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SUSTAINABLE AND SELF-HEALING MECHANISM FOR CONTEMPORARY ARCHITECTURAL BUILDINGS

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ABSTRACT

In this research paper, sustainable design is the means to superior living. A design that grows from nature, and merges back to nature. The blueprint design for a three-floor based residential building being modelled for a sustainable architecture is presented in this paper. It is believed that the concept of sustainability came up with passive self-healing design primarily to repair itself. Different type of architectures being evaluated for sustainability and self-healing mechanism in terms of performance, operations, smart material and surveillance factors. We believe that the concept of sustainability with passive self-healing mechanism design primarily to conserve building. The building prices started increasing and environmental problems became evident. Passive self-healing building designs reduced building costs after it is constructed. We believe that sustainable and self-healing mechanism design tends to become usual in future. The maximum performance is recorded for residential and industrial building at 92.45%, the smart material effectiveness in construction for residential stands at 91.34% and in the last the surveillance and scrutiny in propsed building for residential and storage stands at 90.87% respectively. It is the line that we draw between essential and overdone that makes a building sustainable with self-healing mechanism. Sustainability will become a significant element of architecture and this paper provides an insight into this much needed solution. Material like nano-material, reusable material and optimized load material have also been evaluated for the self-healing architectural buildings

KEYWORDS: Sustainability, performance, smart material, self-healing, surveillance, environment, buildings

1. INTRODUCTION

The human live in a globally networked society. No longer are nation states' actions without consequence to countries located geographically far away, nor are the productions and technological advancements emerging in one region difficult to transfer to another part of the world (Ilha et al., 2019). As technology continues to advance, governments and businesses' abilities to communicate and operate beyond their geographical barriers also expand through constructing sustainable and self-healing mechanism in the buildings (Pitt, et al., 2019). As this occurs, networks become entangled; geographical boundaries become blurred; and markets, businesses and cultures become intertwined. Another word to describe this phenomenon is "globalization".

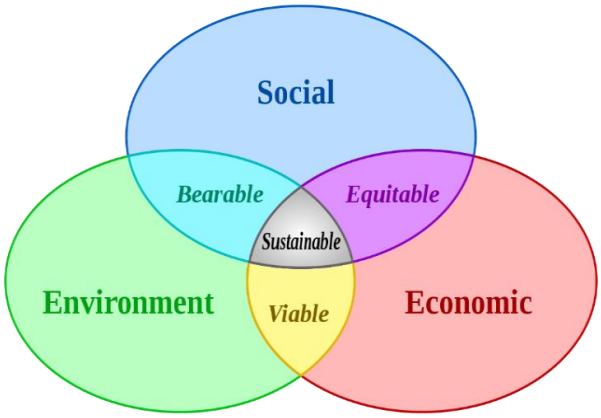

Fig. 1. Three dimensions of sustainable development (Yahya and Boussabaine, 2016).

This paper raises questions about green building standards in the iraqian region. Though there is no consistent definition of "sustainable building standards," environmental agencies' Environmental Protection Agency (EPA), use the term to "encompass model codes, rating systems, and other publications that provide criteria for the design, construction, and maintenance of buildings" ("Sustainable Building Standards, 2016) (Yahya and Boussabaine, 2016). Specifically, this research asks: 1) Are current international green building standards flexible enough to fit the Iraqs needs. 2) Can the Iraqian states collaborate with one another to a sufficient degree to create a critical mass of supporters in favor of an alternative set of local green building standards more appropriate for their regional needs. 3) Alternatively, is it possible that—failing outcome (1) and (2) the Iraqian region will end up without a coherent body of appropriate green standards? This paper seeks to conceptualize these possibilities by developing three alternative scenarios that draw upon the literature in the field (Zimmermann et al., 2015) [4]. Section one of this paper will characterize the introduction in the field. Section two will—based on the literature—develop the three alternative scenarios and propose measures to be used to assess the future outlook.

1.1. Problem Statement

Sustainability has not always been an issue for architects. It was always been integrated with the building designs since there was no technology to cover the poor design. Today, a building can be made without any openings and still be able to function with the help of artificial lighting.

