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Color Psychology on Book Covers: An Analysis of Visual Preferences Across Adult and Children's Books for Enhanced Audience Targeting at Sampoerna Academy Grand Pakuwon Surabaya

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Abstract

Book covers play a crucial role in capturing readers' attention and shaping initial perceptions, making color an essential element in influencing emotional engagement and guiding audience targeting across children's and adult literature. Color functions as a visual communication tool that reflects the tone, theme, and intended readership, while also aligning with psychological and developmental preferences. The objective is to identify how color attributes such as brightness, saturation, and dominant hues differentiate book categories and support effective visual classification. A quantitative content analysis approach is applied using 6,093 book cover images collected from the Sampoerna Academy Library. Data extraction is conducted using Python libraries, including OpenCV and NumPy, to measure RGB (Red, Green, Blue), HLS (Hue, Lightness, Saturation), and colorfulness attributes. The analysis is supported by visualization techniques such as Scatter Plot and Radial Visualization (RadViz) through Orange software to explore relationships between color variables and book categories. The results reveal clear visual distinctions between the two categories. Children's book covers predominantly appear in higher brightness and color intensity ranges, with strong associations to warm and vibrant hues such as red, yellow, and orange. In contrast, adult book covers are more widely distributed across lower brightness levels and are associated with cooler and more subdued tones such as blue, green, and purple. Some overlap is identified, indicating that certain colors can function across categories depending on context. The findings confirm that color attributes serve as reliable indicators for audience targeting and visual classification. Future research is recommended to integrate additional design elements, including typography and layout, to provide a more comprehensive understanding of book cover design.

Keywords: adult and children's books; HLS, RGB; book cover colors; phyton.

Abstrak

Sampul buku memiliki peran penting dalam menarik perhatian pembaca dan membentuk persepsi awal, sehingga warna menjadi elemen esensial dalam memengaruhi keterlibatan emosional serta mengarahkan penentuan target audiens pada literatur anak maupun dewasa. Warna berfungsi sebagai alat komunikasi visual yang mencerminkan nada, tema, dan sasaran pembaca, sekaligus selaras dengan preferensi psikologis dan tahap perkembangan. Tujuan penelitian ini adalah untuk mengidentifikasi bagaimana atribut warna seperti kecerahan, saturasi, dan rona dominan dapat membedakan kategori buku serta mendukung klasifikasi visual yang efektif. Pendekatan analisis isi kuantitatif diterapkan dengan menggunakan 6.093 citra sampul buku yang dikumpulkan dari Perpustakaan Sampoerna Academy. Proses ekstraksi data dilakukan menggunakan pustaka Python, yaitu OpenCV dan NumPy, untuk mengukur atribut RGB (Red, Green, Blue), HLS (Hue, Lightness, Saturation), serta tingkat keberwarnaan (colorfulness). Analisis didukung oleh teknik visualisasi seperti Scatter Plot dan Radial Visualization (RadViz) melalui perangkat lunak Orange untuk mengeksplorasi hubungan antara variabel warna dan kategori buku. Hasil penelitian menunjukkan adanya perbedaan visual yang jelas antara kedua kategori. Sampul buku anak cenderung berada pada tingkat kecerahan dan intensitas warna yang lebih tinggi, dengan dominasi warna hangat dan cerah seperti merah, kuning, dan oranye. Sebaliknya, sampul buku dewasa lebih tersebar pada tingkat kecerahan yang lebih rendah dan didominasi oleh warna dingin serta lebih redup seperti biru, hijau, dan ungu. Meskipun demikian, ditemukan adanya tumpang tindih, yang menunjukkan bahwa beberapa warna dapat digunakan lintas kategori tergantung pada konteks desainnya. Temuan ini menegaskan bahwa atribut warna dapat berfungsi sebagai indikator yang andal dalam penentuan target audiens dan klasifikasi visual. Penelitian selanjutnya disarankan untuk mengintegrasikan elemen desain lain, seperti tipografi dan tata letak, guna memperoleh pemahaman yang lebih komprehensif

Keywords: buku dewasa dan anak; HLS; RGB; warna sampul buku; phyton.

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1. Introduction

There is a phrase “Do not judge a book from the cover”, but how if it could be judge? while this saying is normally used metaphorically to mean to not judge the worth or value of something or someone by its outworld appearance, it can also be used literally which is how it is meant here (Rodgers and Packard, 2022: pp. 1). Book cover color used to shaping readers’ perceptions of the books and conveying the situations when the story occur and play an essential role in guiding readers choices (Gudinavičius and Šuminas, 2017). As knowledge repositories, libraries must carefully curate collections that visually appeal to diverse audiences. Book covers function as the first point of visual interaction between readers and books, both in physical and digital environments.Research indicates that book covers serve as an initial visual stimulus that shapes readers’ expectations, aesthetic evaluations, and emotional responses, ultimately influencing their decision-making process when selecting books (Chana et al., 2025: 1). To optimize the engagement of emotional impact and ensure categorizing the target audiences, it’s important to understand the role of the color usage on book covers.

Some studies have explored the color schemes that are used in children versus adult literature in relation to the connection between color and emotional audience perception. The individuals associate specific colors with emotional responses such as calmness and excitement (Jonauskaite and Mohr, 2025: 1458). The children’s book more often used bright feature, in generally used bright colors to emphasize positive qualities, engaging colors can foster curiosity and excitement in their young age (Song, 2024: 159). Research was conducted by 120 children (age range: 3-10 years old) and 100 university students about color associations between children and adults, the result is children choose white color to represent the prettiest color (Kramer and Prior, 2019: pp. 1978–1980).

The function of color usage on book covers is crucial for optimizing the engagement of emotional impact and ensuring the categorization of target audiences. The relationship between color and emotional audience perception has been the subject of some studies that have compared the color schemes used in children's literature and adult literature. Individuals relate particular hues to emotional responses, including exhilaration and tranquility (Jonauskaite and Mohr, 2025: 1458). In general, the children's books utilized bright colors to accentuate positive qualities, as engaging colors can foster curiosity and excitement in young readers (Song, 2024: 157). In a study conducted by Kramer and Prior, 120 children (ages 3–10) and 100 university students were surveyed regarding the associations between children and adults. The findings indicated that children regard white as the most attractive color. Additionally, research has demonstrated that developmental factors have an impact on color preferences. (Brooker and Franklin, 2016: pp. 252-254), whereas adults are attracted to more refined, subdued color schemes. In 2020, a study of 60 young adults revealed that they prefer black covers over white covers when selecting a book based on its cover (Kachorsky and Reid, 2020, 310-316). These color

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Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

selections assist in conveying the content and tone of the book, directing readers to literature that is compatible with their cognitive and emotional states. Similar color matching, contrast color matching, and similar color matching are among the numerous varieties of color that are used in book design. In general, individuals experience a variety of emotions in response to distinct colors. Red can evoke feelings of enthusiasm, warmth, and celebration in individuals; yellow can evoke feelings of nobility, hope, and brightness in individuals; white can evoke feelings of purity, sacredness, and simplicity in individuals; black can evoke feelings of seriousness, solidity, and sublime in individuals; green can evoke feelings of peace, youth, and peace in individuals, among others (Liu, 2020: pp. 38-39).

The methodology for analyzing book cover colors has advanced considerably using quantitative approaches. Outline the effectiveness of content analysis in categorizing books by their visual attributes, focusing on measuring color elements such as hue and saturation tones by Kobayashi, 1981 (Kang and Yoon, 2016: 28-30). As an intuitive visual element, color can make readers have an intuitive understanding. Based on this feature, book designers can make a deep impression on readers through a reasonable combination of various colors (Liu, 2020, 37-38). Furthermore, studies employing color analysis tools such as RGB and HSL formats have provided detailed insights into how various color schemes can be quantitatively measured and linked to reader preferences (Chiang, Ge and Wu, 2019: pp. 2-4; Raguraman et al., 2021, pp. 110-111). Data analysis techniques such as scatter plots and Radial Visualization (RadViz) have proven useful in identifying patterns in color attributes that differentiate children's and adult book covers, making it easier to understand how specific colors resonate with different age groups (Kramer and Prior, 2019, pp. 1979-1981). These methodologies allow for a nuanced understanding of the emotional and psychological impact of color in book cover design.

