

VISUAL ANALYSIS OF UNIVERSITY ADMISSION POSTERS USING COMPUTER VISION AND VISUAL COMMUNICATION DESIGN APPROACH

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Abstract

The increasing use of visual media in university admissions highlights the need for systematic evaluation of promotional poster design. However, existing assessments are largely subjective and lack measurable indicators. This study aims to analyze the visual and textual characteristics of a university admission poster using a computational approach. A quantitative–descriptive visual case study was conducted using Python-based image processing, including color histogram analysis, dominant color extraction, grayscale density measurement, edge detection, and Optical Character Recognition (OCR). The results show a grayscale density of 140.31, an edge density ratio of 9.16%, and a text area ratio of 11.85%, indicating moderate visual complexity and structured layout organization. The dominant color palette and OCR results (169 words; 1,179 characters) reflect a relatively high informational load. These findings represent visual features associated with communicative design and are interpreted as theoretical proxies rather than direct measures of communication effectiveness. The study provides a computational, theory-informed framework for analyzing promotional poster design in higher education contexts.

Keywords: Visual Communication Design, Computational Image Analysis, Poster Evaluation, Visual Density, Color Composition, Promotional Media

INTRODUCTION

In the digital era, visual communication plays an increasingly critical role in shaping public perception and influencing decision-making processes across various sectors, including higher education (Qadir, 2023). Universities are no longer competing solely based on academic reputation, but also through their ability to communicate institutional identity, academic quality, and campus culture in visually compelling ways (Huo & Wang, 2022). As a result, promotional materials have become essential instruments in institutional branding and student recruitment strategies. Among various formats, posters remain widely used due to their simplicity, flexibility, and strong visual impact, enabling institutions to convey key information efficiently while maintaining aesthetic appeal.

From the perspective of Visual Communication Design (VCD), an effective poster functions as a strategic communication artifact that integrates visual elements such as color composition, layout structure, typography, and visual hierarchy (Hunowu et al., 2023). These elements guide audience attention, enhance readability, and reinforce institutional credibility.

In the context of university admissions, posters serve as a primary medium through which prospective students form initial impressions. Therefore, the visual quality and clarity of information in admission posters are crucial factors influencing communication effectiveness. However, the evaluation of poster design has traditionally relied on qualitative approaches, including aesthetic judgment, semiotic interpretation, and audience perception studies, which often lack objective, measurable, and reproducible standards.

Recent developments in visual complexity theory, computational aesthetics, and cognitive processing provide a theoretical foundation for linking visual structure with communication effectiveness. Studies in visual cognition suggest that visual complexity—often represented through features such as edge density, luminance variation, and spatial distribution—affects attention allocation, perceptual fluency, and cognitive load. High visual complexity may increase cognitive effort and reduce comprehension efficiency, whereas moderate levels of complexity tend to enhance engagement and information processing. Similarly, grayscale density, which reflects luminance distribution, is closely related to contrast perception and readability, both of which are essential for effective visual communication. The proportion of textual elements, often measured through text area ratio and word count, corresponds to information load, which directly influences cognitive load and message retention according to information processing theory. These theoretical perspectives establish a clear relationship between measurable visual features and audience centered communication outcomes.

In parallel, advances in computer vision and digital image processing have enabled the transformation of visual and textual elements into quantifiable metrics. Techniques such as color histogram extraction, dominant color identification, edge detection, grayscale density measurement, and Optical Character Recognition (OCR) allow systematic evaluation of visual composition and information structure (Utami et al., 2025). These methods have been applied in areas such as advertising analysis, document processing, and human–computer interaction, demonstrating their effectiveness in measuring visual complexity, structural organization, and informational density (Dito et al., 2025). Despite these advancements, their application in the evaluation of higher education promotional media—particularly university admission posters—remains limited and underexplored.

Although prior studies have examined visual communication design and computational image analysis independently, a significant research gap persists in the integration of these domains. Existing visual communication studies tend to emphasize qualitative interpretation without incorporating objective measurement, while computational approaches often focus on numerical extraction without linking the results to communication theory or audience perception. Consequently, there is a lack of a unified framework that connects computational visual metrics—such as edge density, grayscale intensity, and text area ratio—with theoretical constructs of cognitive processing and communication effectiveness. This gap highlights the need for an interdisciplinary approach that bridges quantitative image analysis with visual communication design principles to produce both measurable and theoretically grounded evaluations.