Furthermore, buildings that respond to hot climates are no different from those being built in cold climates. Architecture has lost its balance with its environment and is now contributing to problems such as global warming. According to Environmental Protection Agency (EPA), half of the greenhouse gas emission in the Iraq is produced by buildings. Therefore, to offset this, Environmental Protection Agency (EPA) came up with the ultimate goal of the designing sustainable and self-healing building design: carbon-neutral buildings by 2030 (Kukadia et al., 2014). This primarily focuses on designing and developing buildings that are energy efficient and have no impact on the environment with heaking mechanism. A better understanding of sustainable design would help to reduce the negative effect on the environment as well as on buildings.

1.2. Aim of Study

To design a sustainable architecture which includes the relation of performance, culture, economics, and self-healing mechanism. Most of the sustainable buildings built today are highly dominated by building performance. Sustainable buildings lack the balance between performance, culture, economics, and self-healing. The aim is that sustainability is seen as a quantitative approach, an afterthought, something slapped on later. Because of this, even the most energy efficient buildings are not architecturally pleasing. It is the line that we draw between essential and overdone that makes a building weakness or strength. We want an eco-structure to be acceptable to the public they have to be sustainable and self-healing in terms of performance, operations, smart material and surveillance factors.

2. BACKGROUND

Building Performance is a pragmatic approach to generate design. Its traits can be seen in indigenous Standards provide the means for such coordination (Holton et al., 2018). Standards can be defined as the rules governing all interactions—be they among people, between people and machines, or among machines. Accordingly, the Iraq building authority the standard that allows for international discourse of building management. Likewise, the building structure is used as a standard for building processing (Ding, 2018). Standards coordinate interactions within networks and the more parties that join a network of buildings, the more benefits this network provides (Nelms et al., 2017). As a result, existing large-scale networks offer positive externalities, benefits, making it harder for alternative networks to establish and sustain themselves. Consider, a sustainable building that crowd-sources structure reviews for restaurants, stores and more across the globe using a standardized platform. The more active users in each network, the more helpful the website becomes (Osmani et al., 2018). Due to the established base, new competitors must struggle to become established.

Because of these sustainable design effects, global standards are not neutral. They typically benefit some players at the expense of others. As we have noted, the standard setting process is both “disruptive” and “uneven”. Take for an example, the World Trade Organization’s (WTO) nondiscriminatory, free-trade standards. In order for a country to enjoy access to the world’s economies through valuable international markets, it must join the WTO and adhere to its standards (Pettifer, 2017). However, these standards have historically been tailored to industrialized nations. This disadvantages newcomers and nations with nonmarket economies. As a result, these nations might fare better under discriminatory trade practices. Nonetheless,

they must comply with the WTO's nondiscriminatory trade standards in order to continue trading in choice markets.

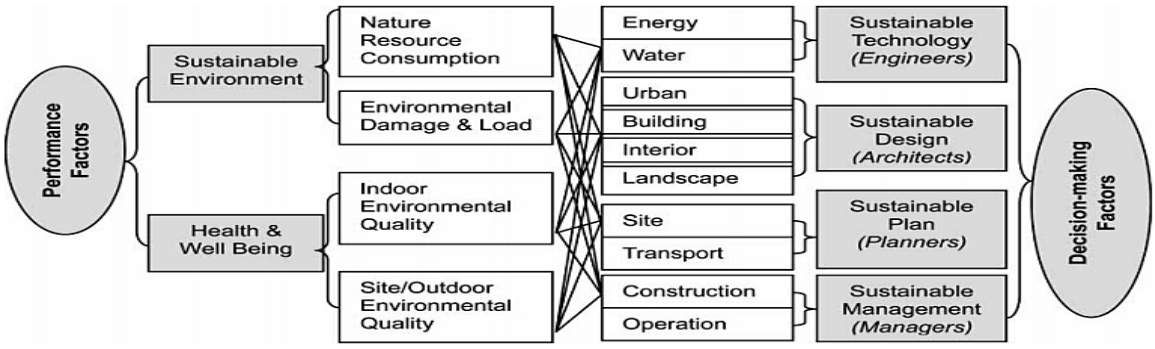

Fig. 2. All the performance factors that are most important in decision making for sustainable design (Osmani et al., 2018).

