Architectural Dimension of Sustainability: Re-establishing the Concept of Recycling

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Abstract

Building related processes as water pollution, landfill waste, global warming gases, energy, material and land loss, are undisputable proofs of the devastating effects of the construction industry on our environment. Given that only a small percentage of a total building stock is made out of new work, it is not enough to develop strategies and principles for a sustainable design only for the new projects, but for the existing buildings as well. Therefore, it is essential that, through repurposing, we consider what can be done with what we already have if we are to significantly benefit the sustainability agenda in the future. This research focuses on the concept of architectural recycling as a method for reaching the sustainable architectural design. In the first place, two concepts, two extremes in dealing with already existing buildings will be analysed: 1) preservation as radical stasis and 2) destruction as radical change. These polar ideas will be analysed through writings and statements of its supporters, mainly those of John Ruskin, Eugène Viollet-le-Duc and Rem Koolhaas. This analysis will enable the formulation of the concept of architectural recycling as 'preservation through change', viewed as a sustainable response to rapidly changing conditions. Thus, the concept of a sustainable architectural design, with its principles and strategies, is also presented and analysed. Interventions aimed at repurposing and improving existing buildings, as an alternative to construction of new buildings, prevent the occupation of more soil and unnecessary use of more energy and materials. Architectural recycling refers to the process of altering the existing building, by using all of its available, useable material, in order to make it suitable for the new function. Unlike other terms which relate to intervention on the existing building, recycling implies the notion of change. Through this process original building is altered, in order to make the accommodation of new function possible, while using as much of the original buildings' material as possible. The elaboration of the concept of architectural recycling, as a key method for reaching the sustainability agendas, is the focus of this research.

Keywords
Preservation, Destruction, Recycling, Sustainable design

Introduction

The subject of this study refers to the topic of recycling of the existing building stock in the context of the sustainable architectural design. However, such specific research subject should be firstly explained in more general context. Namely, current trends in city development, such as rapid urbanization, the spread of poverty in urban areas and, for the first time in history, the fact that most people live in cities, do not lead to sustainable communities (Perić, 2013). Such trends have led to the ecological crisis reflected in the climate change, pollution and decrease of non-renewable resources. Construction industry is responsible for the consumption of about 50 per cent of the natural virgin materials, more than 40 per cent of the produced energy, and around 80 per cent of prime agricultural land (Edwards, 2005). The waste associated with the construction and demolition processes constitute one of the biggest waste streams produced in Europe (Cepinha, Ferrão and Santos, 2007). By overexploiting resources, a society may compromise its ability to meet the essential needs of its people in the future (Jochem, 2004). The environmental sustainability, as one of the components of a sustainable development, was recognized as especially important for this study, considering the impact the building sector has on the environment.

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Sustainable architectural design laid down the principles for the design of sustainable buildings. However, it is not enough to develop principles for a sustainable design only for the new projects. The existing buildings must also be taken into account given that structural issues are usually not the reason why buildings come to their end-of life, but rather the shift of the building's original purpose, making the existing building unsuitable for new roles and functions (Lee, Trcka and Hensen, 2011). Edwards (2005) highlights that existing buildings are central to any strategy for carbon-emission reduction. They are durable goods which can reach 100 years or more of useful life. Building renewal can extend the use of the existing buildings with diverse benefits, such as the exploitation of the existing urban infrastructure (with no need for new site development) and the lesser generation of residues in relation to a totally new construction (Cepinha, Ferrão and Santos, 2007). The process of readapting existing building for other purposes has a number of benefits, such as saving new materials from being used, and cutting the associated environmental impacts of producing and transporting those materials (Lee, Trcka and Hensen, 2011). Edwards (2005) explains that in a sustainable city, brownfield sites are exploited and existing buildings recycled. As only a small percentage of the total building stock is made up of new works, it is essential that, through repurposing, we consider what can be done with what we already have if we are to significantly benefit the sustainability agenda in the future.

Therefore, it is assumed that for the solution of problems concerning the negative effects of the building sector on environment a new approach to the existing building stock is needed. Interventions aimed at repurposing and improving existing buildings, i.e. architectural recycling, as an alternative to construction of new buildings, prevent the occupation of more soil and unnecessary use of more energy and materials. By repurposing the existing building, while using all of its available, useable material, the building's working service life is increased, and so the rentability of the resources already applied (Cepinha, Ferrão and Santos, 2007). Extraction, processing and transport of the new material is diminished through the process of recycling. Thus, the need to manufacture new components and products is lessened which has direct economic and environmental advantages (Couto and Couto, 2007). Architectural recycling is also seen as a process which can mediate between the radical stasis, reflected in the rigid rules of preservation, and the radical change which new construction implies. Therefore, the study aims at elucidation of the concept of architectural recycling as an environmentally sustainable alternative to both demolition and preservation, as two most frequently applied and extremely opposed concepts towards architectural intervention. In short, the notion of architectural recycling as 'a preservation through change' is interpreted as a sustainable response to rapidly changing conditions.

