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Generative AI in Product Design for Mega Events: A Framework for Expo 2031 and FIFA World Cup Saudi Arabia

Rafat Saleh Madani[1*]

Abstract

Saudi Arabia is preparing to host two of the world's most significant mega events: Expo 2030 Riyadh (October 2030–March 2031) and the FIFA World Cup 2034. These events demand unprecedented scales of product design innovation spanning pavilion interiors, branded merchandise, wayfinding systems, fan experience products, and commemorative artifacts. This study investigates the potential of generative artificial intelligence (GenAI) in augmenting the product design workflow for such mega events. A Saudi-based survey methodology was employed, collecting data from 214 design professionals, academics, and event planners across Riyadh, Jeddah, and Makkah. Descriptive and inferential statistical analyses were conducted to evaluate perceptions, readiness, and adoption barriers. Results indicate that 78.5% of respondents perceive GenAI as highly beneficial for accelerating concept generation, while 65.4% expressed concerns about cultural appropriateness of AI-generated designs. A novel framework-the Mega Event Generative Design Integration (MEGDI) model-is proposed, integrating cultural sensitivity filters, iterative human-AI co-creation loops, and sustainability metrics. The findings provide actionable recommendations for policymakers, design firms, and educational institutions in Saudi Arabia as the Kingdom prepares for these landmark occasions.

Keywords: *Generative AI; Product Design; Mega Events; Expo 2030 Riyadh; FIFA World Cup 2034; Saudi Arabia; Vision 2030; Human-AI Co-creation*

Introduction

The Kingdom of Saudi Arabia stands at a pivotal juncture in its national transformation. Under the Saudi Vision 2030 framework, the nation has committed to diversifying its economy, strengthening its cultural identity, and positioning itself as a global hub for innovation, tourism, and mega events (Vision 2030, 2016). Central to this ambition is the hosting of two landmark international occasions: Expo 2030 Riyadh, themed "Foresight for Tomorrow," which will welcome over 42 million visits across 230 pavilions from 197 participating nations (Bureau International des Expositions [BIE], 2024), and the 2034 FIFA World Cup, to be staged across 15 stadiums in five host cities-Riyadh, Jeddah, Al Khobar, Abha, and NEOM (FIFA, 2024).

These mega events generate enormous demand for product design at every scale-from pavilion interiors and immersive exhibition artifacts to branded merchandise, wayfinding systems, stadium seating, fan experience products, and commemorative souvenirs. The design challenges are compounded by the need for cultural authenticity, environmental sustainability, scalability, and rapid prototyping under tight timelines. Traditional product design workflows, while effective for smaller-scale projects, may prove insufficient when confronted with the volume and complexity of design deliverables required for events of this magnitude (Rowe, 2023; Ghobakhloo et al., 2024).

Generative artificial intelligence (GenAI) has emerged as a transformative force in design

[1] Product Design, College of Designs and Arts, Umm Al-Qura University, Makkah, Saudi Arabia; Email: rsmadani@uqu.edu.sa

disciplines. Unlike conventional AI systems that analyze existing data, GenAI models-including generative adversarial networks (GANs), variational autoencoders (VAEs), and large language models (LLMs)-produce novel outputs such as images, 3D forms, material configurations, and textual design briefs (Goodfellow et al., 2014; Ooi, 2025). The global generative AI in industrial design market was valued at approximately USD 255 million in 2024 and is projected to reach USD 2.3 billion by 2034, growing at a compound annual growth rate of 24.6% (Precedence Research, 2024). This growth signals increasing industry confidence in AI-augmented design processes.

Despite this promise, the application of GenAI to product design for mega events remains underexplored. Existing literature has examined GenAI in manufacturing (Doanh, 2023), architectural form-finding (Agkathidis et al., 2024), and fashion design (Sbai et al., 2018), but few studies have addressed the intersection of GenAI, product design, and large-scale event planning, particularly within a Middle Eastern or Saudi Arabian context. This study aims to bridge that gap by: (1) assessing the readiness and perceptions of Saudi design professionals regarding GenAI adoption for mega event product design; (2) identifying key barriers and enablers; and (3) proposing a comprehensive integration framework-the Mega Event Generative Design Integration (MEGDI) model-tailored to the cultural and logistical context of Expo 2030 Riyadh and the FIFA World Cup 2034 Saudi Arabia.

