...::KENT AKADEMİSİ | URBAN ACADEMY

Volume: 15 Issue: D.Ü. 2. Architecture Symposium Special Issue - 2022 | Cilt: 15 Sayı: D.Ü. 2. Mimarlık Sempozyumu Özel Sayısı - 2022

ARTICLE INFO | MAKALE KÜNYESİ

Research Article | Araştırma Makalesi

**Submission Date | Gönderilme Tarihi:** 20.10.2021

**Admission Date | Kabul Tarihi:** 08.12.2021

CITATION INFO | ATIF KÜNYESİ

Eren, B., Darçın, P. (2022). Open Source Architecture and Environmental Improvement Potentials, *Kent Akademisi Dergisi*, *15*(Dicle Üniversitesi 2. Uluslararası Mimarlık Sempozyumu):130-140. https://doi.org/10.35674/kent.1012720

# Open Source Architecture and Environmental Improvement Potentials | Açık Kaynaklı Mimarlık ve Çevresel İyileştirme Potansiyelleri

Berna Eren[1], Polat Darçın[2]

***Öz***

*İnsanların ihtiyaçlarını karşılamak üzere gerçekleştirdiği eylemler sırasında çevreye zarar verildiği bilinen bir gerçektir. Söz konusu olumsuz sonuçların oluşmasında insanın diğer eylemlerinin yanı sıra yapma çevreyle ilişkili olanların önemli bir yer tuttuğu, yapım endüstrisindeki mevcut işleyişin ise bunda büyük bir paya sahip olduğu söylenebilir. Güncel mimarlık pratiğinde yapımla başlayan, yararlı kullanım ömrünün sona ermesiyle yapının yıkımı ve yıkımı izleyen diğer aşamalar boyunca devam eden bu doğrusal süreç, sürekli birbirini tekrarlayan bir yapım ve yıkım döngüsü içinde doğal çevreyi her geçen gün daha da fazla tahrip etmektedir. Bu sorunun çözülebilmesi için mevcut işleyişteki belirli noktalara odaklanan cılız gayretler yerine düşünme sistemini değiştirecek yeni bir yaklaşım gerektiği ortadadır. Bu amaç doğrultusunda bilgisayar teknolojilerinde doğduğu hâlde farklı disiplinlere ve özellikle mimarlık alanına sıçrayarak bir demokratikleşme hareketine dönüşmüş olan açık kaynak düşüncesi ve son 30 yılda yapma çevreye ilişkin ortaya çıkardığı yenilikler ele alınmıştır. Çalışma kapsamında açık kaynak kavramının mimarlık disiplini üzerindeki yansımaları örnekler üzerinden incelenmiş ve açık kaynaklı mimarlık anlayışının yapma çevrenin çevresel etkileri konusunda ne gibi faydalar sağlayabileceği irdelenmiştir. Çoğunlukla fikirlerin ücretsiz ya da uygun bedellerle paylaşıldığı platformlar ve dijitalleşmiş yapım yöntemleri üzerine ilerlemiş gibi görünse de açık kaynaklı mimarlık örneklerinin daha derin ve önemli bir değişim potansiyeli barındırdığı görülmüştür. Mevcut çevresel sorunların yapma çevrenin yaşamında birbirinden keskin sınırlarla ayrılmış süreçler ve aktörler olduğu düşünülürse, bu çalışmada incelenen açık kaynaklı mimarlık uygulamalarının mevcut işleyişteki doğrusallık yerine; her sürecin aktörünün bir diğeriyle çok daha etkili bir iletişim sağlayabildiği, kullanıcı katılımına, esnekliğe, yerel ürün tercihine ve ileri dönüşüme olanak veren döngüler yaratma potansiyeline sâhip olduğu belirlenmiştir. Böylece hem doğa hem insan açısından çok daha iyi sonuçlar verebilen bir yapma çevrenin oluşturulması ve bu fikrin yaygınlaştırılması için uygun bir ortam yaratılabileceğine inanılmaktadır.*

