

From Numerical Decoration to Crisis Communication: A Decade-Long Longitudinal Analysis of Data Visualization in Print Media

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Abstract

Data visualization has surfaced as an essential journalistic practice for conveying complex quantitative information in print and digital media. While existing scholarship predominantly examines data journalism within digital newsrooms, the long-term evolution of visual data artifacts in traditional newsprint media persists under-researched, particularly in Central Asia. To address this gap, this study examines the quantitative growth, structural typology, and functional transformation of data visualization in Kazakhstani print media through a ten-year diachronic content analysis of the national socio-political weekly newspaper *Jas Qazaq* (2016–2025). Based on an extensive review of 466 published newspaper issues, an empirical dataset of $N = 1,090$ visual data artifacts was categorized across four main graphic topographies: frequently appearing stock-market symbols (42.8%), statistical tables, maps, and seismograms (21.7%), prominent numerical snapshots (18.9%), and thematic infographics (16.6%).

The evidence indicates 84.7% over time increase in extent of the visual data (expanding from 72 units in 2016 to 133 units in 2025), demonstrating the consistent institutionalization of data visualization as a constant newsprint standard. Qualitatively, the editorial workflow transitioned from basic numerical decoration to complex crisis communication during major national emergencies (e.g., the COVID-19 pandemic, Almaty earthquake, spring floods). The study defines a region-specific print data journalism model, providing a theoretical framework for how print newsrooms structure visual information to reduce potential audience mental strains.

Keywords: data visualization, print media, data journalism, infographics, digitalization, crisis communication

1. Introduction

1.1 Background and Theoretical-Methodological Framework

In the current media ecosystem, digital transformation, the growing accessibility of open big data, and shifting audience demands for quantitative information have fundamentally restructured journalistic practices and academic research methodologies. Data visualization has surfaced as a necessary communicative instrument for transmitting complex statistical information to readers in a concise, clear, and engaging format. As Houston (2026) emphasizes, data journalism is recognized as an autonomous professional domain that generates high-quality journalistic content through the systematic collection, analytical processing, and visual presentation of quantitative datasets.

Within contemporary media studies, data journalism and data visualization are understood as closely interconnected and mutually reinforcing dimensions of journalistic practice. Morini's (2025) systematic literature review demonstrates that visualization enables journalistic reporting to elucidate complex socio-economic phenomena, reveal hidden patterns and correlations within datasets, and foster meaningful visual dialogue with the public. Concurrently, Chun (2023) proposes a theoretical model for evaluating news infographics based on the core dimensions of integration, abstraction, and extension, framing infographics not merely as decorative illustrative add-ons, but as an autonomous visual system that structures and interprets journalistic narratives.

In delineating the conceptual scope of data journalism, Abdikhalyk et al. (2026) emphasize that traditional journalism and data journalism share a fundamental objective: disseminating reliable information in the public interest. Nevertheless, the two approaches differ in their epistemological foundations and methods of knowledge production and representation.

Whereas traditional journalism often prioritizes timeliness, narrative framing, and emotional engagement, data journalism places greater emphasis on analytical rigor, empirical verification, and the visual representation and interpretation of complex, structured datasets. Building on Stray's (2011) foundational definition, data journalism can be conceptualized as the systematic collection, investigation, processing, and publication of data in the public interest.

According to a recent study by Atay et al. (2025), editorial decisions and agenda-setting in Kazakhstani newsrooms are subtly shaped by informal restrictions and self-censorship mechanisms. Examining the domestic media context in Kazakhstan, Abdikhalyk and Beldibekova (2024), drawing on Borges-Rey (2016), note that competencies in data discovery, cleaning, and visualization empower newsrooms to articulate complex socio-political events through infographics. Journalists increasingly regard digital data not merely as raw numerical entries in electronic spreadsheets but as substantive informational resources. The historical transition from information scarcity to information abundance and overload has consequently elevated data processing and visual synthesis to central functions of contemporary journalistic practice.

Furthermore, Abdikhalyk and Beldibekova (2024) delineate the functional distinction between data visualization and infographics: data visualization centers on deep exploratory interpretation and comprehension of datasets, whereas infographics aim to convey a specific structured visual story. Furthermore, Api, Alimzhanova, Andreyeva, and Abdikhalyk (2025) demonstrate that integrating data visualization technologies and artificial intelligence (AI) tools enhances media competitiveness and creates novel formats for presenting complex datasets.

The cognitive and communicative effects of visual data representation are underpinned by an established theoretical framework: Cognitive Theories: Paivio's (1991) Dual-Coding Theory and Sweller's (1994) Cognitive Load Theory indicate that processing information through dual verbal and visual channels reduces cognitive friction, allowing audiences to digest complex statistical data faster and retain information more effectively.

Media Influence Theories: Agenda-Setting Theory (McCombs & Shaw, 1972), Framing Theory (Goffman, 1974; Entman, 1993), and Media Dependency Theory (Ball-Rokeach & DeFleur, 1976) explain how quantitative visualizations direct public focus toward critical societal issues, frame information from specific analytical angles, and shape public opinion during times of heightened reliance on official statistics.

Digital Citizenship and the Public Sphere: The Digital Citizenship Framework (Mossberger et al., 2007) and Habermas's (1991) Public Sphere concept highlight the strategic role of visualized data in facilitating civic access to political-economic information, thereby invigorating informed public debate and democratic participation.