This study addresses this gap by proposing an integrated analytical framework that combines computer vision-based techniques with visual communication design theory to evaluate the effectiveness of a university admission poster. Specifically, the research analyzes color composition, visual density, layout structure, and textual information extracted through OCR, and interprets these metrics in relation to perceptual clarity, cognitive load, and communication effectiveness. The novelty of this study lies in establishing a systematic linkage between computational visual metrics and audience-oriented communication outcomes, thereby contributing to the advancement of interdisciplinary research between visual communication design and information systems. Furthermore, this study offers practical

insights for developing data-driven strategies to optimize promotional media in higher education contexts.

METHODOLOGY

This study adopts a quantitative-supported visual case study approach utilizing computational visual analysis techniques (Ray & Sucipto, 2023). The primary objective is to systematically examine the visual and textual characteristics of a university admission promotional poster through the integration of computer vision methods and visual communication design principles. By combining digital image processing and Optical Character Recognition (OCR), the study quantifies key design attributes, including color composition, visual density, layout organization, and textual information structure. The extracted metrics are subsequently interpreted within visual communication and cognitive processing frameworks to evaluate the poster's communicative effectiveness.

1. Research Design

The research employs a single-case study design, focusing on a university admission poster used in the 2026 enrollment period. This approach is intentionally selected to enable an in-depth exploration of visual and textual elements within a real-world design context. Rather than aiming for statistical generalization, this study emphasizes analytical depth and methodological integration, which are essential in exploratory and framework-development research. The analytical procedure consists of four stages: (1) data acquisition, (2) image preprocessing, (3) computational feature extraction, and (4) interpretative analysis based on visual communication design and cognitive processing principles (Yuda Phalguna, 2022). This structured workflow ensures methodological consistency, analytical rigor, and reproducibility.

2. Population and Sample

The population of this study comprises promotional visual materials used in university admission campaigns across higher education institutions (Surahmat & Zhahira, 2022). The sample consists of a single official university admission poster in digital image format (.jpeg), selected through purposive sampling.



Figure 1 Original University Admission Promotional Poster

Source: <https://uhnsugriwa.ac.id/index.php/2026/01/05/penerimaan-mahasiswa-baru-tahun-ajaran-2026-2027/>



In line with the case study approach, the selection of a single sample is intended to provide a detailed and focused analysis of a representative design artifact. The poster was chosen based on its relevance, completeness of visual and textual components, and its representativeness as a typical academic promotional medium. This approach allows for an in-depth computational and theoretical examination rather than broad comparative analysis.

3. Data Collection Techniques and Instrument Development

Data were collected through direct acquisition of the digital poster image. The image was processed using computer vision techniques to extract both visual and textual features. Several computational instruments were developed to operationalize key visual metrics (Risma Fitriani et al., 2025).

Color composition was analyzed using RGB histogram extraction and dominant color palette identification. Visual density was measured through grayscale intensity averaging, representing luminance distribution and overall visual complexity. Layout structure was examined using Canny edge detection to identify spatial organization and element segmentation, from which the edge density ratio was derived as an indicator of structural complexity. Textual information was extracted using Optical Character Recognition (OCR) to obtain word count, character count, and textual distribution, which were used to estimate information load.

All computational instruments were implemented using the Python programming language and integrated with open-source libraries, enabling automated processing, quantitative measurement, and visualization of image-based data. This ensures objectivity, consistency, and reproducibility of the analytical process.

4. Data Analysis Techniques

Data analysis was conducted using descriptive quantitative methods. Extracted numerical indicators—including color distribution, grayscale density, edge density ratio, and textual metrics—were summarized and visualized through graphical and image-based representations (Mujtaba et al., 2024).

Given the single-case design, the interpretation of these metrics was guided by theoretical benchmarks derived from visual communication design, visual complexity theory, and cognitive processing frameworks, rather than direct comparison with other samples. Visual density and edge complexity were interpreted in relation to perceptual load and visual complexity, while textual metrics were associated with information load and cognitive processing capacity.