***Anahtar Kelimeler: Açık Kaynak, Açık Kaynaklı Mimarlık, Mimari Süreçlerde Aktörler, Yapma Çevre – Doğa İlişkisi***

**ABSTRACT**

*It is a well-known fact that humans harm the environment during the endeavors they do to fulfill their needs. It can be stated that adverse results are mainly related to creating built environments and the mechanism of current construction industry has a major role. This linear process, which starts at the end of design and continues through the aftermath of demolish of the building at the end of its useful life, has been gradually destroying the natural environment in a repetitive cycle of construction and demolition. It is obvious that a new approach is needed for a shift of paradigm instead of weak attempts that focus on specific subjects of current situation. For this aim, the notion of open source, which emerged in computer technologies, adopted by different disciplines and started a democratization movement, is discussed in this research. The projection of this concept over the field of architecture in the last 30 years has been examined through different examples and the potential benefits of this advancements are reviewed in the context of creating positive outcomes for environmental interaction. Even though the open source architecture seems to advance through sharing platforms and digitalized production methods, we notice that examined references hold a deeper and more effective transition potential. It is logical to regard the hierarchical stages that are embraced for the life of built environments as the main reason for environmental problems and accordingly the examination results of this study reveal*

[1] **Corresponded Author:** Yıldız Technical University Faculty of Architecture, bernaeren213@gmail.com , ORCID: 0000-0001-7199-4055

[2] Yıldız Technical University Faculty of Architecture, darcinpolat@yahoo.com, ORCID: 0000-0001-9508-0290

*that open source architecture can create productive and integrative cycles to allow a better engagement, flexibility with local preferences and upcycle opportunities. Therefore, we believe that a more tangible idea for a built environment which can produce net positive results for humans and nature can be created.*

***Keywords: Open Source, Open Source Architecture, Actors in Architectural Processes, Built Environment – Nature Relationship***

## **INTRODUCTION**:

It is a well-known fact that most of the human endeavors, widely known for their damage on ecological (Rees, 1999) and social systems, are related to built environments. A built environment can be defined as a new and man-made surrounding and it can be stated that prevailing paradigms are the main factors that shape the decisions related to these living spaces. Meeting the needs of humans has been the principal purpose of built environments (Balanlı & Öztürk, 2006) mostly in compliance with largely adopted mechanistic worldview that regards humankind over and independent of nature (Cole, 2012a). All over the world, many harmful outcomes can be observed in stages such as construction or usage (IEA, 2013). Ever-increasing adverse effects extremely disorganize natural systems' functioning to or beyond critical limits (Hofstra & Huising, 2013). However, it is stated that humans are deeply dependent and interrelated to both natural (Cole, et al., 2012) and their own social systems and any negative effects will harm human well-being (MEA, 2005) eventually.

To manage the critical balance between humans' needs and environmental requirements, consequential changes become necessary. In this context, it is almost a requisite to consider Haggard et al.'s (2008) statement: there is a primal need for a shift in paradigms before changing endeavors or methods. Building a sustainable future can be managed by moving towards eco-centric concepts instead of mechanistic discourse. At this juncture, as Zhang (2014) indicated, it is very essential to find proper ways to engage practitioners in creating built environments that support environmental wellbeing. In order to address the necessity of approaches and proper support tools, this study aims to examine the potentials of a different approach that has created by the projection of open source movement from computer technologies over the field of architecture.

With the help of fast developments in production and communication technologies, the open source notion has created new and easier ways of sharing, collaboration and construction in the discipline of architecture. There have been various responses to this movement through many different applications some of which bear a vast potential to redefine and reorganize the whole process. Particularly certain advancements experienced under the effects of this notion reveal that the well-defined hierarchical stages, which create barriers and prevent a better collaboration opportunity between their actors, are no-longer necessary according to Ratti et al. (2011). Since it is possible to regard this stratified hierarchy as the main reason behind today's environmental problems, it can be stated a chance of reorganizing the whole process can definitely help for decreasing negative effects of built environments and even a net positive development. It is believed that examining the implications in open source architecture systematically over the stages in the life of a built environment can reveal those potentials.

The study has been organized in two main sections: examining the development and properties of open source architecture and exploring its possible contributions for more integrative living spaces through a systematic comparison with conventional process and by correlating differentiated activities with its stages. It is believed that the findings of this study can generate consistent principles for implementable methods. Given the primary focus is on energy consumption to a vast majority, the benefits of researches with stated aim are noticeable.

