie
Kartal	252	PDF	Table, Bar, Pie
Maltepe	272	PDF	Table, Bar, Pie, Map
Pendik	134	PDF	Table, Pie
Sancaktepe	490	PDF	Table, Map, Bar
Sultanbeyli	316	PDF	Table, Bar
Şile	-	Report is not available.	-
Tuzla	289	PDF	Table, Map, Bar
Ümraniye	257	PDF	Table, Map, Bar
Üsküdar	334	PDF	Table, Doughnut, Bar, Map

The technical distribution of the reports reflects an operational gap between print-oriented production and digital consumption. While PDF is the predominant format across 36 municipalities, many administrations upload unoptimized print-ready files directly to the web. This practice creates excessively large file sizes and embeds physical page layouts that impair on-screen reading. A minority approach—the flipbook format adopted by two municipalities—mimics a physical reading experience but introduces acute accessibility trade-offs, degrading mobile usability and precluding offline access entirely.

The data-ink ratio is an important concept developed by Edward R. Tufte in the field of data visualization. This concept aims to analyze how much of the total ink used in a visual represents actual data, and how much consists solely of ornamentation, decoration, or repetitive graphical elements (Tufte, 2001) According to Tufte, non-data ink must be systematically eliminated to reduce cognitive burden. However, the sampled reports display a depressed data-ink ratio saturated with extraneous graphical noise. Several municipalities rely on three-dimensional formats, heavy shadows, intense color gradients, and decorative borders. As Cairo (2013) notes, such decorative conventions add perceptual clutter without carrying informational value. Beyond decorative

excess, chart types remain rudimentary—limited predominantly to basic column, line, and pie charts—while spatial datasets are rarely translated into effective analytical maps.

Tabular presentation across the reports exhibits widespread neglect in typographic hierarchy and brand integration. Most municipalities copy tables directly from their authoring spreadsheets without formatting, styling, or structural refinement. Standardized formatting is absent across the sector: only five municipalities apply a consistent visual style to their tables, whereas the remainder present heterogeneous, ad hoc layouts throughout the same document. Furthermore, the tables universally lack deliberate color palettes, fail to incorporate institutional colors, and omit intentional visual cues that would otherwise guide the reader's focus. Only the tables in the reports of 5 municipalities follow a common visual format. The tables in the reports of other municipalities vary depending on their type and purpose.

Rather than presenting balanced administrative performance, the reports exhibit an overt rhetorical bias toward public relations. Visualizations rely heavily on isolated proportional metrics rather than multidimensional or longitudinal indicators. Datasets appear selectively curated to highlight favorable administrative outcomes while omitting explanatory context, systemic benchmarks, or complex civic challenges. This tendency reduces the analytical credibility of the documents, transforming public accountability tools into unilateral promotional materials.

CONCLUSION

Through the studies conducted as part of this research, the 2024 activity reports of district municipalities were systematically reviewed and evaluated. In this regard, the research has achieved its objective. The visual communication elements used by local governments to promote transparency and accountability were identified. The findings indicate that municipalities engage in basic-level visualization, with first-level chart types (line charts, bar charts, and pie charts) being widely preferred. However, the findings indicate that interactive visualizations, dynamic data presentations, and data storytelling techniques have not been sufficiently adopted (Evergreen, 2019; Knafllic, 2015). Significant shortcomings were identified, particularly regarding the simplification of complex datasets and their presentation in a manner understandable to citizens. This situation indicates that the reports prepared by municipalities need to be improved in terms of accessibility and user-friendliness. In terms of accessibility, open access to activity reports has been provided for all 39 districts. (Only one municipality's 2024 activity report is unavailable; however, it has included reports from previous years.) The absence of any restrictions is a positive development.

The findings were evaluated within the context of local governance and data visualization literature. It was observed that current practices do not fully comply with Tufte's (2001) principles of "graphical excellence," particularly in terms of a low data-to-ink ratio and the frequent use of unnecessary visual elements. Furthermore, it was concluded that the principles of transparency and participation emphasized by Pina et al. (2007) can be supported through the effective use of visualization techniques. For example, the adoption of modern techniques such as interactive maps and data dashboards can help citizens better understand local government activities. However, municipalities' shortcomings in terms of technical infrastructure and staff competence present obstacles to such innovative applications. Although the use of PDFs is widespread, the "interactive PDF" format has not been implemented by any municipality.

Several important recommendations can be made for future studies: First, training programs and guidance documents should be developed to enhance municipalities' data visualization capabilities. In particular, case studies could be developed to illustrate how the principles proposed by Tufte (2001) and Few (2009) can be applied in practice. Second, experimental studies should be conducted to understand how citizens perceive and interpret visualizations. For example, the impact of different visualization techniques on information acquisition and decision-making processes can be tested through controlled experiments (Delgado et al., 2018). Finally, although this research was conducted specifically in Istanbul, replicating similar studies for local governments in other major cities would increase the generalizability of the findings. Such comparative studies could provide a more comprehensive framework regarding data visualization practices in local governments across Turkey. Additionally, it is recommended that perception-based qualitative studies be conducted to examine how activity reports are perceived by users (e.g., citizens, journalists, and civil society representatives).

ETHICAL CONSIDERATIONS

Ethical Approval

This study is based on the analysis of publicly available secondary documents (the 2024 annual activity reports of Istanbul district municipalities) and did not involve direct data collection from human participants or animal subjects.

Conflict of Interest

The author declares that they have no competing interests.

DATA AVAILABILITY STATEMENT

The data analyzed in this study are the 2024 annual activity reports of Istanbul's district municipalities, which are publicly available on the respective municipal websites. The coded dataset generated during the content analysis is available at: <https://github.com/kaghas/city-data-viz>

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