Given the significant social and political implications of standardization, how standards are set and who is involved in setting them are of major importance. Historically, the largest companies and countries have governed the standards arena. In the area of telecommunications, for example, Gulf States were able to use large market to leverage its standards internationally (Ofori, 2018). Likewise buildings employed its market power to establish its operating system and structure as an international standard. In a global economy, many more newcomers will enter the standards arena, and issues will likely arise as to how to assure that decision-making is fair and equitable.

2.2. Building Environmental Standards

This paper also presents a need of design for environmental standards. Pollution and over-consumption threaten our world's natural resources. There are more than 500 million buildings on earth and that number is expected to increase to one billion by 2030 (Shen et al., 2019). These problems have no national boundaries and extend across the globe. Nonetheless, given the diverse cultures, geographies and political systems involved, dealing with social issues across national boundaries is difficult.

In this regard, one area that may be especially problematic is developing standards for green building—a term used for structures that are environmentally friendly and resource efficient, according to the different building authorities. A future point of contention may stem from the fact that green building practices are useful and appropriate for all geographical regions. For example, take the case of green roofs and walls, which can help to filter air, bind dust particles and lower CO_2 levels (Ruggieri et al., 2019). In certain areas of the world, such as the Middle East, plastic pieces of the structures used to build green roofs and walls will melt due to extreme heat. Therefore, these plastic parts must be buried or made with stainless steel in such areas. As importantly, the type of soil found in the Middle East is largely made up of sand, which means for a green wall to be successful, it must be mixed with other organic matter and growing mixture.

2.3. Collective Building Action

Collective action, put simply, occurs when a group collectively acts, or makes a decision, that will benefit the whole group. But collective action is often a problem we challenged the previous assumption that a group will act collectively if its members would thereby benefit (Asokan et al., 2019). As he Olson claimed “rational, self-interested individuals will not act to achieve their common or group interests" (Tam, 2019). According to his analyses, collective action rarely happens unless the group is very small or group members are coerced. The larger the group, the harder collective action becomes. Some people will simply “free ride” because they know there are enough others in the group to do the work. Still, collective action can be accomplished if there is a user who can sponsor the effort because he or she would benefit from the action. Additionally, the costs surrounding the development and negotiation of collective action can be quite high. The larger the group, the higher the costs are to organize the process. Participants may deem the action not worth their time or money. We suggested selective incentives -- offering positive and negative rewards -- to encourage participation. (However, even organizing a system like this would take a lot of time and funds.) Selective incentives are not enough to solve the collective action problem. Author wrote that the problem is selective incentives solution is that someone must pay for the selective incentives (Tseng et al., 2019). “Paying for a selective incentive is, itself, a collective action in that it provides a benefit to everyone interested in the collective good, not just the people who pay for the incentive”

3. METHODOLOGY

Building Performance is a pragmatic approach to generate design. Its traits can be seen in indigenous vernacular structures. The basic idea is to derive the building envelop based on the climate of that particular location. Therefore, the building form in a hotter climate is different than that of a building form in a colder climate. Building Performance is basically the amalgamation of climatological, biological, geological, and topographical features. Sustainability acknowledges the understanding of unique characteristics particular to those places and how the characteristics can be celebrated or protected.

The idea of using local material is a big part of sustainable design, but due to restrictive factors associated with importing materials from other places the idea is minimized. That is not to say, however, that someone can find the same building environment. Sustainable design is an art that has a specific answer to specific and is not a science that applies the same general rule to all situations. Nomadic tribes (Plains Arabs) developed a different architectural response, a light-weight mobile structure called tee- pee. During winter, the fire inside would keep the structure warm, letting the smoke out from the small opening on the top. In summer, flaps at the bottom could be opened to access the cool breeze. Humanity’s ancestors looked at nature for inspiration; they understood the fact that nature can provide solutions to problems.