## 2. Open Source Architecture

The open source notion has emerged in computer technologies during 1980s as a reinstitution of the concept of sharing technological information against the commercialization of software. The main idea has been shaped in line with free software movement to grant any user the opportunity to access, use, modify and share source codes: the human readable form of software (OSI, n.d.). Through time, this perception has been adopted by various different professions for various products, information or systems and evolved into a democratization movement.

There have been many responses to open source notion in the discipline of architecture as well in the last 30 years. With the projection of the idea, an architectural environment has emerged where designers can share their knowledge, ideas or experiences free of charge or for a reasonable fee and users can be involved in both design and production by sharing their demands and opinions. Through open source architecture, architectural services can become more accessible, affordable and sustainable.

The reflections of the open source concept can be examined through examples under certain categories:

### 2.1. Sharing Platforms

From the very beginning, various sharing platforms have been the leading reaction. It can be observed that they have been diversified and developed through time from websites for just sharing design / construction drawings towards online / face-to-face interaction platforms for exchanging ideas, knowledge and experiences. One of the first initiatives is a non-profit organization: Architecture for Humanity founded by Cameron Sinclair and Kate Stohr to seek out architectural solutions for humanitarian crises by pairing locals with design professionals, providing education and raising awareness (Sinclair, 2006).

Unfortunately, the founders and board members of this non-profit organization had to filed for bankruptcy in 2015 (Howard, 2016). After the collapse of Architecture for Humanity, its members have banded together to relaunch the organization under the name of Open Architecture Collaborative and continue their mission of providing designers, professionals and local residents a platform to work together in order to find solutions for problems (Open Architecture Collaborative, 2016). Participation, transparency and sharing ideas are the main focus.

Paperhouses which is founded by Joana Pacheco is one of other sharing platforms. She saw the solution of affordable housing crisis in an open source approach and thought that by increasing the role of technology and shared knowledge, it is possible to develop both affordable and high quality housing (Pacheco, 2016). In this platform, architects can share their designs with other professionals and non – professional users to be downloaded, adapted and used for free of charge.

### 2.2. Buildings that can be Assembled by Non-professional Users

Open Systems Lab is one of the leading organizations founded by Alastair Parvin, they have created WikiHouse: a group of single-story houses that can be rearranged and constructed by non-professional and inexperienced users in a short period of time (Wikihouse, n.d.). The main elements of the building are assembled by using numbered plywood pieces which can be downloaded and digitally manufactured in a local laser cutter (Figure 1).

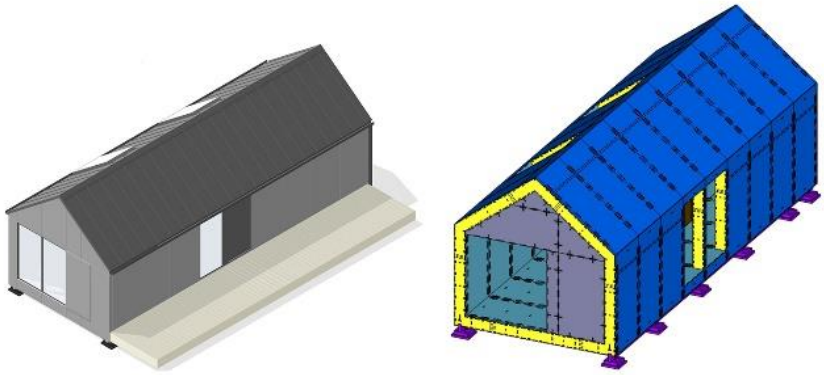

Figure 1. Microhouse assemble scheme (GitHub, n.d.)

PD Lab has been developed as a part of a research project conducted by students of Delft and Eindhoven Technology Universities. With digital design and production methods, a high quality, affordable, energy efficient and sustainable unit (Figure 2) that can be dismantled, reused and rearranged has been created by assembling CNC cut wooden modules (Bilow, et al., 2015).