This study offers a solution to the challenge of identifying how color schemes can be optimized for both emotional engagement and audience targeting in book cover design. By analyzing color attributes such as brightness, saturation, and hue, the study provides a framework for understanding how these elements can be strategically utilized to appeal to specific age groups. Through a combination of color psychology, visual communication, and data-driven analysis, the research aims to offer valuable insights into how book covers can be designed to resonate with readers at different developmental stages. By exploring the intersection of color emotional response color concept, this work seeks to bridge the gap between design and reader engagement.

The structure of this article is as follows: the introduction provides an overview of the phenomena and the importance of color in book cover design, followed by a literature review that connects color psychology and emotional impact in literature. The methodology section describes the tools and techniques employed to analyze color attributes in children's and adult books, while the discussion interprets the findings, highlighting key trends and implications for book cover design. Finally, the discussion summarizes the research contributions and offers recommendations for future studies and practical applications in the field of visual communication and book marketing.

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

2. Literature Review

The Emotional Influence of Color Psychology on Book Cover Design

The emotional responses of readers and their engagement with a book are significantly influenced by color, a study on 24 students who learned in environments with different colors showed that color also influenced their reading focus and comprehension (Al-Ayash et al., 2016: pp. 200-203). According to that study, students who read books for study purposes perceived and engaged with the content more effectively, as color was found to significantly influence their emotions. Based on the research by Shangyu Song investigated the emotional associations that individuals, including children, have with color (Song, 2024: 159). They have emphasized the role of warm and vibrant colors in evoking joy, excitement, and engagement traits that are essential in both children's and adult literature (Jonauskaite and Mohr, 2025: 1458). The Color Image Scale by Kobayashi in his book “The Aim and Method of the Color Image Scale”, which establishes a direct correlation between psychological responses and specific hues. Kobayashi grouped warm tones, such as red and yellow, are frequently used to convey dynamic, gorgeous, pretty, meaning energy and creativity colors (Kang and Yoon, 2016: 28-30). The cool colors, such as blue and green, are associated with smart, refined, and formal, meaning have intellectual depth and calmness colors. Kobayashi's framework underscores the impact of color on the affective experience of readers. The viewer is more actively engaged by warm colors, whereas cooling tones encourage deeper intellectual engagement and reflect more mature emotional states. This dynamic is especially significant in comprehending the extent to which the emotional tone of a book cover's color palette can guide reader expectations and influence book selection (Kramer and Prior, 2019: 1979-1982). Consequently, color is a crucial instrument in the creation of book covers that are both visually appealing and emotionally impactful.

Development to Considerations and Color Perception

Although the developmental phases of readers have an impact on their interpretation and response to color, this phenomenon is not limited to children's literature; it also applies to adult books. The interpretation and response to color are influenced by the developmental stages of individuals, as color perception emerges progressively from infancy into adulthood. Early perceptual development demonstrates that infants transition from limited color detection to more refined color discrimination and categorization within the first months of life, indicating that the ability to perceive and appreciate color is a gradual process (Skelton, Maule and Franklin, 2022: 1-2) Furthermore, empirical evidence shows that infants exhibit preferential attention toward more vivid and saturated hues, suggesting a heightened engagement with bold colors during early infancy. This developmental pattern is not restricted to children’s contexts alone but reflects a broader perceptual mechanism that continues to influence how color is interpreted across different age groups, including adult audiences. This sensory stage is facilitated by the utilization of saturated colors, which promote creativity, active learning, and

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

the recognition of the significance of vibrant colors in the development of cognitive growth and engagement in young readers (Brooker and Franklin, 2016: pp. 246-252). Nevertheless, as individuals age, their color preferences become more complex, influenced by cultural factors, cognitive development, and age. The design choices for both children's and adult books can be influenced by the changes in color perception that are related to age and gender. This is because age-appropriate color palettes can foster a stronger connection with the reader (Ferah Özcan and Tunçeli, 2023: pp. 164-165 and 170). For instance, in adult literature, the use of more subtle color schemes is frequently employed to elicit emotional depth, introspection, or sophistication, which is consistent with the reader's mature cognitive and emotional responses.

Color as a Tool for Visual Social Communication and Branding

Color in book cover design is a potent instrument for visual communication and branding, in addition to its emotional impact. In the same way as branding in other industries, color serves to communicate the genre, theme, and intended audience of the book. The examined color choices have a significant impact on consumer behavior and perception, underscoring their capacity to influence affective responses and decision-making processes (Golestaneh and Naeini, 2022: pp. 29-30).Color functions as a visual shorthand that conveys the intended audience, tone, and thematic content in book cover design. Bright, playful colors are frequently used in children's books to indicate excitement and adventure, while adult books typically employ more sophisticated, subdued hues to elicit contemplation, elegance, or maturity (Darling, 2019: pp. 28). The intended themes are reinforced using these color strategies, which also strengthen the emotional and psychological connection between the book and its reader. This is further substantiated by empirical findings demonstrating that color significantly influences human perception and serves as an effective visual cue for conveying complex and abstract information in communication contexts (Schloss et al., 2018). These color perceptions produce an applicable concept to both children's and adult literature, as cultural and social contexts have a substantial impact on color preferences and their emotional resonance.

Cultural differences have a significant impact on color preferences, particularly in children's literature, and these insights are extended to adult literature as well (Lei and Zhong, 2024).The emotional responses associated with color preferences vary significantly across cultures, underscoring the importance of considering cultural nuances when selecting color palettes, particularly for global audiences. The interpretation of color in book covers is influenced by cultural, societal, and demographic factors (Nakahata et al., 2016: pp. 2-3). Their discoveries underscore the necessity for designers to consider factors such as age, gender, and cultural context when creating book covers, thereby guaranteeing that the color selections are in alignment with the intended audience. This may entail the utilization of color schemes that are indicative of current social trends or cultural norms in adult literature, thereby augmenting the emotive appeal of the work.

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

3. Methods

The objective is to classify book covers into children's and adult book categories by utilizing a systematic quantitative methodology approach to analyze their visual characteristics. This is achieved by utilizing color attributes. The research employed conventional content analysis methodologies, with an emphasis on the extraction of color data in RGB and HSL formats from book covers (Raguraman et al., 2021: pp. 110-111). The study focused on the percentage of predefined colors (red, blue, yellow, purple, orange, and green), as well as key color features such as hue, luminance, saturation, and colorfulness (referred to as RGB deviations). These characteristics were chosen in accordance with emotional significance of color by Kobayashi's Color Image Scale and prior research on color psychology by what differentiates between the use of color on adult and children's books. These studies indicate that children's books are more likely to employ vibrant, multicolored designs with warm, bright colors, whereas adult books are more likely to employ neutral, cool, subdued tones that evoke intellectual engagement and calmness. The study utilized Orange software, a tool that is frequently employed in the fields of visual analytics and Python machine learning, to analyze the extracted color data. The relationships between various color features were represented using Orange's scatter plot and Radial Visualization (RadViz) functionalities. The study was able to investigate the differences in attributes such as luminosity and colorfulness between children's and adult book covers by utilizing scatter plots to visualize the variation. RadViz's multidimensional visualization assisted in the identification of key patterns in the data, thereby facilitating the differentiation between the two book categories. This combination of visual tools offered critical insights into the way specific color features, including brightness, saturation, and the use of specific colors, are employed to specifically communicate emotional tone and genre.

The quantitative analysis was enhanced by utilizing Kobayashi's Color Image Scale, providing a structured approach to understanding the emotional resonance of color attributes with audiences. This scale has been extensively utilized in the realms of design and color psychology to explore the impact of specific colors on emotional perception and decision-making processes. This framework was utilized to explore the relationship between color attributes and the emotional tone of book covers, as well as their alignment with the psychological expectations of various reader ages. The study focused on the impact of warm, vibrant colors found in children's literature on feelings of excitement, creativity, and engagementv(Jonauskaite and Mohr, 2025: 1458), in contrast to the cooler, subdued tones prevalent in adult literature, which promote intellectual depth and introspection (Kramer and Prior, 2019: 1979-1982).