Literature Review

Generative AI in Product and Industrial Design

Generative AI encompasses a family of machine learning models capable of producing novel content, including images, text, 3D geometries, and material specifications. The field has evolved rapidly since the introduction of GANs by Goodfellow et al. (2014), which demonstrated the capacity of adversarial training to generate realistic outputs. Subsequent developments, including transformer-based architectures such as GPT (Brown et al., 2020) and diffusion models like Stable Diffusion (Rombach et al., 2022), have extended the reach of generative systems into design-adjacent domains. In product design specifically, researchers have explored the use of GANs for generating user-aligned conceptual images (Li et al., 2021), ship hull geometries (Heyrani Nobari et al., 2021), and bicycle designs through CreativeGAN (Khan et al., 2023). More recently, Liu and Hu (2023) demonstrated the application of Stable Diffusion for industrial design sketching and rendering, achieving outputs that closely approximated professional-quality deliverables.

A significant contribution is the GAI-PD (Generative AI Product Designer) multi-model framework proposed by researchers integrating GANs with LLMs, which achieved 90.23% accuracy in generating valid design concepts while also demonstrating that hyperparameter tuning significantly enhances image quality (Tandfonline, 2025). Furthermore, the CHI 2025 study by Naqvi et al. (2025) examined generative AI's role across professional, academic, and junior designer cohorts, revealing that AI proficiency enhances perceived competence and marketability, though concerns about ownership, design fixation, and over-reliance persist.

Mega Events as Design Catalysts

Mega events such as World Expos and FIFA World Cups have historically served as catalysts for design innovation and architectural experimentation. The Crystal Palace (London, 1851), the Eiffel Tower (Paris, 1889), and the Osaka Expo's Ring Roof (2025) all exemplify how these events push the boundaries of design practice (Roche, 2000). Within the Saudi Arabian context, the alignment of mega event hosting with Vision 2030 objectives creates a unique design imperative. Expo 2030 Riyadh will be held on a purpose-built site in North Riyadh,

masterplanned by LAVA (Laboratory for Visionary Architecture), featuring nature-led urban design, AI-powered smart infrastructure, and climate-responsive architecture (ArchDaily, 2025). The FIFA World Cup 2034 venues, designed by firms including Populous, Foster + Partners, and Arup, incorporate motifs drawn from coral reefs, acacia trees, and Islamic geometric patterns (Dezeen, 2024). These designs demand product ecosystems-furniture, signage, merchandise, interactive exhibits-that maintain thematic coherence while serving millions of visitors.

Cultural Sensitivity in AI-Generated Design

A critical gap in the GenAI-design literature concerns cultural appropriateness. Most generative models are trained predominantly on Western design datasets, creating risks of culturally incongruent or insensitive outputs when deployed in non-Western contexts (Srinivasan & Uchino, 2022). Saudi Arabia's design heritage, characterized by Salmani architectural principles, Najdi geometric patterns, and Islamic calligraphic traditions, requires design outputs that authentically reflect local identity (Al-Naim, 2008). The establishment of the Saudi Data and Artificial Intelligence Authority (SDAIA) and the National Strategy for Data and AI underscore the Kingdom's recognition that AI deployment must be culturally grounded and ethically governed (SDAIA, 2020).

Research Methodology

Research Design

This study adopted a quantitative cross-sectional survey design to investigate the perceptions, readiness, and barriers associated with GenAI adoption in product design for Saudi mega events. The research was guided by a positivist epistemological stance, appropriate for generating generalizable insights from a defined population (Creswell & Creswell, 2018). Ethical approval was obtained from the institutional review board at Umm Al-Qura University prior to data collection.

Population and Sampling

The target population comprised product design professionals, academics, and event planning specialists based in Saudi Arabia who possessed familiarity with both design practice and emerging technologies. A stratified purposive sampling strategy was employed across three major cities: Riyadh (n = 89), Jeddah (n = 72), and Makkah (n = 53). These cities were selected for their roles as mega event host cities (Riyadh and Jeddah) and as the location of the researcher's home institution (Makkah). Inclusion criteria required participants to hold at minimum a bachelor's degree in design or a related field and to have at least two years of professional experience. A total of 250 survey instruments were distributed, with 214 valid responses returned, yielding a response rate of 85.6%.

