

Integrating Electronic Waste Recycling in Interior Design Education

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Abstract: This research examines the role of interior design education in addressing the challenges posed by electronic waste (e-waste) and promoting sustainable practices. Despite low global recycling rates—approximately 20%—the integration of e-waste management into interior design curricula can foster innovation and creativity while reducing environmental impact. By teaching younger generations to effectively reuse e-waste, this educational approach provides practical experience that empowers future researchers and highlights the connection between environmental preservation and innovative recycling design solutions. This paper follows experimental method using qualitative design thinking approach to explore the application of recycling e-waste into interior products. Through a practical workshop that have taken place in October University for Modern Science and Arts in Egypt. The Workshop was an experimental approach to enhance the interior design curricula and emphasizes the importance of sustainable strategies for resource efficiency and effective waste management, aligning with the principles of the built environment. Ultimately, it advocates for the interior design discipline's critical role in fulfilling environmental responsibilities and advancing sustainable practices in a rapidly evolving technological landscape.

Keywords: Recycling, E-Waste, Interior Education, Product Application, MSA University.

I. INTRODUCTION

Modern society's dependence on rapidly evolving technologies has led to significant electronic waste (e-waste) generation. Each year, millions of electronic devices are discarded as newer models offer enhanced features and capabilities. This trend has resulted in shorter lifespans for electronic equipment, leaving older devices obsolete much sooner. [1]

Effective management and recycling of e-waste not only reduce disposal costs but also recover valuable materials, minimizing the need for new extraction and production processes. Sustainable e-waste practices contribute to lower manufacturing costs and protect ecosystems and communities from the hazards associated with improper disposal of outdated technology. [2] In light of the pressing issues surrounding e-waste, it is crucial for interior design education to go towards solutions that supports the

UN's sustainable development goals. Studies have indicated a discernible shift in the pedagogy and application of sustainability in the interior design domain. [3] Historically, since the Victorian era of the 1960s, interior design has been at the forefront of recycling techniques. [4] Thus, there is an increasing demand for innovative teaching methods in interior design education that equip students with skills in recycling, reusing, and up cycling.

Integrating recycling content into interior design curricula is crucial to cultivate resource-efficient, waste-savvy solutions and enhancing indoor environments. Students must be equipped to make choices promoting both ecological preservation and pro-environmental education, particularly as Millennial (who are born between 1981-1996) and Gen Z (who are born between 1997-2012), the largest student populations in history, shape the future of technology consumption. [5] By instilling these competencies early, the next generation of designers can meaningfully contribute to worldwide waste reduction through sustainable interior design.

Egyptian universities are working to address environmental challenges posed by electronic waste. In order to enhance sustainability practices across campus communities and raise awareness of e-waste issues among faculty members and students. By highlighting The University of October for Modern Sciences and Arts (MSA) and the Faculty of Arts and Design efforts in preserving the environment and proving the research hypothesis, it has initiated the "THINK GREEN" committee to support environmental conservation and sustainability. Also, it can provide university students' with platform for cross-disciplined collaborative and involvement in community sustainability initiatives. This committee allows staff and students from all faculties to propose initiatives, workshops, and seminars focused on environmental protection. In order to be a leading model as a sustainable university.

One of its first efforts, the "E-Waste Workshop," was inspired by an interior design graduation project in 2022. This project aimed to establish an Egyptian center to raise awareness about the harms of e-waste and the importance of recycling. The student utilized e-waste as interior elements, incorporating it into furniture and decorative items. This workshop has been

an experimental approach to the project interior solutions. As such, interior design education must depend on practicing and application to serve and benefit our society and environment. In addition to, engaging students with real-world issues.

Reforming interior pedagogy can stimulate creative thinking around sustainability challenges facing local communities and societies. It can also drive the invention of original design solutions and advancement of the discipline through innovative material reuse applications and consideration of broader social and environmental impacts.

II. LITERATURE REVIEW

Numerous studies have highlighted the significant rise in electronic waste worldwide, underscoring the need to address this issue by promoting and endorsing the practice of recycling and reusing our waste. Additionally, research has shown that incorporating community service in educational settings can influence students' perspectives on society, help shape their minds, and raise their sense of self-responsibility toward their communities. Particularly, inventive and creative curricula, such as those in interior design, can assist students in finding new uses for discarded or undesirable objects.

