

Concept Paper

# Interior Architectural Design for Adaptive Reuse in Application of Environmental Sustainability Principles

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**Abstract:** The paper discusses an interior architectural design model to enable the accomplishment of sustainable design strategy of efficient resources/waste management. The proposed design concept, referred to as interior architectural design for adaptive reuse, is based on the reintroduction of reclaimed or salvaged building construction materials and products acquired from demolished or refurbished building structural portions, into the structure of interior components. The presented design approach puts circular design methods and techniques in interior design practice at the core of environmentally responsible architectural design. To achieve its objectives, the implementation of resources efficiency strategy into the interior design scheme should remain a decisive interior design quality criterion. Meanwhile, the issues related to the environmental contextualization of interior spaces and their constitutive components, in fulfilment of sustainable design requirements for the conservation of natural resources, are neither sufficiently recognized by interior designers, nor appropriately highlighted in the current design practice. The main purpose of this concept paper is to develop a theoretical scheme for systemic inclusion of interior architectural design for adaptive reuse into the environmentally sustainable interior architectural design framework. This study provides interior designers with the concept of interior components design for the fulfilment of resources efficiency and waste management effectiveness.

**Keywords:** sustainable architectural design; sustainable interior design; interior components; adaptive reuse; environmental contextualization

## 1. Introduction

The reuse of reclaimed building construction materials and products should be treated as the supporting method for the reduction of construction and demolition waste [1] produced as the result of cyclical building activities associated with forming the built environment, and thus responding to the environmental ethical questions that are to be addressed by architects, as well as interior designers. The design practice towards the accomplishment of a closed loop concept, as postulated by McDonough and Braungart [2], can be maintained by consequently applying an adaptive reuse model into the building internal environment components design. This model meets the environmentally sustainable demand for minimization of building construction waste.

The issues related to the extension of the lifespan of a building, as well as its structural components, are still insufficiently recognized [3] by interior designers. Meanwhile, the repeated processes of construction, refurbishment, and especially demolition, understood as an undifferentiated process of taking apart and compressing building components for their final disposal at a landfill [4], remain the primary source of wasted resources [5,6].

The sustainable design approaches, from design for waste prevention, to design for recycling, as presented in the waste hierarchy model of the efficient resources' management strategy, enable control over the negative impacts of these destructive procedures on the natural environment. Design



methods for effective waste management are situated between preventing construction and demolition waste production as the most favored and effective method, and the disposal of waste in landfills which is destructive to the natural environment. The objective of their application is the reuse of potential building waste “by extracting from them an extra (i.e., additional or new value) while generating a minimal amount of refuse” [7] (p. 94). The list of possible methods for products’ technical life extension include the following: design for repair, remake and replacement; design for reclaim understood as a process of reintroducing building materials without reprocessing or cleaning, and with limited repairing processes [5]; and design for adaptive reuse. This design concept of retaining the reclaimed or salvaged building materials and products, acquired from refurbished or dismantled objects in new architectural designs, is supposed to be the best design practice to preserve building materials [6] and lengthen the building product’s life cycle. Consideration of the entire lifespan of a building’s products, imperative for sustainable architectural design, is an incentive for changes in interior architectural design. The environmental context of a building and its internal spaces influences the design decision-making process with regard to the consequences of potential repetitive remodeling processes of building structural components or the interior environment. These procedures related to refurbishment, modification or adaptation due to the changing of functional or formal requirements, leads to deconstructed, dismantled, removed or demolished components. They are becoming the vast reservoir of building materials and products, differing in quality, value, and physical parameters, that offer new areas of re-introduction into built structures, thus stimulating a search for innovative design methods.

There is a need for developing a thorough system on the application of building material adaptive reuse involving vendors, deconstruction contractors, developers, facility managers, and interior designers, to provide an effective reintegration of deconstruction or demolition waste with interior components. “Building Material Reuse Consulting Process Workflow” [6] (p. 2) adopted for sustainable interior architectural design, is to develop a multi-disciplinary online platform enabling the exchange of essential information on the availability of reclaimed components, complemented by guidelines providing modes of their successfully exercised reintroduction. The goal is to transform the design process, stakeholders’ involvement, and knowledge on the principles of sustainable design for the built environment. These combine with life cycle assessment, and equally ensure the minimum amount of embodied energy, regarding the specification of building materials and products to form interior components, is retained. Equally formulated exigencies are to be applied to the process of creation of a sustainable interior and are understood as the second building block of the built environment or near environment [8].

Stuart Walker’s view that “sustainable product design explores reuse of materials” [9] (p. 81), and that production of artefacts should be based on “cyclic resource use” [9] (p. 93) can be confirmed through the adjusted interior architectural design methodology. The presented Interior Architectural Design for Adaptive Reuse (IADfAR) concept, to be implemented by environmentally responsible designers realizing “integrated, comprehensive, anticipatory design” [10] (p.268), can be assessed as an attempt to achieve resources efficiency, as well as an alternative solution to the waste of valuable building materials.

The objective of this study is to present a conceptual model of interior architectural design for adaptive reuse defined as the process of acquisition of reclaimed building materials and products from refurbished or demolished buildings, and their incorporation into new spatial and functional contexts of the indoor environment. Conversion of waste building materials from demolished or refurbished building portions into valuable resources to complete interior components, accomplishes eco-effectiveness through the resources’ recirculation and redistribution. The presented design method of forming new or refurbished interior components with reused parts identifies the design discipline contribution to assure the extension of building materials lifespan. An innovative approach from designers to form interior components is required for this method to be successfully applied, and the



development of modified design criteria focuses on the limited use of new resources in order to “cause minimal detriment to the environment” [9] (p. 191).