Methods

Since the subject of this study relates to the architectural recycling, as a key method of the sustainable architectural design and as a sustainable alternative to both demolition and preservation, the study focuses, the first place, on different approaches in dealing with the existing building stock. Namely, opposed concepts of architectural preservation, i.e. radical stasis, and destruction, i.e. radical change, are critically analysed as two extremes in dealing with the existing buildings. A systematic review of the concepts of preservation, restoration and destruction is presented based on the sources by John Ruskin, William Morris, Eugène Viollet-le-Duc and Rem Koolhaas, respectively. Furthermore, the analysis of the concepts of preservation, on one side, and destruction, on the other, elucidates the concept of architectural recycling and enables its positioning between these polar concepts – stasis and change.

Secondly, the research focuses on the concept of architectural recycling as a key method for reaching the sustainable architectural design. Thus, the concept of a sustainable architectural design, with its principles and strategies, is presented and analysed. Based on the thorough overview of the body of literature in the field of sustainable architectural design the notion of recycling is presented as a crucial method which ensures environmentally sustainable design. In addition, architectural recycling is elaborated as a process providing the continuity of the existing facilities' utilization through the alteration of their use.

Preservation *vs.* Destruction

Two opposing concepts, i.e. preservation and destruction, representing the extremes in architectural interventions are selected for the analysis. Preservation implies actions aimed at maintaining the building in its existing state and thus, advocates the retention of the status quo. At the other end of the scale, destruction implies complete tearing-down of the building and clearing of the site. The analysis of these concepts enables the elucidation of the concept of architectural recycling as 'preservation through change' and as a key method of the sustainable architectural design. In the following subchapters, these concepts are further analysed.

Preservation *vs.* radical stasis

Burman (1995) points out that the instant you make any kind of intervention, however subtitle, to a building you change it. He underlines that the most influential contribution to the debate about the philosophy of repair in the 19th century was made by John Ruskin. According to the same source, the most important of Ruskin's many writings which refer to buildings, and the preservation of buildings, is "The Seven Lamps of Architecture" (Ruskin, 1849) and, in particular, chapter "The Lamp of Memory" where Ruskin introduces the idea of trusteeship: "(...) it is again no question of expediency or feeling whether we shall preserve the buildings of past times or not. We have no right whatever to touch them. They are not ours. They belong partly to those who built them, and partly to all the generations of mankind who are to follow us" (Ruskin, 1849). In "The Lamp of Sacrifice" Ruskin (1849) refers to buildings as a legacy of builders given that "all else for which the builders sacrificed, has passed away-all their living interest, and aims, and achievements" except for, "one evidence [that] is left to us in those grey heaps of deep-wrought stone" - their buildings. He argued that the architecture of the past should be recognized as inheritance and preserved as a living memory. More precisely, Ruskin equals the term restoration with destruction, and explains it as "the most total destruction which a building can suffer: a destruction out of which no remnants can be gathered; a destruction accompanied with false description of the thing destroyed" (Ruskin, 1849). He considered that restoration work would cause greater damage than the actual decay of the building. Also, Ruskin believed that "death was the final fate of all beings and things in this world and that the physical ruin of the object should be the result of a more suggestive process than that rational intervention which might try to recover the 'formal unity' of the work". Furthermore, instead of recreating its original form, the memory of what a building could have become should be cherished (Mozas, 2012). He concludes that "it is impossible, as impossible as to raise the dead, to restore anything that has ever been great or beautiful in architecture" (Ruskin, 1849).

Contrary to Ruskin, who argues that any restoration work simply destroys the building and its integrity, Eugène Viollet-le-Duc believed in restoration, i.e. the conservationist school of thought based on the assumption that historic buildings could be improved, and sometimes even completed, using current day materials, design, and techniques. In his seminal work "On Restoration", Viollet-le-Duc (1845) explains that: "The term Restoration and the thing itself are both modern. To restore a building is not to preserve it, to repair, or rebuild it; it is to reinstate it in a condition of completeness which could never have existed at any given time" (Viollet-le-Duc, 1845). Reiff (1971) argues that "this does not mean that he [Viollet-le-Duc] replaces what has never existed, but that a railing changed in the fourteenth century, chapel decorations that had faded away by the sixteenth, and stained glass and statues destroyed in the eighteenth, would all be restored to their original state, although they had never actually coexisted". According to the same source, the term restoration implies the process of bringing back all possible elements of a building to its original state. Viollet-le-Duc (Viollet-le-Duc, 1845) highlights that "in restorations there is an essential condition which must always be kept in mind. It is, that every portion removed should be replaced with better materials, and in a stronger and more perfect way. As a result of the operation to which it has been subjected, the restored edifice should have a renewed lease of existence, longer than that which has already elapsed". Mozas (2012) points out that Viollet-le-Duc's rational approach was opposed to Ruskin's romantic historicism.

