RESEARCH ARTICLE

COLOR WILEY

The emergence of the environmental color design praxis framework

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Abstract

Over the last four decades, development in the environmental color design field challenged the prevailing designer's attitude towards selecting architectural and urban color palettes. Examining praxiological issues in environmental color design is necessary to reveal influential conditions that can facilitate or obstruct a shift in the design paradigm. This research article presents a qualitative study of environmental color design praxis (ECDP) in urban contexts. The study sought to understand how designers constructed their perspectives on contemporary ECDP, how these perspectives influenced their design approaches and the conditions under which designers can change their attitude and practices in environmental color design. The conceptual model of ECDP emerged from the grounded theory analysis of the interviews with Brisbane designers and the interpretation of relevant texts written by prominent designers and scholars. This article describes the core components of the ECDP model and provides interpretations of how educational, pragmatic and socio-psychological factors influence dynamic changes in ECDP. The underlying research concludes that a holistic understanding of ECDP can inform the advanced and socially responsive environmental color design paradigm; the ECDP model provides a frame of reference for developing color design praxis theory.

KEYWORDS

design collaboration, design praxis, environmental color design, environmental color design praxis, interdisciplinary color knowledge

1 | INTRODUCTION

The scientific field of environmental color design (ECD) has been developed over the last four decades. Lucia R. Ronchi[1] described ECD as an approach to creating environmental color compositions for different contexts. The process considers the harmonious relationship between the color of all visual elements presented in a setting, including architecture, urban forms, natural components, illumination impacts, relevant human activities and color semiotics. According to Galen Minah and Antal Nemcsics,[2] ECD aims the apply color as "a more beautiful, usable, and informative component of the environment that allows theoretical and practical activities".[2(p.637)] Verena M. Schindler[3] expanded the ECD objectives towards contributing to the aesthetics

and sustainability of built environments and the inhabitants' psychological well-being.

Color research involving science and spatial design disciplines fostered knowledge development in the ECD field.[4,5] Other leading scholars and design educators recognized and promoted the value of interdisciplinary color knowledge.[6–8] Specifically, several arguments have been established supporting the role of color psychology in advancing ECD. For instance, Frank H. Mahnke[9] stated that scientifically informed ECD could lessen the negative impacts of visual overstimulation and disorder in contemporary built environments. Gerhard Meerwein and his co-authors[10] suggested that awareness of the psychological and physiological responses to color may guide a more socially responsive color design and increase user satisfaction with the visual quality of urban places. To contribute to the "well-being and comfort"[3(P9)] of city dwellers, designers should also bring the users' perceptual experiences of color to the focus of ECD.

However, practitioners have been challenged to understand how interdisciplinary color knowledge can be integrated into design practice. Numerous authors discussed designers attitude towards interdisciplinary color knowledge over decades.[11–13] Jeanne Kopacz,[13] for example, argued that many architects intuitively used knowledge about human responses to color, and only a few adopted an informed approach to ECD considering its multiple impacts in contemporary urban settings. Tom Porter and Byron Mikellides[12] criticized such designers' dispositions and claimed that concern for human-environment relations rather than reliance on designers' intuition should guide the selection of architectural color palettes.

Apart from designer disposition, some studies revealed the lack of explicit methodology as a constraint to applying interdisciplinary color knowledge in design practice.[7,14,15] Yet, the praxiological issues in contemporary ECD have not been thoroughly investigated. Questions remained open about how designers generate their knowledge, perspectives and experiences in ECD and what conditions influence changes in their approaches to ECD.

This research article explores ECD through the conceptual lens of design praxis, investigating the dynamic relationships between the perceptual, professional and socio-psychological factors relevant to environmental color design praxis (ECDP). Three main assumptions gave impetus to the present inquiry,

- Examining various designers' experiences in ECDP could reveal critical variations in their perspectives and strategic approaches to environmental color design, which would signify a theoretical contribution to this knowledge field.

- Understanding the issues designers associate with ECDP could clarify the essential conditions necessary to transform an intuitive approach to environmental color design into a more scientifically informed, environmentally and socially responsible one.

- Holistic interpretation of ECDP can foster further theoretical and methodological accounts for designers, educators, and researchers in the field, and facilitate positive changes in the ECDP.

This article presents the conceptual model of ECDP developed using constructivist grounded theory[16] and hermeneutic phenomenology.[17] The article begins with an overview of the relevant theoretical assumptions framing a notion of design praxis (Section 2). It then outlines the research methodology (Section 3) and describes the emerged conceptual ECDP model (Section 4.1). The article further provides insight into specific educational, pragmatic and socio-psychological factors that can influence positive changes in ECDP (Sections 4.2. and 4.3). The following discussion contextualizes the findings within the relevant research domains and suggests the future theoretical and methodological implication of the ECDP framework (Session 5).

2 | A FRAMEWORK OF DESIGN PRAXIS

The term 'design praxis' has been used by designers regarding design practice. However, the notion of ECDP has not been clearly described nor fully understood by design practitioners.

Philosophically, praxis applied theoretical knowledge to practice.[18] The contemporary theory of praxis has been rooted in both Plato's theory of creative action and the legacy of Aristotle. Plato defined praxis as a patterned activity informed by a moral position and respect for other people.[18] For Aristotle,[19] praxis has been principally concerned with human well-being and pragmatic reasoning of action and its consequences. Overall, praxis included "deliberative, responsible, human-moral action", which involves "the process of wise judgement".[20(p56)]

The works of Paulo Freire,[21] Hans-Georg Gadamer,[17] Richard J. Bernstein[22] and Shirley Grundy[23] conceptualized the fundamental properties of praxis. Freire[21] defined praxis as an informed action guided by theoretical thoughts and influenced by historical and cultural contexts. Bernstein[22] emphasized a reflective nature of praxis that implied the cyclical relationship between action, reflection and theory building. For Grundy, praxis enabled people "to engage with the situation as committed thinkers and actors".[23(p64)] Gadamer