The structure of the article is as follows: the first part addresses sustainable interior architectural design strategy for resources efficiency, then the adaptive reuse design concept is presented as a method of its accomplishment. The next section concerns the interior components assessment model, with emphasis on its environmental contextualization. Then, the interior architectural design for adaptive reuse concept is clarified, with regard to implications, strategies, and determinants of its effectiveness in shaping interior constitutive components.

## 2. Sustainable Strategies in Interior Architectural Design

To prove its ecological effectiveness, interior architectural design identified as environmentally sustainable should be based on a holistic approach, as the building interior forming the near environment directly mediates with its occupants and remains a relevant part of the built environment. It is necessary to make predictions of possible impacts of the interior setting on the natural environment, with which the inner spaces remain another indirect form of mediation. Interior architectural design is to respect this interrelationship and reduce the environmental costs of interior settings completion. Walker claims that sustainability in design, involves “resourcefulness and restraint” [11] (p. 81), and exploration of the reuse and remanufacturing of materials as environmental indicators. Interior architectural design sustainable strategies for resources efficiency and effective waste management, “based on the principles and strategies common for the built-environment” [12] (p. 180), are therefore essential for establishing the role of interior design discipline in fulfilment of environmental responsibility.

### 2.1. Resources Efficiency

Buildings can be considered resources in the long-term perspective [13]. The concept of retaining and reusing existing buildings realized in architectural design and addressed as “a significant priority of sustainability” [14] (p. 222), can be identified as an example of creative approach within interior architectural design as well. Therefore, as Winchip claims [14], reusing buildings and providing the preservation, restoration or reconstruction of a building’s substance to retain the quantity of valuable materials and products is becoming the preferred method for the creation of a sustainable interior environment.

The design methods of adaptive reuse of existing buildings comprise the alterations and conversions of the building structure itself, as well as the functions it accommodates. The important position in this design concept is assigned to the adaptive re-use as intervention adjusted to the scale of the interior environment [15,16]. Among other terms accompanying the adaptive re-use design model and interchangeably investigated, are adaptation, reworking, and rehabilitation [15], which address most adequately this complex issue. All these notions emphasize the benefits of retaining architectural heritage, employed with the implementation of an adaptive re-use design concept into the architectural design framework. Brooker and Stone [17] consider the adaptive reuse of existing buildings from the interior architecture perspective and address the transformation and remodeling of existing buildings to assign them new functions, and to present different approaches to establishing a relationship between new functions and existing building substance. They identify the design strategies toward the accomplishment of this concept as insertion, intervention or installation.

Adaptive reuse and conversion of existing buildings, as a task within the architectural discipline, as well as interior architectural design, complies with sustainability resources efficiency principle, through the minimal physical interventions, efficient management of existing building substance, and environmentally conscious design of interior components. An example of this approach is the dematerialization scheme [18] which outlines the components of interior spaces, and purposefully reduces the amount of used materials permitted to perform their basic functions without deterioration of their quality [19]. This ultimate design concept strengthens sustainability awareness in the effective management of building materials and products by minimizing resource consumption. The rationally



introduced dematerialization concept, assuring the expected quality performance of internal spaces and their components, becomes an innovative design method to shape stylistically and ethically defined sustainable interiors [20]. The fulfilment of the objectives of resources efficiency in interior components creation facilitates other design methods, including design for reclaim [21] which is associated with design for deconstruction [18,19]. According to Kibert [22], the deconstruction process in relation to buildings is becoming an architectural design strategy, which offers opportunities for the reintroduction of recovered and valuable components in new locations through the partial or whole dismantling of existing structures. Design for deconstruction or selective dismantling concept [18], based on the carefully provisioned management of available resources, enables the optimization of products' performance, responding to ethical questions regarding cost-effectiveness and ecological-efficiency of design methods applied for the building's completion. The latter can be described as the basic model for multiple usage of interior components enabling the extension of the components and products' lifespan, and completion of the circular building materials flow scheme within the built environment.

## 2.2. Waste Management

Although an increasing body of knowledge on resources management and methods of waste diversion from construction sites already exists, the substantial role of designers in reducing the amount of waste is not precisely defined [6]. As indicated by Osmani, Glass, and Price [23], very few attempts have been made to address the effect of design practices on the generation of waste.

