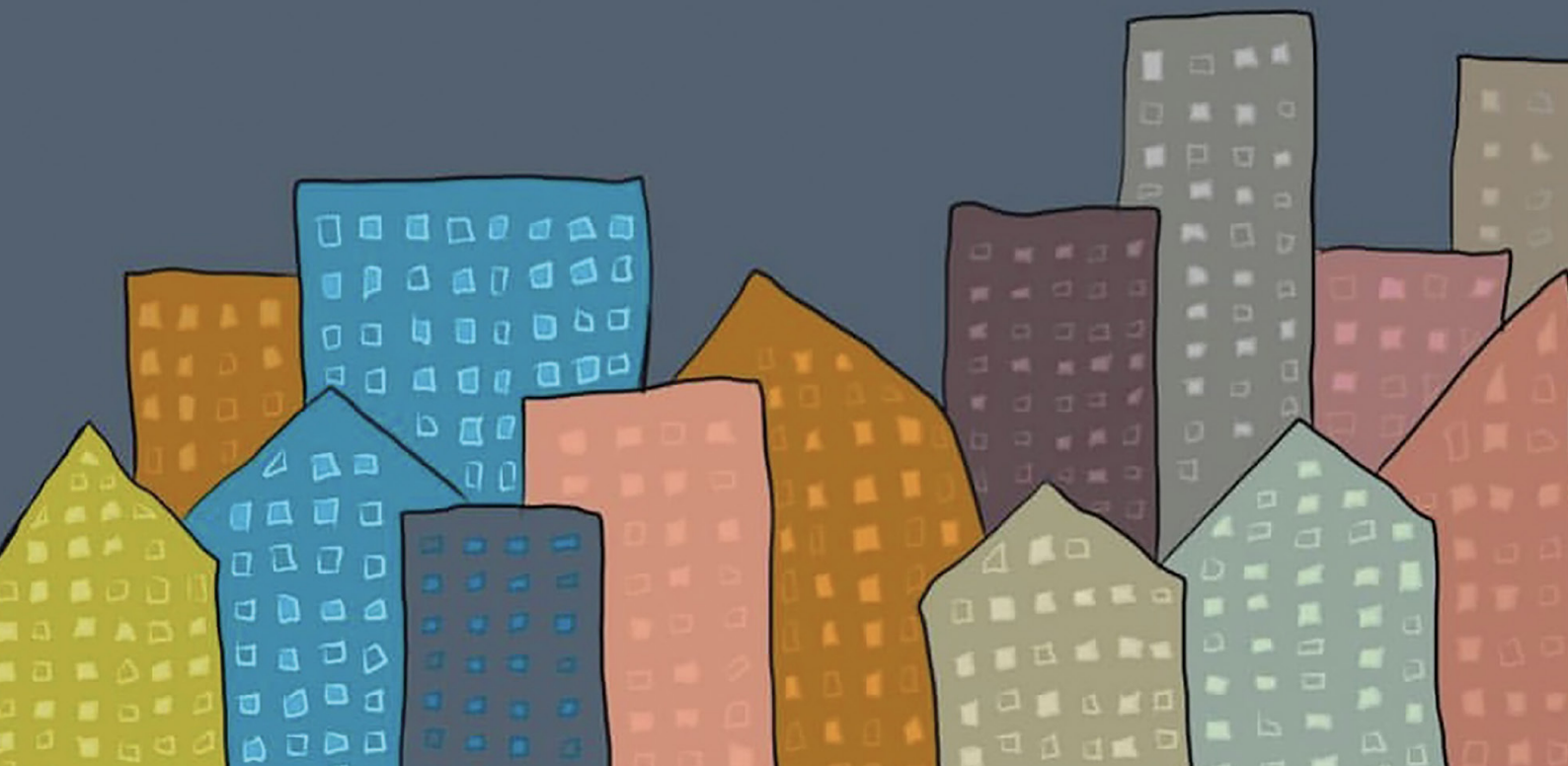


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# Sustainability of the Build Environment and its Impact on User Performance. Case Study Polis University

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**Abstract:** The built environment is important not only for its users and owners, but also for the community and society as a whole, and yet, construction is one of the most energy consuming, destructive, and moreover material consuming industries. Deficiencies with adaptability to meet changing needs in terms of sustainability in architecture can eventually cause needless costs, environmental pressure and dissatisfaction. The aim of this study is to explore whether the circular construction and sustainability of built environments is not only a matter of reducing environmental impacts and limiting the use of non-renewable resources, but it can be successfully used to enhance of environmental protection, social equity, and economic development of a facility. Furthermore, the study tries to understand whether we can use circularity principles not only for the building to be more sustainable and in line with circular economy principles, but also be used to enhance user performance, in this specific case the performance of student and academic staff. The study was applied to Polis University and its premises. Two survey formats were specifically designed to collect data on overall functionality and comfort of Polis University facilities, as well as data on academic staff and student self assessment performance. The study emphasizes the importance of the elements of sustainable built environment, and the care that designers and builders need to achieve what is called optimal comfort and functionality of each element, keeping in mind not only end users but also environmental, social and economical aspects as a fully accomplished sustainable architecture design.

**Keywords:** built environment, circularity, sustainability, university, performance, functionality, comfort, assessment.

## 1. Introduction

The built environment is important not only for its users and owners, but also for the community around it. Deficiencies with adapting to meet changing needs in sustainability can eventually cause needless costs, environmental, economical and societal pressure. In many cases the desired performance nor the foreseen impact performance of the sustainable build environment is not explicitly expressed and recorded in the design brief and in design documentation of a specific building. (Huovila and Leinonen, 2001)

Circular economy or circular architecture is not a new concept. Even before the concept of the circular economy existed, the concept of circular construction was introduced, and there had been major and radical changes and transformations in the construction sector. But, the concept of circularity is being limited to only waste minimization and recycling maximization, or environmentally related benefits. This of course, does not make the buildings sustainable, because sustainability requires a lot of effort and a variety of disciplines (Ogunmakinde et al., 2017). But, in a broader and generalized definition, concept of sustainability and specifically circularity in construction, means trying to adapt them to the constantly changing world of today.