Burman (1995) states that "International Charter for the Conservation and Restoration of Monuments and Sites – The Venice Charter" begins with a series of definitions which have provided a quarry for debate ever since. For instance, Article 6 of the Venice Charter states: "The conservation of a monument implies preserving a setting which is not out of scale. Wherever the traditional setting exists, it must be kept. No new construction, demolition or modification which would alter the relations of mass and colour must be allowed". Rogić (2009) explains that although the type and extent of change to the existing building fabric has been the central theoretical debate of architectural conservation, the consensus always existed regarding the idea that the intervention must be minimal. However, there are different opinions on the importance of the existing building stock and especially on the role of the preservation. This is elucidated in the following subchapter.

Destruction *vs.* radical change

According to Koolhaas, a dichotomy is created for the architects by the rapid urbanization and the increasing difficulty of building in heritage areas (Fairs, 2014). Koolhaas points out that "unbeknown to us, a large part of the world's service is under a particular regime of preservation and therefore cannot be changed" which means that "the world is now divided into areas that change extremely quickly and areas that cannot change" (Fairs, 2014).

Koolhaas (2004) points out that preservation is no longer a retroactive but a prospective activity. Namely, the phenomenon of preservation escalated to the point that today, we can think about preserving things in the very moment they are produced. OMA (2010) is stressing that a new system, mediating between preservation and development, is needed. The increase of the scale and scope of preservation calls for the development of a theory of its opposite: not what to keep, but what to give up, what to erase and abandon. Through the phased demolition the idea of permanence of contemporary architecture can be dropped, revealing the tabula rasa, beneath it, ready for liberation (OMA, 2010). Pestellini (2011) explains that one of the OMA's strategies towards preservation is to approach preservation on the opposite side, i.e. destruction. More precisely, the destruction is seen as a method for preserving specific area of context.

In OMA's project for the transformation of the existing urban fabric of La Défense, Paris, the entire territory has been seen as a strategic reserve, an expansion zone, which can allow the city to modernize itself constantly. Pestellini (2011) explains that some of the fabric of La Défense is the product of a very cheap process and can be referred to as 'junk architecture'. The strategy OMA developed was to remove the existing tissue, which was regarded as irrelevant, allowing the city to grow on the area liberated by the demolition.

Economic viability of a building expires after 20, 25 or at the most 30 years and, thus, the strategy involves the process of demolition every 25 years, leaving the space for the new development (OMA, 1991). This approach would control the size of the city as well (Pestellini, 2011). The strategy involved the projection of a grid over the entire area. Through this grid a new system of selective demolition, as buildings meet their successive expiration dates, is to be applied (OMA, 1991). The grid acts as a filter, preserving the objects which are selected to stay while accommodating their geometries and generating a string of hybrids along its perimeter to achieve coherence. The presence of this grid does not imply homogeneous density, as it incorporates the coexistence of solid and void, density and emptiness (OMA, 1991).

Recycling - preservation through change

The influence of human activity on numerous subtle changes in the environment over time is becoming increasingly clear, from the bleaching of coral reefs and the polluting of oceans by regular oil spills, to the damage of human health caused by harmful processes, materials and buildings (Cepinha, Ferrão, & Santos, 2007). According to Edwards (2005), out of all resources consumed across the planet fifty per cent are used in construction, as shown in the Figure 1, which makes it one of the least sustainable industries in the world.

However, contemporary human civilization depends on buildings for its continued shelter and existence even though our planet cannot support the current level of resource consumption (Edwards, 2005). The definition of the sustainable development coined in the "Brundtland report" (WCED, 1987) has spawned a series of sub-definitions to meet particular sectorial needs. For example, Foster and Partners defines the sustainable design as the process of creating energy-efficient, healthy and comfortable buildings, flexible in use and designed for long life (Edwards, 2005). The Buildings Service Research and Information Association (BSRIA) refers to sustainable construction as a process of creation and management of healthy buildings based upon resource efficient and ecological principles (Edwards, 2005). The 'Earth Summit' (1992), United Nations Conference on Environment and Development (UNCED), included environmental degradation and resource depletion into their agenda. The discourse was broadened in "Agenda 21", and the "Rio Declaration" laid