The comprehensive dataset, encompassing color attributes like colorfulness, hue, lightness, saturation, and the prevalence of six specific colors (red, yellow, blue, orange, purple, and green), was meticulously analyzed to reveal how book cover design conveys age-appropriate content. This approach utilized both quantitative and psychological color frameworks, delivering an objective, data-driven

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

method for examining visual branding in literature. It enhances our comprehension of the impact of color on reader perception and emotional involvement. The procedure for achieve the results is detailed below:

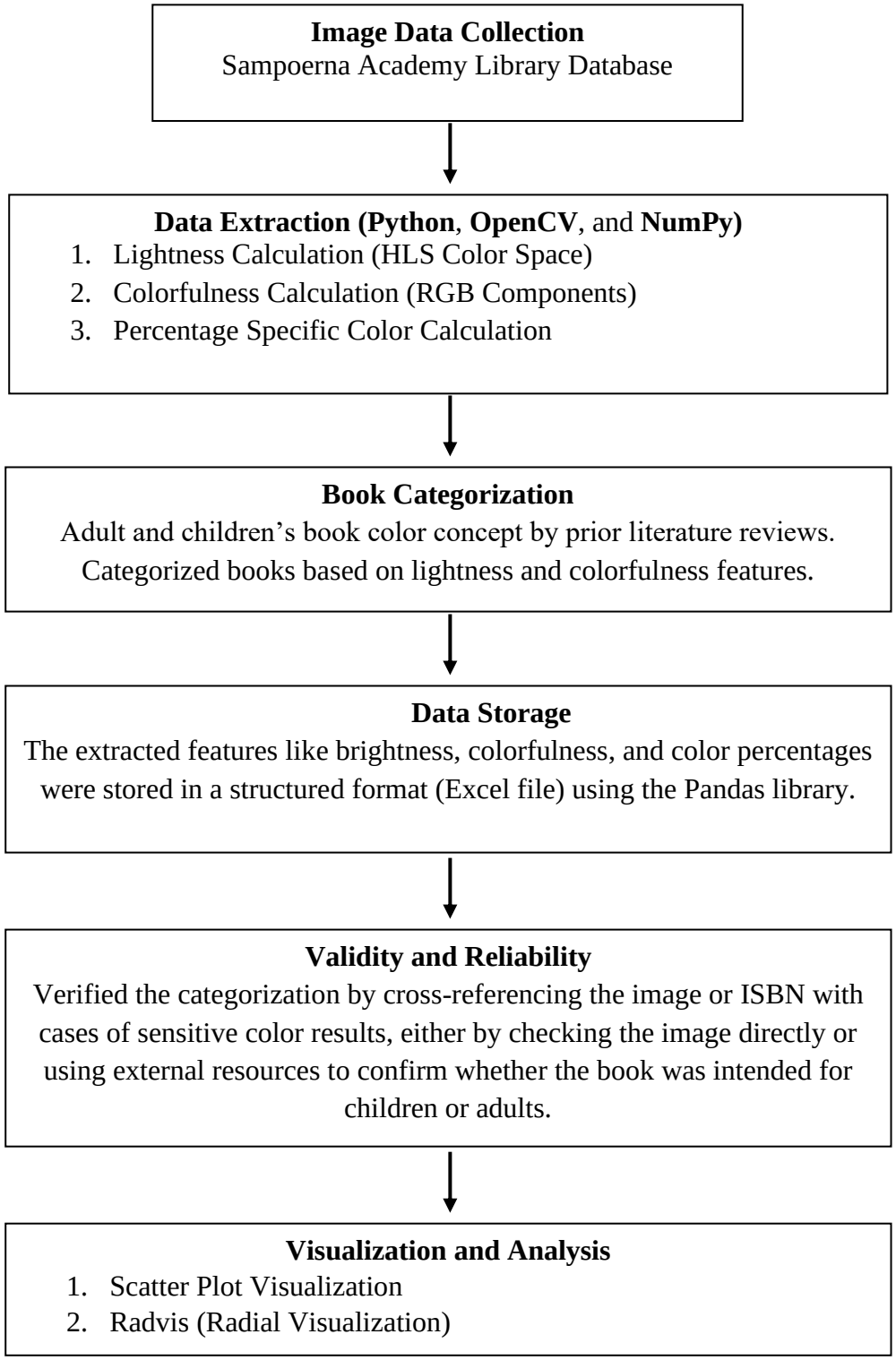

Figure 1. Methodology Flowchart.

Image Data Collection

The data utilized for this study was obtained from the Sampoerna Academy Library, particularly through their online library system (https://library.sampoernaacademy.sch.id/index.php). The Sampoerna Academy Library is a union library that is a combination of the libraries of seven international schools of Sampoerna Academy in Indonesia. These schools are located in Surabaya (Pakuwon Indah and Grand Pakuwon Campuses), Jakarta (L'Avenue Campus), Tangerang (BSD Campus), Bogor (Sentul Campus), and Medan (Citra and Cipto Campuses). Sampoerna Academy operates under the Cambridge Curriculum, which comprises four educational levels by preschool (2-5 years), elementary (7-12 years), secondary (13-15 years), and high school (16-18 years). Consequently, the library at Sampoerna Academy maintains a international collection at the children's and young adult levels. Meanwhile, the database center for the school library is located in Jakarta. Access to a selection of book cover images in standard formats such as JPG, JPEG, and PNG was granted by the institution following an email inquiry. The images were retained locally for subsequent examination. The book cover image data obtained was 6093 images. The book cover images were naming according to the International Standard Book Numbers (ISBNs), offering a clear and unique identifier for each image. This naming convention facilitated straightforward tracking and re-verification of the dataset.

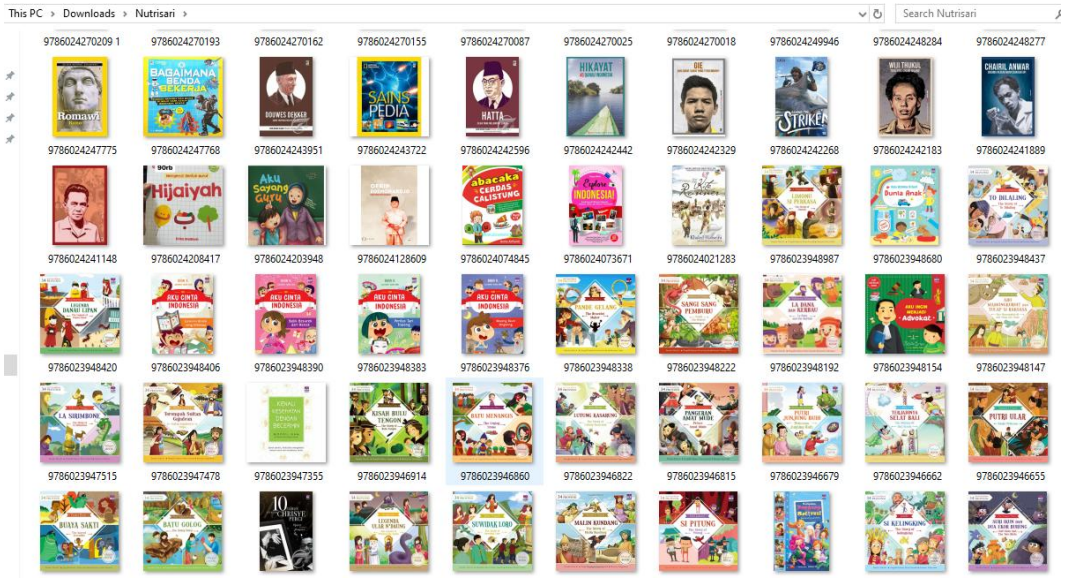

Figure 2. Image Data Collection from Sampoerna Academy Library (Data extraction from https://library.sampoernaacademy.sch.id)

Data Extraction

Combining the OpenCV and NumPy libraries with the Python programming language, the data extraction process for this study involved the processing and analysis of book cover images. NumPy enables efficient management of large datasets and mathematical operations, while OpenCV is a potent instrument for image processing tasks (Raguraman et al., 2021: pp. 110-111). Initially, the book cover images were imported and processed to extract critical visual characteristics, including

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

brightness and coloring. The mean values of the HLS (Hue, Lightness, and Saturation) color space were used to calculate brightness. This color space facilitates the quantification of an image's brightness or darkness by distinguishing between intensity (lightness) and color information (Clausius Scientific Press, Inc., 2024: 6).