FIGURE 1 Interrelated concepts (Knowledge, ethical commitments, reflections, and actions) of the conceptual framework of design praxis (Prop., Propositions). Diagram adapted from McLellan, G.[25(p28)]
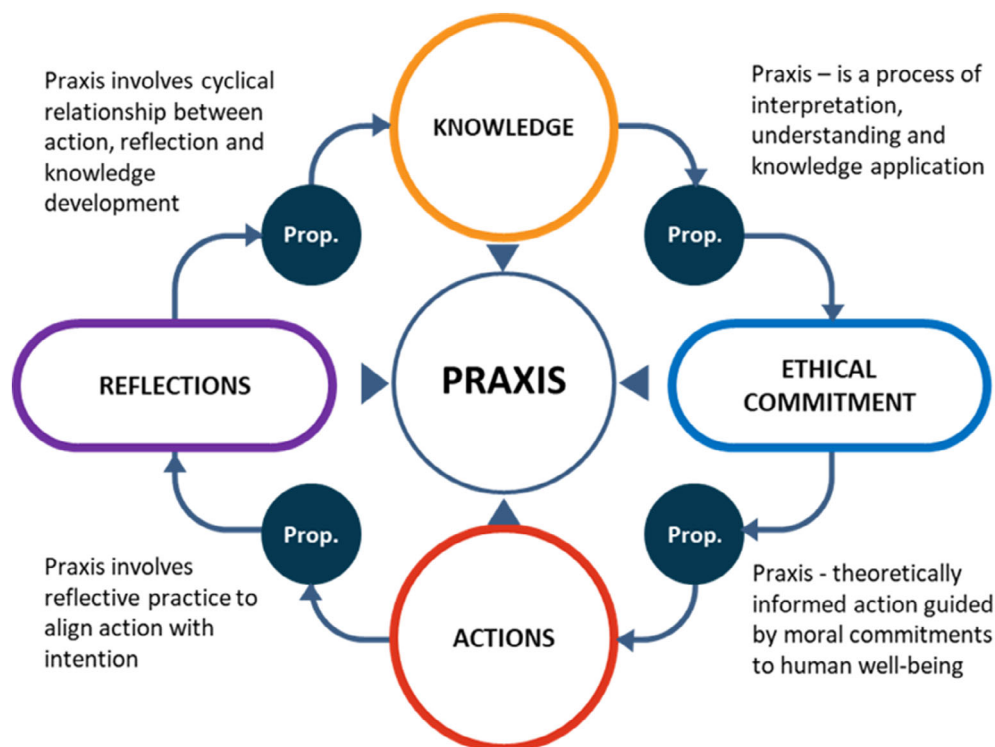
described praxis as "interpretation, understanding and application in one process".[17(p275)]

In contexts of professional activities, Christina Preston and John Cuthell described praxis as "a high-level mode of professional operation" characterized by self and theory-awareness.[24(p51)] The authors argued that praxis should engage professionals in critical reflection on practice, ensuring the approach is grounded in theory and acknowledging different knowledge types.

Based on the synthesis of theoretical propositions,[21–24] it is reasonable to assume that abstract categories such as knowledge, ethical commitment, action/interaction, and reflective practice shape the conceptual framework of praxis. Figure 1 shows four interrelated concepts and propositions of praxis theory.

The reviewed literature revealed a gap in the explicit definitions of design praxis due to various underlying perspectives of designers and scholars. Nevertheless, the framework of design praxis remained coherent with the notion of interrelation between professional actions, reflective practice, ethical commitment, and knowledge development.[19,24] The transformative nature of design praxis can initiate the revision of existing design methodologies and change attitudes towards interdisciplinary knowledge in design. Praxis engages designers in systematic reflection on the consequences of actions and interactions. Hence, designers can advance their practice through continuous knowledge development and insightful analysis of their professional experiences.

3 | RESEARCH METHODOLOGY

3.1 | Theoretical perspectives

The research methodology integrated Constructivist grounded theory (GT)[16] and hermeneutic phenomenology.[17] These approaches have been congruent with constructivist ontology and interpretative epistemology. Methodological triangulation aimed to construct a conceptual framework of ECDP and provide interpretations of various designers' perspectives and experiences in ECDP.

Constructivist GT and hermeneutic phenomenology overlap with symbolic interactionism theory.[26] According to Herbert Blumer,[26] symbolic interactionism assumes that society, reality and self are constructed through interaction and depend on language and communication. Interaction is dynamic and interpretative and explains how people create, enact and change understanding and action.[26] Symbolic interactionism stresses the role of contextual conditions in transforming the knowledge and behavior patterns of an individual or a societal group.

Integrated premises of praxis and symbolic interactionism provided sensitizing concepts[16] for inquiry into the ECDP phenomenon, including,

- Causal conditions that influence the construction of perspectives
- Understanding/perspectives/paradigms

FIGURE 2 Research questions and their correlation to the interrelated theoretical concepts of understanding/perspectives, conditions, design strategies and actions, consequences, reflections and changing conditions. RQ, research question; SubQ, sub question. Diagram adapted from McLellan, G.[25(p47)]
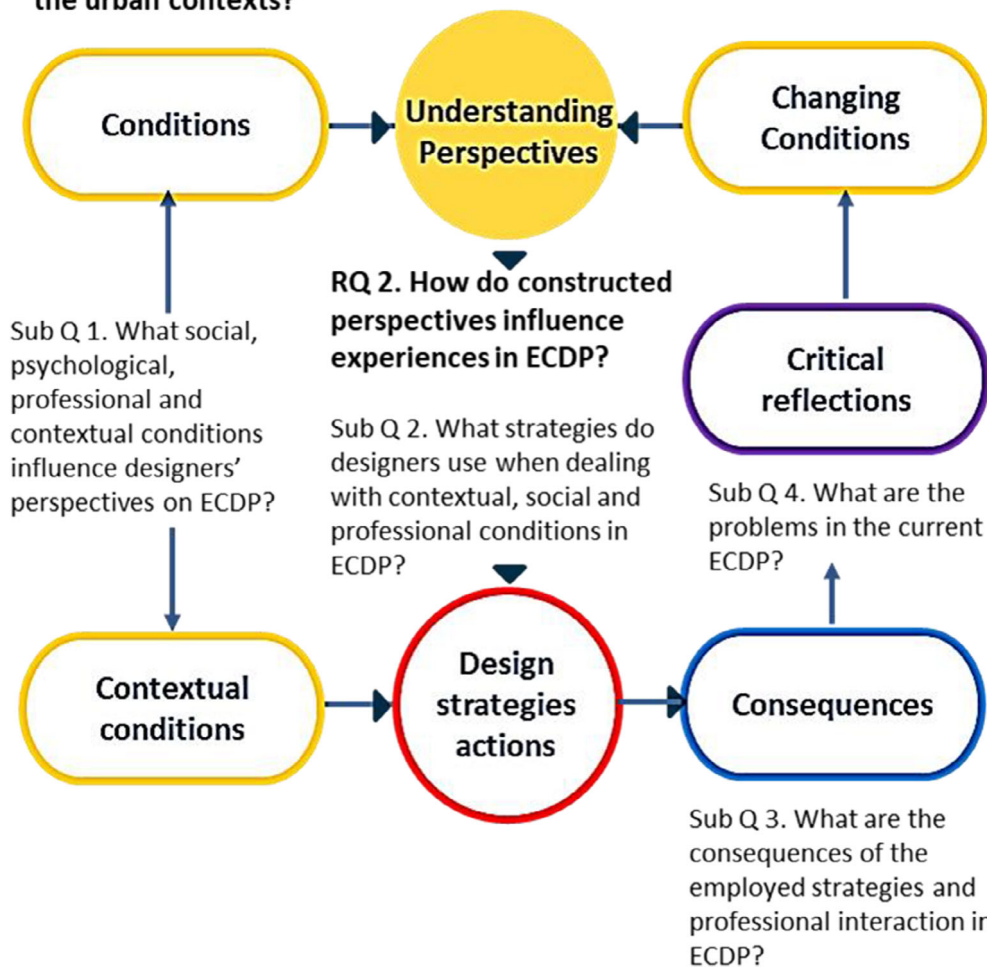
- Actions/interactions
- Consequences of actions
- Critical reflection
- Changing Conditions.