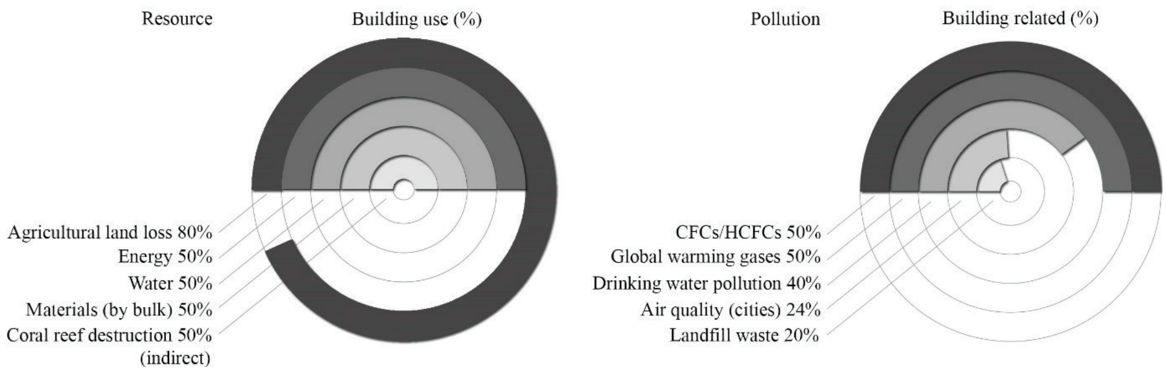

Figure 1 – Global resources used in buildings and global pollution

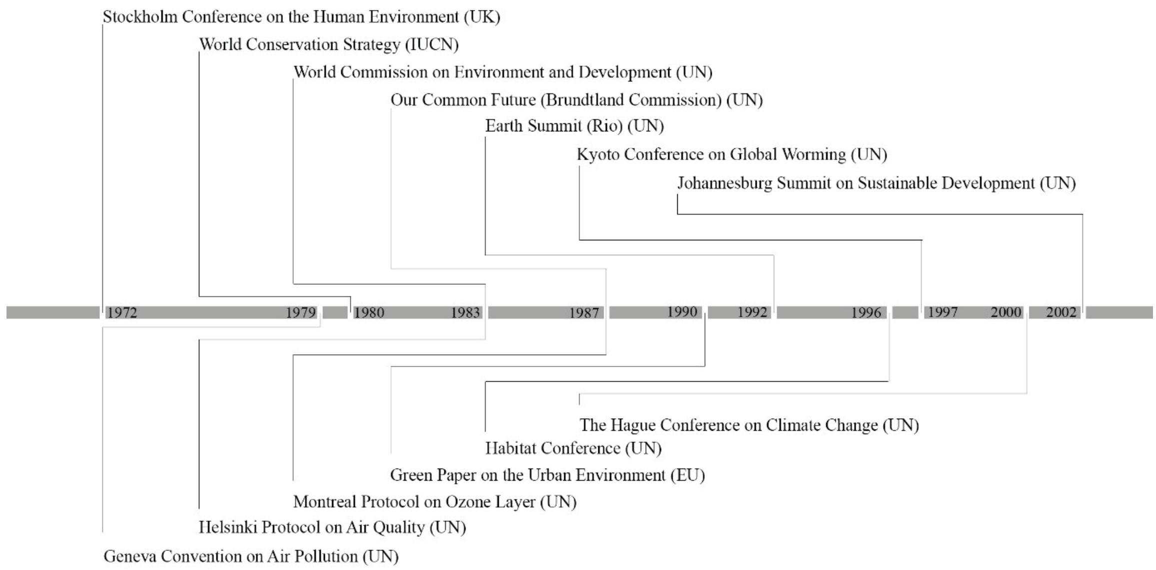

Figure 2 – Major global environmental agreements

down the principles of sustainable development. With the "Declaration of Interdependence for a Sustainable Future" at the Chicago Congress of the International Union of Architects (IUA) in 1993, architecture also joined the movement, and many national bodies and institutions of architecture began producing energy and environmental policies (Szokolay, 2004). Figure 2, designed according to Szokolay (2004), presents chronological overview of major global environmental agreements.

The International Council for Research and Innovation in Building and Construction (CIB) presented the Agenda 21 on Sustainable Construction. This document confirms the importance of the construction industry in the issue of sustainability (Cepinha, Ferrão and Santos, 2007). Given that buildings and cities are long-lived, as shown in the Figure 3, designed according to Edwards (2005), they play a fundamental role in the realisation of sustainable development.

