Visual Design Sustainability

Subjects: Computer Science, Interdisciplinary Applications

Contributor: Chia-Liang Lin , Ching-Yun Hsu , Chu-Ho Ting

The United Nations established 17 sustainable development goals (SDGs) in 2015, but research on these goals in the visual design industry remains limited.

multi-criteria decision making (MCDM) visual design sustainability fuzzy analytic hierarchy process (FAHP)

1. Introduction

Visual design seeks to captivate, inspire, and encourage people to engage with messages in order to achieve positive outcomes. These outcomes are aligned with the objectives of the organisation commissioning the design, whether it is to reinforce brand identity or drive sales. Objectives may include changing behaviour, advocating messages, or disseminating information. The process of visual design involves strategic planning, incorporating market research, creativity, problem solving, and technical expertise in areas such as colour theory, layout, typography, and visual hierarchy. Visual designers communicate ideas and information through a variety of media, using both traditional tangible skills and strategic design thinking to establish credibility and effectively influence target audiences in design and marketing contexts [1][2][3]. In the meantime, Albadi et al. [4] and Martins et al. [5] reported that the concept of visual design encompasses a broader spectrum, including posters, typography, illustration, web design, packaging design, and visual identity design, all of which find application in various sectors within the creative industries. Also, Huang [6] presented new perspectives on the positioning and capability needs of the visual design industry in the post-epidemic era. She mentioned that visual design industry practitioners should continue to improve their cross-disciplinary skills, especially techniques related to achieving sustainable development goals, in order to meet new challenges and opportunities in the post-epidemic era.

In 2022, Li [7] addressed the overlooked perspective of employee perception in design's impact on brand equity in 2022. This is one of the latest studies to explore the concept of green design from the perspective of employees in the post-epidemic era. It examined how green design concepts influence employee perceptions and behaviours. The results indicated that green design elements influence employee perceptions, which in turn promote positive behaviour and brand equity, mediated by green design concepts.

As global attention on caring for the health of the planet and ensuring shared prosperity for humanity continues to grow, the United Nations (UN) established a set of global goals [8]. These goals are known as the 17 Sustainable Development Goals (SDGs), which are further broken down into 169 specific targets that detail the content of each

SDG [9]. Since then, much related research has been developed and published. For example, Zamora-Polo et al. [10][11] proposed some case studies on the application of the SDGs in higher education. They have found that higher education institutions can raise students' awareness of the SDGs with the right pedagogical framework. Meanwhile, university students majoring in education and health-related disciplines are more attentive to the SDGs and perform better than students in other disciplines. Also, Nakamura et al. [12] proposed a case study in 2023 for the investigation of people's willingness to participate in energy and environment-related policy issues in Japan and Taiwan through use of the Morality-as-Cooperation Questionnaire (MAC-Q). They mentioned that Taiwanese respondents had a better understanding of environmental issues and a greater willingness to engage in civil dialogue, a more positive attitude towards dialogue, and a broader scope of cooperation than Japanese respondents. The research work of Nakamura et al. [12] is one of the latest research results on the willingness of Japanese and Taiwanese people to participate in the SDGs. Moreover, Chang et al. [13] investigated the coverage of the SDGs in university course syllabi in Kaohsiung. They reported that the relationship between university curriculum syllabuses and SDGs depended on the subject characteristics and diversity of the university.

Furthermore, some scholars [14][15][16][17] explored the relationship between the service industry and SDGs from the perspective of service quality. Among them, Stamenkov et al. [14] used a sustainable service quality measurement model for the online service industry and contributed to the realisation of SDGs in the online service industry. Ozdemir et al. [15] proposed the concept of sustainable service quality in higher education by developing a set of measurement tools from the perspective of campus services. The views of Ozdemir et al. [15] were quite novel at the time and had a guiding role in the implementation of SDGs on higher education campuses. Johnson et al. [16] presented their opinions on improving the sustainable service competitiveness of Thai telecom operators. Enquist et al. [17] proposed a value-based sustainable service quality evaluation method for commercial services. They reported that the core values of a company play an important inspiring role in improving the sustainability of the company.