The production of solid waste during construction or demolition phases, inevitably associated with the built environment [24], can be assessed in different scales. The maintenance and refurbishment of internal spaces are in fact the beginning of waste producing, due to those partial demolition processes [3]. Constant transformations of the indoor environment cause massive waste production exceeding the amount of waste coming from simple demolition. It is, then, justified to broadly employ waste management as a sustainable design strategy. Frequently executed refurbishments of interior environments, especially commercial ones, characterized by a relatively short lifespan is a cyclical process of making new structures simultaneously accompanied by waste production. Consideration of the constant alterations and refurbishments of interior spaces in the context of building waste production, is to define the latter as an important stage in the continuous cycle of use, decay and regeneration [24] of building substances. Establishing a new approach to reinvent the reclaimed building materials and products in a new surrounding is conditioned by the decline in understanding construction and demolition waste as worthless materials. According to Lyle [25], it is necessary to revise the assumption that building materials, acquired from refurbishment or demolition, cannot exist in any form other than their originally presumed function. Van der Ryn and Cowan [26] and Yeang [27] emphasized the significance of restorative closed cycles of materials in the creation of ecologically efficient architectural design assuring the minimization of impact on natural surroundings through the implementation of reuse or recycling design methods. As Thomsen, Schultmann and Kohler indicate "waste is increasingly considered as another form of resource" [3] (p. 328) in the currently developed theoretic scheme of architectural design. This statement endorses the cradle-to-cradle theory on the cyclic character of building products technical life and highlights the reuse design method as mostly efficient in extending this perspective. The sustainable design of an interior space and its components with regard to the environmental effects of the constant flow of used substances, acknowledges the concern that "the design of a product exists within a wider system of production, consumption and disposal" [9] (p. 813). Interior architectural design must contribute to significant improvements in this procedure, in order to diminish the building waste production; this is possible by achieving the principle of using "what is available and use limited resources in creative new ways" [13] (p. 36). Superuse Studios achieved such a concept of reusing discarded construction material with objects of different scales and functions [28].



### 3. Interior Components in Sustainable Interior Architectural Design

The inclusion of environmental criteria to the process of interior components creation, assures the accomplishment of environmentally sustainable design imperatives, while requiring the employment of different design methods and techniques. These comprise interior design and its components for multi-functionality, design for adaptability, followed by design for flexibility. The above-mentioned design approaches allow for the rational outline and environmentally-responsible arrangement of internal spaces, as well as forming of their components through efficient resources/waste management. The design principles assuring the creation of an environmentally responsible indoor environment comprise the following: (1) reduction in energy and resources as required to produce new building materials and products; (2) reduction in the construction, refurbishment and demolition waste flow due to resources efficiency; (3) preservation of the embodied energy present within the existing and in-use structures from dissipation due to the demolition stage; (4) extension of the lifespan of building materials and products accomplished with the comprehensive implementation of an adaptive reuse model into interior components substance. Adjustments in the conventional interior components design methodology are a condition for the avoidance of the high environmental impact of indoor spaces. In the following sections, the interior components typology is presented, then the constitutive interior components identified by the author as interior responsive constructs, are analyzed within an environmental context.

#### 3.1. Interior Components Typology

Classification of interior environment components, proposed by the author, corresponds with the scheme developed by McClure and Bartuska, where the content of seven built environment connected layers or “levels of varying scales” [8] (p. 7), as well as their spatial contexts are exposed as fundamental factors. The indoor environment as part of this developed set of interrelated components comprises products, understood as basic elements to enable performance of different activities, and interiors described as “arranged grouping of products and generally enclosed within a structure” [8] (p. 6) to enhance activities and mediate external circumstances.

The proposed interior components typology respects the concept of building introduced by Duffy and formally articulated by DEGW — architectural and design practice co-founded by Duffy, Ely, Giffone and Worthington, in the early 1970s [4]. It recognizes the building as several layers of longevity of built components to be designed with regard to their different change rates that influence the whole built environment performance. These interconnected and interdependent parts of the building should be conceived within the spatial, structural and temporal contexts. This approach, further developed by Brand [29], enables consideration of these parts’ adaptation to new functional or spatial requirements, with control over the material and products consumption, as well as energy usage. The model of the built environment presented by Duffy addresses the time-based approach in interior design and distinguishes relatively long-term architectural elements from those responding instantly to shifting demands regarding technological or organizational issues [4]. This scheme of shearing layers comprises of a shell, services, scenery combining space layout along with walls, suspended ceilings, raised floors, and settings. Duffy claims that these elements of different lifespans should be designed to remain independent from each other, so as to enable “intervention and replacement” [4] (p. 45) cycles within the built environment. The model presented by Brand distinguishes, respectively, structure, skin, services, space plan and stuff comprising furniture, recognized as separate parts of the built environment. In Brand’s concept the interrelationship of layers, and the temporal context of changes are essential. As Meagher notices, the diagram developed by Brand suggests “rates of change as a primary organizing principle for building components” [30] (p. 161). This involves sustainable designs for adaptability, flexibility or deconstruction applied to the forming of interior components, as methods to conform to the resource’s efficiency principle.

The typology proposed by the author classifies the interior components within the environmental context, referring to them as constructs that can assimilate the reclaimed or salvaged building materials