Colorfulness was evaluated by analyzing the RGB (Red, Green, and Blue) components of each image (Raguraman et al., 2021: pp. 110-111). The overall vibrancy of the image is indicated by the degree of color variation between these components, with more significant differences indicating a higher level of colorfulness. Furthermore, the investigation concentrated on the examination of specific colors, such as Red, yellow, blue, orange, purple, and green, in order to ascertain their frequency in the book covers. This was accomplished by calculating the percentage presence of each hue in the image and implementing predefined color ranges. The outcome was an exhaustive dataset that included detailed color metrics, allowing for a clear analysis of the distribution of various colors across the covers of children's and adult novels. The algorithm was employed to calculate the following visual features for each book cover image:

1. RBG Algorithm

   The book cover image is read into memory during an image reading procedure using the OpenCV image processing library, which loads the image as a matrix of pixel values. In the conventional 8-bit RGB color paradigm, each pixel is composed of three-color components: Red (R), Green (G), and Blue (B), each of which has a value between 0 and 255 (Tsurumoto et al., 2025: 3). The image is typically represented as a three-dimensional array, with the first dimension representing the image's height (rows), the second representing the width (columns), and the third dimension containing the three-color channels (R, G, B) for each pixel (Tsurumoto et al., 2025: 3). The values of R, G, and B are scaled from [0, 255] to [0, 1] (Teixeira, Brito-Costa and Abbasi, 2026: 4). The following are the methods for calculating RBG:

   a. Red Normalization

      $$R' = \frac{R}{255}$$

   b. Blue Normalization

      $$B' = \frac{B}{255}$$

   c. Green Normalization

      $$G' = \frac{G}{255}$$

   To have Mean RBG will compute overall "average color" of the image in the RGB color space. Compute the mean color values for an image in RGB (Red, Green, Blue), as follows:

   a. Mark R_{ij}, B_{ij}, G_{ij} be the pixel intensities for Red, Green, and Blue channels at position (i,j). In the context of image processing, (i, j) represents the coordinate of the pixel in a 2D image.

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

i: the row index (or vertical position) of the pixel, j: the column index (or horizontal position) of the pixel.

b. For an image of size M×N (height M, width N), so the mean for each channel is:

Mean R = $\frac{1}{MxN}\sum_{i=1}^{M}\sum_{J=1}^{M}R_{ij}$

Mean B = $\frac{1}{MxN}\sum_{i=1}^{M}\sum_{J=1}^{M}B_{ij}$

Mean G = $\frac{1}{MxN}\sum_{i=1}^{M}\sum_{J=1}^{M}G_{ij}$

2. HLS Algorithm

The RGB values of the images are initially converted to the HLS (hue, lightness, and saturation) color space in order to analyze the color characteristics of book covers. This color space is more closely aligned with the perceptual properties of color that humans possess. This conversion enables a more intuitive comprehension of the color attributes, including the general color tone (hue), luminosity (lightness), and color intensity (saturation). The Python-based OpenCV library is used to analyze the book cover images, which are loaded in BGR format. The process commences with this step. The RGB format is then used to convert these BGR values, thereby guaranteeing compatibility with the HLS conversion (Teixeira, Brito-Costa and Abbasi, 2026).

The RGB values are normalized to a scale of [0, 1] by dividing each RGB component (red, green, and blue) by 255, in order to derive the HLS values. The subsequent phase entails the computation of the lightness (L), which is the average of the maximum and minimum values of the normalized RGB components (Tsurumoto et al., 2025: 3). This value represents the color's overall brightness. Indicating the intensity of the color, saturation (S) is determined by the ratio of the difference between the maximum and minimum RGB values to their sum. The hue (H) is determined by the relative dominance of the RGB components, with distinct formulas being applied based on the utmost value of Red, Green, or Blue. These calculations enable a comprehensive analysis of the visual characteristics of the image also in the book cover (Tsurumoto et al., 2025: 3). The HLS values that are generated offer a valuable comprehension of the color palette of the book cover, thereby enabling the comparison of color schemes between adult and children's book covers. The following are the methods of converting RBG to HLS (www.rapidtables.com, 2024):

a. Find Max and Min values:

Cmax = max (R′, G′, B′)

Cmin = min (R′, G′, B′)

b. L (Lightness): The brightness of the color, ranging from black to white (0–1 scale).

L= $\frac{Cmax+Cmin}{2}$

c. S (Saturation): The intensity or purity of the color (0–1 scale).

S=$\frac{Cmax-Cmin}{Cmax+Cmin}$

d. H (Hue): The type of color (e.g., red, green, blue) represented as an angle (0–360°).

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

$\Delta = C_{max} - C_{min}$

Calculate Hue (H) based on C_{max}:

1) If C_{max}= R′

   H = 60($\frac{G'-B'}{\Delta}$)

2) If C_{max}= G′

   H = 60(2 + $\frac{B'-R'}{\Delta}$)

3) If C_{max}= B′

   H = 60(4+ $\frac{R'-G'}{\Delta}$)

Example if the the hue represents the "color type" on a 360° circular scale.

1) Red : H=0
2) Yellow : H=60
3) Green : H=120
4) Cyan : H=180
5) Blue : H=240
6) Magenta : H=300

Captures the average properties of the image's colors in a perceptually meaningful way which is Hue Mean indicates the dominant color tone, Lightness Mean represents the average brightness or intensity of the image, Saturation Mean is reflects how vivid or muted the image is on average. Mark H_{ij}, L_{ij}, S_{ij}be the values for Hue, Lightness, and Saturation at position (i,j).

In the context of image processing, (i, j) represents the coordinate of the pixel in a 2D image. i: the row index (or vertical position) of the pixel, j: the column index (or horizontal position) of the pixel. So, the Mean for each channel is:

a. Mean H = $\frac{1}{MxN}\sum_{i=1}^{M}\sum_{J=1}^{N}H_{ij}$
b. Mean L = $\frac{1}{MxN}\sum_{i=1}^{M}\sum_{J=1}^{N}L_{ij}$
c. Mean S = $\frac{1}{MxN}\sum_{i=1}^{M}\sum_{J=1}^{N}S_{Ij}$

3. Colorfulness Algorithm

The varying intensity of an image's color channels, specifically the Red, Green, and Blue (RGB) components, can be used to quantify its colorfulness. The term "colorfulness" in image processing typically denotes the perceived intensity and vividness of the colors, which can be determined by calculating the standard deviation of each of the RGB channels. This method quantifies the distribution of values in each color channel, which is directly correlated with the dynamic and vibrant appearance of the colors in the image. The first step in determining the colorfulness metric for a book cover is to calculate the standard deviation for each of the three RGB channels (Red,

Green, and Blue). The standard deviation of each channel is calculated using the following formula:

a. Assumed the image to be 3D array of shape (M, N, 3), where M is the height, N is the width, and 3 corresponds to the three RGB channels.
b. For the Red channel (R), calculate the spread of R_{ij} values for all (i, j) in the image, similar to G_{ij} (Green) and B_{ij} (Blue).
c. The result will be a 1D array of three values [σR, σG, σB], where:
   1) $\sigma R = \sqrt{\frac{1}{MxN}\sum_{i=1}^{M}\sum_{j=1}^{N}(Rij - \mu R)^2}$
   2) $\sigma G = \sqrt{\frac{1}{MxN}\sum_{i=1}^{M}\sum_{j=1}^{N}(Rij - \mu G)^2}$
   3) $\sigma B = \sqrt{\frac{1}{MxN}\sum_{i=1}^{M}\sum_{j=1}^{N}(Rij - \mu B)^2}$
d. To compute the average of the three standard deviations of σR, σG, σB is as follows:
   Colorfulness Average = $\frac{\sigma R, + \sigma G, + \sigma B}{3}$