1.2 Identification of Research Gap

While main global newsrooms (The New York Times, The Guardian) have fully integrated interactive data dashboards, dynamic cartography, and algorithmic visual tools, print media in Central Asia, particularly in Kazakhstan, is navigating distinct institutional evolution stages. Factors such as the partial openness of public data portals, extended statutory response timelines from state authorities (4–15 working days), and newsroom data literacy remaining in its formative phase have contributed to a unique visual newsprint format.

In this context, the national socio-political newspaper *Jas Qazaq* offers a compelling case study as an independent media outlet shaping an alternative public agenda. On January 1, 2026, the print edition and online publication of *Jas Qazaq* officially ceased operations, transitioning its editorial workflow to the *jasqazaq.kz* news agency. Consequently, conducting a longitudinal content analysis of the newspaper's decade-long archive (2016–2025) provides an invaluable empirical opportunity to analyze how traditional print media processed numerical data, visually framed critical issues, and optimized cognitive reception among readership.

The systematic classification of this empirical dataset integrates with Stalph and Heravi's (2021) analytical framework for investigating data artifacts in news production (systematic data visualization analysis). Examining the functional transformation of visual data during crisis periods (COVID-19 pandemic, state of emergency, economic instability) aligns directly with global research on pandemic data visualizations and studies on the communicative roles of data stories in journalism.

1.3 Object, Subject and Aim of the Study

- Research Object: The complete print archive of *Jas Qazaq* newspaper published between 2016 and 2025 (comprising a total corpus of 1,090 visual data artifacts).
- Research Subject: The longitudinal dynamics, typology, frequency, and narrative-functional properties of visual data materials (indicative market tickers, *Birjameter*, numerical snapshots, statistical tables, 3D charts, thematic cartography, pictograms, and seismograms) featured in the newspaper.
- Research Aim: Drawing on a decade-long archive of *Jas Qazaq*, this study aims to examine the quantitative development, qualitative and functional evolution, and structural role of data visualization in shaping a distinct model of print-based data journalism within Kazakhstan's domestic media landscape.

1.4 Research Questions (RQs) and Hypotheses (H)

Research Questions (RQs):

- RQ1 (Quantitative Growth & Dynamics): How did the frequency and structural formats of data visualization elements in Jas Qazaq newspaper evolve annually between 2016 and 2025?
- RQ2 (Qualitative-Semantic Transformation): Which thematic domains dominated the newspaper's visual data materials, and did their informational function transition from decorative-illustrative representation to analytical-explanatory interpretation?
- RQ3 (Institutional Style & Formats): To what extent did Jas Qazaq's recurring data communication formats (Birjameter, "Word of the Week", pictographic infographics) facilitate rapid cognitive processing of quantitative information among readers?

Scientific Hypotheses (H):

- H1 (Quantitative Expansion Hypothesis): Between 2016 and 2025, the frequency of data artifacts in Jas Qazaq newspaper increased significantly, expanding from basic currency tickers (Birjameter) to comprehensive thematic infographics.
- H2 (Functional Transformation Hypothesis): While visual numbers primarily served as rapid indicative economic markers during 2016–2019, they transformed into analytical-explanatory instruments for structuring complex socio-medical, environmental, and security data during crisis periods in 2020–2025.
- H3 (Data-Style Hypothesis): Data visualization in Jas Qazaq established a unique domestic visual data journalism model characterized by accessible iconographic pictograms, comparative charts, and numerical snapshots tailored for print newsprint format.

2. Literature Review

2.1 Theoretical-Conceptual Foundations of Data Visualization in Print Media

The transition from a traditional text-heavy reporting model to visual-data communication represents a key qualitative benchmark in modern print media. Data visualization serves as an essential journalistic practice for communicating complex statistical and quantitative datasets to readership in a concise, clear, and cognitive-friendly format. As Houston (2026) highlights, collecting, analyzing, and visualizing numerical data to construct high-quality journalistic content constitutes a core methodology in the contemporary information era. Morini's (2025) systematic literature review underscores the complementary relationship between data journalism and visualization, demonstrating that visual representation enables newsrooms to elucidate complex socio-economic phenomena, expose hidden trends, and establish meaningful analytical connections within datasets.

In the analysis of print journalism, infographics should be understood not merely as decorative or illustrative elements but as independent communicative structures that facilitate the interpretation and contextualization of information. The theoretical model for evaluating news infographics, Chun (2023) identifies integration, abstraction, and extension as primary evaluation dimensions, establishing infographics as integrated visual structures that actively organize and clarify journalistic narratives. Stalpl and Heravi's (2021) systematic data visualization analysis framework provides a dimensional methodology for classifying print-based visual elements across structural, thematic, and functional parameters. As Garreton et al. (2023) observe, data visualizations in modern journalism move beyond passive presentation to execute vital analytical and narrative (storytelling) functions within news reporting. Furthermore, institutional shifts toward computational newsroom practices and algorithmic interface design have been well documented in broader media scholarship (Anderson, 2013; Fink & Anderson, 2014; Anderson & Borges-Rey, 2019)

2.2 Cognitive and Media Influence Models of Visual Data Communication

The cognitive and societal impact of visual data communication on readership is grounded in a synthesis of established theoretical frameworks:

1. Cognitive Theories: Paivio's (1991) Dual-Coding Theory posits that human cognition processes information simultaneously through verbal and visual channels, thereby optimizing the comprehension and retention of quantitative data. Sweller's (1994) Cognitive Load Theory further demonstrates that visually structuring complex numerical data reduces cognitive friction, enabling readers to process intricate economic and social indicators more efficiently.
2. Media Influence Theories: McCombs and Shaw's (1972) Agenda-Setting Theory explains how visualized numbers highlight specific societal, economic, or environmental issues, prioritizing them on the public agenda. Goffman's (1974) and Entman's (1993) Framing Theory emphasizes that visual artifacts frame statistical indicators from distinct analytical angles. Ball-Rokeach and DeFleur's (1976) Media Dependency Theory highlights that during periods of social crisis and

uncertainty, audience dependency on official statistics increases, thereby elevating the explanatory and analytical authority of visual data elements.

3. Digital Citizenship and the Public Sphere: Mossberger et al.'s (2007) Digital Citizenship Framework and Habermas's (1991) Public Sphere concept demonstrate that visual data representations facilitate civic access to socio-political information, fueling informed public discourse and democratic participation.

2.3 Data Visualization of Kazakhstan's Print Media

Within Kazakhstan's evolving media landscape, data visualization practices are developing in parallel with digital transformation, the expansion of open data infrastructure, and shifts in audience news consumption. The transition from information scarcity to information abundance has reoriented editorial priorities from the collection of raw data toward its systematic processing, verification, analysis, and visual synthesis.

Drawing on Borges-Rey (2016), Abdikhalyk and Beldibekova (2024) observe that competencies in data sourcing, cleaning, and visualization empower journalists to articulate complex socio-political events through infographics. Within this conceptual framework, numerical datasets are regarded not merely as static entries in electronic spreadsheets but as substantive sources of journalistic analysis and interpretation. Furthermore, Abdikhalyk and Beldibekova (2024) define the functional distinction between visualization formats: data visualization focuses on deep exploratory interpretation and understanding of datasets, whereas infographics aim to convey a structured, specific visual story.

International scholarship emphasizes the value of visual artifacts in print and digital newsrooms. Boyles and Meyer (2016) as well as Dick (2013) demonstrate that the absence of infographic support diminishes news value and reader engagement, whereas structured visual data elements significantly enrich textual reporting. Api, Alimzhanova, Andreyeva, and Abdikhalyk (2025) observe that the integration of data visualization technologies and digital and AI-based tools strengthens newsroom competitiveness and facilitates the development of innovative formats for presenting quantitative information. Although Kazakhstani print media outlets, including Egemen Qazaqstan, Kazakhstanskaya Pravda, and Jas Qazaq, have increasingly incorporated infographics and statistical graphics into their publications, the longitudinal development and functional evolution of print-based data visualizations remain insufficiently examined and warrant systematic empirical investigation.

2.4 Research Gaps

A systematic review of current scholarly literature reveals three critical research gaps:

1. Geographic-Media Gap: Although international scholarship on data visualization has predominantly focused on digital journalism and online newsrooms in Western media contexts, visual data communication in Central Asian print media, particularly in Kazakhstan, remains comparatively underexplored.
2. Longitudinal Empirical Gap: Existing research on data visualization in Kazakhstan has largely adopted descriptive approaches or focused on limited time periods. Consequently, longitudinal content analyses examining both the quantitative distribution and qualitative transformation of visual data artifacts across a decade-long national print archive remain scarce.
3. Functional-Paradigm Gap: The processes through which numerical information in print media evolves from decorative or rudimentary indicative elements into analytical, explanatory, and crisis-communication tools remain insufficiently theorized and empirically documented.

3. Method

This study adopts a quantitative-dominant mixed methodological design to examine the longitudinal evolution, structural typology, and functional transformation of data visualization in Kazakhstan's print media. By conducting a ten-year content analysis of the national socio-political weekly newspaper Jas Qazaq (Zhas Qazaq) spanning 2016 to 2025, the research design integrates document analysis, empirical content categorization, and functional-semantic evaluation. This approach captures both the structural dynamics and the communicative functions of visual data artifacts within traditional newsprint formats.

3.1 Dataset

The empirical dataset for this study was constructed using non-intrusive archival collection methods, drawing exclusively from the complete, unedited print repository of Jas Qazaq published between January 2016 and December 2025. Following the official cessation of the newspaper's print edition and web publication on January 1, 2026 and its subsequent editorial transition to the jasqazaq.kz news agency. This decade-long archive provides a historically bounded case study for examining visual data practices in print journalism, offering a longitudinal perspective on their development and changing forms of representation.

To ensure empirical rigor and sampling validity, the dataset was compiled using standardized inclusion and exclusion criteria: Inclusion Criteria: All published visual graphic elements that structure, frame, quantify, or visually interpret numerical and statistical information. This includes:

- Recurring indicative market data blocks (Birjameter, foreign exchange tickers, oil futures);
- Prominent typographical numerical facts and snapshots (Word of the Week, large-scale numerical callouts);
- Thematic infographics, 3D charts, bar graphs, and pictographic compositions;
- Statistical tables, spatial cartography (maps), and physical-statistical seismographic diagrams.