Figure 2. PD Lab (Veeger, 2020)

Open Building Institute, another non-profit organization focused on ecological and cost- efficient buildings, has created an open library for building elements such as walls and roofs (Open Building Institute, n.d.). These elements (Figure 3) are designed specifically to contribute to water efficiency, passive heating, etc.; are presented in open source software and can easily be downloaded, rearranged and produced by non-professionals.

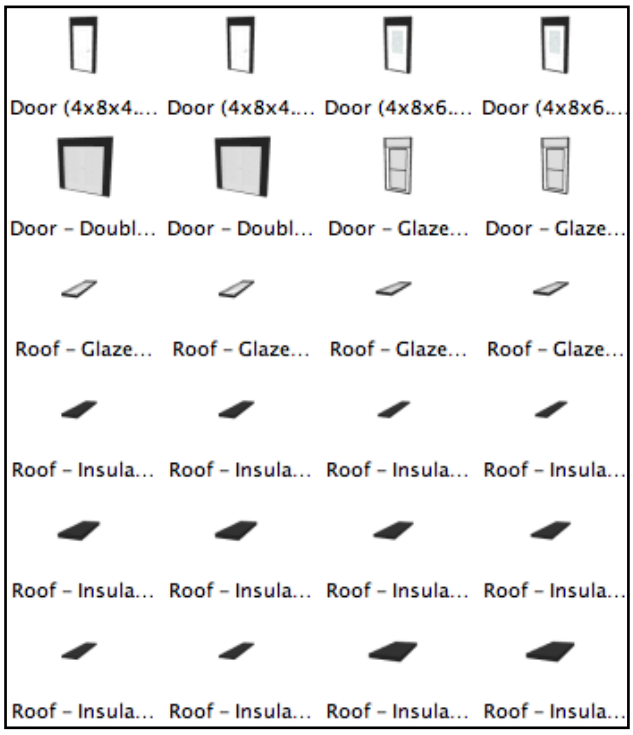


Figure 3. Modular building elements (Open Building Institute, n.d.)

### 2.3. Construction Techniques

Apart from the buildings and building products, certain researchers are designing open construction techniques. TERRA-Ink is one of them, developed by a collaborative team work of TU Delft and Eindhoven University of Technology. This method focuses on layering local soil by implementing 3D printing technologies (Figure 4) to create durable structures that can be easily demolished at the end of useful service time (Venturi, 2018).

Figure 4. TERRA-Ink (Venturi, 2018)

CAST Formwork System (Figure 5), developed by Nadia Remmerswaal, is a reinforced concrete formwork that can be easily set-up and disassembled with CNC cut pieces. The main purpose is to provide a new and open source construction alternative to be used safely in low-income areas by non-professional locals (CAST Formwork System, n.d.).

Figure 5. CAST Formwork System (CAST Formwork System, 2017)

Based on the examined categories, it can be stated that the open source notion has triggered a more developed, multi-layered inspiration for discipline of architecture. Professionals, approaching from different perspectives, has reembraced the idea of design and construction and generated a synergy that re-defines the interaction between many actors. This synergy holds a vast potential for a more prosperous paradigm for the re-organization of the whole process towards net positive environmental results.

## 3. An Improved Process for Built Environments

All information & computer science advancements practiced in manufacturing – also identified as the fourth industrial revolution – have certain effects on the life of a built environment. These effects can be revealed by examining the whole process under certain stages. Differentiated properties can be identified by comparing the operation, relations and results of conventional stages with changing procedures in the open source architecture.

### 3.1. Conventional Stages of a Built Environment

In the conventional practice, the whole life process can be examined under four separate, restricted stages: design, construction, usage and after-use. Each stage has a leading actor: investor, designer, constructor and user, with pre-defined activities, limited authorities and minimum interaction. It can be observed that at the end of design and construction activities, mostly a rigid, unadaptable living spaces are being created in an ever-changing environment for users with very dynamic needs. Designers, depending on their own knowledge and previous experience, try to generate ideal living conditions based on their analysis of context and content in a very limited time frame. The main duty of the contractor is to materialize this idealized scenario. However, it can be easily seen that the essential discrepancy between dynamism of the conditions with stability of the fiction and structure creates the main problem: an unsustainable built environment. After the construction stage, it is just a matter of time for the conditions or needs to change and the system to lose its ideal quality. When

this happens, there are two options: either try to tolerate and endure the usage stage or terminate it, demolish the building – at best recycle or reuse its products (Figure 6).