Campus (or University facilities) design is a perfect example on how important it is today's world to apply circular architecture consciously, and to thoughtfully use it not only for building sustainability but also for increased user performance. Performance at university level is of a particular importance, given the fact that it educates and enhances future generations, the future workforce who contributes in this sense to the overall performance of a city or state. Increasing the capacities of the students and academic staff of a university in particular, should receive an important focus in the environment where these generations grow and form.

But circularity does not come easy in construction. There have been a few manuals addressing the need of a unified design protocol in this front. The Design Protocol for dynamic and circular structures, generally is created to inform designers and leaders about the transformation limit and reusability potential of the design and the effects of design arrangements during the conceptual design stage. It intends to help the design of reversible building structures - and more explicitly workplaces, apartments and public structures with high transformation limit and reusability potential. Few of the design elements that we need to keep in mind when we think of circularity, relates to the building structure, in its core, which is an unpredictable framework and is planned by enhancing three major subsystems,

functional, technical and aesthetic subsystems. Reversible design configuration for example, and one of the most effective, adds extra intricacy to the design process by incorporating the time factor in the design process which requires numerous utilization scenarios for building space and the needed materials. The reversible building structure design and configuration process intends to bring about the meaning of a transformation model with characterized limits and boundaries, which educates the owner as the user of what the planned structure can do and its ability to change is (Durmisevic, 2019). Reversible design is very efficient, since it can be applied to already existing building as well as to new ones. It is important for engineers and architects to become familiar with these factors in their design and implementation of the build environment.

Moreover, and more importantly circularity and sustainability principles need to be constantly used to achieve the required level of comfort for users. It is also important that designers of different categories benefit from the research results and recommendations to create new innovative ways to enhance employee productivity and performance across all types of work, all in line with the new need and demand for circular economy in architecture and construction.

In this regard, the aim of this study is to explore on whether the circular construction principles and sustainability of built environments, is not only a matter of reducing environmental impacts and limiting the use of non-renewable resources, but it can be successfully used to enhance of environmental protection, social equity, and economic development of a facility. Moreover, they can be a very important factor on not only for the building to be more sustainable and in line with circular economy principles, but in can also be used to enhance user performance, in this specific case the performance of student and academic staff, in university facilities. The study was applied to Polis University located in Tirana, Albania. The study aimed at recognizing and analysing the factors that influence and enhance the performance of both students and academic staff, together with analysing design elements in line with circular construction inside the University facility. One of the main questions in this study, is whether principles of circular architecture are designed only to meet environmental paradigms or can it benefits end user as well? "*Good design is subjective and can't necessarily be measured.*" (Dieter Rams 1970s). But if we were to measure it, performance of its end user in a facility design for them, can be a strong indicator.

### 1.2. Methodology

The study uses primary sources. The study's selected methodology for collecting primary data was quantitative.

Primary data were collected through a survey from academic staff and students of Polis University, specifically, the 2 lecturers and 13 students of the Transport Policy and Traffic Management course, taking place on Thursday in A3University Hall. The study used dependent and independent variables. Dependent variable was employee performance, while workplace design element (sustainable design elements) were the independent variables. Observation method was also used during the study by the researcher, through interaction, and images taken at the university during the lecture. Observation methodology was also used to collect data on the flow and direction of movement.

### 1.2.1. Instrument

Two main surveys were adapted for the study, one for lecturers and one for students. The survey consisted on three main parts (most of questions in both surveys were the same).

- The first section had demographic questions on both instruments, such as age, gender, work experience/ educational level, or profile of studies. In the first sections, some questions were also integrated regarding respondents' level of access to nature and green areas and the type of outdoor green area access.
- The second section of the instrument was designed by the researcher to measure the level of comfort and functionality of the room, the section consisted of 17 statements which could be ranked with a Likert scale of 1 to 5. The questionnaires gathered data on staff and students' perceptions on the university build environment and sustainability elements of design.
- The third section contained respondent performance-related questions; the questions included in this section were adapted from a questionnaire designed by Koopmans et al., (*Improving Individual Performance at Work Using Rasch Analysis*). (Koopmans et al., 2014) The questions in this section aimed to evaluate overall performance, (optimal and effective work planning, goals achievement etc.), contextual performance (taking on extra responsibilities, continuous self-improvement, questioning etc.) and the level of counter-productivity (complaining, exaggeration of workload etc.). The same section coded performance, which was divided into 3 subsections namely self-perceived performance, contextual performance and counterproductive behaviour. Likert scale was also used for this section, from 1 minimum to 5 maximum. (Koopmans et al., 2014)

### 1.2.2. Procedure

Surveys were distributed manually from the researcher to the respondents during the course setting. The researcher explained the content of the survey before the distribution of the study. Before starting to fill the survey, the respondents were asked to sign an individual authorization letter. The average time required to complete the survey was on average from 10 to 15 minutes. Providing sufficient time to complete the survey contributed in providing accurate and valid answers from respondents. Prior to distribution, the survey was tested in a pilot phase in order for the researcher to confirm the clarity of the questions and whether the questions' message was fully understood by the respondents, so that the answers were accurate and valid. The pilot phase was performed with only two subjects. There was no need for any further corrections to the questionnaire and therefore the researcher continued with the distribution.

### 1.2.3. Validation and reliability

An important factor regarding the quality of the study is the study reliability, consistency and reliability. Surveillance of authenticity to ensure reliability is essential for qualitative study. In order to distinguish between an excellent or poor study, it is necessary that validity, reliability, quality and rigor, be assessed and enhanced throughout the study. Johansson et al., in their study has shown that the term "quality achievement" has a link to the following research elements: "design quality and interpretive rigor". (Johansson et al., 2010)

## 1.3. Hypothesis

The main hypothesis in this study is as follows:

There is a statistically significant correlation between built environment design and circularity principle applied to the facility and the performance of students and academic staff of the university.