This interpretative approach allows the findings to be understood within a theoretically grounded framework, ensuring that the analysis remains meaningful despite the absence of a comparative dataset. The focus is therefore placed on analytical depth and conceptual integration rather than statistical generalization.

5. Tools and Material Specifications

The primary material used in this study is a high-resolution university admission poster in JPEG format. Computational analysis was performed using Google Colaboratory as the cloud-based processing environment. Python version 3.10 was used as the primary programming language, supported by several libraries, including OpenCV for image processing, NumPy for numerical computation, Matplotlib for visualization, Pillow for image handling, Pytesseract for OCR-based text extraction, and ColorThief for dominant color identification. The Tesseract OCR engine with Indonesian language support was utilized to improve text recognition accuracy. This integrated toolset enables efficient, precise, and reproducible computational

visual analysis, supporting the study's objective of systematically examining visual communication elements.

RESULTS AND DISCUSSION

This section presents the findings of the computational visual analysis conducted on the university admission poster and interprets them within the previously established theoretical framework, which integrates visual communication design principles, visual complexity theory, and cognitive processing perspectives. The analysis focuses on four key dimensions: color composition, visual density, layout structure, and textual complexity.

Given the case study nature of this research, the extracted computational metrics are not treated as direct measures of communication effectiveness. Instead, they function as analytical proxies representing visual structure and information characteristics, which are theoretically associated with perception, attention, and cognitive load.

1. Color Composition Analysis

The dominant color palette extracted from the poster consists of five primary colors: light beige (218, 206, 183), dark blue (19, 96, 186), light cyan (91, 208, 227), dark black (43, 35, 39), and bluish-gray (132, 142, 166). The prevalence of blue tones suggests an emphasis on professionalism, trustworthiness, and academic credibility, consistent with color psychology theory in visual communication design.

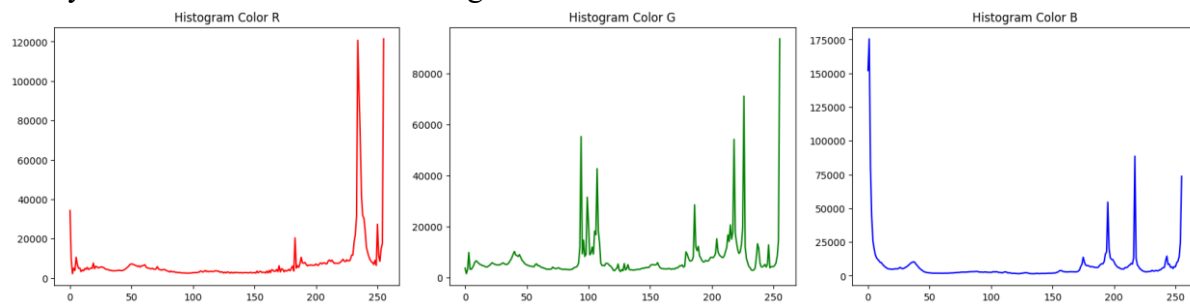


Figure 2 RGB Histogram Distribution of the Promotional Poster Image.

The RGB histogram distribution (Figure 2) shows a dominant presence of blue and cyan components, confirming the prevalence of cool color tones throughout the poster. Within the theoretical framework, color distribution can be interpreted as a factor influencing emotional perception and visual engagement.

The light beige background functions as a neutral visual field that enhances readability and reduces visual fatigue, while introducing a sense of warmth and approachability. Cyan tones contribute visual dynamism, whereas black and bluish-gray elements enhance contrast and support typographic clarity.

From a theoretical standpoint, this configuration aligns with principles of color harmony, contrast, and perceptual balance. Rather than serving as direct evidence of communication effectiveness, these findings suggest that the poster's color composition is consistent with established design strategies that are commonly associated with clarity, credibility, and audience engagement.

2. Visual Density Analysis

The grayscale density measurement yielded a value of 140.31 on a scale of 0–255, indicating a medium-to-high level of visual density. Within visual complexity theory, such

values are generally associated with compositions that balance informational richness with manageable perceptual load.