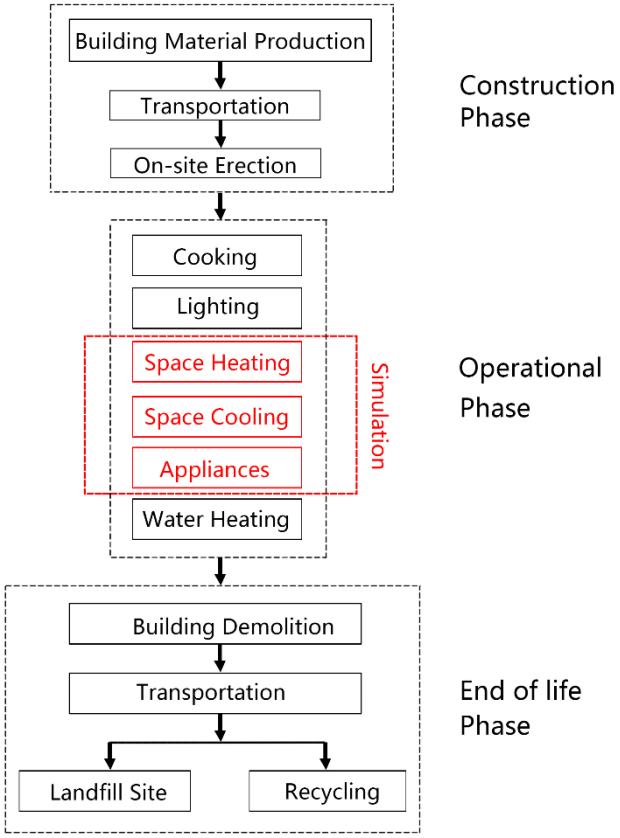

Fig. 3. A flowchart for a sustainable building from construction phase leading to operational phase to end phase of sustainable building (Haibo et al., 2017).

3.1. Self-Healing Mechanism

Self-healing mechanism value is based on how sustainable buildings repair themselves, how we experience space, and what could be perceived about the space with maintainance (Turk, 2019). The idea is to give the experience of space to the essence of its existence with maintenance. The problem, however, is that because there is a disparity between the objective and spiritual value, there is doubly the validity of its ability to explain the world as the author in (Turk, 2019) describes. Architecture without its experiential essence is like a word without self healing, which eventually is nonsensical. A designer gets so carried away from the literal translation of sustainable design that he forgets the 'spiritual' aspect of the being. Hence, self-healing mechanism and sustainable principle can be used to generate a perfect building but it is still not complete if the implication of efficiency is not contradicted. "Sustainable design could be built in any style and appeal to any person regardless of self-healing preferences, then what is there a need to discuss self-healing and healing with the philosophy"

3.2. Cultural Impact of Architectures

Cultural consciousness is an ideology to design building with culture in mind. It is more of a traditional approach to design. For example, whenever mosques are built, they are built with traditional styles in mind. Cultural consciousness doesn't really mean imitating history; rather, it's an approach to make architecture that blends into the Islamic environment (Tam, V.W.Y. and Tam, C.M., 2016). Seen this way, culture could be argued to be a social construct, an ideology created by a particular group in a society. It is not something that automatically exists

but is merely a constituent of a culture. Even if culture is a social construct, there should be no harm in acknowledging and respecting it. As with nature, social constructivism is also an initiator for post-modern movements. This is not to say we are trying to limit experimentation or innovation, but rather that we are evolving in ways that are respectful to culture. However, people who believe in the idea of social constructivism tend to disregard everything that exists. Cultural consciousness is sustainable design approach to design that pushes boundaries but still ties it into the cultural realm.

Cultural consciousness is a principle of designing buildings with culture in mind. Culture can be taken them as beliefs of a group in society, which don't come into existence at once. Social constructivism is the product of the post-modern movement. Building design should be such that it reflects culture as well. Aesthetic value is based on things related to what we see, how we experience space, and what could be perceived about the space. Any building that is sustainable must be beautiful or have some aesthetic value or else it is not going to survive in the long run. Architecture must have its experiential essence. Sustainable economics is related to the cost (Tam, V.W.Y. and Tam, C.M., 2016). We know that green buildings have costs associated with construction and maintenance; however, it is a misconception that green buildings are always expensive.

Fig. 4. An example of operational cultural mosque building in Iraq on left side while a proposed modern sustainable and self-healing based green mosque building on the right side (Tsangouri et al., 2015).