A. Electronic Waste

The term "e-waste" is an abbreviation of "electronic and electrical waste". E-waste includes almost "any household or business item containing circuitry or electrical components with either power or battery supply." [6] Also, The UN defines e-waste as "any discarded product with a battery or plug, and features toxic and hazardous substances such as mercury that can pose severe risk to human and environmental health." [7] E-waste can have many shapes and types, which are categories in figure (1)

Types of E-Waste						
Cell Phones	Personal E-Devises	Monitor & Laptops	Camera & Lenses	Screens & Printers	Head Phones, Key Boards, Mouse	Audio/ Video Gadgets

Figure (1) Types of Electronic Waste, [8]

The UN's fourth Global E-waste Monitor (GEM) reports a concerning trend in electronic waste (e-waste), revealing that global e-waste generation is increasing at a rate five times faster than recycling efforts. In 2022, 62 million tons of e-waste were produced, but only 22.3% of this e-waste was properly collected and recycled. The annual e-waste generation is projected to rise by 2.6 million tons, reaching 82 million tons by 2030—a 33% increase from 2022. This is expected to lead to a decline in the recycling rate due to several challenges, including technological advances, shorter product life cycles, and inadequate e-waste management infrastructure. [9] [2] The increase in the number of e-waste is huge, especially in big cities

that have a dependence on electronic equipment for activities. Cairo, the capital city of Egypt is considered one of the high urban population, to be estimated approximately 22,623,874 people in 2024, which makes the amount of electronic waste generated is significant [10] [11] Which has an average about 58.7% of the amount of electrical and electronic equipment (EEE) put on the market. Thus, Egypt contributes to about 20.1% of the e-waste generated in Africa, despite having only about 8.6% of the continent's population. [12]

According to [9], the world can achieve a 60% collection and recycling rate by 2030 if recycling and reusing strategies were supported. The significant gap between e-waste generation and proper recycling underscores the urgent need for all stakeholders, including young people, to address this challenge. This is particularly relevant in the field of interior design, which can promote recycling through functional and artistic solutions.

B. Recycling E-waste in Interior Application





1) Recycling Importance:

The data and statistics on e-waste indicate that it is imperative to consider methods and solutions for the secure disposal of electronic waste. [2] [9] Recycling allows for the creation of new things rather than burying or burning unwanted electronics; this has caused people to evaluate what they throw away, which is something that interior design could also do. E-waste recycling "is the process of extracting valuable materials after shredding the e-waste into tiny pieces that could be reused in a new electronic appliance". [13]

Global recycling rates for e-waste are alarmingly low. In the EU, which is at the forefront of e-waste recycling, only 35% is officially documented as properly collected and recycled. The worldwide average stands at just 20%, with 80% going unrecorded, much of which is buried as landfill for centuries. [7] Therefore, there have been many worldwide initiatives encouraging recycling e-waste, such as the "Colorful Collections campaign" in the UK, which is organized by Cambridge City Council. It provides residents with bins to collect their unwanted electronics. In Egypt, policymakers have launched the E-Tadweer mobile application. It enables end-users to take their unwanted appliances to dedicated delivery points and exchange them for vouchers, which can be used to purchase new electronic goods from stores that have joined the scheme. However, Singapore's policymakers have put in place progressive legislation, making it the producer's responsibility to collect end-of-life electrical appliances and electronic devices and send them for reuse or recycling. [14]

2) Applying Recycling in Interior Design Education
 The University of Loughborough's Waste Resources and Action Program (WRAP) found that designers have meaningful opportunities to minimize waste generation through their work. [15] However, [16] described traditional interior design methodology as overly focused on lavish aesthetics while neglecting occupant wellness and environmental impacts. Furthermore, [15] reported that while environmentally sustainable interior design is increasingly important, design practitioners still infrequently incorporate sustainability in practice.
 E-waste recycling in interior design education is an innovative approach that addresses both environmental concerns and the need for sustainable design practices. Here are some key applications and examples, as shown in table (1).