Especially the 20th century has been depicted with scientifically evidenced environmental degradation (Cole, 2010), notably because of decisions made by overlooking their forthcoming impacts: natural and social environments are being damaged during each stage with harmful emissions, resource depletion, waste disposal etc. (UNEP SBCI, 2009). As many users are insensibly devoted solely to consume these living spaces, most of the buildings eventuate in wastes and will be replaced with new ones, generally to be the subject of a similar journey.

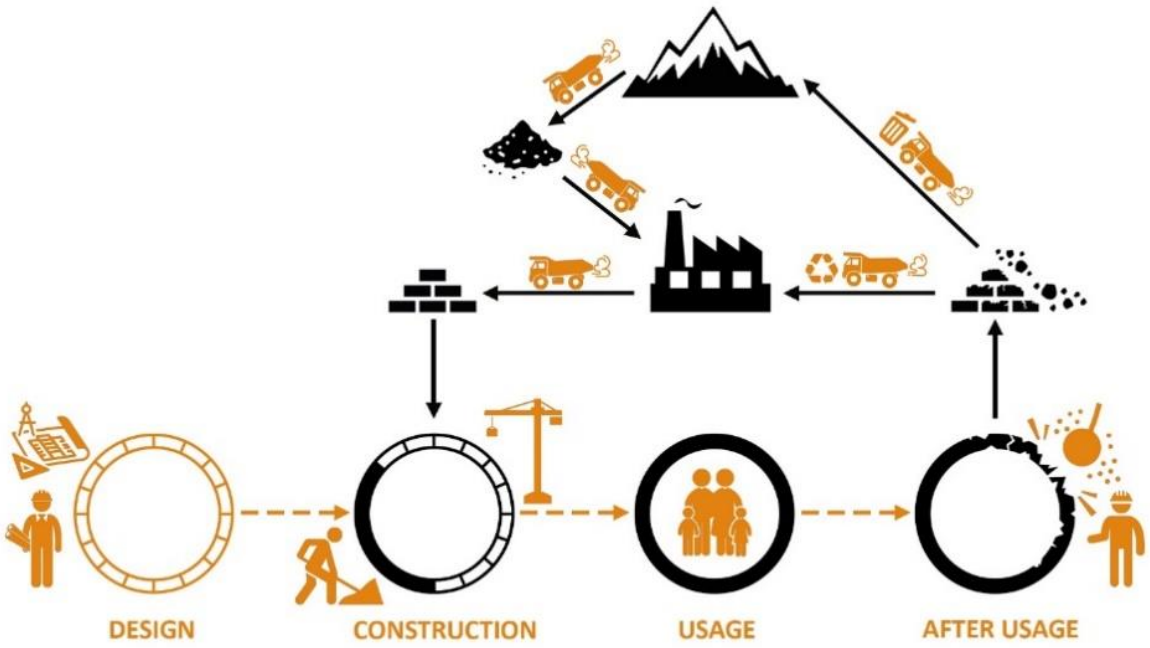


Figure 6. The conventional life of a built environment

### 3.2. Possible Benefits of Differentiated Stages in Open Source Architecture

Nature must not be a passive victim against human actions, instead both should be considered as equal participants and a consciously organized built environment can be regarded as a key component of this future of increased ecosystem health and human prosperity. Pursuing and sustaining healthy lives in a certain place are dependent to the quality of interactions between all living entities (Mang & Reed, 2015). For that matter, the need for a consideration of an association becomes essential (du Plessis, 2012). The main aim of this alliance should be to create a co-evolutionary partnership comprised of humans and other living entities, their interrelated activities and physical non-living surroundings (Anderies, et al., 2006) which targets to add value for the whole system instead of a managerial diminishment (Cole, 2012b).