Exclusion Criteria: Non-statistical political caricatures lacking quantitative indicators, standalone news photographs without data overlays, and purely artistic editorial illustrations were excluded from the analytical corpus. The systematic audit of the 10-year print archive yielded a total analytical sample of $N = 1,090$ visual data artifacts across 466 published newspaper issues (published at an average rate of 24–52 issues annually).

3.2 Materials and Tools

The research corpus comprises physical newspaper pages, high-resolution digital PDF archives, statistical graphics, vector-based pictograms, cartographic representations, and their accompanying journalistic narratives.

Data collection, quantitative tabulations, and statistical processing were executed using standardized data analysis tools commonly applied in media scholarship, including Microsoft Excel for structural categorization and cross-tabulation, Python (pandas, NumPy) for longitudinal trend analysis and R (irr package) for calculating inter-coder reliability metrics.

The analytical workflow was informed by Stalph and Heravi's (2021) Systematic Data Visualization Analysis Framework, adapted specifically to evaluate data artifacts across three core dimensions: thematic domain, graphic topology, and journalistic function.

3.3 Conduction

The research was conducted in four consecutive methodological phases:

1. **Exploratory Archival Inventory & Digital Auditing:** The complete 2016–2025 print archive of Jas Qazaq was systematically audited to identify, digitize, and catalogue every published item containing quantitative visual elements. Metadata including publication date, page layout placement, visual dimensions, and primary topic were logged.
2. **Purposive Sampling & Categorization:** Identified items were screened against the inclusion criteria. Eligible artifacts ($N = 1,090$) were classified into four standardized primary categories based on graphic structure and editorial recurrence:
 - (N_1) : Recurring Indicative Market Tickers ($n = 467$);
 - (N_2) : Prominent Numerical Facts & Snapshots ($n = 206$);
 - (N_3) : Thematic Infographics & Charts ($n = 181$);
 - (N_4) : Statistical Tables, Maps & Seismograms ($n = 236$).
3. **Qualitative-Semantic Coding:** Each artifact was coded across three analytical dimensions:
 - Content/Thematic Dimension: Macroeconomics, public finance, social welfare, public health/COVID-19, infrastructure, environmental/disaster management, and crime statistics;
 - Visual Representation Form: Tickers, 3D bar/pie charts, pictographic illustrations, thematic cartography, and seismographic diagrams;
 - Journalistic Function: Indicative (rapid snapshot), comparative (longitudinal/regional comparison), explanatory (process breakdown), and crisis/analytical interpretation.
4. **Longitudinal Synthesis & Hypothesis Testing:** Quantitative distributions were aggregated annually to evaluate longitudinal expansion (testing Hypothesis (H_1)). Qualitative shifts across four historical periods (2016–2017, 2018–2019, 2020–2022, 2023–2025) were analyzed to trace the transition from decorative illustration to analytical interpretation (testing Hypotheses (H_2) and (H_3)).

Journalistic functions were operationalized based on distinct qualitative criteria: (1) Indicative: rapid, standalone market or numerical snapshots without contextual narrative analysis; (2) Comparative: cross-sectional or longitudinal evaluations across regions, timeframes, or sectors; (3) Explanatory: step-by-step structural breakdowns of policy, healthcare, or economic processes; and (4) Crisis/Analytical: comprehensive multi-variable visualizations contextualizing public safety emergencies and socio-economic disasters.

3.4 Analytical Framework and Coding Matrix

The study operates on a multi-dimensional analytical model that conceptualizes visual data artifacts not as auxiliary editorial ornaments, but as epistemic instruments that structure journalistic storytelling, reduce audience cognitive friction (Cognitive Load Theory), and shape public discourse (Agenda-Setting & Framing Theories).

Methodological Research Questions & Hypotheses Alignment

The analytical model directly evaluates three core Research Questions ((RQ)) and Scientific Hypotheses ((H)):

- (RQ_1) & (H_1) (Quantitative Growth): Assesses whether the annual volume of data artifacts expanded significantly from baseline years (2016) to final publication years (2025).
- (RQ_2) & (H_2) (Functional Transformation): Measures the shift of visual numbers from basic currency/oil indicators (2016–2019) to complex crisis, epidemiological, and socio-economic explanatory graphics during major national/global emergencies (2020–2025).
- (RQ_3) & (H_3) (Institutional Visual Style): Analyzes the emergence of recurring newsprint data formats (Birjameter, pictographic infographics, spatial cartography) in establishing a localized print data journalism model.

Inter-Coder Reliability Protocol

To validate coding reliability and guard against subjective interpretative bias, an inter-coder reliability test was conducted. A randomized 10% sample ($n = 109$) artifacts) was independently coded by two media researchers using the standardized codebook. Agreement was calculated using Holsti's coefficient of agreement and Percent Agreement:

$$C = \frac{2M}{N_1 + N_2} = 0.92$$

An inter-coder agreement rate of 92.0% (Holsti's $C = 0.92$) was achieved across all evaluated coding dimensions, including graphic topology categorization (94.5%), thematic domain assignment (91.8%), and journalistic function operationalization (89.7%), confirming high coding stability and reproducibility.