TABLE (1) E-Waste Interior Design Practices, by the Researchers

Interior Practices	Description	Example
Furniture and Decor	E-waste components such as circuit boards, wires, and metal parts can be repurposed into unique furniture pieces and decorative items. For example, old computer parts can be transformed into stylish lamps, tables, or wall art. [17]	 Ewaste Art – Binary Collection
Educational Projects	Interior students' create projects that incorporate e-waste. This not only teaches them about sustainability but also encourages creativity and problem-solving. Projects might include designing functional items or art installations using discarded electronic components.	 Haya sat Alyaman, Interior Graduation Project 2022, MSA University
Material Innovation	E-waste can be processed and combined with other materials to create new, sustainable building materials. For instance, crushed e-waste can be mixed with concrete to create eco-friendly building blocks. [17]	 Bricks combined with E-waste
Art and Installations	E-waste can be transformed into unique art pieces or installations, adding a modern and tech-inspired aesthetic to interior spaces	 E-waste Art Work
Awareness and Advocacy	Incorporating e-waste recycling into the curriculum helps raise awareness about the environmental impact of electronic waste. Students learn about the importance of recycling and how they can contribute to reducing e-waste through their design practices	

Case Studies and Real-World Examples	Educational programs can include case studies of successful e-waste recycling projects. For example, some designers have created entire interior spaces using recycled electronic components, showcasing the potential of e-waste in sustainable design. [18]
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These applications not only reduce the environmental impact of e-waste but also promote innovation and creativity in interior design. Educating younger generations on the safe reuse of e-waste through interior design provides practical experience that empowers future researchers and underscores the link between environmental preservation and innovation. Interior architectural design must acknowledge and address the environmental costs of its practices. As Walker notes, sustainability in design involves “resourcefulness and restraint” [19], and emphasizes the reuse and remanufacturing of materials as key environmental indicators. Therefore, implementing sustainable strategies for resource efficiency and effective waste management in interior design is essential for fulfilling our environmental responsibilities and establishing the discipline's critical role in a sustainable future. [20]

III. METHODOLOGY

The methodology applied in this paper is the experimental method using qualitative design thinking approach to explore the application of recycling e-waste into interior products. As the study aligned with SDG Goal 12 and the "Go Green" initiative to ensure the relevance of waste management and environmental impact reduction principles in the development process. The workshop utilized the following steps:

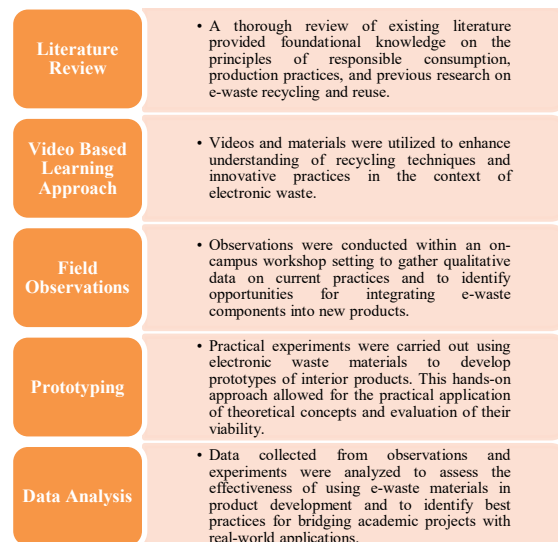


Figure (2) Research Methodology, By the Researchers

Through this methodology, the study aimed to demonstrate the practicality and potential impact of student-led projects advancing sustainable practices within the interior design industry.

IV. WORKSHOP STAGES

The E-waste Workshop was created specifically for third-year and senior interior design students at MSA University in Egypt. The two-week class utilized Brown's design thinking framework, emphasizing three crucial phases: ideation, inspiration, and execution. [1] This methodology was chosen to support creative design initiatives aimed at transforming e-waste into new types of furniture and interior products. The workshop was organized into four primary stages, as shown in Figure (3): preparation, collecting and sorting, ideation and sketching, and testing and prototyping.