Instrument Development

The survey instrument was developed through a multi-stage process. First, an initial item pool of 42 items was generated based on a thorough review of the GenAI-design and mega event literatures. Items were organized into five constructs: (1) Perceived Usefulness of GenAI (8 items), (2) Cultural Sensitivity Concerns (7 items), (3) Technical Readiness (6 items), (4) Organizational Support (6 items), and (5) Adoption Intention (5 items). All items were measured on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The instrument was reviewed by a panel of five subject matter experts-three in product design and two in AI and digital transformation-from Saudi universities. Following pilot testing with 30 design professionals in Makkah, four items were removed due to low item-total correlations (< 0.30), resulting in a final instrument of 38 items. The Arabic translation was prepared using a back-translation protocol to ensure semantic equivalence (Brislin, 1970).

Data Collection

Data were collected between January and March 2025. The survey was distributed electronically via institutional email lists, professional WhatsApp groups of Saudi design associations, and in-person at two design industry events in Riyadh (Saudi Design Week) and Jeddah (21,39 Jeddah Arts Festival). Informed consent was obtained from all participants, and anonymity was guaranteed. The bilingual (Arabic-English) survey was hosted on the Qualtrics platform, with geolocation tagging enabled to verify respondent locations within Saudi Arabia.

Data Analysis

Collected data were analyzed using SPSS version 28. Descriptive statistics (means, standard deviations, frequencies) were computed for all constructs. Internal consistency was assessed using Cronbach's alpha, with all constructs exceeding the 0.70 threshold recommended by Nunnally (1978). Independent-samples t-tests and one-way ANOVA were used to compare perceptions across demographic groups (city, professional role, years of experience). Pearson correlation analysis was conducted to examine relationships between constructs, and multiple regression analysis was performed to identify predictors of GenAI adoption intention.

Results and Data Analysis

Demographic Profile

The sample consisted of 214 respondents, of whom 58.9% were male and 41.1% were female. Regarding professional roles, 42.1% identified as practicing product designers, 28.5% as academics in design-related departments, 18.7% as event planning professionals, and 10.7% as design managers or consultants. The mean age was 36.4 years (SD = 7.8), and the average professional experience was 9.2 years (SD = 5.1). In terms of prior exposure to GenAI tools, 61.2% reported having used at least one GenAI platform (e.g., Midjourney, DALL·E, Stable Diffusion) for professional or personal purposes, while 38.8% had no direct experience. Table 1 presents the demographic distribution.

Table 1. Demographic Profile of Respondents (N = 214)

Variable	Category	n	%	Mean Exp. (yrs)
City	Riyadh	89	41.6	9.8
	Jeddah	72	33.6	8.9
	Makkah	53	24.8	8.6
Role	Product Designer	90	42.1	10.4
	Academic	61	28.5	11.1
	Event Planner	40	18.7	6.3
	Design Manager	23	10.7	7.8
GenAI Exp.	Yes	131	61.2	-
	No	83	38.8	-

Descriptive Statistics by Construct

The construct-level descriptive statistics reveal moderate to high perceptions across all five dimensions. Perceived Usefulness of GenAI received the highest mean score (M = 4.12, SD = 0.68), indicating strong agreement that GenAI tools can enhance the product design process for mega events. Cultural Sensitivity Concerns also scored highly (M = 3.89, SD = 0.81), reflecting

widespread awareness that AI-generated designs may not inherently align with Saudi cultural values and heritage aesthetics. Technical Readiness yielded a moderate score (M = 3.41, SD = 0.93), suggesting that while many professionals recognize the potential of GenAI, a substantial proportion feel inadequately equipped with the technical skills required for effective implementation. Organizational Support was rated lowest (M = 3.18, SD = 0.87), indicating a perceived gap in institutional infrastructure, training programs, and policy frameworks. Adoption Intention was moderately high (M = 3.76, SD = 0.74). Table 2 summarizes these results along with Cronbach's alpha reliability coefficients.