4. Dominant Color Percentage Algorithm

The quantities of red, green, and blue in each color are denoted by three numerals (Goyal and Bansal, 2023: 5). The procedure entails the classification of pixels into predetermined color categories and the calculation of the percentage of each color present in the image. The specific color is identified by ranges in the RBG chart (Walsh, 2026). The methodology employed is delineated below:

a. Black Range (dark pixels): [0, 0, 0] to [50, 50, 50].
b. White Range (light pixels): [200, 200, 200] to [255, 255, 255].
c. Red Range (mostly red pixels): [100, 0, 0] to [255, 80, 80].
d. Blue Range (mostly blue pixels): [0, 0, 100] to [80, 80, 255].
e. Orange Range (mostly mixed red and yellow pixels): [180, 100, 0] to [255, 160, 80].
f. Purple Range (mostly mixed red and blue pixels): [100, 0, 100] to [200, 80, 255] (purple pixels).
g. Green Range (mostly mixed yellow and blue pixels): [0, 100, 0] to [80, 255, 80].
h. Yellow Range (mostly yellow pixels): [150, 150, 0] to [255, 255, 100].

The color ranges are specifying the lower and RBG boundaries to count the value percentage for each color above. The counting step is as follows:

a. Define the total pixels
   Total Pixels = M(height) × N (width)
b. Define the Color Percentage
   Color Percentage = $\left(\frac{Color\ Pixels}{Total\ Pixels}\right) \times 100\%$

These attributes were extracted for each book cover and stored in a structured column format. The data was then saved into an Excel file using the Pandas library, the excel data is as follows:

1	Filename	Hue HLS	Lightness H	Saturation H	Red RGB	Green RG	Blue RGB	Colorfulne	Black	Whit	Re	Blue	Yello	Orang	Purpl	Gree	Catego
1400	9780241380536.jpg	42.445908	169.685256	69.348624	175.236476	164.248888	163.9734	82.19753082	3.9208	42.97	7.82	0.0004	0.0676	0.3692	0	0	Children
1401	9787530578278.jpg	96.63608837	159.1996419	142.3122186	193.9309442	138.4209814	126.3080372	75.55337924	1.115813953	22.8507	38.206	0.000465	5.06512	0.25814	0.00465	0.21023	Children
1402	9786023942459.jpg	37.14867456	191.0831219	66.04133254	187.0782888	198.7126343	187.0667408	86.10381033	1.49112426	61.00994	0.0556	0.000473	0.4703	0.022012	0.18604	8.34249	Children
1403	9786020619385.png	10.9362	215.8422238	32.61320952	225.6833762	219.7880143	205.7824095	62.3077244	0.327619048	69.38	0.1205	0.000476	1.08952	0.08619	0	0	Adult
1404	9787303122240.jpg	55.17609592	154.0377506	137.6938801	159.5833333	170.5735252	134.087271	70.1404079	0.41294964	18.64652	3.2825	0.00048	8.82878	2.868106	0.00911	5.7247	Children
1405	9787545526905.jpg	19.81399519	170.2490974	179.7316382	228.2846052	159.353741	111.8072368	78.81032076	2.160516827	28.37109	17.686	0.000481	5.0878	12.66268	0.00325	0.07536	Children
1406	9789814801485.jpe	133.9144921	146.7893614	49.25164078	164.7647559	128.2628353	154.1266852	29.45537398	1.236316568	0.115385	0.4189	0.000493	0	0	4.06755	0	Adult
1407	9781847177315.jpg	63.92546	206.588895	78.9376	211.61649	211.182245	200.921435	47.08038438	0.2895	63.521	0.094	0.0005	2.041	0.2055	0.0465	0.0015	Adult
1408	9780462004716.jpe	66.15013876	163.2660342	23.23560855	164.4245937	162.2847486	161.3172007	49.38055786	0.00066712	28.75322	0.5819	0.0005	0.01968	0.000834	0	0	Adult
1409	9786022827955.jpg	33.08409081	172.0386808	89.46022676	195.4288346	198.1468337	141.1892851	67.19435264	1.958334385	33.25896	0.1324	0.000505	30.4597	2.393374	0.01818	0.0096	Adult
1410	9780547939681.jpg	29.75084987	133.8238015	62.89667176	147.3221527	139.0006921	119.7707634	63.51734005	10.96284987	5.682443	0.5812	0.000509	0.58524	0.029517	0	0	Adult
1411	9780153665745.jpg	42.76917048	159.8077812	124.4796234	193.5212519	184.4755725	123.4185547	53.9594545	1.574554707	13.27583	2.2534	0.000509	18.6651	0.891094	0.54504	0.02087	Adult
1412	9781107611399.jpe	27.35157653	161.3253571	113.7090714	198.4475714	152.513352	122.9607806	71.31771947	3.912755102	33.2801	1.674	0.00051	6.06378	25.19388	0	1.37194	Children
1413	9781843623045-us.j	34.18612466	149.492645	179.3465908	203.3958916	106.8212629	95.24220596	71.05545173	8.816260163	12.27588	53.061	0.000542	0.60054	1.088889	0	0	Adult
1414	9787303133291.jpg	31.88783606	186.2447338	107.4346459	207.9022409	179.3901319	164.985691	61.70886382	2.181218593	28.83896	7.5899	0.00055	2.14557	2.476445	0.05316	0.0084	Adult
1415	9789625934181.jpe	68.95575595	151.1348036	131.6802798	181.3242381	145.0936012	124.264875	70.03897305	6.811904762	6.293452	9.9375	0.000595	0.86548	2.072619	0.59524	0	Children
1416	9789675439858.jpe	71.054716	209.596709	105.680779	223.609822	201.874009	201.826632	61.46755554	0.1104	55.6007	0.6905	0.0006	4.8622	0.9523	0.3311	0.0013	Adult
1417	9781741141467.jpg	26.06090259	140.1098413	115.4958987	171.424615	154.9817774	107.2221259	60.86232277	5.32596725	0.817852	1.8812	0.000602	9.61743	5.057563	0	0.01143	Adult
1418	9781570911521.jpg	50.00419813	174.4167381	109.4155603	179.4681305	192.4952884	157.001045	71.33571471	4.859559046	53.0752	0.363	0.000604	9.31743	0.102688	0	0.8952	Children
1419	9780525954125.jpe	44.87763142	50.89182477	100.4326103	66.70325076	42.97142598	35.46569789	59.86275973	59.8326284	1.351057	7.2779	0.000604	0.97764	2.247734	0.00242	0	Adult
1420	9786026633477.jpg	119.4817589	47.9059671	103.223075	64.74733087	49.2060409	32.44035055	63.51883177	70.67896679	2.376999	0.5269	0.000615	3.86639	5.57826	0	0.00015	Adult

Figure 3. Images Extraction result by Panda Library.

Validity and Reliability

This study also employs phyton to partition the images into distinct folders based on the operating system (OS), the Python Imaging Library (Pillow), and the Shell Utility (Shutill). This combination results in a folder that contains a combination of adult and children's book images, which are then organized into separate folders. A comprehensive validation process was implemented to ensure the accuracy and dependability of the functions that are intended to classify book covers as either children's or adult books. The classification model was verified and refined through the integration of visual analysis with metadata, specifically International Standard Book Numbers (ISBNs). The validity and reliability between the formula model and the categorization are as follows:

1. Cross-referencing with ISBNs

   Throughout the analysis, each book cover image was systematically labeled with its unique ISBN, allowing for precise monitoring and verification. This method facilitated the efficient rechecking of classifications and the seamless identification of individual images. In order to guarantee that book covers were accurately categorized, manual evaluations concentrated on edge cases, such as those with subdued tones and low colorfulness.