The basic difference brought by the open source notion relies not in the activities but in its essence: the idea of sharing creates a huge potential of various interrelations between different actors. In the first place, there is a chance of an interaction between designers and users, other designers, specialists, people who know the design area thoroughly etc. This interaction can potentially produce an advanced analysis by examining the context and content in a wider and deeper way both temporally and spatially. By this way, not only the needs of the users, but also character of the place with all its key

elements, their properties, needs and interactions can be deeply comprehended. Thereby, it will be possible to organize the forthcoming steps on the basis of its fruitful outcomes.

The online access opportunities and presenting the documents of designed buildings in free and easy-to-use software provide users to re-arrange the living spaces according to their needs. Digital manufacturing techniques and consciously organized assembly methods also offer the possibility for users to undertake an active role during the construction activities as well. All these advancements can lift the boundaries between actors and stages, an effectual integration of design-construction activities can be spread throughout the whole process. By a collaborated team work of specialists and non-professional, unskilled users and with the possibility to benefit from different open source examples, these activities become flexible, open to be developed by various open source methods. With this adaptability, innovative solutions can be gained whenever there is a change in environmental conditions or needs. One of the additional benefits of this system is the flexibility of product decisions, it can be possible to locally select a variety of building products that can be more suitable and proper. Indicated connections can also be made between different users which will affect the after-use stage positively. When the usage of the whole or certain parts of the building ends, the products can be shared and even upcycled by different users.

It can be stated that all these integrated interactions blur the hierarchical division between actors and stages of the conventional practice (Figure 7). Organizing activities throughout the life of a built environment in a collective, transparent and flexible manner gives the chance to re-arrange the whole process in a productive cycle integrated with local systems towards the aim of providing mutual benefit instead of a linear lifespan from resources to wastes.