Table 2. Descriptive Statistics and Reliability of Survey Constructs

Construct	Items	Mean	SD	Min	Max	Cronbach's α
Perceived Usefulness	8	4.12	0.68	2.13	5.00	0.89
Cultural Sensitivity	7	3.89	0.81	1.57	5.00	0.84
Technical Readiness	6	3.41	0.93	1.00	5.00	0.81
Organizational Support	6	3.18	0.87	1.00	5.00	0.78
Adoption Intention	5	3.76	0.74	1.60	5.00	0.86

Key Item-Level Findings

At the item level, several findings are particularly noteworthy. Within the Perceived Usefulness construct, the item "GenAI can significantly accelerate the concept generation phase of product design for mega events" received the highest agreement (M = 4.38, SD = 0.61), with 78.5% of respondents selecting "Agree" or "Strongly Agree." This aligns with international findings that GenAI's primary value proposition lies in the ideation and early conceptualization stages (Naqvi et al., 2025; Wadinambiarachchi et al., 2024). The item "GenAI can help designers produce culturally appropriate products for Saudi mega events without human oversight" was strongly rejected (M = 2.14, SD = 1.02), with 65.4% disagreeing or strongly disagreeing, reinforcing that practitioners view GenAI as a collaborative tool rather than an autonomous design agent.

Within the Cultural Sensitivity Concerns construct, the highest-scoring item was "AI-generated designs may fail to reflect Saudi heritage elements such as Salmani architecture and Islamic geometric patterns" (M = 4.21, SD = 0.69). This concern is consistent with broader critiques of GenAI systems trained predominantly on Western datasets (Srinivasan & Uchino, 2022). Regarding Technical Readiness, 52.3% of respondents indicated they had received no formal training in GenAI tools, and 43.9% expressed a desire for university-level or professional development courses specifically focused on AI-augmented design.

Comparative Analysis

Independent-samples t-tests revealed that respondents with prior GenAI experience scored significantly higher on Perceived Usefulness (M = 4.31 vs. M = 3.82, $t(212) = 4.87$, $p < .001$) and Adoption Intention (M = 3.94 vs. M = 3.47, $t(212) = 4.21$, $p < .001$) compared to those without experience. One-way ANOVA indicated significant differences in Technical Readiness across cities ($F(2, 211) = 5.62$, $p = .004$), with Riyadh-based respondents reporting the highest readiness scores (M = 3.64, SD = 0.88), followed by Jeddah (M = 3.38, SD = 0.91) and Makkah (M = 3.09, SD = 0.96). Post hoc Tukey HSD tests confirmed a significant difference between Riyadh and Makkah ($p = .003$). No significant gender differences were found across any constructs.

Correlation and Regression Analysis

Pearson correlation analysis revealed significant positive correlations among all constructs.

Perceived Usefulness was most strongly correlated with Adoption Intention ($r = .67$, $p < .001$), followed by Technical Readiness ($r = .54$, $p < .001$). Cultural Sensitivity Concerns showed a moderate negative correlation with Adoption Intention ($r = –.38$, $p < .001$), suggesting that heightened concerns about cultural appropriateness partially inhibit adoption enthusiasm. Table 3 presents the full correlation matrix.

Table 3. Pearson Correlation Matrix

	PU	**CS**	**TR**	**OS**	**AI**
Perceived Usefulness (PU)	1.00	.41**	.54**	.49**	.67**
Cultural Sensitivity (CS)		1.00	.29**	.33**	–.38**
Technical Readiness (TR)			1.00	.52**	.58**
Organizational Support (OS)				1.00	.51**
Adoption Intention (AI)					1.00

*Note. ** $p < .001$*

Multiple regression analysis was conducted with Adoption Intention as the dependent variable and the remaining four constructs as predictors. The overall model was significant ($F(4, 209) = 47.83$, $p < .001$) and explained 47.8% of the variance in Adoption Intention (Adjusted $R^2 = .468$). Perceived Usefulness was the strongest predictor ($\beta = .39$, $p < .001$), followed by Technical Readiness ($\beta = .28$, $p < .001$) and Organizational Support ($\beta = .19$, $p = .002$). Cultural Sensitivity Concerns was a significant negative predictor ($\beta = –.21$, $p < .001$). Table 4 presents the regression coefficients.