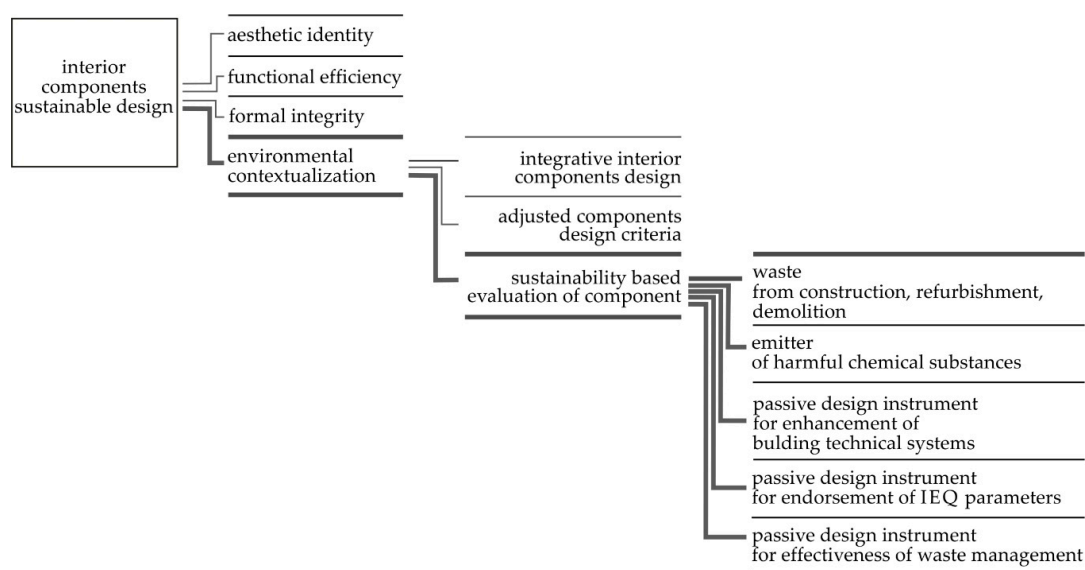
and products from building structural portions of refurbished or demolished buildings. The first group comprises components described as constitutive or structural, that establish the group of “non-shell portions” of building as assigned by Yudelson [31] (p. 188). In the proposed classification to discuss design methods to accomplish sustainable strategies in forming interior components, the author proposes inclusion of the following: (1) external walls and remaining structural building elements, determined as enclosures separating the inner space from the natural environment that remains physically developed and accompanied on the inner side by various technical devices or biological finishing [20]; (2) partitions and space dividers of various dimensions and configurations and multifunctional structures; (3) raised floors and (4) integrated, as well as suspended ceilings. The second group, described as supplementing or completing, comprises finishes of partitions or space dividers. The third one includes furniture, furnishings, fixtures and equipment, which remain of lower significance for the fulfilment of the sustainability requirement for waste management, realized with the further discussed adaptive reuse concept.

### *3.2. Interior Components Environmental Contextualization and Evaluation*

The evaluation of man-made settings and its components, concentrated exclusively on the assessment of the degree to which a designed setting supports occupants’ demands or affects human behavior, is incomplete. The post-occupancy evaluation mode offering the human-centered approach, and the analysis of “transactions of people and the built environment” [32] (p. 5), in sustainable design is to be expanded upon as well. It should extend the proximate environmental context (i.e., location of the space characterized by local climate conditions, air quality or transportation) on the valuation of the designed setting and its physical elements, and change the perspective assigned to the evaluation process. Comprehensive design assessment is to consider the consequences of creation of the designed environment on the integrity of the natural environment, while underlining both settings interdependency. Woolley, Kimmins, Harrison and Harrison claim that “each design decision [ . . . ] has environmental implications” [33] (p. 5) demonstrates this complex approach to the design concerns. Their statement can be assigned to the creation of interior components, evaluated in terms of their impact on the health of the natural setting, as well as the occupants of the built environment.

The environmentally sustainable interior architectural design scheme emphasizes the role of these components in moderating the interrelationship between designed and natural environments, based on predicting the consequences of mutual interconnectedness. Application of the interior components multifaceted environmental contextualization [34] proposed by the author, facilitates identifying and interpreting this interrelationship. The adjusted interior architectural design model integrates demands for interior components functional compliance, formal integrity and aesthetic identity, considered priorities within the conventional design framework, with the components’ environmental contextualization, which is becoming the sustainable interior architectural design principle, and a driver of the process of integrative design (Figure 1). The design scheme of interior components comprises: (1) development of interior components in conformity with integrative architectural design objectives; (2) employment of comprehensive design criteria with emphasis on the temporal context; (3) inclusion of the interior components’ environmental sustainability-oriented assessment to the design procedure.





**Figure 1.** Interior components assessment based on their environmental contextualization. Source: author's drawing.

Application of interior components sustainability-based assessment (Figure 1) with regard to their spatial configuration, developed technical solutions and specification of used building materials, enables their recognition as: (1) waste coming from the cyclical processes of construction, refurbishment or demolition; (2) emitters of potentially harmful chemical substances influencing occupants health and wellbeing due to off-gassing process; (3) passive design instruments to employ passive mode design approach in the creation of the indoor environment.

Interior components, considered as passive interior architectural design instruments, and being environmentally activated [34,35], integrate the following multidimensional functions:

- Enhancement of building systems' performance through the reduction in energy consumption (e.g., suspended ceilings with light reflective finishing materials and inner light shelves supplementing external passive solar optical systems, to endorse building lighting systems with increased transmission and distribution of daylight in underlit areas of closed spaces, thermally activated suspended ceilings to enhance cooling and ventilating systems, partitions and space dividers' dimensions permitting cross ventilation and unobstructed air flow to reduce the usage of mechanical ventilation systems).
- Endorsement of indoor environment quality parameters including inner air parameters, relative humidity, thermic and acoustic comfort (e.g., vertical biological space dividers to assure appropriate level of relative humidity and temperature of inner air, and to provide occupants with acoustic comfort).
- Effectiveness in resources/waste management achieved with the reuse of reclaimed, recovered, and salvaged building materials and products initially forming other dismantled or refurbished interior or building components (e.g., ceramic bricks reclaimed from structural building portions, and reused as partitions finishes).