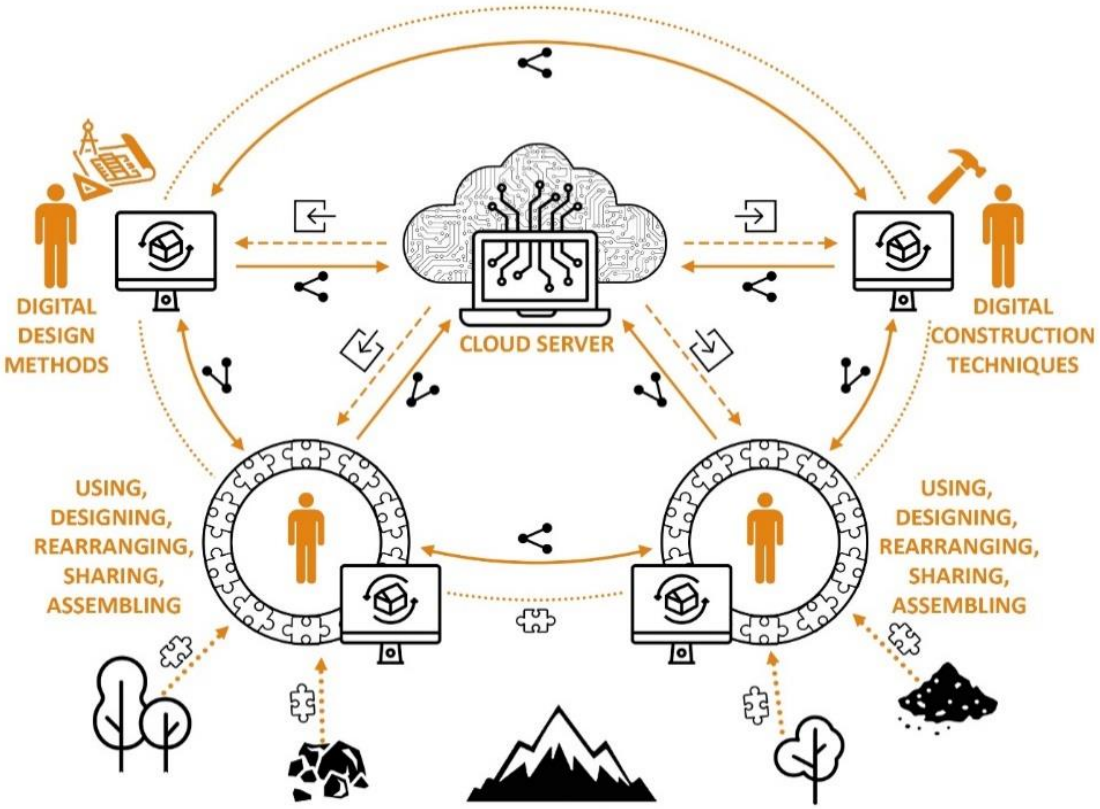


Figure 7. Collaborative activities in open source architecture

**CONCLUSION**:

A built environment can be contemplated as a proper mediator for a continuous and healthy life for both humans and ecosystems in a place, it can be organized to exist integrally with natural and social processes. In order to achieve this, more practitioners should be motivated against the complicacy of the mission. As an honest effort to address this deficit, a systematic evaluation of a potentially beneficial projection of open source notion to architecture discipline has been the main concern in this research.

Throughout the development of open source architecture, different examples and alternative methods have emerged for especially the construction stage. With the help of sharing and communication platforms and digitalized construction techniques, more flexible built environments that can be easily re-organized by non-professionals according to their needs are made possible. Many of these techniques allow users to upcycle building products in after-use stage. It can be stated that all these opportunities can help for a tangible decrease in depletion of natural resources throughout stages that follow design. However, the most effective advancement can be realized as an opportunity to re-organize the whole life process based on improved interactions between different actors. It is believed that this realization holds a great importance mainly because of the fact that the value of a role comes from the pattern of relationships which allows exchanges of that value in a system.

Impulsive advancements like the open source notion can trigger a new social organization over a better human-nature-society engagement. Adopting systems thinking to focus on the whole rather than fundamental parts, relationships over isolated entities and processes before structures, it will be possible to comprehend a living space as a shared system that integrates different systems of nature, humans, structures etc., their interrelated activities, organizations and interactions between each other and non-living environments. By this way, instead of causing harm, this intervene can produce capacity to sustain positive evolution in time, become a stimulant within its place of organization that receives and transforms inputs to net positive outputs through its designed features.

It is hoped that this study will be useful in order to start a discussion towards searching for better, implementable and systematic solutions for different stages of a built environment. With this aim, we believe that more practitioners can embrace support tools against current insufficiencies and intricacy of the subject. However, detailed future interdisciplinary researches are needed in order to find out how to create and apply these tools actively in design processes along with follow-up studies to test their efficiency.

**Compliance with Ethical Standard**

**Conflict of Interests:** The authors declare that for this article they have no actual, potential or perceived conflict of interests.

**Ethics Committee Approval:** Ethics committee approval is not required for this study.

**REFERENCES**:

Anderies, J. M., Walker, B. H. & Kinzig, A. P. (2006). Fifteen weddings and a funeral: case studies and resilience based management. *Ecology and Society, 11(*1), art 21.

Balanlı, A. & Öztürk, A. (2006). *Yapı biyolojisi yaklaşımlar*. YTÜ.MF.YK-06.0759, YTÜ Basım Yayın Merkezi.

Bilow, M., Entrop, B., Lichtenberg, J., & Stoutjesdijk, P. (2015). PD Lab. *SPOOL, 2*(2), 5-8. https://doi.org/10.7480/spool.2015.2.962

CAST Formwork System. (n.d.). *What is it?.* Retrieved September 25, 2021, from http://www.castformworksystem.com/#post-180

CAST Formwork System. (2017, January 27). *Photo's Pooring & End Result Prototyping Delft.* Retrieved September 25, 2021, from http://www.castformworksystem.com/#post-180

Cole, R. J. (2010). *Emerging issues in building design.* Sustainable Built Environment – Vol. I, Encyclopedia of Technology, Information and Systems Management Resources, Encyclopedia of Life Support Systems (EOLSS – An Integrated Compendium of Twenty Encyclopedias). https://www.eolss.net/Sample-Chapters/C15/E1-32-03.pdf

Cole, R. J. (2012a). Regenerative design and development: current theory and practice. *Building Research & Information, 40*(1), 1-6. https://doi.org/10.1080/09613218.2012.617516

Cole, R. J. (2012b). Transitioning from green to regenerative design. *Building Research & Information, 40*(1), 39-53. https://doi.org/10.1080/09613218.2011.610608