4. Results

A comprehensive long-term content analysis of the complete decade of Jas Qazaq in print published between 2016 and 2025 (comprising 466 published newspaper issues, appearing at a rate of 24–52 issues annually) yielded a total empirical sample of $N = 1,090$ visual data artifacts. Following the official discontinuation of its print edition on January 1, 2026, and the subsequent transition of its editorial operations to the Jas Qazaq online news platform (jasqazaq.kz), the newspaper's decade-long print archive constitutes a historically bounded and comprehensive case study for examining the longitudinal development, structural typology, and functional evolution of data visualization in Kazakhstani print media.

4.1 Quantitative Growth and Longitudinal Dynamics ((RQ_1) and (H_1))

To systematically examine the longitudinal distribution of data elements, all identified visual artifacts were classified into four primary categories according to their graphical structure and patterns of editorial recurrence:

1. Recurring indicative market data blocks (Birjameter, financial exchange tickers – (N_1));
2. Prominent typographical numerical facts and snapshots (Word of the Week – (N_2));
3. Thematic infographics and charts (3D, bar, and pictographic graphs – (N_3));
4. Statistical tables, spatial cartography, and seismographic diagrams ((N_4)).

The annual distribution and categorical breakdown of visual data artifacts across the 10-year timeline are detailed in Table 1.

Table 1. Quantitative-Longitudinal Distribution of Visual Data Artifacts in Jas Qazaq (2016–2025)

Publication Year	Recurring Market Tickers ((N_1))	Numerical Snapshots ((N_2))	Thematic Infographics & Charts ((N_3))	Statistical Tables, Maps & Seismograms ((N_4))	Annual Total Data Content ((N))
2016	42	12	3	15	72
2017	45	28	8	18	99
2018	46	32	14	22	114
2019	44	10	9	16	79
2020	48	24	21	35	128
2021	47	15	16	20	98
2022	48	22	18	26	114
2023	49	18	27	24	118
2024	50	25	31	29	135
2025	48	20	34	31	133
Total	467	206	181	236	1,090

Note: Compiled by the authors through quantitative content analysis of the Jas Qazaq print archive (2016–2025).

The empirical calculations in Table 1 fully validate Hypothesis (H_1) . From a baseline volume of 72 units in 2016, the annual volume of visual data artifacts expanded by 84.7%, reaching 133 units in 2025. This longitudinal trend demonstrates that quantitative visualization shifted from an occasional illustrative ornament to an institutionalized editorial standard within newsprint reporting.

The quantitative trajectory revealed two distinct periods of pronounced growth:

- The 2020 Emergency Period (COVID-19 Pandemic, $(N = 128)$): Driven by an urgent editorial need to translate epidemiological statistics and emergency regulations into accessible formats, the combined volume of explanatory infographics and statistical tables expanded by 124% relative to 2019 baseline levels (increasing from 25 units in 2019 to 56 units in 2020).
- The 2024–2025 Analytical Peak ($(N = 135)$ and $(N = 133)$): Triggered by critical national events – including the Almaty earthquake seismographic reporting, widespread spring flooding emergencies, oil refinery industrial capacity audits, household debt crises, and national tax code reform debates – the newspaper published its highest historical volume of multi-element data visualizations.

Across the entire 1,090-item corpus, recurring market tickers (Birjameter) comprised the largest share at 42.8% ($(n = 467)$), followed by statistical tables, maps, and seismograms at 21.7% ($(n = 236)$), prominent numerical snapshots at 18.9% ($(n = 206)$), and thematic explanatory infographics at 16.6% ($(n = 181)$). These quantitative dynamics directly answer (RQ_1) , establishing that Jas Qazaq prioritized visual-data communication during periods of socio-economic and infrastructural uncertainty.

4.2 Qualitative-Semantic Transformation Across Chronological Stages (RQ_2) and (H_2)

A qualitative content analysis of the empirical corpus elucidates (RQ_2) by uncovering four distinct evolutionary phases in the newspaper's visualization paradigm:

4.2.1 Initial Emergence Phase (2016–2017): Indicative Tickers and Numerical Callouts

During the initial phase, the newsroom established the foundations of indicative data reporting. Located *prominently on page 2*, the recurring Birjameter column framed foreign exchange rates ($(KZT/USD, KZT/EUR, RUB, SOM)$) and Brent crude oil futures using vector pictograms ($(€, \$, \text{oil barrel})$). In alignment with Cognitive Load Theory, these visual anchors minimized reader cognitive friction, allowing audiences to digest financial fluctuations through rapid mental snapshots. Simultaneously, the Word of the Week column introduced large-scale typographical callouts ("2 million KZT", "12.4 million KZT", "40 million KZT"), pioneering a "numerical snapshot" technique designed to highlight the quantitative scale of legal and social incidents.

4.2.2 Format and Genre Expansion Phase (2018–2019): Comparative Data and Spatial Cartography

From 2018 onward, Jas Qazaq broadened its data journalism practices to incorporate longitudinal comparisons and regionally differentiated reporting.

The newsroom introduced comparative tabular structures evaluating transport-logistics revenue growth (expanding from 1,774,167.4 million KZT to 2,076,435.4 million KZT) and Consumer Price Index (CPI) fluctuations across major Kazakhstani municipalities. In 2019, spatial cartography was introduced; thematic maps of Kazakhstan featuring red indicator nodes were deployed to contextualize the geographic distribution of regional development projects.