In addition, some scholars proposed relevant research results from the perspective of creative and design industries. For example, Tu [18] proposed sustainable approaches and suggestions of the product design industry. Clark et al. [19] discussed the sustainable trend of product design and development. They reported that ecological design factors will be an important indicator for the future industrial design industry to achieve SDGs. Goubran et al. [20] proposed a novel analytical drawing tool to help architectural designers achieve the SDGs, which can inform architectural practice in the private and public sectors and contribute to the theory and practice of sustainable building design. Fan et al. [21] utilised the Porter's Diamond Model as a research tool to put forward strategies and suggestions for the sustainable development of China's animation industry from multiple aspects such as production, demand, supply chain, corporate strategy, cultural factors, and government. Chen et al. [22] collaborated with designers to create a board game on the SDGs. Their findings are not only one of the most recent studies to introduce a design approach to the field of education in the post-coronavirus era, but also prove that games can be effective in promoting the SDGs, whether they are used in the classroom or played outside the classroom, by stimulating players' interest in the SDGs.

2. Fuzzy Analytic Hierarchy Process

Analytic hierarchy process (AHP) was proposed by Saaty in 1980 [23]. It is one of the most complete techniques for solving MCDM issues in many areas and has been confirmed by many studies [24][25][26]. This method can better systematise complex issues, decomposing them at different levels to make a comprehensive evaluation after quantitative judgment [27][28][29].

Meanwhile, some scholars have applied AHP to the sustainable design field. For example, Arukala et al. [30] presented a case study of sustainability performance assessment of the built environment in India using AHP. They found that applying the AHP method to assess the sustainability performance of the built environment in developing countries is effective and feasible. Also, Dai et al. [31] proposed an integrated method of AHP and QFD from the perspective of sustainable development to provide relevant suggestions for suppliers to achieve sustainable development goals. Moreover, Tu et al. [32] utilised Theoria Resheneyva Isobretatelskehuh Zadach (TRIZ) and AHP to establish sustainable development rules for product design and to contribute to the realisation of sustainable development goals in the product design industry.

Although AHP can be used to address the above problems, unfortunately, it falls short when it comes to explaining problems that involve uncertain phenomena or imprecise solutions. Therefore, Chang [33] first proposed integrated techniques consisting of fuzzy theory and AHP in 1996, called Fuzzy AHP (FAHP), which is used to handle and calculate decision-making problems caused by imprecise phenomena. Since then, FAHP has been widely applied and proven as a highly reliable and valid research method on MCDM problems [34][35][36][37][38].

In the view of this, some scholars have applied FAHP to find answers to questions related to sustainable development within these decades. For example, Larimian et al. [39] developed a FAHP model for the evaluation of sustainable environment design factors in Tehran city. They discovered that factors related to environment design are the most vital scheme for promoting environmental sustainability by establishing a sense of ownership and responsibility in citizens. Rehman et al. [40] used FAHP as a research tool to put forward relevant strategies and suggestions for the manufacturing industry to achieve SDGs. Wang et al. [41] proposed a case study on the sitting of renewable energy power plants in Vietnam using a hybrid approach of FAHP, data envelopment analysis (DEA), and The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). Mostafa et al. [42] evaluated the forest management plans by implementing FAHP. Alyamani et al. [43] utilised FAHP to assess and select a sustainable project. They found that the most important criterion to consider in sustainable project selection was project cost, followed by novelty and uncertainty. Pan [44] applied FAHP to the evaluation and selection of sustainable bridge engineering methods, demonstrating the feasibility of FAHP in solving problems in the field of sustainable engineering. Ashour et al. [45] applied FAHP to explore the obstacles that the interior design industry may encounter in achieving SDGs. They reported that sufficient sustainable design modules, effective design specifications, and client interest in SDGs are important factors for the interior design industry to remove obstacles and achieve SDGs.