Table 4. Multiple Regression Results: Predictors of GenAI Adoption Intention

Predictor	**B**	**SE**	**β**	**t**	**p**	**VIF**
(Constant)	0.52	0.24	-	2.17	.031	-
Perceived Usefulness	0.42	0.06	.39	6.83	<.001	1.68
Cultural Sensitivity	–0.19	0.05	–.21	–3.92	<.001	1.31
Technical Readiness	0.22	0.05	.28	4.67	<.001	1.62
Organizational Support	0.16	0.05	.19	3.11	.002	1.54

Note. $R^2 = .478$, Adjusted $R^2 = .468$, $F(4, 209) = 47.83$, $p < .001$

The MEGDI Framework

Drawing on the empirical findings and the extant literature, this study proposes the Mega Event Generative Design Integration (MEGDI) model as a structured framework for incorporating GenAI into the product design pipeline for Saudi mega events. The framework comprises five interconnected phases.

Phase 1: Cultural Briefing and Dataset Curation. Before any GenAI tool is deployed, the design team assembles a culturally curated training dataset that includes Saudi architectural motifs (Salmani, Najdi, Hejazi styles), Islamic geometric patterns, traditional material palettes

(limestone, palm wood, woven textiles), and contemporary Saudi brand guidelines. This dataset serves as a cultural filter that conditions GenAI outputs toward heritage-aligned aesthetics. The importance of this phase is underscored by the survey finding that 65.4% of respondents doubted GenAI's ability to produce culturally appropriate outputs without human oversight.

Phase 2: AI-Augmented Ideation. Designers input event-specific design briefs-including functional requirements, spatial constraints, target audience profiles, and sustainability parameters-into GenAI platforms (e.g., Midjourney, DALL·E, Stable Diffusion, or custom fine-tuned models). The AI generates a broad spectrum of concept variants, which designers then curate, combine, and refine. This phase leverages the finding that 78.5% of respondents view GenAI as highly effective for accelerating concept generation.

Phase 3: Human-AI Co-Creation and Refinement. Selected concepts are iteratively refined through a co-creation loop in which designers modify AI outputs using professional CAD and 3D modeling tools (e.g., SolidWorks, Rhino, Blender), while periodically re-querying GenAI for variation, material suggestions, or ergonomic optimization. This phase reflects the human-in-the-loop paradigm advocated by recent design research (Zhu et al., 2024; Naqvi et al., 2025) and addresses the strong consensus among respondents that GenAI should augment rather than replace human design judgment.

Phase 4: Sustainability and Feasibility Assessment. AI-generated and co-created designs are evaluated against sustainability metrics aligned with Saudi Arabia's commitment to net-zero emissions by 2060. GenAI tools are deployed to simulate material lifecycle impacts, estimate carbon footprints, and suggest eco-friendly alternatives. This phase aligns with the sustainability sub-theme of Expo 2030 ("Sustainable Solutions") and the green stadium design principles of the FIFA World Cup 2034 (FIFA, 2024).

Phase 5: Scalable Production and Localization. Finalized designs are prepared for mass production, incorporating generative parametric modeling to enable rapid customization across different venue contexts (e.g., adapting a wayfinding system from an Expo pavilion to a World Cup stadium concourse). GenAI-driven parametric tools enable the generation of design families-sets of related but distinct product variants-that maintain brand coherence while accommodating site-specific requirements.

Discussion

The findings of this study contribute to the emerging body of knowledge at the intersection of GenAI, product design, and mega event management. The strong perceived usefulness of GenAI for mega event product design (M = 4.12) echoes international trends in the design profession, where AI-augmented workflows are increasingly recognized as essential for managing the volume and pace of contemporary design demands (Ghobakhloo et al., 2024; Ooi, 2025). However, the relatively low scores for Organizational Support (M = 3.18) and Technical Readiness (M = 3.41) suggest that Saudi Arabia's design ecosystem requires targeted investment in capacity building.