3.3. Smart Material

Smart materials for sustainable buildings are limitedly produced and there is a lack of competition along with lots of research work which increases the cost. However, sustaible buildings combine superior amenity and comfort, which can improve health and productivity. In article (Huang et al., 2014), the author emphasizes that any effective sustaible building has costs associated with its construction and maintenance using smart material. Green economics has always been a controversial topic in terms of green buildings vs. generic buildings. A lot of clients shy away from greener building because of their preconception that green buildings are expensive to build, which is not always true. Most green buildings seek additional costs because of the limited production of a particular material and lack of competition in that market.

Also, since the idea requires a lot of research beforehand, it further adds cost as designers still try to learn and innovate on sustainable designed strategies. The ability to design healthier buildings that improve people's mindset by living in the building adds to their productivity, which is also accounted for in green economics. According to research by the rocky mountain institute, "Sustainable buildings typically sell or lease faster, and retain tenants better, because they combine superior amenity and comfort with lower operation costs and more competitive terms (Huang et al., 2014). The resulting gains in occupancies, rent, and residuals all enhance financial return". The institute also reported "better indoor air quality can improve health and productivity and reduce liability risks.

Fig. 5. An example of typical operational residential building in Iraq on left side while a proposed modern sustainable and self-healing based green building architecture on the right side (Tsangouri et al., 2015).

3.4. Environmentally Friendly Buildings

Eco-friendly has been the bonafide theme of today's globalized world. Everything is going green, but in the long run, it has to be sustainable. Sustainable architecture can be said to be an attitude. The main purpose of architecture is to provide shelter, against all climatic changes to be borne by humans. Sustainably has always been merged with building designs in architecture and has not been a separate issue. Today, buildings are built with artificial systems like artificial lighting or artificial heating. In article (Sangadji and Schlangen, 2012), the innovations lead to other issues such as global warming as architecture loses it balance with the environment for the environmentally friendly buildings. In this context, we came up with excellent ideas of carbon-neutral buildings in the near future, which focus on designing and developing buildings that are energy-efficient and environmentally friendly. For this, one needs to know sustainable designs better.

3.5. Dataset Description

The Building Class data provides detailed information about residential housing types including the house age and structural type. This information can be used for urban regeneration studies,

crime monitoring, urban flooding and urban gardens. The open source dataset is available online at: http://learningzone.rspsoc.org.uk/index.php/Datasets/Building_Class/Download-Building-Class.

3.6. Reuse Mechanism in Sealing and Healing

The sealing and healing phenomena, depends of the size of the crack, the implementation of reinforcement is necessary, so the cracks remain in an acceptable size for self-healing to occur in building architecture. Several techniques and methods have been developed to perform crack inspection for reuse, they are often inaccessible or invisible, such as in underground structures and infrastructure such as bridges and highways as indicated in survey (Van Tittelboom et al., 2012). This kind of application is the target of this research, in this study is proposed to investigate the self healing in architectural building for reuse and found the concrete crack, since self healing would be favourable in this situation due to reuse mechanism given by the article (Gruyaert et al., 2015), because there would be cracks that can not be repaired or be easily visualized, though this cracks compromise the structure of the concrete as well as it would be reused and rectified. It is not known, this paper can enhance the self healing of the architectural building, and however it is acknowledged that these cracks can self heal with reuse, it is needed time and the sealing effect is achieved.

3.7. Remote Health Monitoring Architecture

In the growing construction industry, especially in the field of remote health monitoring architecture in modern buildings, there is a need to ensure a suitable health for more significant loads using self healing architecture with nano-material. Among many methods which can prepare remote health monitoring building on chemical compound aggression and mechanical loads, self healing is commonly used as a coating layer in modern hospital buildings. Recently, this method has developed as an alternative preventive repair method as described in (Tsangouri et al., 2015) in contrast to limited pure concrete which can be only grinded or brushed with nano-material. The concrete substrate without protection layer can be easily destroyed during normal exploitation. Self-healing coating layer has the properties which extend the health conditions in self-healing-based architecture. This usually allows a satisfactory adhesion of the concrete substrate to be obtained in (Karaiskos et al., 2015). During designing remote health monitoring building anyone is analyzing thermal shock influence on the coating of building with nano-material. Overheated of the coating occurs when the protecting layer has low strength adhesion and the remote health monitoring system is exposure to building loads.