3. Grey Rational Analysis

Grey rational analysis (GRA) was proposed by Deng in 1982 [46]. Its primary focus lies in addressing system models characterised by uncertainty or incomplete information. This approach is adept at managing “uncertainty”, “multivariate input data”, or “discrete” information through techniques such as system correlation analysis, model development, predictive analysis, and decision making [47].

In the meantime, GRA finds necessary information from some known and unclear conditions through parameter correlation and then clarifies the interactive relationship between parameters. Afterwards, the degree of correlation between the two series is indicated by the degree of grey correlation [48]. Therefore, these features make GRA an effective method for solving MCDM problems with multiple attributes or with multiple scenarios [49][50][51][52].

Also, Hu et al. [53] and Javanmardi et al. [54] reported that GRA is very suitable in its application to solve sustainable development issues. Muhammad Muneeb et al. [55] proposed a case study of the Pakistan telecommunication industry for achieving SDGs using GRA. Liu et al. [56] implemented GRA to analyse and develop the general sustainability indicators for the Australian renewable energy industry. They found that their general indicators are suitable for the sustainability assessment of four systems with different combinations of grid, solar photovoltaic, and wind renewable energy.

Moreover, Bai et al. [57] evaluated the sustainability of the supplier chain using GRA. The main contribution of their research was to introduce an analysis and application of the method, as well as a clear assessment and insights into the sustainability attributes of the supply chain industry for providing relevant recommendations for the supply chain industry to achieve the SDGs. Manjunatheshwara et al. [58] proposed a decision-making model for the sustainable materials selection of tablet device enclosure based on GRA. Zheng et al. [59] applied GRA to evaluate the energy-saving performance of the building industry, demonstrating the feasibility of using GRA for the sustainable development of the building industry.

Furthermore, Gumus et al. [60] proposed a fuzzy-based hybrid approach of AHP and GRA for solving the problems of the energy-saving industry. Zhang et al. [61] proposed an algorithm to evaluate load balancing in a hybrid wireless environment using FAHP and GRA. Paul et al. [62] and Ilangkumaran et al. [63] applied the hybrid model of FAHP and GRA to mutual fund performance evaluation and wastewater treatment technology.

References

1. Brabham, D.C.; Guth, K.L. The Deliberative Politics of the Consultative Layer: Participation Hopes and Communication as Design Values of Civic Tech Founders. J. Commun. 2017, 67, 445–475.
2. Satria, H.W.; Tantuah, N.N.; Thoriq, M.A. The Role of a Graphic Designer in the Visual Marketing Team to Accelerate Awareness of Premium Content KumparanPLUS. Proceedings 2022, 83, 40.
3. Aakhus, M. Communication as Design. Commun. Monogr. 2007, 74, 112–117.