The link between the sustainable development and the construction industry is extremely important considering the impact of this sector on all dimensions of the sustainable development; 1) contribution to national wealth – economic dimension, 2) offer of the raised number of work ranks – social dimension, and 3) raised tax of natural resources consumed and environ-

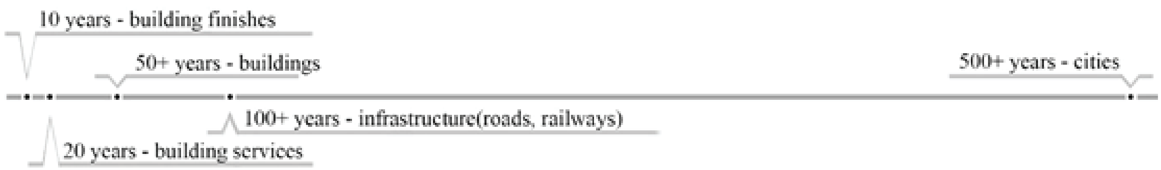

Figure 3 – Typical lives of different aspects of construction

mental loads produced – environmental dimension (Cepinha, Ferrão and Santos, 2007). As stated earlier, about 50 per cent of the natural virgin materials are consumed, at the world-wide level, by the construction industry, which is far beyond the sustainable level. More than 40% of the produced energy is consumed, in The Organisation for Economic Co-operation and Development (OECD) member countries, throughout the live cycle of the buildings, and approximately one third of the GGE (Greenhouse Gas Emission) total emissions are produced by the built environment (OECD, 2003). Edwards (2005) stresses that this percentage is even higher. Namely, 60 per cent of all resources globally go into construction (roads, buildings, etc.), nearly 50 per cent of energy generated is used to heat, light and ventilate buildings and a further 3 per cent to construct them. Further, 50 per cent of water used globally is for sanitation and other uses in buildings, 80 per cent of prime agricultural land, lost to farming, is used for building purposes, 60 per cent of global timber products end up in building construction and nearly 90 per cent of hardwoods (Edwards, 2005). The environmental capital locked in buildings is enormous, as is the waste footprint, making them one of the biggest users of raw material. The waste produced from the construction and demolition activities constitute one of the biggest waste streams produces in Europe (Cepinha, Ferrão and Santos, 2007). Rob Watson, founding father of LEED and an international pioneer in the modern green building movement, highlights: "Buildings are literally the worst thing that humans do to the planner. Nothing consumes more energy; nothing consumes more materials; nothing consumes more drinking water, and human beings spend up to 90% of their time indoors so if they are getting sick from their environment, in fact, they are getting sick from their indoor environment not form their outdoor environment" (Kubba, 2012).

The "Declaration of Interdependence for a Sustainable Future" (IUA/AIA, 1993) addressed the sustainable design in the following way: "Buildings and the built environment play a major role in the human impact on the natural environment and on the quality of life; sustainable design integrates consideration of resource and energy efficiency, healthy buildings and materials, ecologically and socially sensitive land-use, and an aesthetic sensitivity that inspires, affirms, and ennobles; sustainable design can significantly reduce adverse human impacts on the natural environment while simultaneously improving quality of life and economic wellbeing". According to De Garrido (2012), a truly sustainable architecture is one that meets the needs of its occupants, in any time and place, without jeopardizing the welfare and development of future generations. Furthermore, sustainable architecture involves using strategies with the aim at: optimizing resources and materials; reducing energy consumption; promoting renewable energy; minimizing waste and emissions; minimizing the maintenance, functionality and cost of buildings; and improving the quality of life of their occupants (De Garrido, 2012). The "Whole Building Design Guide" (WBDG) has established a set out rules and principles regarding sustainable design. WBDG's objectives are to: 1) avoid resource depletion of energy, water, and raw material; 2) prevent environmental degradation caused by facilities and infrastructure throughout their life cycle; and 3) create liveable, comfortable, safe, and productive built environments. Principles defined in the WBDG are: "1) optimize site potential; 2) optimize energy use; 3) protect and conserve water; 4) use environmentally preferred products; 5) enhance indoor environmental quality; 6) optimize operations and maintenance procedures" (Kubba, 2012).

All the above mentioned definitions of the sustainable building design confirm that only through parallel consideration of site, energy, materials and wastes can truly sustainable architecture be conceived. According to Szokolay (2004) these four components constitute the basis of a sustainable architectural design. First, the land is a non-renewable resource and all building activity disturbs the land. These disturbances should be minimised and it use should be avoided whenever possible, which would lead to the preservation of the biodiversity. Szokolay (2004) highlights that the use of already disturbed derelict land or the rehabilitation of neglected or disturbed land is desirable. Preservation and cleaning-up of land, as a non-renewable resource, has become a key issue in Europe. Protection and reuse of land and sites, and the need for brownfield development are powerful drivers for new approaches to sustainable city planning (Roaf, Horsley and Gupta, 2004).