4. RESULTS

The Tobacco Warehouse Building is located in the city of Brooklyn. It features a planning flexibility that helps in multiplying the building's use. As it was redesigned in 2010 to double the spaces to give the largest possible number of activities, it is expected to obtain a silver or higher classification according to the LEED classification, by preserving the historical fabric of the outer walls and injecting them with self-healing materials, relying on the adaptive reuse of the facade elements and making them able to face future changes to reach a more sustainable building (Pier, 2016).

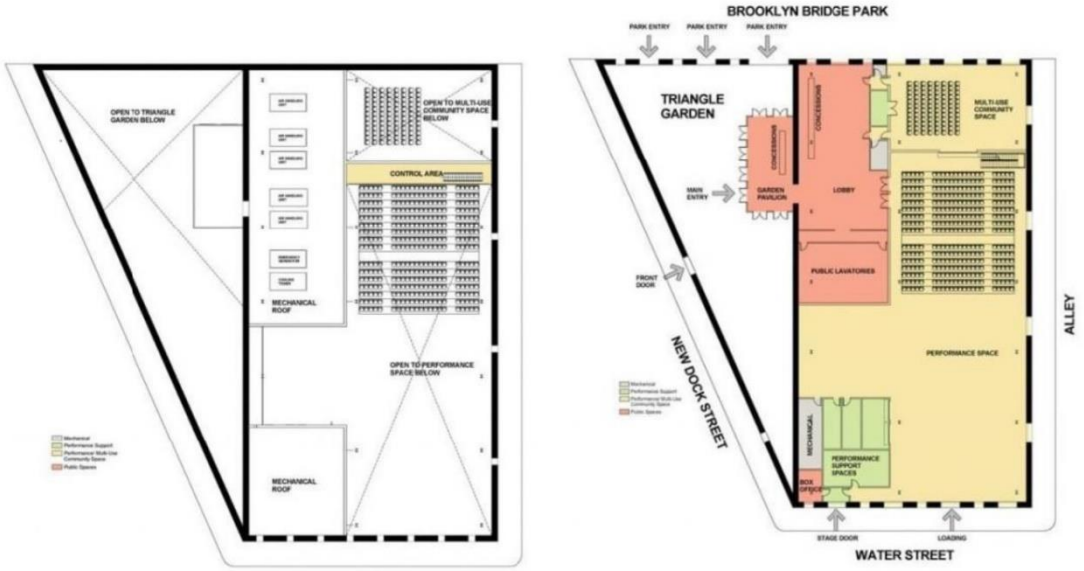

Fig. 6. Tobacco Warehouse plans (Sarah, 2017).

Fig. 7. Tobacco Warehouse elevation (Sarah, 2017).

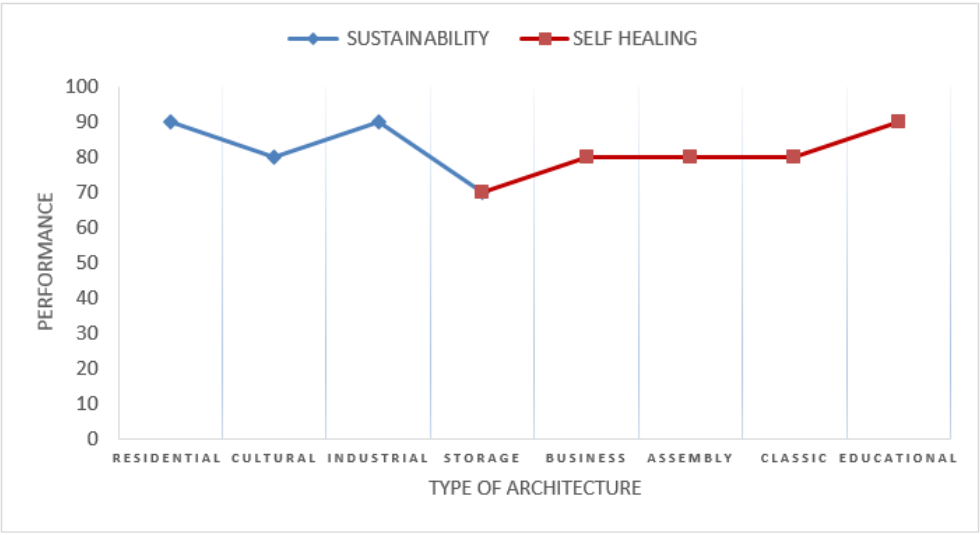

Fig. 8. Different type of architectures being evaluated for sustainability and self-healing mechanism in terms of performance and operation ability factors (by researchers).