The statement indicating that "closing materials loops in construction remains the most challenging of all green building efforts" [36] (p. 390), can be applied to the design process of building interior spaces. The same requirements assigned to the complexity of building materials and products' manufacturing, transportation, installation, use, and maintenance processes, are to be met while creating the components of an indoor environment. The phases of completion and exploitation process followed by components dismantling and recovery to enable the remanufacturing procedure, remain in accordance with the close-loop concept [37]. The life-cycle approach to the creation of inner space,



as required from the environmentally responsible interior designers [38], and applied to the interior components shaping, is to decrease the negative environmental impact of building products, due to the execution of their “integrated life cycle management” [39] (p. 11). With the assigned substantial role in diminishing building waste production, interior components can be recognized as responsive parts of the built environment in reducing its negative effect on natural settings due to the reintroduction of building waste into interior space as valuable resources.

#### 4. Interior Architectural Design for Adaptive Reuse

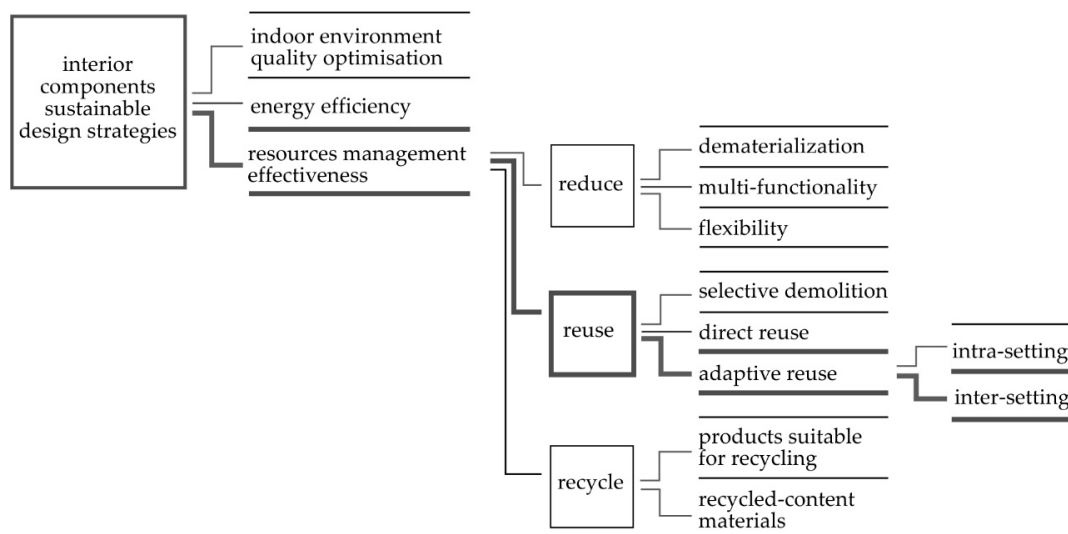
The design concept based on the process of reintroducing reclaimed materials or products into the building setting, requires adjustments of planning procedures and design solutions according to what becomes available, as Baker-Brown from the Superuse Studios indicates [28]. This approach to the architectural design process combines the comprehensive framework of adjustment existing building substance to new functional requirements, along with the cost-effective process of deconstruction, reclaiming and adaptive reuse of building materials and products. The interior components made with reused parts without significant reshaping or reprocessing, and placed in a different functional and spatial context, are becoming developed products of a high environmental profile. Prevention of the negative environmental impact of building products through their conversion as deconstruction or demolition waste to valuable indoor environment components, is therefore a complementing design method for the adaptive reuse of existing buildings.

The design approach of remanufacturing building waste into high performance, valuable interior components, indirectly leads to changes in users’ consumption-related attitudes. With the modifications of design intervention focused on design for the sustainable use of products [40], these components become drivers for changes in consumers’ perception of environmentally responsible design methods and build up reflections on the reduction of the negative impact on natural settings accomplished through the resources’ efficiency strategy. Therefore, this interior architectural design approach, emphasizing the environmental context in interior components development, is to become a part of Design for Sustainable Behaviour. As the “environmental performance of a product during its use phase is directly affected by user’s behavior” [41] (p. 426), it is justified to make assumptions that the performance of the product made by a sustainable interior architectural design method of inter-setting adaptive reuse, as detailed in the following section, can influence occupants’ environmental attitudes and habits.

##### 4.1. Inter-Setting Adaptive Reuse in Application of Waste Management Scheme

The proposed interior design intervention situated between reuse and recycle architectural design approaches, and oriented towards controlling the consumption of building materials and products, is appropriate for sustainable interior components creation (Figure 2). Interconnectedness of natural and built environments allows us to recognize adaptive reuse as an integrative interior architectural design model, as well as essential for a designers’ environmental-responsibility indicator of an interior and its components. It is, thus, reasonable to apply a similar scheme regarding the indoor environment constitutive components creation process, and design methods in search for the means of resources management optimization and extension of building materials’ lifespan. The most effective and technically affordable methods of fulfilment of reuse demand, combine the design for selective demolition, design for direct reuse, as well as design for adaptive reuse of reclaimed or salvaged building construction materials and products. The latter refers to the employment of acquired objects in another, differently defined application mode, while preserving their usefulness and performance. Components designed with the proposed adaptive reuse method can be identified as complex “instrumented products” [41] (p. 430) that are structured with acquired parts and then situated in different environmental, functional and formal contexts.