2. Revaluating the Precision of the Formula

   The formula, which was created to evaluate visual attributes such as RGB deviations and HLS (Hue, Lightness, Saturation), was subjected to a rigorous evaluation against the metadata associated with each ISBN. By cross-referencing classification results with comprehensive book descriptions obtained from online databases and library catalogs. In the validation of visual analysis methodologies, this iterative validation procedure is analogous to metadata.

3. Reliability Testing

   The formula's reliability was verified by applying it to numerous subsets of the dataset. The classification model's ability to differentiate between children's and adult book covers was

confirmed by the consistent emergence of similar patterns in these repeated tests. The formula's ability to accurately categorize visual attributes such as luminosity and colorfulness is further validated by the consistency observed in these results. The grouping validation result is as follows:

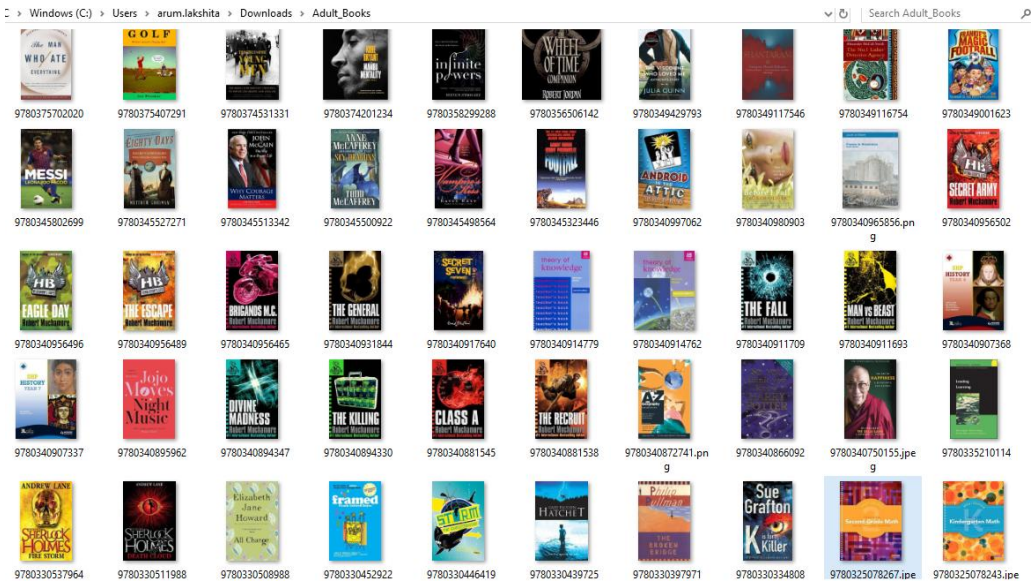

Figure 4. Grouping validation results of Adult book covers.

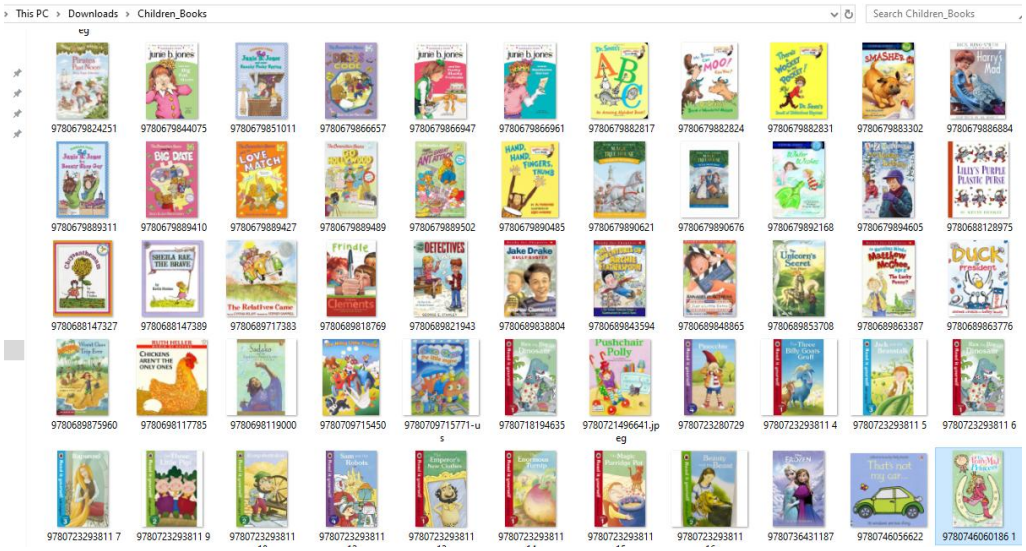

Figure 5. Grouping validation results of Children book covers.

4. Results and Discussions

4.1 Results

The analysis involved the use of a scatter plot to investigate the relationship between the primary visual two main indicators, lightness and colorfulness, which serve as basic categorizations based on book cover color attributes. The scatter plot displayed the luminosity of the book covers on the x-axis and the vibrancy of the colors on the y-axis. This method allowed for an analysis of the

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

extent to which these two factors could distinguish children's books from adult books. The Orange data visualization tool, a platform that is frequently employed for data analysis and visualization, was employed to generate the scatter plot. The plot's points were color-coded to establish obvious visual distinctions between the two categories: red for children's books and blue for adult books. Ellipses were drawn around each category to emphasize their concentration areas and facilitate the visualization of category boundaries to improve the clarity of the analysis. The identification of clusters of points, which reflect the typical distribution of lightness and colorfulness for each group, was facilitated by these ellipses. This information provided a glimpse into prospective patterns in book cover design in both categories. The primary factors for distinguishing between categories are brightness and colorfulness, as indicated by the scatter plot analysis. Brightness is represented on the x-axis, while colorfulness is represented on the y-axis. These two characteristics establish a clear foundation for visual separation, facilitating the identification of patterns and distinctions among the categories depicted in the plot. The scatter plot visualization is depicted below:

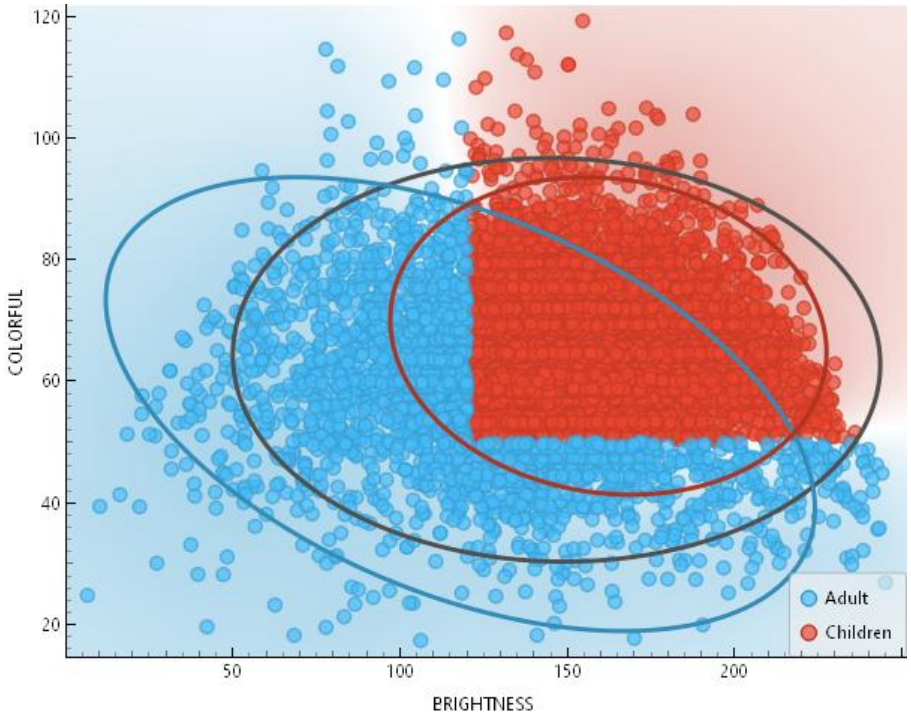

Figure 6. Scatter plot Visualization.