4.2.3 Crisis and Medical Data Analysis Phase (2020–2022): Emergency Contexts

The outbreak of the COVID-19 pandemic and subsequent socio-political crises elevated the newspaper's data practices to a higher analytical tier, fully confirming Hypothesis (H_2) . In 2020, the paper published comprehensive explanatory infographics, such as "What Does Quarantine Entail?" alongside global outbreak tracking maps (Global Trend) and national-versus-international comparative tables. As conceptualized in pandemic visualization scholarship, these artifacts combined statistical tables, textual explanations, vector icons, and bar graphs into explanatory journalistic narratives. By 2022, this analytical approach was adapted to chart national COVID-19 vaccination rates (45.3% population coverage callouts) and summarize official casualty figures following the January 2022 social unrest (225 fatalities, 4,578 injured).

4.2.4 Advanced Analytical Visualization and Pictographic Consolidation Phase (2023–2025)

In its final three years of print publication, Jas Qazaq consolidated a distinct visual data style, confirming Hypothesis (H_3) . Public infrastructure degradation was mapped using color-coded urgency zones (red, yellow, green), healthcare system revenues under OSMS were visualized using stethoscope iconography, and national household debt ((24.1) trillion KZT across 9 million borrowers) was depicted through bank card and automobile pictograms. Following the 2024 Almaty earthquake, the front page featured a physical seismographic wave diagram highlighting wave amplitude and epicenter coordinates. Spring flood emergencies were similarly communicated via real-time data dashboards ($(99,869)$).

evacuees, (36,591) children). By 2025, multi-variable infographics covering oil refinery output across Shymkent, Atyrau, and Pavlovar, tax reform deficits (400) billion KZT), and national demographic benchmarks (20.3) million population) established visual data stories as a primary analytical genre of the newspaper.

4.3 Qualitative-Semantic Typology of Visual Data Artifacts (RQ_3) and (H_3))

To address (RQ_3), all identified data materials were categorized into four overarching qualitative-semantic typologies based on graphic structure and journalistic function, as summarized in Table 2.

Table 2. Qualitative-Semantic Typology of Visual Data Artifacts in Jas Qazaq

Thematic Category	VisualPrimary Graphic Tools and Structural Features	Journalistic & Communicative Function
Indicative Data	Economic <i>Birjameter</i> column, currency symbols (€, \$, ₸), oil barrel icons, gold ounce metrics, live market tickers.	Provides rapid mental snapshots (<i>snapshots</i>) of market dynamics without requiring length text reading.
Crisis & Emergency Visuals	COVID-19 trend curves, physical seismographic wave diagrams, flood evacuation tallies, emergency vectors.	Establishes the empirical magnitude and emotional urgency of public safety disasters.
Socio-Infrastructural Data	Stethoscope icons, color-coded degradation zones (<i>red/yellow/green</i>), vehicle and housing pictograms.	Simplifies complex social policy issues (OSMS, household debt, utility grid wear) into accessible visual frames.
Geo-Cartographic Visualizations	Regional Kazakhstan maps, red indicator nodes, nuclear power plant (NPP) logistics schemas.	Explains the spatial and territorial distribution of regional resources, infrastructure, and socio-political events.

Note: Developed by the authors based on Stalpl & Heravi's (2021) systematic data artifact framework.

4.4 Summary of Empirical Findings

The longitudinal content analysis of Jas Qazaq's decade-long archive (2016–2025) provides definitive answers to all research questions and confirms all formulated hypotheses:

1. Quantitative Expansion (H_1) Confirmed): The annual volume of visual data artifacts expanded by 84.7% over ten years. While reporting in 2016 relied on isolated financial boxes, reporting between 2023 and 2025 regularly integrated four to five multi-element visual data blocks per issue, establishing data visualization as a permanent newsprint standard.
2. Functional Transformation (H_2) Confirmed): The newsroom executed a qualitative shift from "decorating stories with numbers" (2016–2018) to "analyzing and explaining socio-political crises through numbers" (2020–2025). During pandemic and emergency contexts, data graphics acted as essential explanatory instruments for civic orientation.
3. Institutional Visual Style (H_3) Confirmed): Jas Qazaq established a localized print data journalism model anchored in accessible pictographic graphics, recurring financial tickers (*Birjameter*), numerical snapshots (*Word of the Week*), and spatial cartography tailored specifically for traditional print newsprint layouts.

5. Discussion

The empirical findings of this longitudinal study illuminate the quantitative expansion, genre diversification, and qualitative-functional transformation of data visualization across a decade-long print archive (comprising (N = 1,090) visual data artifacts) of the national socio-political weekly newspaper Jas Qazaq (Zhas Qazaq, 2016–2025). Contextualizing these findings within global data journalism literature and Kazakhstani media scholarship provides a comprehensive theoretical synthesis addressing the core research questions (RQ_1, RQ_2, RQ_3) and formulated scientific hypotheses (H_1, H_2, H_3)).

5.1. Theoretical and Conceptual Interpretation of Results

5.1.1 Quantitative Growth, Editorial Standardization and Epistemic Knowledge Production (RQ_1) and (H_1))

The empirical analysis demonstrates an 84.7% longitudinal increase in the annual volume of visual data artifacts published in Jas Qazaq – expanding from 72 units in 2016 to 133 units in 2025. This quantitative expansion fully confirms Hypothesis (H_1), indicating that visual data communication evolved from an auxiliary graphic add-on into an institutionalized editorial standard within Kazakhstani newsprint reporting.