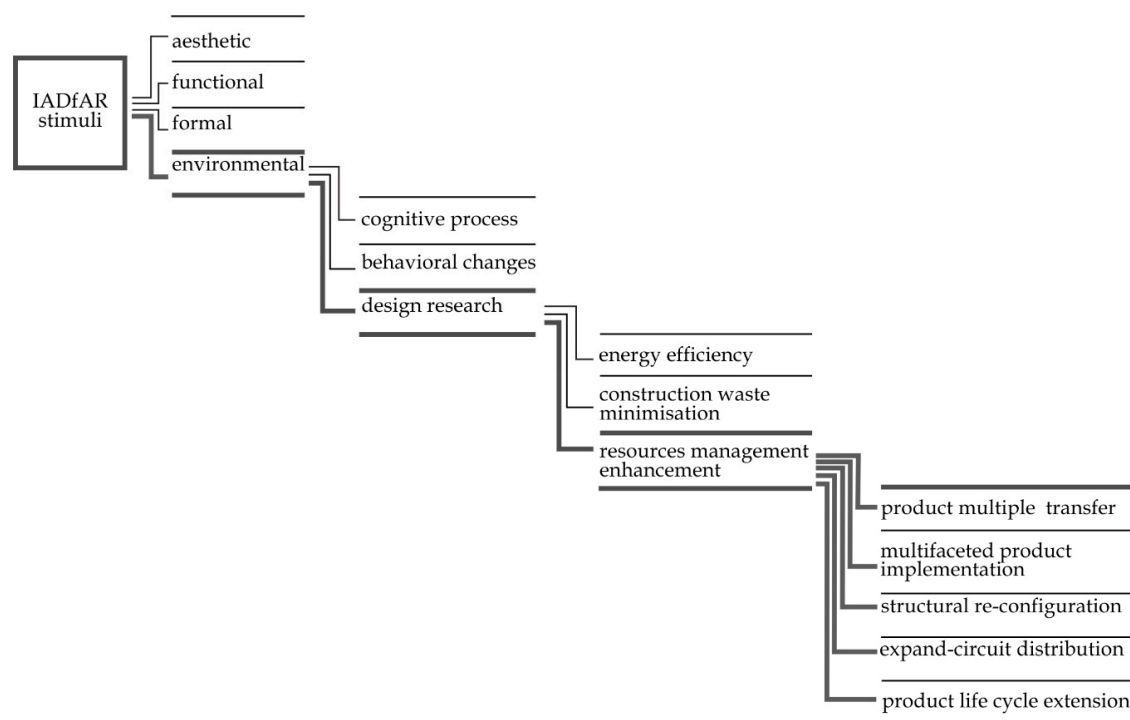
**Figure 2.** Inter-setting adaptive reuse in application of efficient resources management strategy into interior components design. Source: author's drawing.

Interior architectural design for adaptive reuse, respects semiotic connotations of adaptive reuse, meaning to reuse in order to fit [42]. The term is identified for the purposes of this study, as a design method based on the reintroduction of reclaimed building materials and products from refurbished or demolished buildings into the indoor environment in order to: equip them with new functions, add new formal value, and provide them with a new spatial context resulting from their transfer and conversion from building waste to resources enabling the completion of new interior components. Through their placement in different functional and environmental contexts, the value of building materials and products is maintained, and usefulness extended. Interior architectural design for adaptive reuse concept can be analyzed from different perspectives and in multi-dimensional aspects. Building materials or products recovered from a dismantled or deconstructed building structural portions and re-introduced in a new context of internal spaces on the basis of the inter-setting adaptive reuse scheme, are becoming quality resources for the completion of refurbished or newly conceived interior space components.

#### 4.2. Implications of Interior Architectural Design for Adaptive Reuse

The scope of possible environment-oriented implications, due to the employment of this design method, is described in the Figure 3. The consequences identified by the author include the following: (1) multiple transfer of reclaimed or salvaged building materials or products and their reintroduction into structures of interior components; (2) multi-faceted implementation of reclaimed or recovered building materials or products as multifunctional structural parts of interior components; (3) structural reconfiguration of interior components achieved with partial replacement of their originally conceived parts; (4) expand-circuit distribution as more environmentally friendly than the unfavorable open-circuit linear process and achieved by drawing back building materials from refurbished or demolished building structural portions, and incorporating them into the indoor environment as interior components construction or finishing; (5) extending building products' lifespan through the reintroduction of reclaimed building materials and products, with limited treatment procedures and generated post-construction waste, into the indoor environment as a quality part of developed interior components.





**Figure 3.** Environmental implications of Interior Architectural Design for Adaptive Reuse (IADfAR).

Source: author's drawing.

The proposed conceptual model of interior architectural design for adaptive re-use, generates new design strategies and methods for the shaping of interior components. Functional and formal assimilation of reclaimed or salvaged building materials and products with interior components is an alternative to the production of their equivalent substitutes containing recycled materials. This adaptive reuse design model assures a closed-circuit model identified by Kibert [22], as being in the opposition to the once-through or open-circuit design patterns.