The significant negative relationship between Cultural Sensitivity Concerns and Adoption Intention ($\beta = -.21$) is a finding of particular relevance to the Saudi context. It implies that unless GenAI tools are adapted or fine-tuned to respect and incorporate Saudi cultural elements, adoption may be suppressed even among otherwise enthusiastic practitioners. This finding resonates with the broader AI ethics discourse, which emphasizes the need for culturally inclusive AI development (Srinivasan & Uchino, 2022), and with Saudi Arabia's own SDAIA guidelines for responsible AI (SDAIA, 2020).

The MEGDI framework addresses these concerns through its phased approach, beginning with

cultural dataset curation and maintaining human oversight throughout. This design is consistent with the human-AI co-creation paradigm that has gained traction in the design research community (Zhu et al., 2024). By embedding sustainability assessment as a dedicated phase, the framework also responds to the growing imperative for environmentally responsible mega event planning, as exemplified by Saudi Arabia's commitment to powering the NEOM stadium entirely by renewable energy and achieving net-zero carbon for its Expo infrastructure (Expo 2030 Riyadh, 2025).

The city-level differences in Technical Readiness, with Riyadh scoring highest, likely reflect the capital's concentration of technology companies, startup incubators, and design firms. This geographic disparity suggests that capacity-building programs should be strategically distributed, with particular attention to design professionals in secondary cities such as Makkah. The Saudi government's establishment of SDAIA and investment in AI training initiatives through programs like Tuwaiq Academy provide an existing infrastructure upon which GenAI-specific design training could be built.

Conclusion and Recommendations

This study has investigated the perceptions, readiness, and barriers associated with adopting generative AI in product design for Saudi Arabia's forthcoming mega events-Expo 2030 Riyadh and the FIFA World Cup 2034. Through a survey of 214 design professionals across three major Saudi cities, the research has established that GenAI is perceived as a highly valuable tool for accelerating concept generation and supporting design innovation at scale, while cultural appropriateness remains a significant concern that must be addressed through curated datasets and human oversight. The proposed MEGDI framework offers a structured pathway for integrating GenAI into mega event product design workflows in a manner that is culturally sensitive, sustainable, and human-centered.

Based on these findings, the following recommendations are offered. First, Saudi design institutions, including Umm Al-Qura University and King Saud University, should develop specialized curricula in AI-augmented product design that equip graduates with both technical proficiency and critical evaluation skills for GenAI outputs. Second, the Saudi Data and Artificial Intelligence Authority (SDAIA) should collaborate with the design community to develop Saudi-specific cultural design datasets that can be used to fine-tune generative models. Third, mega event organizing committees, including the Royal Commission for Riyadh City and the Saudi 2034 FIFA World Cup Local Organizing Committee, should establish GenAI integration units within their design departments, charged with piloting and evaluating AI-augmented workflows. Fourth, future research should adopt mixed-methods approaches, incorporating qualitative interviews and case studies of actual GenAI deployment in mega event design projects, to deepen understanding of the human-AI co-creation dynamic in this distinctive context.

Limitations of this study include the cross-sectional design, which precludes causal inference, and the reliance on self-reported data. The sample, while geographically distributed across three cities, may not fully represent the diversity of Saudi design professionals. Nonetheless, the study provides a foundational empirical contribution and a novel integrative framework that can inform both practice and policy as Saudi Arabia prepares to welcome the world.

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References

Agkathidis, A., Song, Y., & Symeonidou, I. (2024). AI-assisted design: Utilizing artificial intelligence as a generative form-finding tool in architectural design studio teaching. In Proceedings of the 42nd Conference on Education and Research in Computer Aided Architectural Design in Europe (eCAADe 2024), Vol. 2, pp. 619–628.

Al-Naim, M. (2008). Identity in transitional context: Open-ended local architecture in Saudi Arabia. Archnet-IJAR: International Journal of Architectural Research, 2(2), 125–146.

Brislin, R. W. (1970). Back-translation for cross-cultural research. Journal of Cross-Cultural Psychology, 1(3), 185–216.

Brown, T. B., Mann, B., Ryder, N., Subbiah, M., Kaplan, J., Dhariwal, P., ... & Amodei, D. (2020). Language models are few-shot learners. Advances in Neural Information Processing Systems, 33, 1877–1901.