4. Albadi, N.; Zollinger, S.W. Dominant Learning Styles of Interior Design Students in Generation Z. J. Inter. Des. 2021, 46, 49–65.
5. Martins, N.; Raposo, D. (Eds.) Communication Design and Branding: A Multidisciplinary Approach; Springer Series in Design and Innovation; Springer Nature Switzerland: Cham, Switzerland, 2023; Volume 32, ISBN 978-3-031-35384-0.
6. Huang, H.-L. Examining the Design Policies and Taiwan's Visual Design Industry from the Design Ladder Perspective. Ph.D. Thesis, National Cheng Kung University, Tainan, Taiwan, 2021.
7. Li, Y. Design Visual Elements and Brand-Based Equity: Mediating Role of Green Concept. Front. Psychol. 2022, 13, 888164.
8. United Nations. United Nations Transforming Our World: The 2030 Agenda for Sustainable Development; Resolution Adopted by the General Assembly on 25 September 2015; United Nations: New York, NY, USA, 2015.
9. United Nations. 17 Goals to Transform Our World. 2015. Available online: https://www.un.org/sustainabledevelopment/ (accessed on 18 May 2022).
10. Zamora-Polo, F.; Sánchez-Martín, J. Teaching for a Better World. Sustainability and Sustainable Development Goals in the Construction of a Change-Maker University. Sustainability 2019, 11, 4224.
11. Zamora-Polo, F.; Sánchez-Martín, J.; Corrales-Serrano, M.; Espejo-Antúnez, L. What Do University Students Know about Sustainable Development Goals? A Realistic Approach to the Reception of This UN Program Amongst the Youth Population. Sustainability 2019, 11, 3533.
12. Nakamura, H.; Chen, W.-L. Dialogue and Collaboration for Sustainable Development in Japan and Taiwan: Epistemic Foundation of Partnership toward Sustainable Development Goals. Environ. Sci. Policy 2023, 145, 238–249.
13. Chang, Y.-C.; Lien, H.-L. Mapping Course Sustainability by Embedding the SDGs Inventory into the University Curriculum: A Case Study from National University of Kaohsiung in Taiwan. Sustainability 2020, 12, 4274.
14. Stamenkov, G.; Dika, Z. A Sustainable E-Service Quality Model. J. Serv. Theory Pract. 2015, 25, 414–442.
15. Ozdemir, Y.; Kaya, S.K.; Turhan, E. A Scale to Measure Sustainable Campus Services in Higher Education: "Sustainable Service Quality". J. Clean. Prod. 2020, 245, 118839.
16. Johnson, W.C.; Sirikit, A. Service Quality in the Thai Telecommunication Industry: A Tool for Achieving a Sustainable Competitive Advantage. Manag. Decis. 2002, 40, 693–701.
17. Enquist, B.; Edvardsson, B.; Petros Sebhatu, S. Values-based Service Quality for Sustainable Business. Manag. Serv. Qual. Int. J. 2007, 17, 385–403.

18. Tu, J.-C. Product Sustainable Design: Green Design in Theory and Practice; Asia-Pacific: Taipei, Taiwan, 2002; ISBN 978-986-7809-03-2.
19. Clark, G.; Kosoris, J.; Hong, L.N.; Crul, M. Design for Sustainability: Current Trends in Sustainable Product Design and Development. Sustainability 2009, 1, 409–424.
20. Goubran, S.; Cucuzzella, C. Integrating the Sustainable Development Goals in Building Projects. J. Sustain. Res. 2019, 1, 1–43.
21. Fan, K.-K.; Feng, T.-T. Sustainable Development Strategy of Chinese Animation Industry. Sustainability 2021, 13, 7235.
22. Chen, F.-H.; Ho, S.-J. Designing a Board Game about the United Nations' Sustainable Development Goals. Sustainability 2022, 14, 11197.
23. Saaty, T.L. The Analytic Hierarchy Process: Planning, Priority Setting, Resources Allocation; McGraw-Hill: New York, NY, USA, 1980.
24. Tseng, H.-E.; Li, R.-K. Analytic Hierarchical Process for Design Alternative Selection. J. Des. 1998, 3, 43–54.
25. Shahin, A.; Mahbod, M.A. Prioritization of Key Performance Indicators: An Integration of Analytical Hierarchy Process and Goal Setting. Int. J. Product. Perform. Manag. 2007, 56, 226–240.
26. Tu, J.-C.; Chang, Y.-C. Strategy of Sustainable Product Development by Applying Analytic Hierarchy Process (AHP). Kaohsiung Norm. Univ. J. 2006, 21, 139–153.
27. Saaty, T.L. Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World; RWS publications: Pittsburgh, PA, USA, 1980.
28. Lee, Y.-C.; Ho, M.-C. A Study on the Weighting of Indicators for Image Design. J. Des. 2011, 16, 41–64.
29. Chen, W.-L.; Chen, T.-H. The Establishment and Analysis of Evaluation Index in Sportswear Design. J. Des. 2007, 12, 79–95.
30. Arukala, S.R.; Pancharathi, R.K.; Pulukuri, A.R. Evaluation of Sustainable Performance Indicators for the Built Environment Using AHP Approach. J. Inst. Eng. India Ser. A 2019, 100, 619–631.
31. Dai, J.; Blackhurst, J. A Four-Phase AHP–QFD Approach for Supplier Assessment: A Sustainability Perspective. Int. J. Prod. Res. 2012, 50, 5474–5490.
32. Tu, J.-C.; Chen, H.-C.; Guan, S.-S. Development of Green Innovative Strategy by Applying the Triz Theory and AHP Method. J. Sci. Technol. 2015, 24, 71–83.
33. Chang, D.-Y. Applications of the Extent Analysis Method on Fuzzy AHP. Eur. J. Oper. Res. 1996, 95, 649–655.