On the other hand, the energy conservation is a central concern in the quest for sustainability, as it is expected that, by the year 2050, the world doubles its use of energy (Edwards, 2005). European Commission declared that the sustainable design is one of the priorities for the future of the construction sector (EU Commission, 2007). In order to achieve the sustainable construction, one of the main points that had to be addressed is the improvement of the energy performance in buildings. Thus, first, we have to recognize the amount of energy used to construct the building, and minimize it through good practices, as well as consider the type of energy used, looking, whenever possible, for renewable sources (Cepinha, Ferrão and Santos, 2007). By improving the energy performance of buildings a vast set of objectives can be reached, such as: "1) reduction of the global needs of energy production; 2) reduction of the emissions of carbon dioxide, and consequently of GGE; 3) improvement of comfort in households and workplaces; 4) contribution for cleaner cities; 5) improvement of urban regeneration; 6) improvement of the health of the population and promotion of the social inclusion; 7) increase the standards of living of the European citizens" (Cepinha, Ferrão and Santos, 2007). Further, as building are responsible for about 40-50% of the energy use in each member state of the EU, it makes them the main users of final energy. The residential sector is responsible for two thirds and the commercial sector for one third of the use of the energy in the buildings (Cepinha, Ferrão and Santos, 2007).

Besides the land and the energy, material is the one of the basic components of a sustainable architectural design. Due to the exponential growth of the population (as our society gets more developed the standards and requirements get each time bigger) the search and consumption of the materials increased to a hallucinating rhythm, whereas the amount of available resources presented a completely inverse scene (Yeang, 2001). Through the extraction, processing, transport, use and disposal, materials used in construction industry have enormous environmental impact. Natural resources used in construction, as roads and buildings, account for about one-half of all resource consumption in the world (Edwards, 2005). According to Szokolay (2004), material selection must be influenced by the embodied energy, but also by a number of other issues affecting sustainability of their use. Lawson (Lawson, 1996) developed a method which gives an 'environmental rating' of various building products on a straightforward 5-point scale: 1: poor, 2: fair, 3: good, 4: very good and 5: excellent (Figure 4).

	Raw material availability	Environmental impact	Embodied energy	Product life span	Freedom from maintenance	Product re-use potential	Material recyclability
Plantation-grown sawn softwood	4	4	4	3	2	2	1
Hardwood from native forests	2	2	5	4	3	4	1
Wood fibre hardboard	4	4	2	3	2	1	3
Medium density fibreboard (MDF)	5	4	3	3	3	3	2
Particleboard (chipboard)	5	4	3	3	3	1	4
Plywood	4	4	3	4	3	3	1
Glued laminated timber	4	4	4	4	3	4	2
Plastics (synthetic polymers)	3	2	3	4	4	1	3
Stabilised earth (cement or bitumen)	4	5	4	3	3	1	5
Building stone (sawn)	3	2	3	4	4	4	3
Clay bricks	4	3	4	5	5	2	3
Cement-concrete products	3	3	4	5	5	1	3
Fibrous cement (pine fibre)	4	4	3	5	5	1	1
Glass	3	3	3	5	4	3	4
Steel	4	3	3	4	3	3	5
Aluminium	4	1	1	5	4	2	5
Copper	2	1	2	5	5	1	5
Lead and zinc	2	1	2	5	5	1	5

Figure 4 – Environmental rating of various building products

Lastly, our towns and cities produce huge amounts of waste, which includes solid (refuse or trash), liquid (product of our sanitary arrangements: the discharge of baths, showers, basins, kitchen sinks and laundry tubs) and gaseous (mostly motor vehicle emissions and the discharge of power stations) wastes, and architects can have a strong influence on how wastes are disposed (Szokolay, 2004). Furthermore, the average waste produced is about 1 kg/pers.day in the UK, 1.5 kg/pers.day in Australia and up to 2.5 kg/pers.day in the USA. Collection, handling and disposal of waste is a problem, given that we are running out of space for the creation of garbage dumps (Szokolay, 2004). Combination of cheap energy, technical sophistication and abundance have caused excessive waste, and according to some predictions, global waste production will double over the next twenty years (De Graaf, 2012).

Through the analysis of the sustainable design principles the importance of the repurposing of the existing building stock, as one of the most effective methods for reaching the sustainable architectural design, and thus reaching general sustainability agendas, was confirmed. Therefore, only through the optimization of natural and artificial resources, reuse of the existing structures and materials and reduction of energy consumption and waste, can a truly sustainable architecture be reached.