Consistent with the underpinning theoretical assumptions, the study sought to answer the questions (RQ1) how designers construct their perspectives on contemporary ECDP; (RQ 2) how the constructed perspectives influence experiences in ECDP; and (RQ3) what conditions can change designers' perspectives and approach to ECDP. For this study, the term 'designers' referred to practising architects and urban designers.

Figure 2 illustrates the correlation of the research questions to the sensitizing theoretical concepts (Understanding/Perspectives, Conditions, Design Strategies and Actions, Consequences, Critical reflection, and Changing Conditions).

3.2 | Data collection

The conceptual model of ECDP emerged from the rigorous analysis and comparison of designers' perspectives and experiences in the color design presented in primary and secondary data. The transcripts of in-depth interviews with fourteen Brisbane (Australia) designers provided the primary data.[25] Nine participants specialized in architecture, three in urban design and two in urban art. Nine participants were solo practitioners, while five worked in large collaborative offices. Ten designers received professional education in Australian universities, and four graduated from overseas design schools. All participants were practising in Australia, and five had international design experience.

Each face-to-face interview lasted 45 min and was semi-structured. The interviews were conducted in the participants' offices or other agreed locations. The

interview questions explored participant perspectives, experiences and evaluations relevant to environmental color design. Participants were asked, before the interviews, to choose two or three of their projects (architecture, urban design, individual or collaborative) that demonstrated elements of color design. The initial open-end questions asked participants to describe the design process and reasoning for color/material selection. The intermediate questions aimed to understand how designers learnt about color design and how they define the relevance of interdisciplinary color knowledge to architecture/urban design. Finally, the participants were asked to reflect on the current situation in ECDP and identify issues and opportunities for improvement. The interviews were audio-recorded and transcribed by a researcher. Each transcript was labeled: I – interview transcript; P – participant; Number – the interviews' order from 1 to 14. Note: This article used similar labels for quote identification. For example, IP2 refers to a quote from the transcript of an interview with participant number 2.

The recruitment, number and geographic location of the research participants defined the limitation of the primary data collection. The participants were randomly selected and recruited in Brisbane, Australia. While some participants had local and overseas design experience, they all emphasized the impact of the specific subtropical context on ECDP, contesting the validity claims. Using extant texts as secondary data sources enabled the analysis of a broad spectrum of color design experiences within Australia and internationally. Three texts were selected based on the criteria: (1) architectural scholars reported interviews with prominent designers or analyzed approaches to color design, and (2) practising designers reflected, in writing, on their perspectives on color design. The texts included,

1. McLachlan, F. *Architectural Color in the Professional Palette*. London: Routledge, 2012.[27] The volume provided rich data, including the author's reflective account of her experience in color design and insightful analysis of eight architectural practices chosen for their distinctive use of color in architecture. In contrast, the selection of interviewees was not influenced by the preliminary assessment of their projects. Comparison of unique and conventional approaches contributed to the breadth and depth of understanding of the ECDP phenomenon.
2. Koolhaas R, Foster N, Mendini A, eds. *Colors*. Basel: Birkhäuser, 2001.[28] The text included Rem Koolhaas's[29] professional reflection on using color in contemporary architecture. Paul Overy[30(pp122–133)] provided a thorough account of the societal,

psychological and aesthetic values underpinning Norman Foster's perception of color in architecture. The interview with Alessandro Mendini by Stefano Casciani[31(pp238–245)] focused on the role of color across design disciplines and the inheritance of artistic traditions in color design. Largely, these texts offered insight into specific aspects of color design communicated by renowned designers.

3. Linz B. *Color = Farbe = Couleur*. Königswinter, Germany: h.f.ullmann, 2009.[32] This text described contextual and social conditions that influenced the design and appreciation of 40 architectural color schemes in diverse contexts. The author selected examples based on the expressed public recognition and professional feedback. Analysis and interpretation of this text explained some similarities and differences between public and design professionals' appraisals of architectural color palettes.

The use of primary and secondary data allowed for examining and comparing the research participants' and the non-participants' perceptions and reflections on environmental color design. The transcripts of interviews represented the meanings expressed by designers in their own words. The extant texts provided descriptions and analyses written by designers. Hermeneutic phenomenology offered a lens for interpreting different meanings captured in written words.[17] Kathy Charmaz[16] has acknowledged the validity of extant data in generating a grounded theory.

3.3 | Data analysis

According to the grounded theory protocol, primary and secondary data were scrutinized through three consecutive stages of coding and constant comparative analysis.[16] Constructivist grounded theory methodology required initial, focused and theoretical coding. As an analytical technique, coding sought to identify initial concepts, comparisons and theoretical reoccurrence in data. Where initial coding fractured the textual data, the focused coding aimed to compare and connect codes into more abstract categories representative of the emerging theory. The focused coding involved intensive diagramming that enhanced analysis. For example, Figure 3 shows how the abstracted categories themed with relevance to underpinned theoretical concepts of the ECDP framework, including Core Design Paradigm (Understanding/Perspectives); Causal Conditions and Intervening Conditions (Conditions), Strategies and Actions, Consequences of Actions/Interaction, Critical Reflections and Changing Conditions.