34. Hsu, Y.; Lee, C.; Kreng, V.B. The Application of Fuzzy Delphi Method and Fuzzy AHP in Lubricant Regenerative Technology Selection. Expert Syst. Appl. 2010, 37, 419–425.
35. Kaganski, S.; Majak, J.; Karjust, K. Fuzzy AHP as a Tool for Prioritization of Key Performance Indicators. Procedia CIRP 2018, 72, 1227–1232.
36. Kwong, C.K.; Bai, H. A Fuzzy AHP Approach to the Determination of Importance Weights of Customer Requirements in Quality Function Deployment. J. Intell. Manuf. 2002, 13, 367–377.
37. Lam, K.C.; Lam, M.C.K.; Wang, D. MBNQA–Oriented Self-Assessment Quality Management System for Contractors: Fuzzy AHP Approach. Constr. Manag. Econ. 2008, 26, 447–461.
38. Nguyen, P.-H. A Fuzzy Analytic Hierarchy Process (FAHP) Based on SERVQUAL for Hotel Service Quality Management: Evidence from Vietnam. J. Asian Financ. Econ. Bus. 2021, 8, 1101–1109.
39. Larimian, T.; Zarabadi, Z.S.S.; Sadeghi, A. Developing a Fuzzy AHP Model to Evaluate Environmental Sustainability from the Perspective of Secured by Design Scheme—A Case Study. Sustain. Cities Soc. 2013, 7, 25–36.
40. Rehman, A.U.; Mian, S.H.; Umer, U.; Usmani, Y.S. Strategic Outcome Using Fuzzy-AHP-Based Decision Approach for Sustainable Manufacturing. Sustainability 2019, 11, 6040.
41. Wang, C.-N.; Nguyen, V.T.; Thai, H.T.N.; Duong, D.H. Multi-Criteria Decision Making (MCDM) Approaches for Solar Power Plant Location Selection in Viet Nam. Energies 2018, 11, 1504.
42. Mostafa, M.; Hatami, N.; Espahbodi, K.; Asadi, F. Fuzzy Analytic Hierarchy Process (FAHP) Applied to Evaluating the Forest Management Approaches. J. For. Sci. 2022, 68, 263–276.
43. Alyamani, R.; Long, S. The Application of Fuzzy Analytic Hierarchy Process in Sustainable Project Selection. Sustainability 2020, 12, 8314.
44. Pan, N.F. Fuzzy AHP Approach for Selecting the Suitable Bridge Construction Method. Autom. Constr. 2008, 17, 958–965.
45. Ashour, M.; Mahdiyar, A.; Haron, S.H.; Hanafi, M.H. Barriers to the Practice of Sustainable Interior Architecture and Design for Interior Renovations: A Parsimonious-Cybernetic Fuzzy AHP Approach. J. Clean. Prod. 2022, 366, 132958.
46. Deng, J.-L. Control Problems of Grey Systems. Syst. Control Lett. 1982, 1, 288–294.
47. Deng, J.-L. Introduction to Grey System. J. Grey Syst. 1989, 1, 1–24.
48. Huang, S.-W.; Lin, Y.-C.; Liao, C.-H. Applying Analytic Hierarchy Process (AHP) and Grey Relational Analysis (GRA) to Purchase Factors of University Students for Smart Phones. J. Technol. 2016, 31, 193–208.