The scatter diagram above, which was generated using the orange app, illustrates the book categories in terms of two critical attributes in the brightness and colorfulness. This analysis demonstrates effective differentiation of the categories by these factors. Adult books are distributed across a broader spectrum of lower values, while children's books tend to cluster in areas with higher brightness and color. This distinction between children's and adult literature in terms of visual design is illustrated by the fact that brightness and color are dependable indicators. The following is an examination of the manner in which these factors differentiate the categories in trends in brightness, color scheme and separation of categories.

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

The brightness levels of books that are intended for minors are generally higher than those intended for adults. The scatter plot analysis indicates that the points representing children's books (red points) are predominantly situated in the upper brightness range, typically above 120. In contrast, adult literatures (blue points) are distributed across lower brightness values, primarily between 40 and 130. The significance of brightness as a distinguishing factor between the two categories is underscored by this unambiguous distinction. Additionally, the color scheme of children's literature is distinguished by its increased use of color. On the spectrum of colorfulness, the majority of points for children's books are at or above 60 in the scatter plot. In contrast, adult books exhibit a more extensive distribution, frequently falling below 80, although there is some overlap in the intermediate range. This distribution emphasizes the visual distinction between books intended for children and those intended for adults by demonstrating how colorfulness complements luminosity. The scatter plot indicates the separation of categories that there is some overlap between the categories; however, it is clear that there is distinct clustering. The top-right region is primarily occupied by children's books, which are distinguished by their high luminosity and vibrant colors. In contrast, adult novels are grouped in the lower left to middle sections, which suggests that they are less colorful and bright. The concentration areas are further defined by ellipses that are drawn around each category, underscoring the importance of luminosity and color in visually distinguishing the two categories.

A Radvis was implemented to conduct a more thorough examination of category distinctions that are based on a variety of visual attributes. In order to facilitate the comparison of the relationship between categories (children's and adult books) and these visual features, this visualization employed six indicators: red, yellow, blue, green, orange, and purple, which were presented in a circular layout. Radvis enabled a holistic understanding of the ways in which various indicators contribute to categorization, with the position of each point around the circle representing the strength of its association with a specific indicator. The most frequently used color in printed book covers is depicted in this visualization.

The dominant color on the cover of a children's book (red dots) or an adult book (blue dots) is represented by each data point, which is mapped using Radial Visualization (RadViz). The position of each data point is indicative of the proximity between the six color attributes. The Orange application's Radvis visualization is as follows:

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

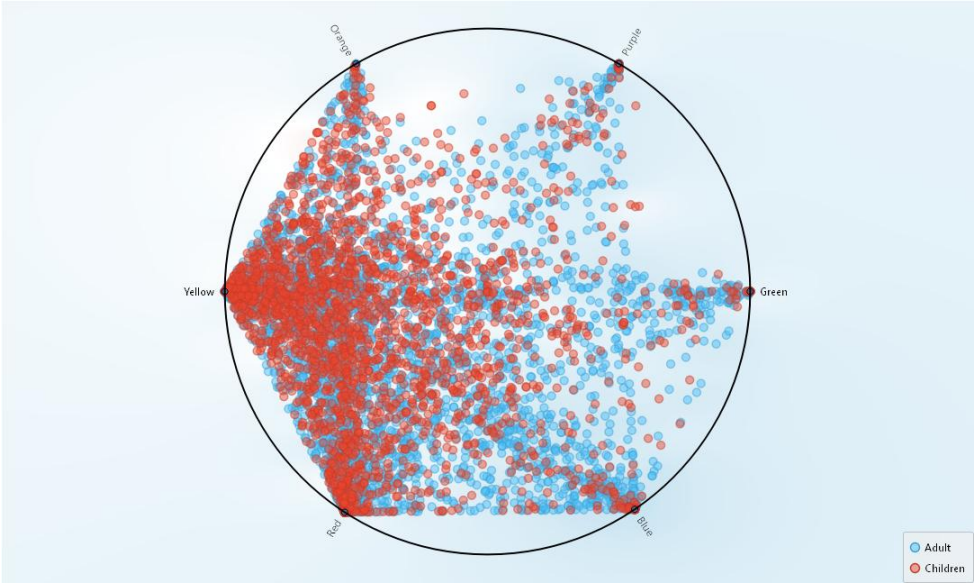

Figure 7. The Radvis Visualization in 6 Color Indicators.

Based on six visual color indicators: Red, Green, Blue, Yellow, Purple, and Orange, this visualization illustrates two book categories (Adult in blue and Children in red). Radvis' visualization results generate data that analyzes the distinctiveness of these indicators between the two categories of children's books and adult books. Yellow, red, blue, orange, purple, and green are the six fundamental color attributes that serve as anchors around a circular framework, each representing a unique color dimension. The placement of data points representing book covers is determined by their relative strength or "pull" toward these color anchors. For instance, a book cover that contains a greater quantity of yellow would be placed in close proximity to the yellow anchor. This system enables a structured and comparative examination of the manner in which various color combinations are employed in book cover designs, thereby demonstrating the relative importance of each color dimension. On the left side of the circle, children's books (red dots) are primarily located, as indicated by the red spots in the color distribution plot. This suggests that they have more pronounced associations with the colors yellow, orange, and red. These warm, vibrant hues are frequently employed in the design of children's book covers, as they are recognized for their ability to captivate the attention of younger audiences by evoking feelings of playfulness, energy, and warmth (Kang and Yoon, 2016: 28-30). The positioning implies that children's books favor these warmer, more colorful tones to establish a visually stimulating and engaging environment that is conducive to the developmental requirements of young readers. The Adult volumes, which are represented by blue dots, are more evenly distributed across the color circle, with higher concentrations near the blue and green anchors. These colors are cooler in tone and are known to evoke a sense of sophistication, calmness, and maturity, which is consistent with the typical preferences of adult consumers. The use of muted and subdued colors implies that adult books frequently adopt more refined and professional designs, which are indicative of the more serious or nuanced themes present in the content (Kang and Yoon, 2016: 28-30). Despite the distinct clustering of children's and adult literature in the color

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

spectrum, there is a substantial overlap between the two categories, particularly in the regions influenced by yellow and blue hues. Although children's book covers are predominantly dominated by mild colors such as yellow and orange, they are also found in some adult books, albeit in substantially reduced quantities. Blue, a cooler color, is also shared by both categories, indicating that it can be a versatile design element for both children's and adult literature. This overlap emphasizes the fluidity of color selections in book design and suggests that specific colors may transcend age boundaries, contingent upon their context and application within the design.

4.2 Discussions

The results of the scatter plot and Radial Visualization (RadVis) analysis offer valuable insights into the significance of luminosity and color in the differentiation between children's and adult book covers. The analysis of the scatter plot reveals distinct clustering patterns, with children's books tending to exhibit higher levels of brightness and color, which underscores their emphasis on promoting engagement, joy, and enthusiasm. In contrast, adult books are distributed across a broader spectrum, with the use of subdued colors and reduced brightness to reflect their alignment with themes of emotional maturity and intellectual deepness. These visual distinctions emphasize the intentional application of color and luminosity to address the psychological and developmental requirements of various reader ages. This is consistent with Kobayashi's framework, which demonstrates the influence of intentional design decisions on reader perception by associating specific colors with psychological and affective responses (Kang and Yoon, 2016: 28-30).