The subsequent theoretical sampling and comparative analysis further developed the theoretically relevant
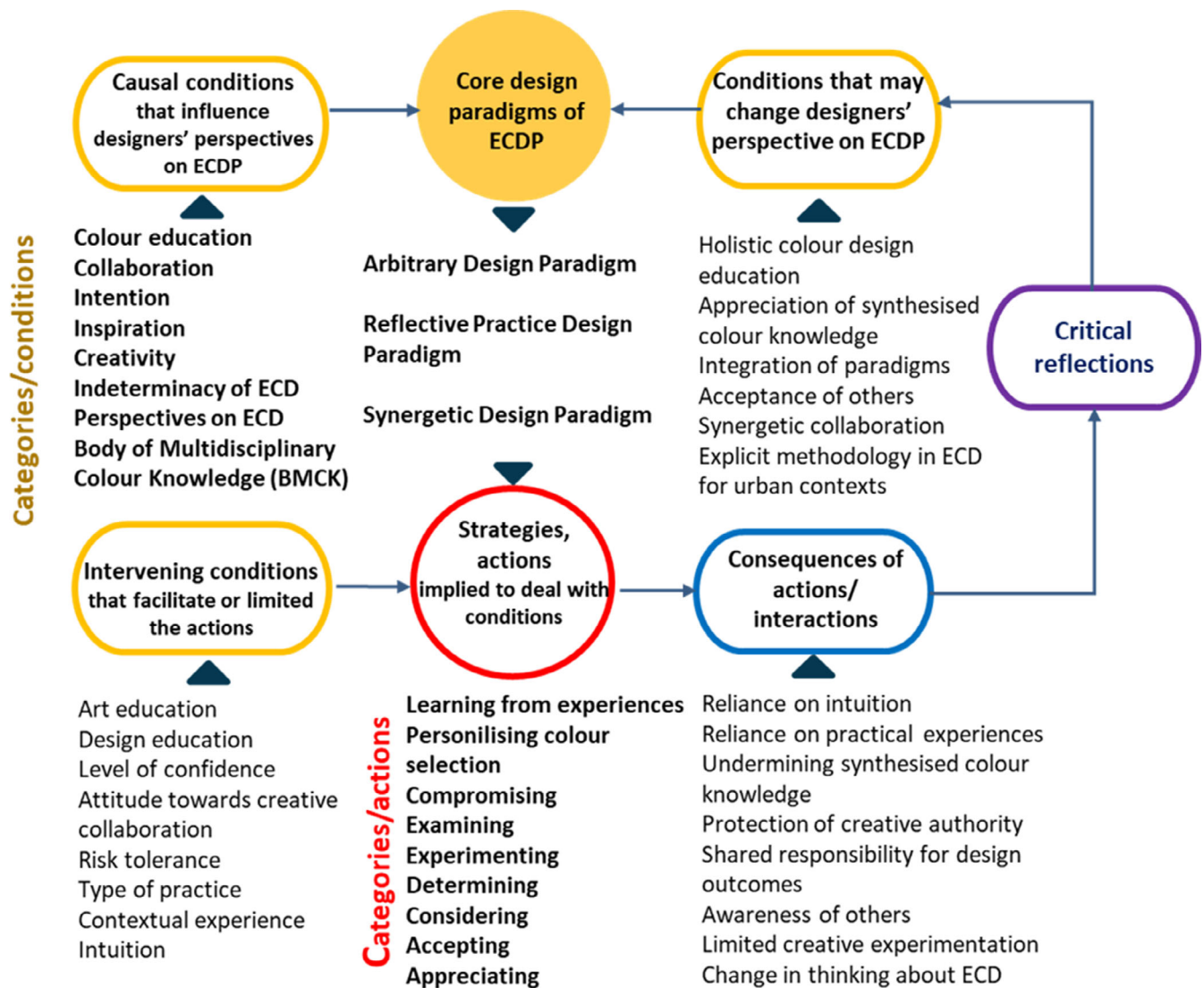
FIGURE 3 Summary of categories and concepts emerged from the grounded theory analysis and themed according to the conceptual framework. The themes include core design paradigms, causal conditions, intervening conditions, actions, consequences of actions, reflections and changing conditions. Diagram adapted from McLellan, G.[25(p72)]

categories and their dimensions. Theoretical sampling sought to saturate the categories under development.[16] Additionally, the produced theoretical narratives identified and explained relationships between the categories and concepts of ECDP. The storyline technique was used to integrate the produced theoretical propositions and explain the conceptual framework of ECDP.

4 | FINDINGS

The key research findings of the study are presented as a conceptual model of ECDP (4.1) and the interpretations of the role of color design education, the body of knowledge in environmental color, collaboration and indeterminacy of environmental color in ECDP enriched

with references to primary and secondary data (Sections 4.2 and 4.3).

4.1 | Description of the ECDP model

Application of the conceptual framework guided conceptualisation of the significant ECDP components, including three core paradigms of thinking about ECDP (Figure 4); a system of conditions that influence designers' approaches in ECDP (Figure 5); programs of actions guided by three design paradigms (Figure 6A); and changes in a designer's attitude and professional disposition in ECDP resulted from a paradigm shift (Figure 6B). Figure 7 shows the assembled ECDP model.
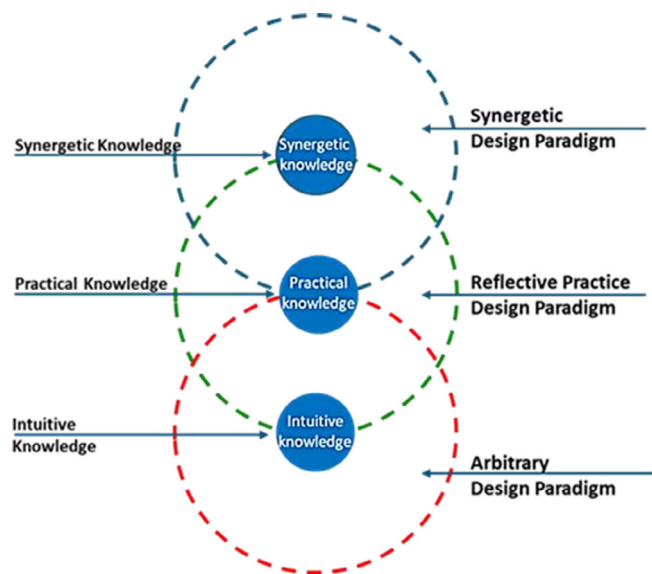
FIGURE 4 Development of the conceptual ECDP model. This first element of the ECDP model is integrated design paradigms: Arbitrary design paradigm (ADP), reflective practice design paradigm (RPDP) and synergetic design paradigm (SDP). Diagram adapted from McLellan, G.[25(p81)]
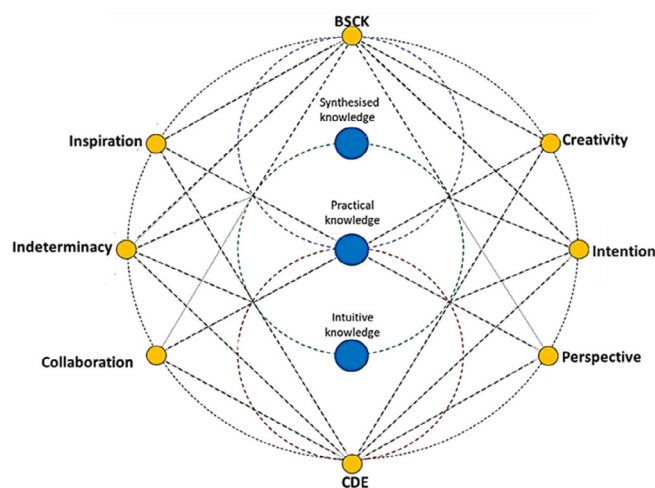
FIGURE 5 Development of the ECDP model. This second element of the ECDP model is the system of conditions that influence designers' actions relevant to ECDP. BSDK, body of synthesized color knowledge; CDE, color design education. Diagram adapted from McLellan.[25(p82)]