This longitudinal trajectory aligns with Houston's (2026) conceptualization of data journalism as an autonomous professional methodology that constructs high-quality news content through systematic collection, analytical processing, and visual presentation of quantitative datasets. Furthermore, these findings provide empirical support for the theoretical arguments advanced by Ausserhofer et al. (2017) and Abdikhalyk and Beldibekova (2024), who suggest that the historical transition from information scarcity to information abundance has reshaped journalistic priorities. Rather than focusing primarily on information gathering, journalism increasingly emphasizes the critical selection, verification, analysis, and visual synthesis of information.

As Borges-Rey (2016) and Pilgun (2016) note, contemporary journalists increasingly view structured numerical data not as passive figures in spreadsheets, but as substantive analytical content, shifting the locus of news authority from subjective quotes to empirically grounded data claims.

5.1.2 Functional Transformation and Crisis Data Communication ((RQ_2) and (H_2))

The qualitative shift observed in the newspaper's coverage – moving from "decorating stories with numbers" (2016–2018) to "analyzing and explaining crises through numbers" during major national and global emergencies (2020 COVID-19 pandemic: $(n = 128)$; 2024–2025 Almaty earthquake, spring floods, oil refinery capacities, and tax reform debates: $(n = 135)$ and $(n = 133)$) – provides robust empirical support for Hypothesis (H_2) .

This functional shift echoes Indah and Hasanah's (2022) pandemic visualization model, which demonstrates how infographics integrate statistical datasets, regulatory texts, vector icons, and comparative charts into coherent explanatory narratives. As Garreton et al. (2023) emphasize, visual data artifacts in long-form journalism move beyond aesthetic ornamentation to perform active analytical and narrative (storytelling) roles within the journalistic text.

From a media-effects perspective, this functional transformation can be interpreted through Ball-Rokeach and DeFleur's (1976) Media System Dependency Theory. During periods of societal crisis and heightened uncertainty, audiences may become increasingly reliant on media-mediated information, including official statistics, to interpret unfolding events and navigate complex circumstances. Under these conditions, data visualizations can serve as important cognitive and orientational resources, facilitating the comprehension of complex information and supporting the formation of informed judgments. Concurrently, through the lenses of Agenda-Setting Theory (McCombs & Shaw, 1972) and Framing Theory (Goffman, 1974; Entman, 1993), prominent numerical snapshots (Word of the Week), 3D bar graphs, and front-page physical seismograms focused public attention on the precise empirical magnitude of socio-economic and public safety crises, framing statistical indicators from specific analytical perspectives.

5.1.3 Institutional Visual Style and Cognitive Optimization ((RQ_3) and (H_3))

The decade-long consolidation of recurring data formats in Jas Qazaq – most notably the Birjameter column (comprising 42.8% of the total dataset, $(n = 467)$), numerical callouts (Word of the Week), pictographic infographics, spatial cartography, and multi-element schemas – established a distinct, localized print data journalism model (confirming Hypothesis (H_3)). This institutional visual style operationalizes Chun's (2023) evaluation framework for news infographics (integration, abstraction, and extension) as well as Stalph and Heravi's (2021) dimensional model for data artifact analysis.

From a cognitive communication standpoint, this visual layout is supported by Paivio's (1991) Dual-Coding Theory and Sweller's (1994) Cognitive Load Theory. The newsroom's systematic deployment of vector pictograms (€, \$, oil barrels, stethoscopes, bank cards) alongside numeric tickers activated dual verbal and visual processing channels simultaneously. This visual-symbolic combination is theorized under Cognitive Load Theory and Dual-Coding Theory to reduce cognitive friction, facilitating rapid information reception and infrastructural degradation data through rapid mental snapshots. As Boyles and Meyer (2016) and Dick (2013) observe, integrating structured infographic support enhances news value, enriches textual reporting, and fosters positive reader evaluations of the publication.

5.2 Comparative Analysis of International and Kazakhstan's Media Practices

In major Western newsrooms (The New York Times, The Guardian, Der Spiegel), data journalism relies heavily on dynamic digital environments, interactive dashboards, algorithmic visualizations, and open big data repositories that enable readers to explore raw datasets independently (Api et al., 2025; Howard, 2014). Conversely, data journalism in traditional Kazakhstani print newsprint is defined by pre-processed, static visual products (Birjameter, 3D bar charts, tabular layouts, thematic cartography). While this static presentation is inherently shaped by the physical constraints of newsprint formatting, the case of Jas Qazaq demonstrates that traditional print media can successfully establish a rigorous, highly structured model of visual data communication.

Furthermore, research by Abdikhalyk and Beldibekova (2024) and Abdikhalyk et al. (2026) indicates that, despite advances in Kazakhstan's national open data infrastructure (data.egov.kz), data journalists continue to encounter persistent institutional and procedural constraints. These include incomplete public procurement records, inconsistent data formats, and statutory waiting periods of 4 to 15 working days for responses to official information requests under applicable media legislation. Within this constrained information environment, Jas Qazaq drew on official statistical releases from the Bureau of National Statistics, the National Bank of Kazakhstan, and relevant sectoral ministries, processing and organizing numerical information into accessible visual representations and print narratives. This practice provides a basis for examining how official data are transformed into journalistic content while preserving their accuracy and contextual integrity.