49. Hinduja, A.; Pandey, M. Comparative Study of MCDM Methods under Different Levels of Uncertainty. Int. J. Inf. Decis. Sci. 2021, 13, 16–41.
50. Wang, Q.B.; Peng, A.H. Developing MCDM Approach Based on GRA and TOPSIS. Appl. Mech. Mater. 2010, 34–35, 1931–1935.
51. Asjad, M.; Talib, F. Selection of Optimal Machining Parameters Using Integrated MCDM Approaches. Int. J. Adv. Oper. Manag. 2018, 10, 109–129.
52. Esangbedo, M.O.; Xue, J.; Bai, S.; Esangbedo, C.O. Relaxed Rank Order Centroid Weighting MCDM Method With Improved Grey Relational Analysis for Subcontractor Selection: Photothermal Power Station Construction. IEEE Trans. Eng. Manag. 2022, 1–18.
53. Hu, M.; Liu, W. Grey System Theory in Sustainable Development Research—A Literature Review (2011−2021). Grey Syst. Theory Appl. 2022, 12, 785–803.
54. Javanmardi, E.; Liu, S.; Xie, N. Exploring Grey Systems Theory-Based Methods and Applications in Sustainability Studies: A Systematic Review Approach. Sustainability 2020, 12, 4437.
55. Muhammad Muneeb, F.; Karbassi Yazdi, A.; Wanke, P.; Yiyin, C.; Chughtai, M. Critical Success Factors for Sustainable Entrepreneurship in Pakistani Telecommunications Industry: A Hybrid Grey Systems Theory/ Best-Worst Method Approach. Manag. Decis. 2020, 58, 2565–2591.
56. Liu, G.; Baniyounes, A.M.; Rasul, M.G.; Amanullah, M.T.O.; Khan, M.M.K. General Sustainability Indicator of Renewable Energy System Based on Grey Relational Analysis. Int. J. Energy Res. 2013, 37, 1928–1936.
57. Bai, C.; Sarkis, J. Integrating Sustainability into Supplier Selection with Grey System and Rough Set Methodologies. Int. J. Prod. Econ. 2010, 124, 252–264.
58. Manjunatheshwara, K.J.; Vinodh, S. Grey-Based Decision-Making Method for Sustainable Material Selection of Tablet Device Enclosure. Clean Techn Env. Policy 2018, 20, 2345–2356.
59. Zheng, G.; Jing, Y.; Huang, H.; Gao, Y. Application of Improved Grey Relational Projection Method to Evaluate Sustainable Building Envelope Performance. Appl. Energy 2010, 87, 710–720.
60. Gumus, A.T.; Yayla, A.Y.; Çelik, E.; Yildiz, A. A Combined Fuzzy-AHP and Fuzzy-GRA Methodology for Hydrogen Energy Storage Method Selection in Turkey. Energies 2013, 6, 3017–3032.
61. Zhang, D.; Zhang, Y.; Lv, N.; He, Y. An Access Selection Algorithm Based on GRA Integrated with FAHP and Entropy Weight in Hybrid Wireless Environment. In Proceedings of the 2013 7th International Conference on Application of Information and Communication Technologies, Baku, Azerbaijan, 23–25 October 2013; pp. 1–5.
62. Paul, T.K.; Pal, M.; Jana, C. Portfolio Selection as a Multicriteria Group Decision Making in Pythagorean Fuzzy Environment with GRA and FAHP Framework. Int. J. Intell. Syst. 2022, 37,

478–515.

63. Ilangkumaran, M.; Sakthivel, G.; Sasirekha, V. Waste Water Treatment Technology Selection Using FAHP and GRA Approaches. Int. J. Environ. Waste Manag. 2014, 14, 392–413.