The conceptual ECDP model has been initially visualized in a spherical three-dimensional form encapsulating all interrelated components. But this article represents it in two-dimensional sections. The composition of the model was inspired by the contemplation of diverse theoretical prototypes. Figures 4, 5 and 6 demonstrate the stages of the model development.

The data analysis indicates three interrelated paradigms epistemologically frame ECDP. Three "ways of knowing" underlie different values and design approaches pertaining to each paradigm and ECDP. Figure 4 shows that intuitive knowledge informs the Arbitrary Design Paradigm (ADP), practical knowledge is central to the Reflective Practice Design Paradigm (RPDP), and the Synergetic Design Paradigm (SDP) drives upon synthesized knowledge.

Figure 5 shows a section of the abstract sphere that envelops the defined paradigms and links categories representative of the conditions that influence designers' actions associated with ECDP. The conditions include Color Design Education (CDE), Collaboration, Indeterminacy, Inspiration, Creativity, Intention, and a Body of Synthesized Color Knowledge (BSDK).

The variable patterns of the external conditions and the design paradigms inevitably impact designers' strategies and actions. In the ECDP model, the abstracted strategies are Personalizing, Compromising, Experimenting, Examining, Determining, Considering, Integrating and Appreciating. Each strategy coordinates a set of actions. Figure 6A shows that some strategies relate to a particular paradigm, but others can be executed from different knowledge bases. For instance, Compromising and Personalizing are intrinsic to the ADP. However, Examining or Experimenting can be performed from arbitrary and reflective practice perspectives. In the model, cross-paradigm alignments of strategies and actions are depicted by two synchronized, zigzagged lines. While the red line links strategies predominantly related to pragmatic design aspects, the solidblue line shows a continuum of social actions.

Figure 6B shows the consequences of actions in ECDP that can occur in personal, professional and social contexts. These consequences categories are allocated along the vertical axis of the model and reveal the transformation of self-awareness into awareness of others due to a shift in professional confidence in color design.

Figure 7 presents the assembled ECDP model. The notion of the model allows for tracing the potential condition-action-consequence relationships through the core paradigms. Examinations of these relationships reveal variables of designers' motivations, ways of thinking and dealing with the conditions upon one of the ECDP paradigms. Interpretations of the relationships generate eight explanatory statements and theoretical propositions integrated into the storyline.[25] This article presents only examples of statements and propositions centred on the role of color design education, the body of knowledge in environmental color, collaboration and indeterminacy of environmental color in ECDP.
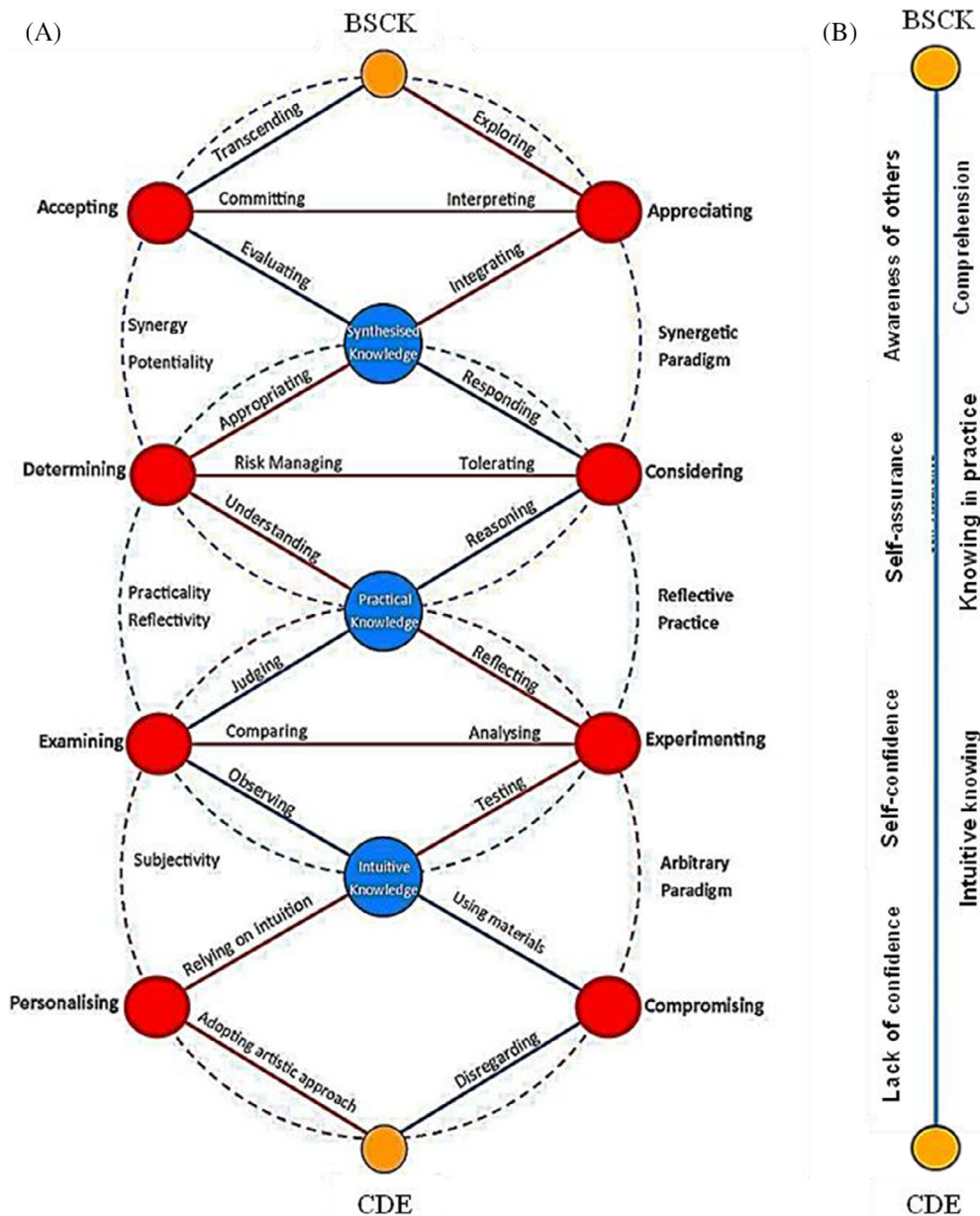
FIGURE 6 Development of the ECDP model. The third and fourth elements of the ECDP model. BSCK, body of synthesized color knowledge; CDE, color design education. (A) The third element is a system of strategic actions employed by designers. Diagram adapted from McLellan.[25](p84) (B) The fourth element demonstrates changes in a designer's attitude and professional confidence through paradigm shifts. Diagram adapted from McLellan.[25](p84)