The RadVis visualization enhances this analysis by mapping book covers against six primary color attributes: yellow, orange, red, blue, green, and purple. Warmer hues, including yellow, orange, and red, are strongly associated with children's literature. These colors are known to elicit emotions of creativity, energy, and warmth. These colors are consistent with the developmental objectives of younger readers, thereby promoting a visual experience that is both imaginative and inviting (Brooker and Franklin, 2016: 252-254). These colors are also associated with positive emotional responses, including optimism, enthusiasm, and pleasure, which reinforce early childhood development strategies (Kang and Yoon, 2016: 28-30). Conversely, mature literature is more closely associated with cooler hues, such as blue, green, and purple, which evoke a sense of introspection, calmness, and sophistication. The reflective, intellectual nature of adult literature is in harmony with the colors that resonate with mature audiences (Jonauskaite and Mohr, 2025: 1458). The use of subdued or low-saturation color tones is associated with reduced visual overstimulation, allowing individuals to allocate greater cognitive resources to sustained attention and deeper information processing (Teixeira, Brito-Costa and Abbasi, 2026: 2). Such conditions encourage closer inspection and enhance concentration, which are essential for reflective thinking and critical analysis (Diachenko et al., 2022: 6). Moreover, less intense color schemes are linked to more stable emotional responses, supporting higher-level cognitive functions and contributing to perceptions of calmness,

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

maturity, and self-regulation (Lin, Mottaghi and Shams, 2024: 367-370). In simple terms, the utilization of subdued tones fosters contemplation and concentration, thereby reinforcing principles such as critical thinking, maturity, and forbearance. Kobayashi's emphasis on the role of colors in nurturing emotional resonance and maturity is reflected in the reflective and nuanced themes commonly found in adult literature, which are echoed by this visual language. The observed versatility of these hues is further supported by the overlaps in shared hues such as yellow and blue, which suggest a degree of universality in certain colors. Yellow is associated with optimism, while blue encourages deliberate engagement across age groups.

These results substantiate the theoretical framework that Kobayashi's Color Image Scale has proposed, which establishes a connection between color psychology and behavioral and affective responses. The dynamic, playful qualities that children's books exhibit, such as high luminosity and saturation, are conducive to the development of openness and confidence, which are critical for early development. In contrast, the adult book covers' restrained brilliance and cooler tones encourage critical thinking, patience, and focus, all of which are indicative of maturity. Nevertheless, the observed overlaps between the two categories indicate that luminosity and color alone may not be sufficient for a comprehensive classification of book designs.

An analysis of visual book cover designs from international school libraries highlights the significant impact of color on readers' character development and book appeal. The study examined the hue, brightness, and tonal qualities of the designs to illustrate the impact of consciously chosen colors on personal development, behavior, and emotion. These results are consistent with Shigenobu Kobayashi's Color Image Scale, which provides a theoretical framework for understanding the psychological and emotional responses evoked by color (Kang and Yoon, 2016: 28). Yellow, orange, and red are vibrant and warm colors that are frequently employed in children's literature. These colors are acknowledged for their capacity to evoke emotions of energy, joy, and exhilaration, which are essential for the cultivation of creativity and imagination during early infancy. The high luminosity and saturation of children's book covers create a visual experience that is both engaging and inviting, evoking positivity and inquiry. As per Kobayashi's framework, these colors are associated with dynamic, approachable, and hospitable qualities that contribute to the growth of openness, playfulness, and confidence in young readers. Conversely, adult book covers frequently employ subdued, chilly colors, such as blue, green, and purple. Kobayashi's scale's more refined and tranquil quadrants are consistent with these colors, which are indicative of intellectual depth, introspection, and tranquility. The purpose of these palettes is to promote contemplation and concentration, thereby reinforcing the qualities of patience, maturation, and critical thinking that are particularly appealing to mature readers. The desaturated tones and restrained luminosity of adult literature facilitate the emotional and intellectual development of its audience, reflecting the complexity and reflective nature of the genre (Jonauskaite and Mohr, 2025: 1458-1459 ; Mirzaei, 2025: 11-15; Pinna and

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

overlap between the two categories. For instance, transitional hues, including blue and yellow, are evident in both children's and adult literature, albeit in different contexts. The universal promotion of deliberate engagement is facilitated by blue, which is renowned for its tranquil effect, while yellow, with its warmth, fosters optimism across all age groups. This overlap emphasizes the potential for specific colors to establish shared affective connections among diverse reader groups, thereby fostering a unified visual language through literature.

The influence of colors on book cover designs is not restricted to their visual appeal; they also have a significant impact on the character and values of readers. Inspiring enthusiasm, creativity, and delight, bright and warm tones foster a curious and optimistic worldview in children. In contrast, adult book covers, which are characterized by chilly and more subdued colors, encourage introspection, resilience, and a more profound engagement with complex themes, thereby enhancing emotional intelligence and critical thinking skills. These observations emphasize the significant impact of visual elements on emotional and psychological development, as color not only elicits immediate reactions but also contributes to long-term developmental traits.

Libraries as spaces that facilitate the connection between consumers and resources, can leverage these insights to develop collections that are visually appealing and resonate with a diverse audience. By strategically utilizing color, libraries can facilitate thematic connections and direct users to books that align with their interests or emotional needs. For instance, libraries may implement color-coded themes to establish displays or sections that emphasize books with tones that correspond with educational programs or reading initiatives. Libraries could organize books with subdued, sophisticated tones in sections that encourage adult learning, intellectual engagement, or reflective reading, while books with vibrant, playful hues could be showcased in sections for children's literacy, which would encourage curiosity and creativity. These strategies would not only enhance the aesthetic appeal of library spaces but also cultivate a more profound connection between the thematic content of the books and the visual presentation.

Similarly, designers can employ intentional color strategies to create book covers that not only captivate the attention of readers but also aid in their intellectual and emotional growth. In children's literature, vibrant and playful designs can foster creativity and inquiry, whereas subdued and refined palettes can encourage introspection and engagement with complex themes in adults. The value of interdisciplinary approaches in understanding the connection between visual design and diverse reader experiences further emphasizes the relevance of these findings. This study improves the understanding of color psychology in book design by emphasizing the influence of intentional color and luminance choices on reader engagement and perception. Even though the results confirm the significance of these factors, they also offer opportunities for further research, particularly in the area of how supplementary design features can complement color-based strategies to establish a

e-ISSN: 3109-2535
Volume 15, Nomor 1, Bulan April Tahun 2026
https://ejournal3.undip.ac.id/index.php/jip

comprehensive approach to book cover design that incorporates emotional and aesthetic elements to create more impactful visual communication strategies in literature.

5. Conclusion

Key color properties in book cover design, namely brightness, color intensity, and dominant hues, can be used to differentiate children's books from adult literature, while also examining how these visual elements relate to emotional appeal and audience targeting. Using a quantitative approach, a total of 6,093 book covers were analyzed through RGB and HLS color models, with additional visualization techniques such as scatter plots and Radial Visualization (RadViz). The results offer strong empirical support that color is a significant factor in distinguishing book categories and influencing how readers perceive them.

Children's book covers tend to feature higher brightness and stronger color intensity, forming clear clusters at the upper end of these variables. This pattern reflects a deliberate use of vivid, saturated colors to stimulate emotions like excitement, curiosity, and happiness, responses that align with the developmental characteristics of younger readers. In contrast, adult book covers generally display lower brightness levels and more restrained color palettes, spread across a wider range. This suggests a preference for softer, cooler tones that encourage a sense of depth, reflection, and intellectual engagement, which better suits mature audiences.

The RadViz analysis reinforce this contrast. Children's books are more closely linked to warm hues, especially yellow, orange, and red, while adult books are more frequently associated with cooler colors such as blue, green, and purple. These tendencies are consistent with Kobayashi's Color Image Scale, which connects warm colors with energy and emotional stimulation, and cooler colors with calmness, refinement, and contemplative thinking. At the same time, some overlap is evident, particularly with colors like blue and yellow, suggesting that certain hues can function across age groups depending on context and overall design.

The study meets its objective by demonstrating that color characteristics especially brightness, saturation, and hue that can serve as reliable visual markers for classifying book covers and aligning them with their intended audiences. However, the presence of overlapping color use also indicates that color alone cannot fully define a category. Other visual elements, such as typography, imagery, and layout, should be considered in future research to achieve a more comprehensive understanding.From these findings, several practical implications emerge. Designers are encouraged to apply color strategically based on target readers, using bright and warm tones to attract children, and more subdued, cooler palettes to convey sophistication in adult books. Libraries and educational institutions could also benefit from organizing collections visually, for instance by grouping books according to dominant color themes to enhance user navigation and experience. Future studies, meanwhile, should explore more integrated approaches by combining color analysis with additional design and contextual factors. This research highlights the importance of color as both a psychological and communicative element in book

design. By linking empirical analysis with established color theory, it offers a clearer understanding of how visual choices can shape reader engagement and improve the effectiveness of books across different audiences.

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