The concept of architectural recycling implies the use of the existing building stock and its alteration for the accommodation of new function. Through this process building are saved from the total demolition and replacement. However, the practice of recycling is the practice of transformation, i.e. recycling demands change – the right amount of change. Through this transformation a new, viable use is affiliated to the disused building. Thus, recycling cannot be compared to preservation, which persists in maintaining status quo, nor to total replacement of a given building. Through this process a balance is searched for between the radical stasis and radical change. The concept of architectural recycling, i.e. 'preservation through change', embodies the principles of the sustainable architectural design (preservation of the embodied energy of building materials, cutting pollution and waste, and lowering impact on new land) and allows the building to evolve and adapt to market needs, while producing minimal environmental impact.

Conclusions

Two radical concepts, extremes, in dealing with the existing building, - preservation as a radical stasis and destruction as a radical change, have been analysed. The concept of preservation, promoted by John Ruskin and later William Morris, implies securing and maintaining of the formal and material condition in which the given building is found. Any alterations and upgrading are seen as a lie and a total destruction of the building's integrity. Ruskin believed that the collective memory and history are embodied in buildings which should, therefore, be preserved as found and without alterations. For Ruskin the only honest way to deal with the existing buildings is to preserve it in its original state. However, Ruskin's passive model of preservation embalms the buildings as a monument, a museum piece, and prevents a wide range or conversion schemes (which could respond to the market needs by incorporating new functions) to be implemented. This passive model of preservation no longer meets the needs of the ever-changing society. On the other hand, Viollet-le-Duc embraced the concept of restoration as a logical step in the evolution of the treatment of the original building. According to Viollet-le-Duc, restoration improves and completes original building with the introduction of new, better and stronger materials, thus, bringing a building in a state which never existed before. While Ruskin advocated passive preservation, Viollet-le-Duc promoted preservation of building through change of use, enabling in this way the continuity of the building occupancy.

On the other hand, according to Koolhaas, destruction has been seen as an answer to over -preservation which escalates relentlessly and claims new buildings and territories every year due to its elastic and vague selection criteria. He points out that preservation has become progressive action which rapidly limits construction due to its strict regimes. Koolhaas argues that through demolition space can be liberated and should serve as a strategic reserve. Further, all architecture that bears no meaning and is a product of a cheap processes should be considered as 'junk architecture' and therefore demolished. According to Koolhaas, the process of demolition should be considered a repetitive action, which needs to be implied every 25 to 30 years, corresponding to the buildings economic viability expectancy. However, demolition requires additional energy to break the building into smaller, less useful pieces. As the high proportion of this demolished building becomes waste, the stored material and energy is essentially dissipated and lost. To replace the building also entails additional energy and the use of virgin materials inherent in new construction.

Building related processes as water pollution, landfill waste, global warming gases, energy, material and land loss, are undisputable proofs of the devastating effects of the construction industry on our environment. As demonstrated in the subchapters above, construction industry is one of the least sustainable industries in the world. This worrying fact was recognised by professionals in various fields which, through summits, conferences and agreements, laid down the principles of the sustainable development and sustainable architectural design. Given that only a small percentage of the total building stock is made up of new works, this inevitably means that existing buildings play a key role in reaching the sustainable agendas. Through architectural recycling substantial material, energy and economic savings can be achieved. Through this process the embodied energy of building materials is saved and the environmental impact associated with excavation, production and transportation of the new materials is avoided. Further, the land, as a non-renewable resource, is preserved and the production of waste, associated with demolition and new construction, is minimised.

Therefore, architectural recycling has been positioned between two polar and radical methods of dealing with the existing building, preservation as radical stasis and destruction as radical change. Architectural recycling – a 'preservation through change', is a process which, contrary to passive preservation (which persists in maintaining status quo) or total replacement, through the right amount of change responds to the changing conditions while exploiting the original building to a high degree. Through this process the balance is created between the preservation and destruction, i.e. stasis and change, in order to allow the building to alter its original function and adapt to the new requirements. Through the architectural recycling, i.e. 'preservation through change', the original building is allowed to evolve and adapt to market needs through transformation and change of function, while producing least possible environmental impact.

In time of accelerated economic, social and environmental change, architecture has to be in a constant state of transformation. Flexibility is the key feature which should be nurtured as it allows the existing building to adapt to newly emerging conditions. Architectural recycling is undoubtedly a key method of a sustainable architectural design as it allows the continuity of the building occupancy through the transformation of our building stock while reducing the impact on our environment.