## 4.2 | Color design education and body of knowledge in environmental color

The study of ECDP revealed that color design education was the critical condition that influenced designers' understanding of environmental color design. While research participants gained professional qualifications in different design schools, they agreed on the inadequate representation of color knowledge in architectural training. For instance, one research participant argued, "there is virtually no formal training in color for architects".[IP2] Another recalled, "when we talk about color, it was through drawing and painting, not through materials".[IP7] Most participants agreed that the content of color studies and delivery methods were not convincing, and learning did not occur.

The educational issues caused the disregard of theoretical color knowledge in design consideration. Consequently, some designers admitted to arbitrary rather than knowledge-informed judgments in selecting architectural and urban colors. As Fiona McLachlan suggested:

> Color theory is taught in a few schools, yet many architects will admit a lack of confidence in color, or at least a sense of arbitrariness in choice and application. Many practitioners feel ill-equipped to explore the potential of simple pigments to alter, tune or define the character of a space or surface.[27](p2)

FIGURE 7 The Assembled ECDP model. The Assembled ECDP model incorporates the following element: (1) three core paradigms of thinking about ECDP (see Figure 4); (2) a system of conditions that influence designers' approaches in ECDP (see Figure 5); (3) programs of actions guided by three design paradigms (see Figure 6A); and (4) changes in a designer's attitude and professional disposition in ECDP resulted from a paradigm shift (see Figure 6B). Diagrams adapted from McLellan.[25(p80)]
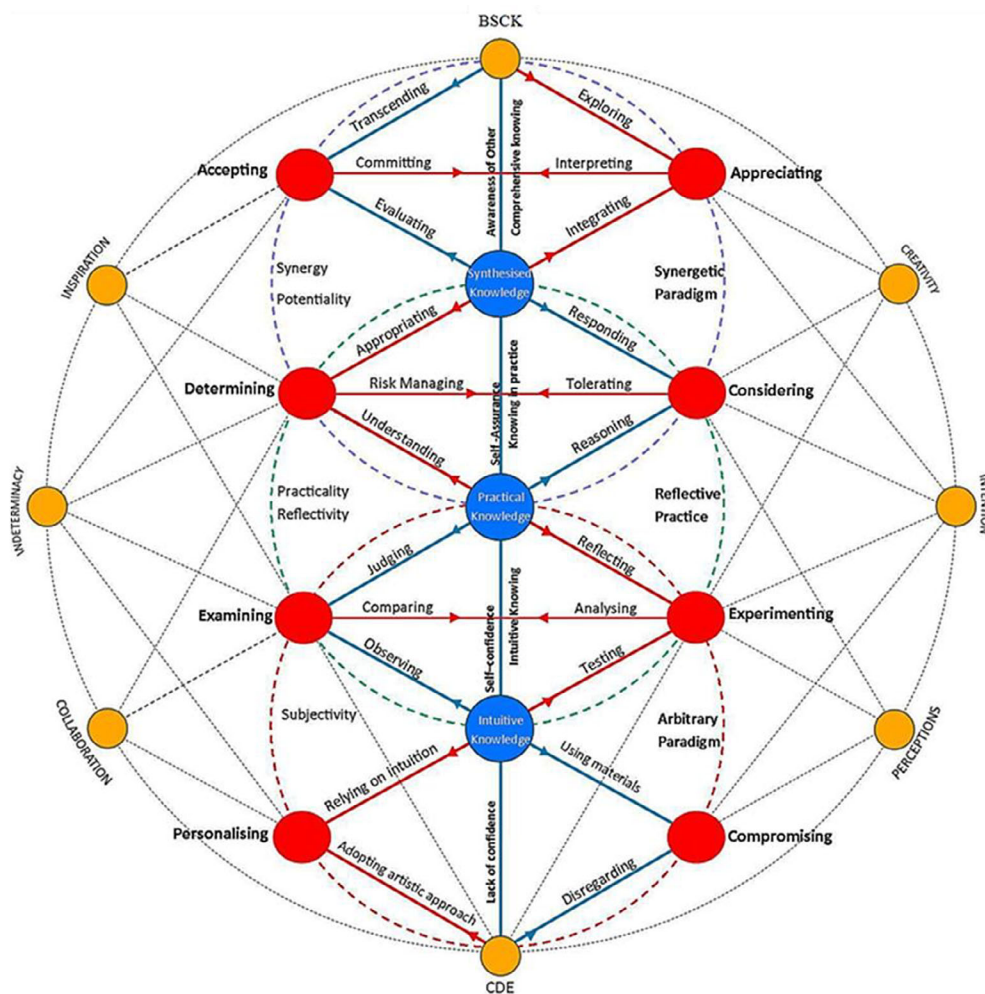
Analysis of primary data revealed that the design approaches guided by the Arbitrary Design Paradigm (ADP) showed two tendencies. Designers in the sample who had a formal art education before attending architectural school adopted an artistic approach relying on intuition or a personal feeling for color. In contrast, the participants with primarily architectural education adopted a more conscious and pragmatic approach. They were less confident in the selection of architectural colors and preferred self-colored materials and monochromatic palettes. Some interviewees claimed that neutral color palettes are universally appropriate and most appreciated. However, others testified about public dissatisfaction with colorless architecture in the executed project. Yet, general satisfaction with architectural color palettes was not considered a validation criterion. Analysis of the extant texts also confirmed the inheritance of artistic traditions in color design.[27,31]

To overcome the limitation of formal color training, designers learned from experiences. The practical knowledge was built on observing and scrutinizing the color palettes in urban settings. One participant said, "I learnt through observing and experimenting with colors. There were many trials and errors, but with time I developed a feeling for what works and what doesn't".[IP4] Thus, some designers developed strong preferences for particular hues, saturation and combinations of colors. An inclination towards developing a signature color palette was highlighted in the secondary data.[27,28,32]

Critical reflections on the contextual use of environmental colors could lead to comprehension of the pragmatic, aesthetic and social aspects of ECDP. Designers could, therefore, shift their approach from arbitrary and intuitive to more rigorous and logical. While acting upon the RPDP perspective, designers expressed preferences for the functional application of color articulating the architectural element, enhancing the building tectonic or creating diversity through coloring similar facades. They also considered clients' color preferences and environmental colors' indeterminacy and provided a well-developed rationale supporting the proposed color-material palettes. The RPDP approach to environmental color design focused on aesthetics, appropriateness, risk management and rigorous reasoning.