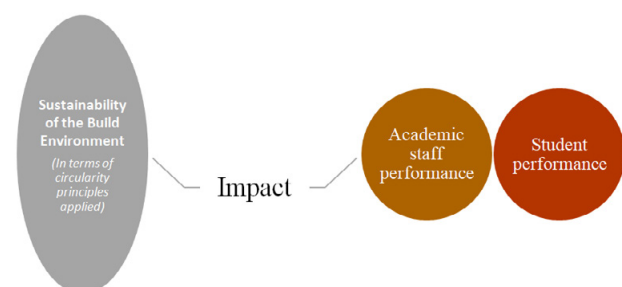


Figure 1 | Hypothesis diagram.

## 2. Literature review

The literature will address a few concepts. First, the concept of circular architecture and the sustainability of the build environment. Secondly, it will address some functional and aesthetic elements of the facility which will be further used to make the Polis University analysis case.

The concept of circular building is mainly based on the concept of circular economy. In both cases, the main aim is to go from a linear to a circular form of functioning. This relatively new concept is based on a few principles, such as:

- *The power of the inner circle* – which refers to the minimization of material usage. This means that, the tighter the circle is, the less material or product is used, so less of it has to be reused. This helps to save material, energy and labour to get the process going.
- *The power of circling longer* – which means that the maximization of the number of cycles done can have a positive impact on quantity of materials used overall. This can be achieved by reuse, re-manufacturing as well as recycling.
- *The power of cascaded use* – which is based on the diversification of reuse in all value chain.
- *The power of pure circles* – which refers to the increased efficiency that comes from gathering materials on uncontaminated sources. (Durmisevic, 2019)

To support the effectiveness of a facility circular construction, we have to analyse its elements, their effects and the overall impact. Starting with one of the most important constituents, *spatial reversibility*, this is related to the transformation element. Transformation is very important in the build environment, because it is linked with the ability of a building structure to change its function. The analysis regarding the spatial reversibility and transformation capacity of the building structure is based on the general capacity of the space and the structure itself to accommodate the changing of functions, without needing to cause major demolition, reconstruction or material loss. The transformation capacity is evaluated during the feasibility and preliminary design phase of the building process. This determines the effort needed to transform a building. There are three major transformational options: mono functional, trans-functional and multidimensional functional transformation options, which integrates the two first ones with other elements such as exchangeability and relocation. The two main parameters of spatial reversibility and transformation ability of a building structure are the core of the structure

itself and the facilitation of energy based on the climate of the new potential location. The core of the structure is needed to provide the whole stability of the structure; meanwhile the facilitator of energy is needed to make the building compatible with the relocation. The parameters of the spatial reversibility regarding the design aspects, relies on the chosen transformation model. The transformation model is the one who determines the level that the spatial reversibility can reach. The parameters that determine the transformation model, on the other hand, are the volume dimensions, the positioning of the core elements, the potential of disassembly of the main structure. The core design is an integrated base element, and is needed to provide stability for different use scenarios of the buildings, while trying to do so without demolition or creation of waste.

Furthermore, we need to analyse more important definition in this study, relating to build design environment and performance. To understand the impact of the build environment, we need to consider that this is the environment where people spend the most active part of their day. This is why it is important to first recognize the impact that this environment has on the physical and mental well-being of these people, which in turn directly affects their productivity and performance. Learning environment, such as universities, are a place when we spent a lot our younger life, and mostly shapes our adult life. Researchers have looked at factors that may affect people's productivity, job satisfaction, and psychological well-being (Sangar, 2008). There is a special branch of study called environmental psychology, which studies and seeks to find the impact and the ways in which this influence is distributed, between the work environment and the individuals who occupy it. According to environmental psychologists, there is a close relationship between the physical environment and performance, emotional, health and social status, stress levels in the work or study environment, and efforts and plans for the life after work. Researchers have denied the potential possibility that changes in the physical environment have a measurable or relevant impact on staff or students working in that environment (Largo-Wighta et al., 2010). A study from environmental psychology has concluded that there are five key elements that need to be taken very seriously in designing the work environment, in order for this environment to have a more positive impact on productivity and performance. These elements are natural light, greenery, noise level, aesthetic appearance and finally the colors chosen to paint and decorate the environment, where light ones seem to bring the best results (The Global Impact of Biophilic Design in the Workplace, 2015, p. 16).

There are a few (among many more) very important elements which can address both sustainability of the facility and its circular principles application, as well as can give very important indications on user comfort and functionality.

*Starting from the first element, natural light, we need to take into account that from the perspective of the individual who is studying, lack of light, poor lighting or the presence of only artificial lighting, creates eye strain and a bad state of health, tiredness, fatigue, headache, stress, errors, incidents as well as lack of attention. On the other hand, it should be taken into account that it is important to maintain a balance between light, as a large amount of light causes health and safety related problems as well, such as headaches due to staying for a long time exposed to direct sunlight, as well as stress. Both scenarios, the one with too much light, and the one with insufficient light lead to reduced productivity, errors and incidents, poor quality of work, and general discomfort. The most optimal solution is the strategic use of natural light. This means that the building should have as many open facades as possible from which light can enter freely, but in specific places where staff or students work and study, the light should illuminate the work environment, but not fall directly into it. This can be controlled the specific direction of the building. The light can fall directly on the premises of the building used for recreation or other various activities. Beyond the positive impact that natural light has on the health and productivity of staff and students, natural light also serves to give more life to the environment, making it look more spacious and more welcoming, inviting people and boosting their productivity. Also, lighting is one of the elements considered in terms of the sustainability of the buildings. Maximum and strategic use of natural light, serves to achieve the overall energy efficiency of the building, having less needs for the use of electricity, at least for the period of the day that may have natural light.*

*The second element that highly affects teaching staff and student performance is greenery. The term greenery can be applied to inside and outside plants. Not only does greenery help to purify the air of the work environment, as they reduce the levels of the accumulated CO<sub>2</sub>, but they also help reduce heat in and around the building during the hotter months, thus minimizing the need for air-conditioning. This not only helps the people utilizing the workspace, since having the AC on all the time makes the air relatively heavy, and makes it hard to breathe, but it also is a good indicator of sustainability, since it saves a lot of the energy that would otherwise be used (Shannaq, et al, 2012). The application of greenery may include green roofs or facades, green dividing walls, etc. Moreover, numerous studies show that*

greenery reduces stress, and also increases the level of concentration. Both of these elements directly affect the productivity and performance of individuals who utilize these spaces. An alternative to the circular economy is the green economy. Green economy on the other hand, may involve the use of plants to build the interior parting walls of the building. This affects two aspects, firstly in sustainability of the building, and secondly in reversibility and transformation, due to the possibility for easy disassembly and reassembly, as well as minimization of inert and building materials.