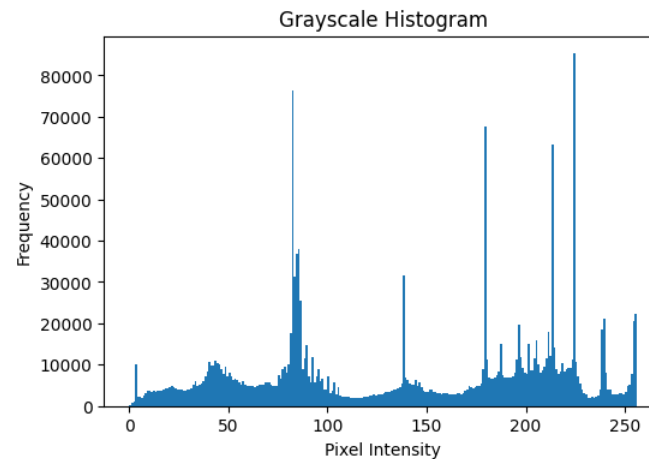


Figure 3 Histogram Grayscale

The grayscale histogram (Figure 3) demonstrates a balanced distribution between mid-tone and high-intensity values, suggesting sufficient luminance variation. From a perceptual perspective, this tonal distribution supports readability, contrast clarity, and visual segmentation.



Figure 4 Canny Edge Detection

Edge detection analysis identified 175,789 edge pixels out of 1,920,000 total pixels, resulting in an edge density ratio of 9.16%. This value represents moderate structural complexity, indicating that the layout contains distinguishable visual boundaries without excessive fragmentation.

Within the theoretical framework, edge density can be interpreted as a proxy for visual complexity and structural organization, which influence attention allocation and perceptual processing. A moderate level of edge density suggests that the poster may support efficient visual scanning by providing sufficient structural cues.

Text Area Segmentation Mask



Figure 5 Text Area Segmentation Mask

Text area segmentation reveals that 11.85% of the total visual area is occupied by text. This proportion reflects a relatively strong informational orientation while maintaining sufficient negative space.

Table 1 Summary of Visual Complexity Metrics

Metric	Value	Interpretation
Grayscale density	140.31	Medium–high complexity
Edge density ratio	9.16%	Moderate layout structure
Text area ratio	11.85%	Strong informational orientation

Taken together, these metrics indicate that the poster exhibits moderate visual complexity and structured organization. Based on visual complexity and cognitive load theory, such a configuration is generally associated with balanced perceptual demand. However, within this study, these findings are interpreted as theoretically aligned indicators, rather than definitive measures of design effectiveness.

3. Textual Complexity and Information Load Analysis

Table 2 Textual Complexity Metrics

Metric	Value	Interpretation
Word count	169	Medium–high verbal complexity
Character count	1,179	High informational density
Text area ratio	11.85%	Balanced visual–verbal composition

OCR-based extraction identified 169 words and 1,179 characters, indicating a moderate-to-high level of textual complexity. This reflects a substantial amount of information typically found in educational promotional materials.

From a cognitive processing perspective, textual quantity can be interpreted as a representation of information load, which influences comprehension and attention. The observed text area ratio (11.85%) suggests a balance between verbal content and visual space, supporting readability and reducing visual fatigue.

The textual structure follows a hierarchical pattern, beginning with a headline, followed by program information, schedules, and contact details. This organization aligns with information design and progressive disclosure principles, which facilitate efficient information scanning and selective attention.

Within the theoretical framework, the combination of moderate textual volume and structured hierarchy suggests that the poster's information design is consistent with strategies aimed at supporting comprehension and reducing cognitive overload. However, these interpretations remain theoretical in nature and are not directly validated through audience-based measurements.

4. Integrated Visual–Verbal Interpretation

The integration of color composition, visual density, layout structure, and textual complexity demonstrates a cohesive visual communication strategy when viewed through the proposed theoretical framework.