Designers became aware of the psychological impact of color through their professional development. Most participants acknowledged the importance of multidisciplinary color knowledge but denied its practical applicability in design. One participant stated, "I am not consciously considering the psychological impacts of colors. But I know they exist."[IP11]. Other participants also demonstrated a tendency to determine boundaries of relevant knowledge that resulted in fixed perspectives on the ECD.

However, the secondary data provided examples of how renowned architects embraced interdisciplinary color knowledge in design. For instance, McLachlan used the works of Steven Holl to illustrate the creation of highly experiential spaces and "subtle color palettes".[27(p85)]

Overy[30] offered a thorough account of Norman Foster's open-minded and creative exploration of environmental color beyond the conventional knowledge contextualized within architectural design. Some of Foster's projects celebrate the experiential aspects of ECD underpinned by an understanding of interrelated societal, psychological and aesthetic values.

Synthesis of theoretical, professional and interdisciplinary color knowledge unlocked a more holistic approach defined as the SDP. The SDP stimulated the appreciation of users' perceptual experiences of environmental color and altered intention and commitment to ECDP. Acceptance rather than disregarding different viewpoints and values involves conscious consideration of the ethical responsibility for multiple impacts of ECDP outcomes. When acting from the SDP perspective, designers transcended design objectives beyond aesthetics and practicalities towards contributing to users' experiences.

4.3 | Collaboration and indeterminacy of environmental color

The data analysis suggested that awareness of the indeterminate appearance of color in urban environments and creative collaboration were the most evident conditions in ECDP.

The study revealed that professional knowledge was a critical determinant of designers' actions in ECDP. Through practical experience, designers became aware of the environmental impacts that could alter the appearance of the intended architectural colors in urban settings. This realization added the dimensions of indeterminacy to ECDP. The data revealed that a lack of accuracy in predicting color performance influenced designers' perspectives. One interviewee stated, "In Queensland, we have always been scared to use bold, expressive colors on facades because of the intensity of the sun".[IP3] Another said, "I had too many clients who

run away from color in architecture because of the risk involved".[IP12] Several designers exaggerated issues in applying color in architecture. McLachlan confirmed that often "color was thought to be dangerous, risky, and unreliable".[27(p69)] Still, some prominent architects evidentially "welcome unpredictable admixtures in a setting which cannot be precisely regulated"[27(p127)]

To reduce undesirable color changes caused by environmental impact, designers applied diverse risk management strategies classified as proactive, reactive and constructive. The proactive strategy involved accepting the inevitable alteration of the initial color palette due to the environmental impacts. In the high-risk context, defined by intense sun, high humidity, rapidly fluctuating temperature or a high pollution level, designers used previously tested hues or applied color sparingly on small surfaces. One participant described the approach to color selection for the large commercial building

> We treated a building as beige but highlighted the sun fins that protrude with colors. We applied green, grey, and purple with the philosophy that if they faded, they would not be so offensive, but you can do something about it because the paint was applied in layers.[IP3]

Reactive strategies aimed to recognize unacceptable changes in the color palette and take corrective actions. These reactive strategies included monitoring and reconsidering the initial colors if they did not deliver the expected aesthetic outcomes. Radical risk management was associated with using materials that produced more controllable results. Preferences for the risk management strategies reflected designers' tolerance for the indeterminacy of environmental colors. One participant argued that "architects need to know their limits, their color tolerance. I was trained to use monochromic colors and carried it out through the design process. Though, if other designers acquired more knowledge in color, they should use it"[IP9]

The concept of collaboration had the most robust presence in the interviews with Brisbane designers. However, primary and secondary data revealed a polarity in attitude towards creative collaboration in color design. While some designers endorsed collaboration with peers, artists and color consultants, others avoided it.

In a multidisciplinary office, the positive aspects of peer collaboration were attributed to the combined expertise and shared knowledge. Designers from such offices denied personal color preferences and emphasized the collaborative selection of color-material palettes. One participant stated, "I came from the practice where we are highly collaborative and don't have big egos.

Consequently, we are willing to work in a group".[IP3] Plausibly, if team members willingly share the creative authority over the invented color palette, they should also share accountability for the design outcomes. Instead, two designers in the same project reported different personal satisfaction with the final palette. One of the involved architects emphasized, "I have to say that the color of this building resulted from the collaboration between several people. So, I am taking no credit for this color scheme".[IP1] This statement indicated an alarming ethical issue regarding the personal accountability for architectural color as a less essential design element.

The collaborative design could challenge a designer's color tolerance. If designers who love color complied with a conservative team's palette, they felt they did not execute their creative potential.[IP3;IP5;IP12] The designers with a lower color tolerance also experienced dissatisfaction with a high-risk team's attitude.[IP1;IP9] Remarkably, only two participants recognized opportunities for learning about color from peers.

Architects from the large offices were highly skeptical about the involvement of color consultants in the design process. The smaller offices and solo practitioners were more lenient. Nevertheless, these architects reserved the right to adapt or disregard recommendations by a color consultant. While taking full accountability for the design outcomes, they also protect their creative authority.

Diversity of color preferences and conflicting views on the appropriateness of color palettes could cause tension between designers and stakeholders. Some designers positioned themselves as color experts when dealing with clients and stakeholders. The status of the expert allowed them to defend the proposed solutions if they did not match the client's expectations. For example, one participant stated, "We try not to let the client to rule. We say we are experts".[IP3] Another architect expressed a more liberal position saying, "We never felt that we should dictate to the clients. I have to say, we led through collaboration, but stakeholders are involved and heard".[IP1] A few accounts reported the extreme manifestation of the architect's authority. For example

> I once had experience designing a childcare centre where we looked at the kitchen colors, and places kids would play. There were committee meetings. So, they decided that the color combination would be beige and lemon. We just completely ignored them because it would be a disaster to have lemon and beige in a palette.[IP9]

Arguably, designers could claim their expertise in color during the design process, but the most valuable feedback would come from the users of the environments. A color palette could be rational or stylish but not necessarily aesthetically appealing to the public eye. In opposition to the authoritative approach, some designers expressed interest in a participatory color design. This position led to synergetic relationships between designers, stakeholders and prospective users. The secondary data confirmed that appreciation of cultural values and community expectations in color design enhanced appraisals of color palettes.[27,28,31]

Overall, a negative attitude to color design collaboration resulted from a subconscious desire to protect the designer's creative authority and professional status. The discrepancy between individual and team perspectives on environmental color influenced the effectiveness of creative collaboration. In contrast, sharing inspiration and aesthetic values rather than creative authority engendered a more satisfying collaborative design process.