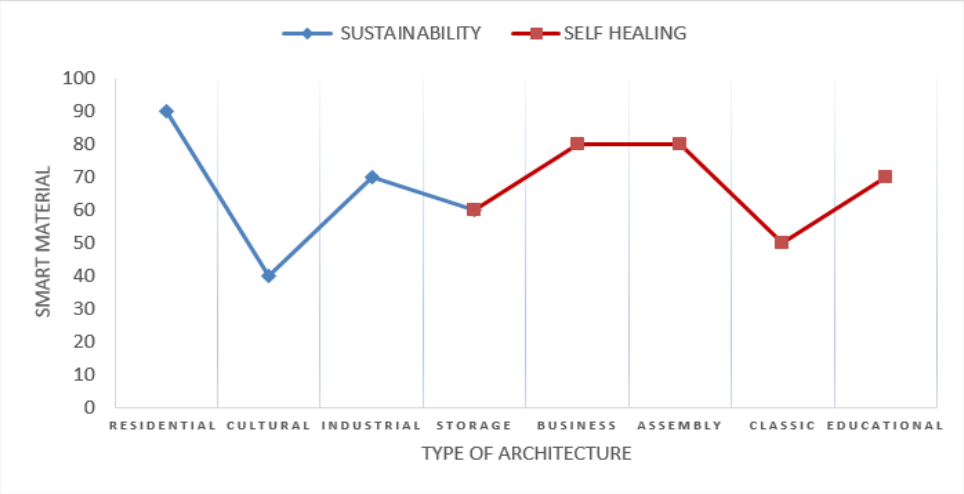

Fig. 9. Different type of architectures being evaluated for sustainability and self-healing mechanism in terms of smart material factor (by researchers).

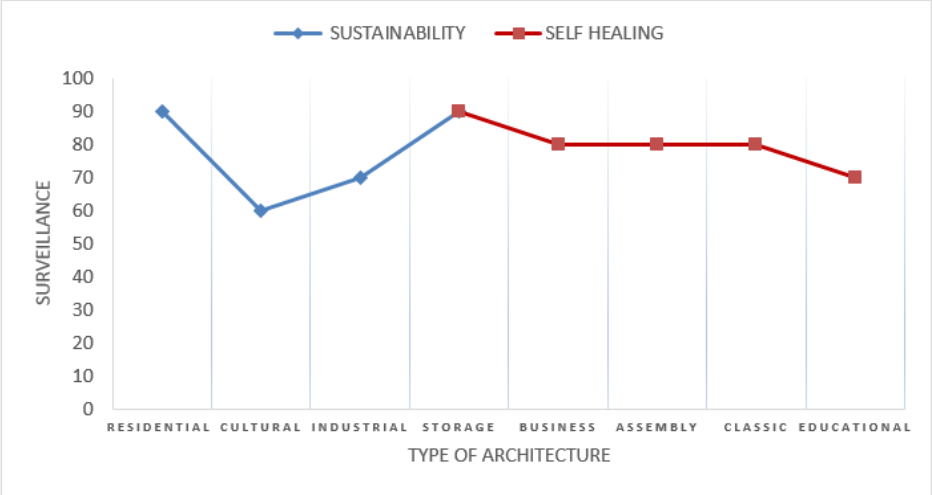

Fig. 10. Different type of architectures being evaluated for sustainability and self-healing mechanism in terms of surveillance and scrutiny factors (by researchers).