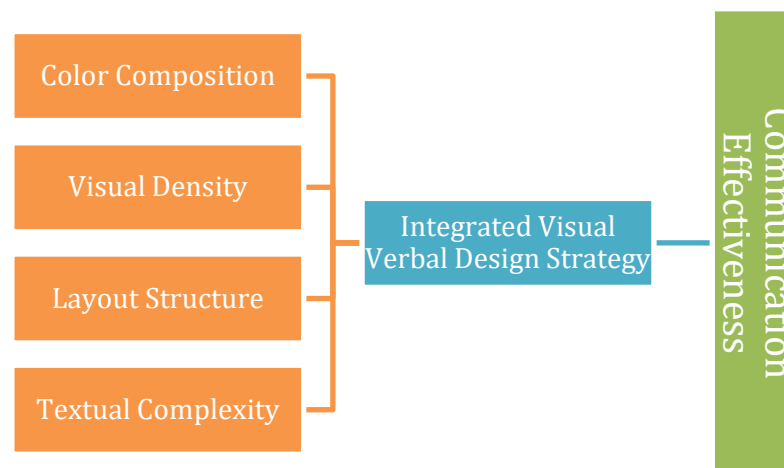


Figure 6 Integrated Visual–Verbal Communication Framework

Figure 6 illustrates the conceptual relationship between visual and textual elements, where color, structure, and information load interact to influence perception and cognitive processing. The framework represents a theoretical integration model, rather than a predictive or empirically validated system.

The combination of moderate visual density and balanced textual proportion suggests conditions that, according to cognitive processing theory, may support dual-channel information processing, where visual and verbal information are processed simultaneously.

These findings indicate that the poster exhibits characteristics that are consistent with theoretically effective visual communication practices, particularly in terms of perceptual balance and structured information delivery. However, it is important to emphasize that this study does not empirically measure audience response or communication outcomes.

5. Theoretical Contribution and Novel Insights

This study proposes a computational approach to visual communication analysis by linking measurable image features with theoretical constructs from visual design and cognitive processing. The contribution lies not in predicting communication effectiveness, but in providing a systematic analytical framework for examining visual artifacts.

By operationalizing concepts such as visual complexity, structural organization, and information load into computational metrics, this research demonstrates how quantitative analysis can complement traditional qualitative approaches in design evaluation.

As a case study, the findings serve as a proof-of-concept for integrating computer vision techniques into visual communication research. The proposed framework highlights the potential of computational methods to support theory-driven analysis, while also emphasizing the need for future studies incorporating audience-based validation and comparative datasets.

CONCLUSION

This study demonstrates that the integration of computational image analysis and visual communication design principles provides a systematic and theory-informed framework for examining the visual and textual characteristics of university admission promotional posters. Using Python-based image processing techniques, several key visual metrics were quantitatively extracted, including a grayscale density value of 140.31, an edge density ratio of 9.16%, a text area ratio of 11.85%, and textual content consisting of 169 words and 1,179 characters.

These results indicate that the analyzed poster exhibits a medium-to-high level of visual density and moderate structural complexity, suggesting a composition that emphasizes informational richness while maintaining organized visual segmentation. The identified color palette, dominated by blue and neutral tones, reflects visual characteristics commonly associated with readability, visual harmony, and institutional credibility within visual communication theory. Furthermore, the textual metrics reveal a relatively high informational load, indicating that the poster is designed to convey comprehensive content, although such density may also increase cognitive processing demands.

From a theoretical perspective, these findings suggest that the poster demonstrates visual and textual characteristics that are aligned with principles of visual complexity, information design, and cognitive processing, particularly in terms of balancing perceptual clarity and informational depth. However, it is important to emphasize that these quantitative metrics function as analytical proxies and do not directly measure audience perception or communication effectiveness.

This study contributes to the interdisciplinary integration of visual communication design and information systems by proposing a computational approach to analyzing visual artifacts. The novelty lies in positioning quantitative visual metrics as complementary tools for theory-driven interpretation rather than direct indicators of design success. As a visual case study, this research provides a proof-of-concept for applying computer vision techniques in design evaluation.

Future research is recommended to incorporate multiple samples, comparative analysis, and audience-based evaluation to validate the relationship between computational visual metrics and actual communication outcomes. Such developments may strengthen the role of computational analysis as a supporting methodology for evidence-based design evaluation in higher education promotional contexts.

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