*Another important factor is noise, which is one of the strongest environmental stressors; especially in industrial environments it causes hearing loss. It is assumed that the impact of noise on employee performance at work depends on the combination of individual employee characteristics, job type, and noise type, but is not true for all cases, as Miller (1974) has concluded that in the circumstances certain noise boosts performance. Noise is a problem both inside and outside environment, and it violates privacy, damages interpersonal relationships, causes physiological damage such as hearing loss and worsening cardiovascular problems. (Largo-Wighta et al., 2010).*

*Furthermore climate / temperature is another environmental factor that influences the behaviour and performance of people in the workplace, it is measured through effective temperature, which includes humidity and movement of air masses. Temperature effects are usually controlled through clothing and are reported in part as a result of temperature and clothing values, degree of acclimatization, and knowledge of coping strategies, motivation, and type of work (Gifford, 2007, p. 385). Engineers have described comfort zones, but environmental psychologists have found that comfort depends on perception, actual effective temperature, and optimal performance can be achieved even outside the comfort zone. Stress occurs when templates vary significantly from the comfort zone, but many people may adjust after long-term exposure to these extreme temperatures. Some air components, including carbon monoxide, air ions, and bad smells that can affect performance at work, but their effects are not exceptional under normal conditions. On the other hand, the presence of chemical residues or pathogenic organisms and a lack of air pollution control can seriously impair health, work engagement and, in some circumstances, impair social interaction between employees (Largo-Wighta et al., 2010).*

*We live in a world of colour (Huchendorf, 2007, p. 1). Based on various studies, the colours that surround us in our daily life, especially in the active part of the day, have a substantial effect on the way we feel, behave and act.*



Figure 2 | Polis University, view from the outside. Source: <http://www.universitetipolis.edu.al/>

Starting from the interior space, landscape, and also the relationship of colours with light, colours can affect our behaviours from confusion to intelligence, from fear and anxiety to self-confidence. So, colour is used strategically to level strong emotions and create different moods. These elements affect the way staff and students work within the premises of the university building.

### 3. Analysis of sustainability and the built environment elements in Polis University

#### 3.1. Brief history of the University

Polis University is the result of an era of change in Albania after the fall of communism since in 1990. The origin is the establishment of Co-Plan as a professional institute and civil movement for participation in urban planning and good governance. In the early 2000s, Co-Plan established the "Training Centre". In 2006, this centre was transformed into the concept of "Polis University, International School of Architecture and Urban Development Policy". The study program in Architecture started in 2006 and the study program in Urban Planning & Management started in 2007. The school has been accredited both institutionally and in programs since 2009. New study programs opened in Art Design (2010) and Environmental Studies (2011). There are also 6 international study programs. In 2012 it increased the status to "University" and was granted the right to offer Doctoral studies. In 2013, new branches were opened: B.Sc. in Construction Engineering and a few Vocational Schools. The MBA Master's Program was further established in collaboration with IPAG Business School in Paris, opened in October 2014. Finally, the University has

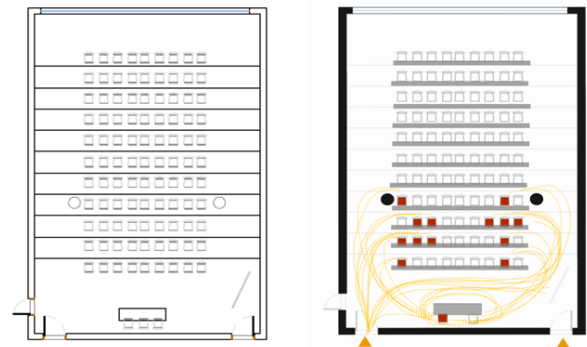


Figure 3 | The left figure shows the approximate layout of hall A3, while the second figure on the right shows the schematic of the student movement in the hall during the course.

also added Computer Science study programs in 2019. As can be seen from the chronological analysis above, Polis University is increasing its performance year after year.

#### 3.2. Circularity principles applied

##### 3.2.1. Infrastructure, an important element of spatial reversibility and transformation potential

The focus in this section relies on analysing elements such as space, height, movement/flow in inside the university facility, and more importantly circularity principles applied regarding the reversibility of the facility. The University premises have ample space and height suitable for all functions for which they are intended to function and more. The design of the premises serves the function entirely from the point of view of the academic staff as well as the students as his end users. In general, the interior spaces of the University provide ample comfort to all its users in every infrastructure and architectural element.

Floor to ceiling height is an important element, which impacts the natural light, flexibility, acoustics, and construction methods point of view. In addition to floor to ceiling height, a dimension of floor slab is added as well as the space for installations. When changing function of space, number of installations need to be modified. This means that distribution network of installations needs to be accessible and therefore separated from the floor or integrated in the floor structure in a way that modifications will not cause damages to the floor. If solid floor is applied than additional space is added on top of the floor thickness to allow for easy distribution of installations. This is a principle which for the university is fully met.