#### 4.3. Strategies and Methods of Interior Architectural Design for Adaptive Reuse

The effectiveness of the presented design model requires design intervention strategies to emphasize the inventive character of design based on the reintroduction of construction waste, namely reused parts of building portions, into the interior space components substance and techniques of integration from the building product's former appearance with their new image. The framework of interior architectural design for adaptive reuse corresponds to the design strategies defined by Brooker and Stone [17]. The IADfAR conceptual model identifies following possible design strategies:

- Inversion, meaning the broad acquisition of available reclaimed building products from refurbished or demolished buildings to their reintroduction into the indoor environment and adaptive reuse as valuable building materials, understood as the superior design principle aimed at building products reversal from costly reprocessing, recycling or final disposal in a landfill.
- Inclusion, meaning fragmentary inclusion of salvaged building materials or products, and their link with other parts of interior components, as means of an exercised flow of resources between the indoor environment and natural surroundings.
- Integrity, understood as established unity of building components and interior spaces constituting components, to enable multi-functional interpretation and exploration of their potential.

The design methods and the execution modes to complete the inter-setting adaptive reuse design concept are to assist consumers in understanding sustainability principles, accept pro-ecological design proposals focused on the conscious resources' management, as well as stimulate their pro-ecological



behavioral schemes. Building up a relationship based on recognition of environment-responsibility associations with appearance of an interior component can be realized through the exemplary design methods: (1) design for display to attract users' attention through the appearance of reused building materials; (2) design for interaction to build up knowledge on the impact of interior components on the natural environment; (3) design for connection to provide users with evidence on their contribution to environmental integration due to interior components selection based on adaptive reuse models.

The objectives of the above-mentioned design methods, supplemented with the exemplary execution modes to enable their application, are presented in Figure 4.

Design methods of Interior Architectural Design for Adaptive Reuse (IADfAR)	
Design for display	
objective	exposition of developed interior's component content to attract users' attention through the reused building materials or products appearance
execution	truth windows allowing partial exposition of structural components, due to limited treatment and finishes
Design for interaction	
objective	building knowledge on environmental context in interior components design with the ephasis on resources consumption in control of components impact on natural environment
execution	graphic information on the energy and resources savings due to employment of adaptive reuse architectural interior design concept
Design for connection	
objective	providing users with clear information on their environmental contribution due to selection of interior spaces components made in accordance to IADfAR concept as methods to integrate environments
execution	graphic information on the amount of materials reintroduced into indoor environment that were reversed from the landfill supplemented with costs of their disposal as alternative procedure

**Figure 4.** Design methods for application of Interior Architectural Design for Adaptive Reuse (IADfAR). Source: author's drawing.

#### 4.4. Interior Architectural Design for Adaptive Reuse Determinants

The successful application of this sustainable strategy of resource consciousness requires an innovative approach from designers in forming interior components, and developing modified design criteria focused on the limited use of new resources in order to "cause minimal detriment to the environment" [9] (p. 191). To investigate determinants for successful acquisition and recirculation of reclaimed building materials and products from structural building components in the indoor environment, the analysis of multiple data is required. Data assembled as a the result of conducted studies to facilitate the application of sustainability-oriented proposals into environmentally responsible interior design comprise: (1) feasibility studies on availability of material supply from refurbished or demolished buildings to create a distribution model, and assess the technical aspects related to method's application; (2) assessment of designers' knowledge and commitment to apply adaptive reuse design model to accomplish sustainability principles; (3) assessment of users' environmental habits, and their approach toward the implementation of reclaimed building materials or products into interior components substance.

Feasibility concerns regarding the inter-setting adaptive reuse design conceptual model address the following questions:



- Availability of building materials and products reclaimed from structural portions of refurbished or demolished buildings that are suitable for reintroduction into indoor environment, costs of their acquisition, transportation and distribution;
- Access to the online detail inventory of waste materials from demolition or refurbishment processes to be reintroduced into interior components substance;
- Access to the systems to connect building materials to reuse vendors and deconstruction contractors with architects or interior designers in order to provide them with the information about the undertaken “just-in-time building demolition” [43] (p. 391) activities;
- Assessment of physical parameters of reclaimed products, including the content of potentially harmful chemical substances used in the production and assembly processes employed initially;
- Specification of necessary restoration works or treatment procedures as preceding reintroduction of acquired building materials or products, to assure their high performance;
- Specification of treatment of materials or products to conform the current building code requirements (e.g., thermal insulation, acoustical conditions, fire safety rules);
- Accessibility of accredited green building consultants and professionals to provide expertise on the process of reintroducing reclaimed products into the interior environment;
- Accessibility of professionals skilled in performing the restoration of reclaimed building products to be reintroduced.

Reintroduction of the reused artefacts into an indoor environment involves other practical problems that address different technical and technological aspects to investigate. These refer to the evaluation of the structural obsolescence and poor durability of acquired products, as a consequence of originally employed faulty techniques and assessment of the exploitation and maintenance procedures implemented in the previous technical life phases of the objects, due to low performance standards of reclaimed building products as a result of outdated manufacturing methods and poor material quality.