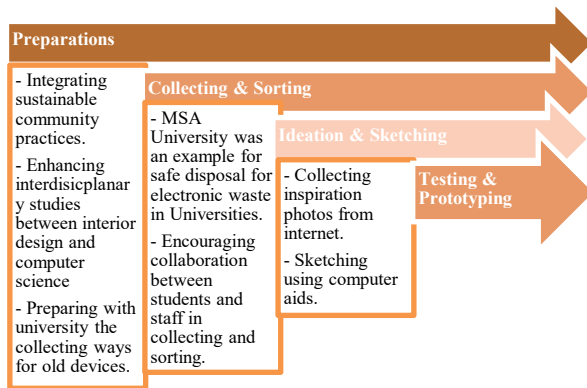


Figure (3) Workshop Primary Phases, By the Researchers

Teaching students how to upcycle old electronics into artistic and functional furniture and interior elements was the main goal, as it promotes environmental sustainability. This project gave e-waste a new purpose, encouraging student creativity while increasing staff and student awareness of sustainability issues and e-waste.

A. Preparation Stage:

- Integration of Sustainable Community Practices with Interior Design Education:
 - Establishing a partnership with e-waste management companies to equip workshops and integrate interior design education into community service initiatives. This involves raising awareness among faculty regarding the role and responsibilities of e-waste management firms.
 - Ensuring that MSA University collaborates with an e-waste company to facilitate the safe disposal of electronic waste generated by the institution.
 - The partnership with e-waste management firms has underscored the adverse environmental impacts of electronic waste, providing workshop participants with an overview of the electronic recycling process and the disposal of hazardous components.
- Enhancement of Interdisciplinary Studies: Facilitating collaboration between interior design students and computer science students to introduce the fundamental components of electronic waste.

This interdisciplinary approach aims to inspire interior design students through the exploration of various components and to mitigate risks associated with hazardous parts.

- Preparation for the Collection of Obsolete Devices: MSA University has allocated a secure area within its workshop for the collection, storage, and safe disposal of outdated and unwanted electronic devices, which will be utilized for experimental purposes.

B. Collecting & Sorting:

- Effective procedures for the safe disposal of electronic trash in educational environments are best demonstrated by MSA University.
 - An extensive contribution of unwanted and outdated electronic equipment has been made by the institution to a specialized workshop. These devices come in a wide range, as Figure (4) illustrates.



Figure (4) Samples of the Electronic waste donated by MSA University, By the Researchers

The Arts and Design Faculty staff and students have contributed some outdated devices, including old mice, keyboards, and cables.

- Promoting teamwork between students and staff: Interior design students and staff have been involved in gathering and sorting all the unwanted electronics. The disassembly of e-waste was carried out by MSA IT staff and E-Tadweer Company to ensure it was done safely and professionally. Figure (5).

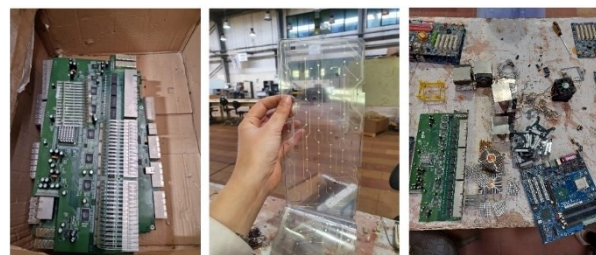


Figure (5) Disassembling the collected Electronic Waste, by the Researchers

E-Tadweer Company has provided participants with a concise overview of hazardous electronic components to be avoided in design processes. Additionally, they have detailed the components of each device, as depicted in the accompanying figure (6).