Controversy lies in the functionality of outdoor spaces and parking due to insufficient spaces for all. Let's analyse room A3. In the figure above, a picture is presented which gives a rough layout and to the right is a schematic of the movement of the teaching staff and students, along with the layout of their classrooms. The class, being too large for a class with very few students, normally groups and divides. The pictures shows that the two classes that attend the lectures are grouped in both classes (sign and territoriality in environmental psychology, where large spaces make people seek their sense of personal privacy in an actually a great controversy for the design of so-called open spaces. Inter-classroom collaboration becomes even more difficult with rigid classroom design formats that do not allow for the accomplishment of workshops or collaboration between each other. In conclusion, the design of the room is made for open lectures, or different lectures, which do not last more than 2 hours. But in this case the room is not a comfortable place to take a class of 4 or 5 classes. In contrast to the academic staff, the room environment is quite comfortable, easy to move around freely, offers a wide range of didactic materials needed, such as laptops, projectors, computers, etc.

Furthermore, regarding the spatial reversibility and transformation capacity of the room, and not only, the building structure is based on the general capacity of the space and the structure itself to accommodate the changing of functions, without needing to cause major demolition, reconstruction or material loss. We must emphasise that halt of the construction of this facility is steel, with removable parts, very adaptable and with no need for demolition.

Regarding the three transformational options: mono-functional, trans-functional and multidimensional functional transformation options, the facility offers a multidimensional functionality, which integrates the two first ones with other elements such as exchangeability and relocation.

### 3.2.2. *Community Integration*

The most unimposing way to support the sustainable architecture as well as apply circular architecture principles in a building, is to conserve for as much as we possibly can existing structures. In fact, we can well say that if we manage to make a structure last longer, you've actually achieved to make the material more sustainable, and perfectly applied the first principle or circular architecture (Lammert, 2018).

We should increase the usage percentage of existing buildings to curb the effects of the sustainability crisis (Arponen et al, 2014). For example, the utilization rate of

offices in Finland is only about 40% (Herlevi, 2015). This means that a significant part of the built environment is lying in a partially or even fully unused state, while new space is simultaneously being created ever more rapidly. In a better and more connected society, sharing could become more important if the information about unused and shared spaces would be available comprehensively and in real time (Raunio et al, 2016). Architects, engineers and designers must work hard together to achieve results where the building does not just serve as an empty structure made up of exterior walls. The building should be an environment where the teaching staff and students are able to learn every day, work together, communicate and be in harmony. The building should serve as a mediator of interactive relationships.

The concept of community integration includes increasing the participation of all in various learning activities or extracurricular ones. One benefit of community integration is the school / community partnerships formation. Providing strong, authentic community interactions where families, community groups and businesses can get together to support learning can only be beneficial in the long run. One of the biggest reasons to integrate our local community into our Universities is the majority of these spaces remain underutilized and empty during the summer season as well as evenings. To better utilize the space year-round and throughout the evening, the university facilities various spaces are opened up for shared use throughout the community. This would do not only help to maximise the space utilization, but it aids in additional funds to the university to offset the costs already incurred to maintain the building at all times. Today's system integration includes all of the control systems in a building, but also encompasses facility management systems, and business systems, and eventually will extend to utility grids.

Moreover, in the case of Polis University, we can say with conviction that this goal has been achieved. The university is open for use 24 hours a day, at any time of the year. It serves a variety of activities in addition to those related to University itself. A mentioned above, it hosts trainings, conferences, workshops, as well as entertainment activities such as parties, karaoke, talent shows, book clubs or barbecues. This brings the community closer together, and makes them more supportive of each other. When this happens, the university facility becomes a welcoming environment where people study and work cheerfully and willingly, so the positive results in their productivity and performance are clearly visible.

The facility is also currently shared as an office space for three different organizations, continuing



multidimensional space for students and academic staff to continue lessons, and is used as a space for different activities.

### 3.3. Design elements analysis

#### 3.3.1. Colour

Colours play a very important role in trying to create a good relationship between people and the environment. They define the “*visual climate*” of the environment (Elgner, 2006). Colour theory also includes the idea of how influences one’s thinking emotions in a given environment. Red pigmented colours such as orange, reddish brown and yellow are supposedly warm colours because they are associated with sunlight and the warmth of fire. Wood colour is considered as a cozy colour and represents stability. Blue colours are perceived as cool and cold colours because they are associated with water and ice in the human brain. Harmony colour is a nice combination of colours and the amount of these colours in a design; but it can also be a visually pleasing combination of colours that enhances the style and character of a design, and that promotes social functioning between people and their performance. (Gibbs, 1995). In designing and implementing an environment it is very important to achieve a balanced voltage that supports either concentration or communication depending on the function of the room. And in case of Polis University, both of the above mentioned.

Moreover, literature shows that colours that manage to positively affect the performance, both of the teaching staff and the students are warm colours. In order to ensure that the colours have the desired beneficial effect, the colours and spaces should also be used in the proper proportion. This is largely determined by the functions and proportions of the halls. In rooms, which are always full, the colour should only be used as an accent; as more colours is required in communication areas or recreation areas (Elgner, 2006).

Looking back at the case of Polis University, and more specifically of the A3 hall room, there is a disproportion between space and colours, being a relatively large hall, the cool colours incorporated in the design make this hall even bigger than it could actually, and cooler, thus reducing interactivity and social functioning among students or lecture attendees. Although the wood-coloured flooring somewhat seeks to warm the room, the space-colour disproportionate, leaves no room for optimal stability and comfort in the room. Finally, we can conclude that this specific environment is not particularly inviting or positive when it comes to performance and productivity.

#### 3.3.2. Light

Lighting is a functional component of the environment because it is essential for good vision. However, it is also an element of design, creating a sense of volume and form. But on the other hand, it has the potential to create excitement, motivation and pleasure in an environment. Light affects not only the aesthetics of the environment but also the motivation of staff or students. For these reasons, the efficient design and installation of high quality, energy efficient lighting systems are an advantage in an environment (Rayfield, 1997). The light design is related primarily with two aspects of human sensory behaviour, the visual task of spatial orientation, which requires the designer to be interested in the effect of light on the designation of space and structural closure or activity, without introduced irrelevant patterns or visual confusion.