The commitment of interior designers to the consequent execution of innovative design strategies focused on rationalization of resources’ consumption requires complex decision support systems, as well as the support of end users assured with the incorporation of social-cultural dimensions within the environmentally responsible interior design model. Application of IADfAR moderates adjustments in occupants’ behavioral attitudes towards the assignment of environmental perspective to design decisions, as “designing a product means designing a user experience with the product” [40] (p. 429). Indication of the potential benefits of reintroduction of reclaimed materials and products made by designers on the basis of the identification of these artefacts’ aesthetic and experience values [16], is a condition of users’ acceptance of proposed pro-ecological solution. The behavioral effects of reintroduction of reclaimed products into the indoor environment combines occupants’ engagement in the environmentally-conscious creation of the near environment, as well as their involvement in the employment of sustainable practices in other forms of activities. Thus, establishment of users’ reconnection to reclaimed building materials or products, remains another positive aspect of this innovative method in interior architectural design.

As indicated Kollmuss and Agyeman [44], an investigation to undertake prior to the project is to comprise internal factors assigned to the personal experience, (i.e., personal attitudes, individual priorities influencing the awareness of environmental impact of buildings internal surroundings) as well as external factors comprising normative influences (i.e., traditional socio-cultural models as exercised in a close circle or family customs being traditionally repeated). The Model of Responsible Environmental Behavior [44,45] forms another substantial tool for the relevant research. It emphasizes the knowledge of issues and situational factors (e.g., social pressures, opportunities to choose different actions) as important and scientifically proven variables associated with the ability of taking pro-environmental actions. All these factors can influence the users’ pro-environmental behavioral schemes, and affect their acceptance of sustainable interior design decisions, including the discussed adaptive reuse concept.



The predesign research on the socio-behavioral context of the interior design process is to provide designers with valuable outcomes on the respondents' approach toward the indoor environment, and to determine the reasons of probable rejection of IADfAR in shaping indoor environments by consumers. The exemplary factors to be identified and measured in the predesign phase are as follows:

- Recognition of the value of the environmental context applied into the interior architectural design;
- Assessment of the influence of the visual obsolescence of acquired building materials and products, as a probable source of unsatisfactory aesthetical sentiments or negative emotional responses;
- Assessment of the social obsolescence of acquired reclaimed building products, as source of confusing semantic connotations;
- Assessment of the scale of attachment to the aesthetical preferences established on the traditional socio-cultural schemes.

This research measures occupants' abilities to discover the main benefits of the reintroduction of reclaimed or salvaged building construction materials and products into interior spaces. These comprise preservation and adaptation of cultural and heritage values expressed in the valuable reclaimed components, exposure of multi-functional values of selected reclaimed components, continuity in the cultural proficiency coming from the reused building parts, expression of the identity of local building tradition, craftsman's workshop, and development of new knowledge related to technical methods of forming building components. The identification of these possible effects on values associated with human activities is to increase the users' interest in exploring the environmental context in the interior components' creation, through the application of the adaptive reuse concept. The complex introduction of this design method is to build knowledge on sustainability issues that stimulate users' sustainable behavior and encourage them to make environmentally responsible choices focused on efficient resources management.

## 5. Conclusion and Future Research

The waste that results from building deconstruction, refurbishment, or demolition is recognized as one of the leading problems by architecture critics and the design profession. The design methods and techniques toward the conservation of natural resources, minimization of energy consumption and waste production, have to be supplemented with the adaptive reuse of reclaimed or salvaged products. Regenerative and restorative objectives of environmentally-oriented interior design could be endorsed and achieved with the consequent application of the adaptive reuse of reclaimed or salvaged building materials and products in the interior design concept. This model assures resource efficiency in the interior's completion in a more than alternatively considered manufacturing or recycling processes.

The multi-faceted introduction of recovered products or their parts as proposed by the author, assuring their superuse [27] within the indoor environment can be identified as an important environmentally responsible interior design method. The reclaimed building materials and their specification in the project's documentation, can become a decisive factor in the shaping of "deep ecological aesthetic" [46] (p. 165). This notion, originally used in the context of architectural design to explore the influence of environmental factors on buildings spatial modeling, can be assigned to the interior architectural design process that includes the comprehensive management of materials, products or internal components, available on site or acquired from buildings under deconstruction or demolition.

Interior architectural adaptive reuse design model can be identified as an incentive for innovative searches for aesthetical identity, functional conformity or formal integrity of inner spaces and their components, as considered in conventional design processes. The proposed interior architectural design concept stimulates the accomplishment of environmental sustainability, endorses cognitive transformations and evolutions in the interior spaces of users' behavioral schemes and drives an interior architectural design research toward pro-ecological design solutions, assuring control over construction waste production, as well as the enhancement of resources management. This demand



is achieved with the implementation of interior architectural design for adaptive reuse, particularly through its inter-setting procedure.

This conceptual paper points out some new approaches for the sustainable interior components design and provides a starting point for further discussions on the comprehensive inclusion of adaptive reuse into the interior design methodology, highlighting the importance of the waste management criterion as for the object's ecological effectiveness. Inclusion of this concept into the decision-making process, as well as its further development is to defeat uncertainties or misunderstandings over the position of discipline in the reduction of the negative impact on the natural environment, and to build up the informed interior architectural design.

There is necessity for the complementing studies on the designers' perception of this innovative design model in order to build a framework for integrative building materials and products adaptive reuse concept within a traditionally structured linear design process. Further studies should provide empirical findings on effects of this new design method on the measurement of the designers' ability to: (1) identify the main benefits of reimplementation of reclaimed or salvaged building materials and products from structural building components into interior components; (2) explore the architectural implications of forming internal spaces components in accordance with the interior architectural design adaptive reuse model; (3) develop design techniques to shape interior components as responsive multifunctional structures within the indoor environment.

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