References

• Burman, P. (1995), 'A Question of Ethics' in: *The Conservation and Repair of Ecclesiastical Buildings*. London: Cathedral Communications

• Cepinha, E.; Ferrão, P. & Santos, S. (2007), The certification of buildings as an enterprise strategy of the real estate sector: a national scope analysis, in L. Bragança, L. & A. Cuchí, (Eds.), *Portugal SB07. Sustainable construction, materials and practices: Challenge of the industry for the new millennium*. Amsterdam: IOS Press, pp.113-120

• Couto, J. & Couto, A. (2007), Construction sites environment management: establishing measures to mitigate the noise and waste impact, in L. Bragança, L.and A.Cuchí, (Eds.). *Portugal SB07. Sustainable construction, materials and practices: Challenge of the industry for the new millennium*. Amsterdam: IOS Press, pp.56-62

• De Graaf, R. (2012), Nothing New. On the Idea of Recycling, in P. Ciorra P.; S. Marini (eds.), *Re-cycle: Strategies for Architecture*, City and Planet. Milano: Electa S.p.A, pp.50-63

• Edwards, B. (2005), *Rough guide to sustainability*. London: RIBA Enterprises

• European Commission (2007), *Progress Report on the Sustainable Development Strategy*. Brussels, EU Commission

• Fairs, M. (2014), *Dezeen Book of Interviews*. London: Dezeen Limited

• IUA/AIA (International Union of Architects/American Institute of Architects), (1993), *Declaration of Interdependence for a Sustainable Future*. World Congress of Architects, Chicago, 18–21 June 1993

• Jochem, E. (2004), *Steps towards a Sustainable Development – A White Book for R&D of Energy-Efficient Technologies*. Zurich: CEPE/ETH and Novatlantis

• Koolhaas, R. (2004), Preservation is Overtaking Us. *Future Anterior*, 1(2), pp.1-4

• Kubba, S. (2012), *Handbook of green building design and construction: LEED, BREEAM, and green globes*. Waltham: Elsevier Butterworth-Heinemann

• Lawson, B. (1996), *Building materials, energy and the environment*. Canberra: RAIA

• Lee, B.; Trcka, M. & Hensen, J. (2011), Embodied energy of building materials and green building rating systems: a case study for industrial halls. *Sustainable Cities and Society*, 1(2), pp.67-71

• Mozas, J. (2012), Remediate, Reuse, Recycle Re-processes as atonement. In Fernández Per, A.; Arpa, J. (Eds.), *Reclaim: remediate reuse recycle*. Vitoria: Colegio Oficial de Arquitectos Vasco-Navarro, pp.4-25

• OECD. (2003), *Environmentally Sustainable Buildings: Challenges and Policies*. Paris: OECD Publications

• OMA (1991), *Mission Grand Axe, La Defense, France, Paris, 1991*. Retrieved from: http://www.oma.eu/projects/1991/mission-grand-axe

-la-defense/. Accessed 05 July 2014

• OMA. (2010), *Venice Biennale 2010: Cronocaos, Italy, Venice*, 2010. Retrieved from: http://oma.eu/projects/2010/venice-biennale-2010-cronocaos. Accessed 05 July 2014

• Perić, A. (2013), *Uloga urbanističkog planiranja u procesu regeneracije braunfild lokacija (The Role of Urban Planning in the Process of Brownfield Regeneration)* Doctoral dissertation, University of Belgrade, Belgrade, Serbia

• Pestellini, I. (2011), *Preservation / Destruction: OMA – CRONOCAOS* (Lecture recording) RA Forum: Future Memory. Royal Academy of Arts. 04 April 2011. Retrieved from: http://static.royalacademy.org.uk/files/pestellini-westcott-972.mp3. Accessed 15 July 2014

• Reiff, D. (1971), Viollet le Duc and Historic Restoration: The West Portals of Notre-Dame. *Journal of the Society of Architectural Historians*, 30(1), pp.17-30

• Roaf, S.; Horsley, A. & Gupta R (eds.) (2004), *Closing the Loop: Benchmarks for Sustainable Buildings*. London: RIBA Publications

• Rogić, T. (2009), *Converted Industrial Buildings: where past and present live in formal unity* (Doctoral dissertation). Delft University of Technology, Delft, Netherlands

• Ruskin, J. (1849), *The Seven Lamps of Architecture*. New York: John Wiley

• Szokolay, S. (2004), *Introduction to Architectural Science: the basis of sustainable design*. Oxford: Architectural Press

• Viollet-le-Duc, E. (1875), *On Restoration* (e-book). Retrieved from: https://archive.org/details/onrestorationby00wethgoog. Accessed 05 Dec 2013

• WCED. (1987), *Our Common Future - Brundtland Report*. Retrieved from: http://www.un-documents.net/our-common-future.pdf. Accessed 01 Jun 2013

• Yeang, K. (2001), *El Rascacielos ecológico*. Barcelona: Gustavo Gili