Detailed vision of the central tasks, which requires the designer to be focused in the effect of light on the designation of important information centers and on helping to accurately communicate the visual details required for the acceptable performance of normal activities. Balanced manipulation of these visual conditions should ensure that the viewer needs to judge distances and recognize relevant objects, materials, colours and shapes. At the same time, this environmental equilibrium must reflect the occupier by the bright glow and the senseless visual cues that the patterns of Light structure our sense of space, our impressions, and consequently our actions in that environment. Therefore, the designer must become sensitive to the uses of silhouette, focal accent, colouring and other forms of spatial light (Flynn, Segil & Steffy, 1988). In today’s environment, a successful lighting model must support the desired function and atmosphere of each space, maximize the use of daylight, support employee productivity and morale, while also *maximize energy efficiency* (Gibbs, 1995). Having good quality natural light is an important aspect for comfort and other basic qualities of a building. This is why light plays an important role in the designing of the reversible structure. One example is having a glass façade with the height of 2.5 m, which reflects light into the inside space 2 times the length of the glass surfaces. During the conceptual phase of the designing process, this height can be taken as a reference, on creating a reversible building volume which supports natural light. This also means that all the inside areas that are usually populated or used by people, need to be within the range of 5m from the façade. The issue of lighting is also categorized according to the light source. The presence of natural light is an extremely positive element, and if it is at a controlled level, it is proved to have a very positive effect on comfort, health, productivity, and of course performance.

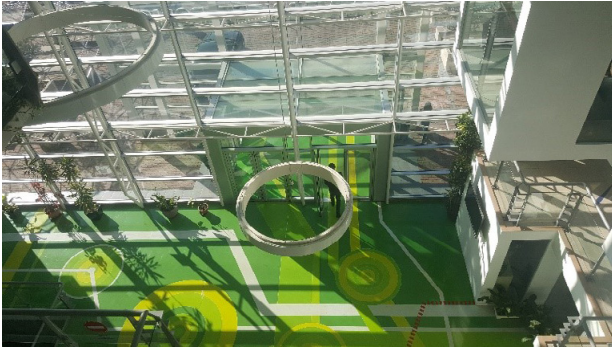


Figure 4 | Polis University, view of indoor spaces, main entrance.



Figure 5 | Polis University, view of indoor spaces, University Hall.

In this context, Polis University seems to have met these lighting design standards mainly at the University entrance (see Figure 4), where the use of natural light is maximized. Considering that during the literature review numerous studies claimed that the higher presence of light is less necessary in the work environment itself, but much needed in environments that serve for leisure



Figure 6 | Lighting, Room A3, the room under artificial lighting.



Figure 7 | Lighting, Room A3, the room under natural lighting.

or other various activities. In this case, the presence of natural light in large quantities in a common environment such as the front entrance and corridors, as well as the dining hall, is a very positive element.

But in the case of one of the halls (A3 hall, see Figure 6), it seems that this concept has not been preserved. In fact, the use of natural light in school premises (for classrooms) varies from floor to floor; the ground floor generally does not use natural light due to the height of the floor and windows. Also, natural light is often not used due to the need for pedagogical staff to use projectors throughout the lesson.

While the top floor of the school, where the school dinner is located, has a great deal of natural light efficiency, it often makes for a very desirable environment even though there is often overcrowding during long vacations.

Classes use artificial and natural light, which is white, and for a long period of time creates eye fatigue. This is because people are mostly comfortable with the yellow light which resembles natural daylight. The study room, however, uses more of the artificial white colour than the natural one. This affects the health of the individuals in a temporary way, and also the overall comfort, productivity and performance. In terms of energy efficiency in lighting however, the University has achieved full functionality with highly sustainable resources in energy.

### 3.3.3. Temperature, air

As noted in the literature review, air quality, with all its constituent elements, affects the behaviour and comfort of the individual. As for Polis University, the air temperature is usually optimal (between 20-22°C). However, taking into consideration that often the temperature and air quality is a factor that can be changed very quickly and easily in this faculty depending on the need, it is an element of comfort in the University and not the other way around. Other elements related to air quality, such as heavy smells, chemical elements or pathogens, it can be said that they are not considered problematic in the indoor environment of the building. This is due to the large spaces and relatively large windows, with which a very adequate distribution and circulation of air can occur, not allowing the concentration of these elements. Much attention is given to the energy use of a building during its use also in the temperature and air, emphasizing that the building is very energy efficient.

### 3.3.4. Noise

Acoustics is the science of sound production, control, transmission, reception and effects. The need for acoustic excellence is certainly very important when the acoustic objective is to support a comfortable and productive workplace. This objective is achieved by applying the basic principles of natural acoustics as well as minimizing noise which can affect well-being and performance (Myerson, 2006). Sound is transmitted through barriers such as floors, partitions, ceilings, and doors. As sound waves travel through a barrier, some of the sound is absorbed by the materials. The amount of sound absorption or sound wave reflection is a function of the thickness, density and porosity of the materials. In general, materials that are full, porous and soft absorb more sound. The sound is also reflected from the surfaces just as light is reflected and returned by the glass (Gibbs, 1995).

In the case of Polis University, noise is a comfort element, as there are no noises that may disturb the neither teaching nor learning process. Polis also has areas where you can find tranquillity for study, for both staff



Figure 8 | Greenery and infrastructure elements.

and students such as the library. Noises are generated by student movement only during breaks, which creates no discomfort or concern for either staff or students. The same is true of A3 Hall, where there is no noise over the norm throughout the learning process. The lack of distractions is a positive element which does not interrupt the process of thinking, working or teaching, increasing the efficiency of the work and study processes, thus positively affecting performance.

### 3.3.5. Greenery

Another very important element to consider is greenery. As mentioned in the literature above, greenery is one of

the primary and most important elements in the design of environments which enhances comfort and, most importantly, enhances performance. At Polis University, greenery is sporadic, not well thought out, and is found only in the lobby of the premises. On the other hand, the lounge environments of the where the lesson takes place, the greenery is almost absent in the environment. This missing element is one less factor in increasing the comfort and performance of the academic staff and students at this University. Also, the concept of using greenery to build diving walls or other structures of that sort is absent.