5.3 Impact on Civic Engagement and Digital Citizenship

By converting abstract statistics into accessible visual formats, data visualization facilitates public access to socio-political and economic information. This process directly supports Habermas's (1991) Public Sphere concept and Mossberger et al.'s (2007) Digital Citizenship Framework by fueling informed public discourse and democratic accountability. As Api, Alimzhanova, Andreyeva, and Abdikhalyk (2025) note, integrating data visualization technologies and digital tools enhances newsroom competitiveness and elevates audience engagement to a qualitatively higher analytical level.

The official cessation of *Jas Qazaq*'s print edition on January 1, 2026, and its editorial transition to the *jasqazaq.kz* news agency marks a critical turning point. The newsroom's decade-long experience in print data visualization provides an empirical foundation for adopting interactive, digital-native data journalism practices in the online sphere.

5.4 Limitations and Future Research Directions

Limitations of the Study:

1. **Single-Case Focus:** Since this study draws on a 10-year print archive from a single newspaper, *Jas Qazaq*, its findings should be interpreted with caution and may not fully reflect trends across the wider Kazakhstani print media landscape.
2. Although quantitative and qualitative content analysis can effectively examine the structure, themes, and functions of visual data, these methods cannot directly capture how readers respond to such materials in real time or how they influence reader behavior. Investigating these responses would require additional methods, such as eye-tracking experiments or reader surveys.

Recommendations for Future Research:

1. **Comparative Media Analysis:** Conducting comparative longitudinal studies across traditional print newspapers and native digital media platforms in Central Asia.
2. **AI-driven Data Visualization:** Examining the application of artificial intelligence and automated visualization tools (Data2Vis, VisML, DeepEye, Draco, Flourish) within Kazakhstan's newsrooms.
3. **Audience Understanding & Civic Behavior:** Conducting experimental and audience-based studies to measure how visual data artifacts impact reader comprehension, trust, and civic participation in emerging democracies.

6. Conclusion

This study has identified the structural evolution, long-term dynamics, and qualitative transformation of data visualization in Kazakhstan's print media through a ten-year content analysis of *Jas Qazaq* newspaper (2016–2025). Despite the fact traditional print media faces intrinsic physical layout impediments and structural challenges – leading to the official shift towards of *Jas Qazaq* from print to a digital news agency in 2026 – the decade-long print archive demonstrates a steady institutionalization of data visualization practices. This trend is evidenced by the significant expansion of visual data artifacts, which evolved from basic financial tickers into complex, multi-element explanatory infographics. As a result, print-based data visualization is poised to inform digital-native media practices, driven by a new generation of newsrooms equipped with data literacy and visual storytelling techniques.

This study identifies to the growing field of media scholarship by examining longitudinal methodological approaches to visual data artifacts within newsprint journalism. Focusing on a comprehensive dataset of 1,090 visual data materials, the study highlights how statistical sources, analytical frameworks, and graphic topographies (market tickers, numerical snapshots, thematic infographics, spatial cartography, and seismograms) increasingly influence the creation of scientifically sound media content. Drawing on quantitative content analysis, semantic coding, and visual storytelling, this study demonstrates that effective data visualization in print media depends not only on the application of visual design techniques but also on rigorous editorial practices, statistical accuracy, and context-sensitive interpretation.

The study shows that print data visualization functions as both an analytical process and a communicative practice. While the visual representation of quantitative data expands opportunities for contextualizing socio-economic and public health issues, the communicative power of journalism depends largely on journalists' ability to critically interpret raw numbers, structure information in a manner aligned with cognitive load reduction principles and translate complex datasets into accessible visual narratives. In the context of Kazakhstan's evolving media landscape, these practices are increasingly important in strengthening public accountability, providing civic orientation during periods of social and environmental crisis (such as the COVID-19 pandemic, natural disasters, and economic reforms), and supporting evidence-based public discourse.

Overall, this study contributes to existing scholarship on data journalism by adopting a longitudinal analytical framework that integrates data filtering, structural classification, thematic framing, and visual communication in print media. The findings underscore the importance of developing interdisciplinary competencies that bridge traditional journalistic practice, quantitative analysis, and visual design. Amid the ongoing digital transformation of media systems, preserving the analytical rigor of print-based data visualization while adapting its methodological principles to digital newsroom workflows represents an important consideration for the future of analytical and investigative journalism. As the media landscape continues to evolve, media organizations must strengthen their capacity to apply visual data methodologies effectively, ensuring that journalistic reporting remains methodologically rigorous, transparent, and responsive to growing public demands for accountability in an increasingly data-driven information environment.

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Author contributions

PhD student Olzhas Abdikhalyk was responsible for study conceptualization, research design, primary archival data collection, quantitative data analysis, visualization, writing the original draft, and executing overall revisions. PhD Aikerim Alimzhanova served as the corresponding author, contributing to the theoretical framework development, study conceptualization, qualitative findings validation, research supervision, and critical editing of the manuscript. PhD student Bayan Mussayeva contributed to the qualitative-semantic coding matrix, data curation, statistical analysis verification, and manuscript drafting assistance. PhD Altyn Akynbekova contributed to methodology refinement, formal analytical protocol verification, research project administration, and critical manuscript revision. PhD student Zhadyra Almish contributed to archival data curation, literature review synthesis, inter-coder reliability testing support, and proofreading the manuscript. All authors have read and approved the final version of the manuscript.

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