Concluding, the evolving relationships between the ECDP model components can facilitate different scenarios in ECDP. The conventional approach integrates the values of the ADP and the RPDP. This approach's main attributes prioritize practical knowledge, intuitive design experimentation without the clarity of expectation, arbitrary judgment, artistic or pragmatic approaches to selecting color palettes, rigorous reasoning, and management of the indeterminacy of the environmental colors in urban contexts.

The more holistic scenario integrates the ADP, RPDP and SDP paradigms. This approach springs from an appreciation of the multidisciplinary color knowledge, effective collaboration and ethical responsibility for the consequences of ECDP for individuals, communities and urban environments. From unbiased perspectives, interdisciplinary expertise in color enables designers to enhance and adequately assess design values. Design value is an attribute central to ethics and moral conduct in ECDP. Universally, design ethics require contextual consideration and understanding of the prospective users' needs, desires and experiences. Therefore, the advanced scenario in ECDP promotes a transition from creating color palettes to designing contextual color experiences while focusing on commitment to well-being.

5 | DISCUSSION AND CONCLUSION

The main theoretical contribution of the study was the conceptualisation of the ECDP framework. The framework signified the multidimensional notion of ECDP phenomena incorporating cognitive, perceptual and socio-psychological attributes. The interpretations of relationships between core theoretical categories clarified

professional, social and contextual conditions that influenced different tendencies and caused praxiological problems in ECDP.

For instance, data analysis emphasized the role of synthesized color knowledge in the conventional and holistic scenarios in ECDP. The emerged propositions suggested that synthesized color knowledge could positively change environmental color design intentions, leading to socially and personally satisfying design outcomes. This knowledge can contribute to a scientific understanding of how environmental color palettes affect the well-being of urban environment occupants. However, data analysis revealed that designers would not appreciate synthesized color knowledge until it is structured according to design epistemology.

The study suggested that interdisciplinary color knowledge could be taught in two ways: through formal design education and a continuous professional development system. Regarding color design education, most research participants stated that color design training was not thoroughly integrated with the architectural curriculum, resulting in an arbitrary rather than knowledge-informed use of color in the design. In line with this finding, design educators and scholars have continuously discussed the effectiveness of color design education, specifically in architecture and urban design. Several authors addressed the problems and opportunities for improving color design education for design students.[33-35] Earlier, Nancy Kwallek and Luanne Stovan[36] proposed a framework for introducing interdisciplinary color knowledge to first-year architectural students. Lately, João Carlos de Oliveira Cesar[37] has discussed opportunities for systematic infiltration of color exercises in the architectural design curriculum. However, a question remained about how color design education can present interdisciplinary color knowledge meaningfully, ensuring that this knowledge can be embedded in design praxis.

In contrast to formal education, the recommendations for continuous development in color design expertise remain overlooked in color education research. While all research participants had extensive design experience, they admitted that reliance on practical knowledge and intuition could cause errors in selecting architectural and environmental colors. They expressed interest in learning about ECDP but specified a need for coherent information rather than design guideline.

To sum, this discussion illuminated a need for further inquiries into ECDP to clarify: (1) the structure and scope of the relevant color design knowledge; (2) methods of knowledge representation; and (3) principles of knowledge synthesis and validation considering the multiple impacts of environmental color design and contribution to people well-being. It is reasonable to assume that authentic and valuable environmental color design training for design students and practitioners should involve innovative teaching and learning strategies.

The creative collaboration in ECDP was another condition signified by data analysis. The findings showed that designers demonstrated two distinctive attitudes towards collaboration: egocentric and constructive. The egocentric position was associated with a desire to protect the designer's creative authority and professional status. The constructive collaboration executed all team members' experience, knowledge and creativity, proving rather than exposing the team's expertise.

The literature provided numerous studies on collaboration in a broader context of design environments. For instance, Petra Badke-Schaub and her co-authors analyzed attributes of creative collaboration defining three significant factors that influence "the effectiveness of team performance: sharedness, accuracy, and importance."[38(p9)] Specifically, sharedness was discussed in knowledge, values, and responsibility contexts. The authors[38] claimed that sharing values and responsibilities significantly influenced individual designers' satisfaction with the collaborative selection of color. However, the findings of the ECDP study presented in this article contradict this claim. Several research participants linked the collective choice of color palettes to social and ethical problems in ECDP. In some incidents, accepting the team's decision and sharing responsibility for the color design outcomes could cause negative design experiences. The balance between sharing and maintaining autonomy in the creative team is essential.[38] Is it achievable? Further research is needed to answer this question.

In conclusion, this article argues that understanding the interrelated cognitive, social, and professional aspects of ECDP can advance environmental color design as a social process. The advanced paradigm in ECDP can be facilitated by the synthesis of color knowledge, constructive collaboration, and ethical responsibility for the consequences of environmental color design for individuals, communities, and urban environments.

The ECDP framework suggests several steps towards enhancing creative collaboration in color design. First, the framework extends the ethical dimensions of ECDP beyond the design team collaboration, promoting designers' responsibility not only for aesthetics and visual appropriateness of environmental color palettes but also for social and environmental action in color in ECDP. Secondly, such attributes of ECDP as acceptance and appreciation involve considering users' aesthetic expectations, preferences, and socio-cultural color associations. Both steps require a scientific understanding of the multiple impacts of environmental color in urban contexts. A holistic understanding of the interrelated creative,

professional, and social processes involved in ECDP can help designers clarify the goal and objectives of environmental color design committed to urban well-being.

While the ECDP model explicates relationships and dimensions specific to architecture and urban design, it provides a frame of reference for further developing color design praxis theory. The model is not hierarchical or linear, allowing the generation of systematic and more specific applications. Hypothetically, it can foster further theoretical and methodological accounts for designers, educators and researchers in the ECD field. Moreover, the ECDP framework offers an academic platform for debates in the environmental color design praxis field and advocates for informed changes in the environmental color design process.

AUTHOR CONTRIBUTIONS

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DATA AVAILABILITY STATEMENT

Data available on request from the authors. The data that support the findings of this study are available from the corresponding author upon reasonable request.

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