This was one of the main concepts that promoted not only more green spaces indoors, but also saved space by installing them vertically, and also minimised building materials that would otherwise be used to divide the spaces, by adding up to the reversibility criteria as well.

#### 4. Sustainability of the built environment and its impact on the performance

##### 4.1. Analysis of demographic data

The study participants were 87% students (no. 13) and 13% academic staff (no. 2, and 15 in total). The age of the respondents ranged from 18-25 years old, which constituted 73% of the respondents, followed by 20% with the age of 26-36%. 53% of the respondents were female and 47% were male. Some of the respondents were studying bachelor level, 7% of doctoral studies and most of the respondents belonged to scientific master's level of education (73%). Three were the study profiles of student respondents, Urban Environmental Management, which made up almost half of respondents, Urban Planning and Management, and one respondent who attended Architecture studies. Regarding the academic experience 50% had an experience of 0-5 years, and the other half of more than 20 years of experience.

##### 4.2. Analysis of the built environment elements according to the respondents' perception

Respondents were asked about their access to greenery. As can be seen in the graphs below, respondents indicated that they had moderate (53.3%) or little (40%) access, only 6.7% of them indicated that they did not have much access.

This type of access to greenery was mostly direct 66.7%, indirect 26.7% and no form 6.7%. Referring to the above analysis regarding the lack of greenery in school environments, these results correspond to the fact that the university has a lot of greenery incorporated into

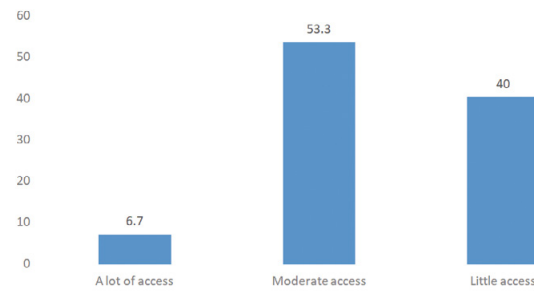


Figure 9 | Access to green areas.

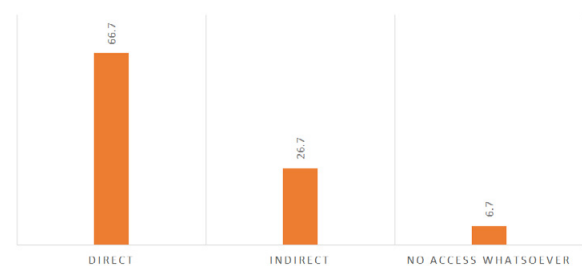


Figure 10 | Type of access in green areas.

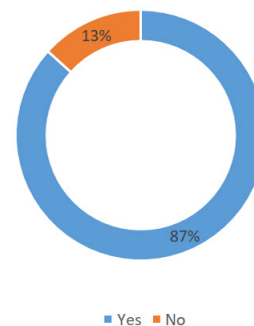


Figure 11 | Do you think university settings are designed to facilitate your movement?

indoor and outdoor spaces, and that greenery that is located is largely sporadic in the university lobby.

Another question related on whether respondents think the university-designed spaces are appropriate and facilitate their movement to the university and access to the various facilities they need. Respondents responded positively by 87%, spaces were designed to facilitate their mobility. Only 13% of the respondents didn't think so, and that this element needs to be further improved (see the Figure 11).



Figure 12 | Summary descriptive analysis regarding the comfort and functionality of the build environment at Polis University according to respondents' perception.

Next, the questionnaire had a dedicated section on the comfort and functionality of the room, incorporating all the elements also analysed in the literature. The results of this section are presented cumulatively through the minimum, maximum and average of the result achieved.

The section on the comfort and functionality of the room as a whole consisted of 17 questions in total, with a score of 17 points minimum (indicating a very low level of comfort and functionality), and 85 points maximum, (indicating an optimal level of comfort and high functionality of the build environment). The graph above shows the results of our respondents. Respondents scored a minimum of 35 points and a maximum of 65 points, with an overall average of 51.13 points. From the results can clearly see that the respondents perceive that the comfort and functionality of the A3 hall the build environment is above average.

### 4.3. Analysis of respondents' perceived performance

The Figure 12 shows the results regarding respondents' self-perceived performance. Self-perceived performance was divided into three main subsections throughout the survey. Correspondingly, self-perceived overall performance, contextual performance, and counter-productive performance. Using the same calculation logic for the analysis of the built environment, the 3 performance subsections were calculated. From the Figure 13, we see that the overall self-perceived performance of the respondents ranges between 19 points minimum and 29 points maximum with an average of 25.6 points. On the other hand, contextual performance ranges between a minimum of 17 points and a maximum of 35 points with an average of 26.06 points. Meanwhile, counter-productivity performance ranges between 5 points minimum and 15 points maximum, with an average of 9 points. In general, the standard deviations in the responses are

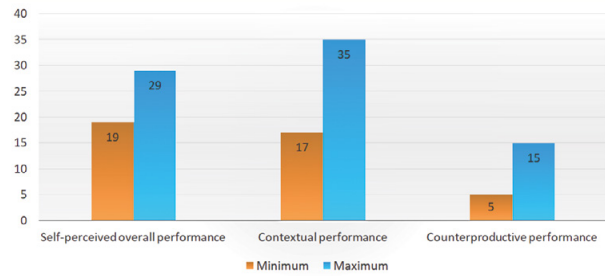


Figure 13 | Performance.

high, so there are significant differences in the responses among the respondents. Regarding the average values, however, we find that respondents present a perceived above-average overall and contextual performance as well as low counter-productivity.

It is important to highlight the difference between contextual performance and overall performance. Overall performance is usually related to the results achieved based on the objectives one has, scheduling time and delivering results, separating key tasks from secondary ones, achieving high results, managing time to achieve objectives etc.