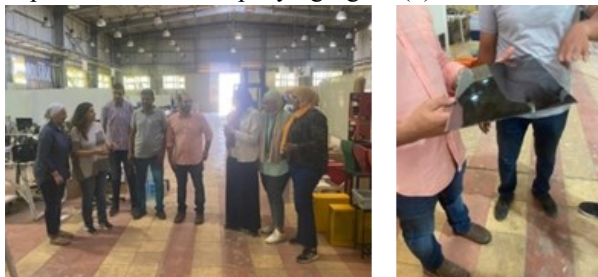


Figure (6) E-Tadweer Company participation in the E-waste Workshop, By the Researchers

C. Ideation & Sketching:

- Collection of Inspirational Photographs from Online Sources:

Participants in the workshop gathered a substantial number of inspirational photographs from online sources. These images predominantly feature interior products and furniture items constructed from electronic waste components. The collection includes examples of various objects such as lighting units, office shelves, home accessories, recycling bins, and tables



Figure (7) Sample of Collected Inspiration Photos, Source: [21] [22]

Computer-Assisted Sketching: Workshop participants utilized several design programs to create sketches and explore various concepts, including redesigning a printer model into a storage unit with a distinctive design, as illustrated in figure (8).



Figure (8) Sketches of the Printer model, Source: By the Researchers

D. Testing & prototyping:

The university workshop has integrated the testing and prototyping phase, enabling all participants to experiment with various designs and draw inspiration from the tiny fragments of e-waste particles.



Figure (9) Samples of Testing and Prototyping Process, By the Researchers

RESULTS:

The workshop yielded twelve primary products, including lighting units, office storage solutions, and accessories, as illustrated in figure (10). These items were showcased at the e-waste event organized by the Faculty of Arts and Design. The event featured guest speakers from the community to emphasize the positive impact of the products and their applications on both the local community and the environment.



Figure (10) an overall perspective for the Exhibition, By the Researchers

This culmination of efforts not only demonstrated the participants' achievements but also inspired several students to develop exceptional items.

All exhibits were accompanied by a QR code, which allows visitors to learn about the origin of the product. This proves that interior design education can give a second life to electronic waste through recycling and reusing techniques.



Figure (11) Samples of the Exhibition products, By the Researchers

However, during the execution of the workshop the team has encountered multiple challenges across various dimensions, which are:

- Financial Constraints: Securing sufficient funding was a major obstacle that hindered the smooth execution of the workshop activities.

- Experience and Precedents: The absence of prior examples and limited experience with similar workshops posed challenges, impacting the effectiveness and efficiency of the proceedings.
- Technical Difficulties: Technical issues, particularly non-removable batteries in some devices, hindered recycling efforts. Extracting valuable materials from electronic waste requires advanced mechanical processing techniques, complicating the workshop's goals.

V. CONCLUSION AND RECOMMENDATIONS

E-waste has become a significant global issue due to its impact on the environment and human health. Therefore, recycling and reusing are essential solutions to mitigate the effects of e-waste. As interior designers, it is crucial to participate in addressing the e-waste problem by encouraging the integration of recycling and practical applications in the interior design curriculum.

The research emphasizes the importance of multidisciplinary collaboration in the design process, leading to innovative solutions and superior project results. This collaborative approach fosters creativity and allows for the sharing of knowledge among team members. A structured design methodology enhances systematic idea development, while practical experience in education helps students connect theoretical concepts to real-world applications.

Key recommendations for improving design education include:

1. Integrate Product Design Across Courses: Incorporate product design principles into various design disciplines for a comprehensive understanding.
 2. Broaden Perspectives: Use hands-on experiences to expand students' mindsets, preparing them for complex challenges.
 3. Enhance Awareness and Opportunities: Integrate practical knowledge and multidisciplinary skills to align students with industry needs.
 4. Facilitate Diverse Approaches: Encourage exploration of various design methods through interdisciplinary collaboration.
 5. Support Practical Research: Increase funding for practical research to achieve timely, relevant outcomes.
- Overall, these insights advocate for a comprehensive design education that prepares students for future industry challenges.

By adopting these recommendations, educational institutions can better prepare design students for the dynamic and multifaceted nature of the design industry, ultimately contributing to their success and advancement in their careers.

When properly trained in e-waste prevention strategies, including responsible disposal and design for durability, future interior designers can instill

sustainability-minded habits in academic settings. They can also apply these skills to benefit society through environmentally conscious commercial and residential design. Overall, upgrading design education standards can significantly impact environmental stewardship at both the university and societal levels. It is essential to update curricula to emphasize sustainable material reuse. By integrating circular design thinking from the outset, future interior designers will be prepared to create innovative products and spaces that prioritize waste reduction.

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