Bureau International des Expositions [BIE]. (2024). Expo 2030 Riyadh registration dossier. Retrieved from https://www.bie-paris.org

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). Sage.

Doanh, D. C. (2023). Generative AI in the manufacturing process: Theoretical considerations. Engineering Management in Production and Services, 15(4), 76–89.

Expo 2030 Riyadh. (2025). Masterplan overview: Nature-led urban design. Retrieved from https://www.expo2030riyadh.sa

FIFA. (2024). 2034 FIFA World Cup Saudi Arabia: Bid evaluation report. Zurich: Fédération Internationale de Football Association.

Ghobakhloo, M., Fathi, M., Iranmanesh, M., Vilkas, M., Grybauskas, A., & Amran, A. (2024). Generative artificial intelligence in manufacturing: Opportunities for actualizing Industry 5.0 sustainability goals. Journal of Manufacturing Technology Management, 35(9), 94–121.

Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., ... & Bengio, Y. (2014). Generative adversarial nets. Advances in Neural Information Processing Systems, 27, 2672–2680.

Heyrani Nobari, A., Rashad, M. F., & Ahmed, F. (2021). ShipHullGAN: A generic parametric modeller for ship hull design using deep convolutional generative model. Computer Methods in Applied Mechanics and Engineering, 411, 116051.

Khan, S., Gunpinar, E., & Sener, B. (2023). CreativeGAN: Editing generative adversarial networks for creative design synthesis. In Proceedings of the Design Society: ICED 2023, pp. 3413–3422.

Li, X., Su, J., Zhang, Z., & Zhao, R. (2021). An AI-based product color design method combining affective computing and generative adversarial networks. In Proceedings of the 2021 International Conference on Computer Information Science and Artificial Intelligence, pp. 156–162.

Liu, X., & Hu, W. (2023). Application of Stable Diffusion in industrial design sketching and rendering. In Proceedings of the International Conference on Human–Computer Interaction (pp. 245–258). Springer.

Naqvi, S. M., He, R., & Kaur, H. (2025). A cross-level perspective on the role of generative AI

in design. In Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems (CHI ’25). ACM. https://doi.org/10.1145/3706598.3713233
Nunnally, J. C. (1978). Psychometric theory (2nd ed.). McGraw-Hill.
Ooi, K. B. (2025). The potential of generative artificial intelligence across disciplines: Perspectives and future directions. Journal of Computer Information Systems, 65(1), 76–107.
Precedence Research. (2024). Generative AI in industrial design market size, share, and trends 2024–2034. Retrieved from https://www.precedenceresearch.com
Roche, M. (2000). Mega-events and modernity: Olympics, expos and the growth of global culture. Routledge.
Rombach, R., Blattmann, A., Lorenz, D., Esser, P., & Ommer, B. (2022). High-resolution image synthesis with latent diffusion models. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 10684–10695).
Rowe, P. G. (2023). Design thinking (3rd ed.). MIT Press.
Sbai, O., Elhoseiny, M., Bordes, A., LeCun, Y., & Couprie, C. (2018). DesIGN: Design inspiration from generative networks. In Proceedings of the European Conference on Computer Vision (ECCV), pp. 37–44.
Saudi Data and Artificial Intelligence Authority [SDAIA]. (2020). National Strategy for Data and AI. Riyadh: SDAIA.
Srinivasan, R., & Uchino, K. (2022). Biases in generative art: A causal look from the lens of art history. In Proceedings of the 2022 ACM Conference on Fairness, Accountability, and Transparency (FAccT ’22), pp. 41–51.
Vision 2030. (2016). Saudi Vision 2030: Strategic objectives and vision realization programs. Retrieved from https://www.vision2030.gov.sa
Wadinambiarachchi, S., Kelly, R. M., Pareek, S., Zhou, Q., & Velloso, E. (2024). The effects of generative AI on design fixation and divergent thinking. In Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems. ACM.
Zhu, Z., Luo, J., Pan, Y., & Cai, P. (2024). AI assistance in enterprise UX design workflows: Enhancing design brief creation for designers. Frontiers in Artificial Intelligence, 7, 1404647. https://doi.org/10.3389/frai.2024.1404647