On the other hand, contextual performance is related to other indicators. If overall performance only indicates whether a person is capable, whether a person succeeds in completing the tasks assigned to them, and succeeds in completing them with the best possible results, the contextual performance goes beyond this. Contextual performance includes elements such as taking on extra responsibilities beyond what the person currently has, taking on challenging and difficult tasks, not being satisfied only with taking what university knowledge gives but needing to seek further. So, there is a constant growing need for personal and professional growth. Contextual performance also relates to people who are very innovative and looking for new personal and professional challenges. It's the people who always have one more question to ask in the auditorium and question everything they see and hear. As we can see there is a difference between overall performance and contextual performance. As for counterproductive performance, it relates mainly to non-productive behaviours, such as complaints to colleagues, for example complaints about workload etc. Overall, our respondents showed low counterproductive behaviour, from both academic staff and student perspectives.

**Table 1** | Correlation analysis.

		Sustainability of the build environment	Self-perceived overall performance	Contextual performance	Counterproductive performance
Sustainability of the build environment	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	15			
Self-perceived overall performance	Pearson Correlation	0.234	1		
	Sig. (2-tailed)	0.400			
	N	15	15		
Contextual performance	Pearson Correlation	0.944**	0.260	1	
	Sig. (2-tailed)	0.000	0.349		
	N	15	15	15	
Counterproductive performance	Pearson Correlation	0.255	-0.320	0.279	1
	Sig. (2-tailed)	0.359	0.246	0.315	
	N	15	15	15	15

\*Correlation is significant at the 0.05 level (2-tailed).

\*\* Correlation is significant at the 0.01 level (2-tailed).

#### 4.4. Discussion

The study case findings showed that Polis University built environment is designed with a balancing voltage that supports either concentration or communication depending on the function of the room, and furthermore is design to be spatially reversible altogether with a strong sense of community integration. Polis University has met the sustainability and circular principles requirements, such as the lighting design standards, because it uses the natural light in school premises or artificial light in evenings. High quality, energy efficient lighting systems are an advantage in an environment (Rayfield, 1997). They must support the desired function and atmosphere of each space, maximize the use of daylight, support employee productivity and morale, and maximize energy efficiency (Gibbs, 1995). The University premises have ample space and height suitable for all functions for which they are intended to function. Space is designed to facilitate mobility and density at the university. In general, the respondents perceived that the comfort and functionality of the build environment is above average. As a result, they perceived themselves as productive.

The hypothesis raised by the study suggested that there is a statistically significant correlation between built environment design and circularity principle applied to the facility and the performance of students and academic staff of the university. Below is the table which shows the results from the correlations analysis of the study variables.

The Table 1 shows that there is a statistically significant correlation between sustainability of the build

environment and its impact on user performance, specifically the contextual performance of our respondents. The correlation is statistically significant at the value of  $r = 0.944^{**}$ . In addition, the correlation is positive, which means that the two variables are positively correlated to one another. The more sustainable the build environment, and the more the circular architecture principles are applied to the building, the higher the contextual performance of the students is.

The study hypothesis is fully validated, which means that elements of sustainability and the built environment, and implementation of circular architecture principles, have a direct impact on the performance of people who use that space, and in the specific case of pedagogical staff and students at Polis University. These study findings are in line with other studies that correlate the build environment settings with performance (Largo-Wighta et al., 2010).

It should also be noted that there was also a statistical correlation between mobility adaptability of the build environment and contextual performance, counterproductive performance at work, also with level of comfort and functionality of the environment, however the correlation was not very strong therefore and statistically significant, also due to the fact that movement adaptability was not analysed in some particular elements so that the respondents were able to analyse and perceive the importance of the element in more detail. Therefore it's recommended to be further studied in detail in another research.

## 5. Conclusions

The purpose of this study was to investigate whether sustainability of the build environment and implementation of circular architecture principles has an impact on user performance. More specifically, to better understand and evaluate if principles of circular architecture are designed only to meet environmental paradigms or can also directly benefit end user as well. The current study focused on analysis the impact of build environment sustainability on performance in academic staff and student performance at Polis University, situated in Tirana, Albania. The study raised the hypothesis that the sustainability of the built environment has a significant impact on performance. The study analysis focused on some key elements of circularity in construction and the built environment, such as spatial reversibility, community integrations, light, noise, climate/temperature, infrastructure, etc. All very important elements not only of comfort and functionality of the built environment but as well as in circular economy and in construction principles.

At Polis University, the sustainability of the build environment and the circular architecture principles applied were found to be strongly linked, correlated with contextual performance, more specifically with an academic staff and students take on additional responsibilities beyond the person currently duties, taking on challenging and difficult tasks, not meeting only with university demands only also needing to search and discover even further, with an enhanced need for personal and professional growth. Furthermore, the rising contextual performance shows innovative stamina and need for new challenges and the need to question everything.

Clearly, the study shows that the University facilities, through sustainable design, and implementation or circular architecture principles such as spatial reversibility, energy efficiency system, community integration design, comfort and functionality of its spaces, brings in

innovative individuals who are able to take on new challenges that require constant personal and professional growth.

In this regards, university facilities can take maximum advantage on implementing full sustainable and circularity in architecture principles. As we saw from Polis University built environment, a facility can be designed with a balancing energy efficiency principles, spaces that supports either concentration or communication depending on the function of the room, and furthermore is designed to be spatially reversible altogether with a strong sense of community integration, and still enhance fully the performance not only of the designated users but also of the community surrounding it.

Furthermore, the study findings emphasizes the importance of the elements of sustainable built environment, and the care that designers and builders need to achieve what is called optimal comfort and functionality of each element, keeping in mind not only end users but also environmental, social and economical aspects as a fully accomplished facility. This research contribution would not only help designers and builders, but managers, business executives who want to increase the productivity of the performance of their employees and businesses, and ultimately help the individuals themselves as part of this built environment in performance, psychological, physical well-being and higher performance, but it can also help them to implement sustainable construction practices to bring better social, economic and environmental benefits.

However, the study also faces its limitations. The study sampling was small; a more comprehensive study is needed, as well as further comparison between facilities were sustainable principles of the built environment are not met to further see the impact of end user. Also, there is a strong lack of literature in this regard, demanding for more research on the field.

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