Cole, R. J., Busby, P., Guenther, R., Briney, L., Blaviesciunaite, A., & Alencar, T. (2012). A regenerative design framework: setting new aspirations and initiating new discussions. *Building Research & Information*, *40*(1), 95-111. https://doi.org/10.1080/09613218.2011.616098

du Plessis, C. (2012). Towards a regenerative paradigm for the built environment. *Building Research & Information, 40*(1), 7-22. https://doi.org/10.1080/09613218.2012.628548

GitHub. (n.d.). *Wikihouseproject / microhouse.* Retrieved September 25, 2021, from https://github.com/wikihouseproject/Microhouse

Haggard, B., Reed, B., & Mang, P. (2008). Regenerative development. *Revitalization*, March/April, 24-26.

Hofstra, N., & Huisingh, D. (2013). Eco-innovations characterized: a taxonomic classification of relationships between humans and nature. *Journal of Cleaner Production, 66,* 459-468. https://doi.org/10.1016/j.jclepro.2013.11.036

Howard, D. (2016). *Architecture for humanity founders and board members sued for $3 million, dezeen*. Retrieved October 25, 2021, from https://www.dezeen.com/2016/07/13/architecture-for-humanity-founders-board-members-sued-3-million-dollars/

IEA (International Energy Agency). (2013). *Transition to sustainable buildings: strategies and opportunities to 2050*. OECD / IEA.

MEA (Millennium Ecosystem Assessment). (2005). *Ecosystems and human wellbeing: synthesis*. Island Press.

Mang, P., & Reed, B. (2015). The nature of positive. *Building Research & Information, 43*(1), 7-10. https://doi.org/10.1080/09613218.2014.911565

Open Architecture Collaborative. (2016, March 10). *What We Believe - Open Architecture Collaborative* [Video]. YouTube. https://www.youtube.com/watch?v=13KtKUfYGGI&t=40s&ab_channel=OpenArchitectureCollaborative

Open Building Institute. (n.d.). Retrieved September 25, 2021, from https://www.openbuildinginstitute.org/about-what-we-do/

OSI (Open Source Initiative). (n.d.). *Basics of open source*. Retrieved September 25, 2021, from https://opensource.org/faq#osd

Pacheco, J. (2016, April 29). Why Aravena's Open Source Project is a Huge Step Toward Better, Cheaper Housing for Everyone. ArchDaily. Retrieved September 25, 2021, from https://www.archdaily.com/786528/why-aravenas-open-source-project-is-a-huge-step-toward-better-cheaper-housing-for-everyone?ad_medium=widget&ad_name=recommendation

Ratti, C., Antonelli, P., Bly, A. et al., (2011). Open source architecture (OSArc), *Domus*, *948*. https://www.domusweb.it/en/opinion/2011/06/15/open-source-architecture-osarc-.html

Rees, W. E. (1999). The built environment and the ecosphere: a global perspective. *Building Research & Information, 27*(4-5), 206-220. https://doi.org/10.1080/096132199369336

Sinclair, C. (2006, February), *My wish: A call for open-source architecture* [Video]. TED Conferences. https://www.ted.com/talks/cameron_sinclair_my_wish_a_call_for_open_source_architecture?language=en

Wikihouse. (n.d.). *About*, Retrieved September 25, 2021, from https://www.wikihouse.cc/About

Veeger, M. (2020, January 25). *PD Lab Moves to Green Village*. AE+T Blog. Retrieved September 25, 2021, from https://tudelftaet.wordpress.com/2020/01/25/pd-lab-moves-to-green-village/

Venturi, T., Turrin, M., Setaki, F., Veer, F., Pronk, A., Teuffel, P., Moonen, Y., Slangen, S. & Vorstenmans. R. (2018). TERRA – INK. Bakker, S. (Ed.). *Research to reality* (pp. 224 – 227). TU Delft Open. https://bureaubakker.com/wp-content/uploads/2018/12/Research-to-Reality-4TU.Bouw-2014-2017.pdf

Zhang, X. (2014). Toward a regenerative sustainability paradigm for the built environment: from vision to reality. *Journal of Cleaner Production*, 65, 3-6. https://doi.org/10.1016/j.jclepro.2013.08.025