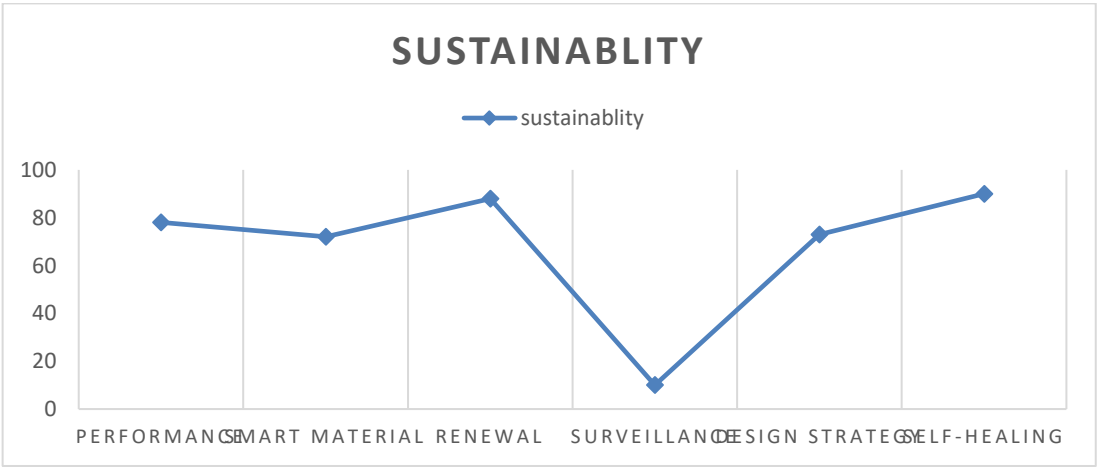

Fig. 11. Scheme showing the percentage of realization of the concepts related to sustainability in the Tobacco Building (by researchers).

Sustainable design includes four factors: performance, smart-material, surveillance, and sustainability. Most energy-efficient buildings are architecturally pleasant. People believe that green designs are not satisfying and it is also true that green architecture is not always good architecture. A good building should be sustainable and eco-friendly. Building performance, a realistic approach based on the climate of a particular location, is concerned with a combination of weather, biological, geological, and topographical features. Sustainability recognizes understanding the distinctive characters of places and how it can be protected. Therefore, sustainable design is an art and not a science.

5. DISCUSSION

This research investigates sustainable and self-healing mechanism for buildings with smart material, surveillance and performance. In general, the building supports sustainability and self-healing standards. The design prensented in this work for construction and building materials boasts more than 1,200 standards (optional) and regulations (mandatory) in construction in building (Turk, 2019). A variety of organization established these standards, and they are identified below:

- 58 percent are sustainable building design standards for enhancing the structure operations and strength set by ISO, the International Standards Organization
- 18 percent are sustainable building design standards for enhancing the structure operations and strength set by CEN, the European Committee for Standardization
- 16 percent are sustainable building design standards for enhancing the structure operations and strength set by ASTM, the American Society for Testing and Materials
- 8 percent are sustainable building design standards for enhancing the structure operations and strength given by GCC (Tam, V.W.Y. and Tam, C.M., 2016).

Additionally, with the International Construction Technology and Building Materials Exhibition, host a performance, smart material and surveillance based modern buildings to "introduce sustainability-based participants to additional knowledge of codes and standards and their support for sustainable construction as well as the link between codes and standards with manufactured products and compliance for self healing buildings".

Table 1. Evaluation of different construction material being used in the self-healing architectural buildings (Tam, V.W.Y. and Tam, C.M., 2016).

EVALUATION ACCURACY	TEST-1	TEST-2	TEST-3	TEST-4	TEST-5
MATERIAL	60%	70%	80%	90%	100%
Conventional Material (Gruyaert et al., 2015)	51.57	62.97	73.92	83.23	90.64
Nano Material	58.67	67.86	76.63	88.06	98.39
Reusable Material (Gruyaert et al., 2015)	54.47	65.50	75.27	85.01	93.28
Optimized Load Material	55.47	66.92	74.92	85.61	93.89

The results shown in this work indicate that high efficiencies obtained in terms of sustainability and self-healing mechanism which translate directly to similar improvements in terms of reuse,

assembly and remote health monitoring. This could also happen when analyzing the correlation between other durability properties, and thus, further investigations are needed to evaluate the self-healing consequences in architectural buildings.
These results are of great importance in order to predict the durability properties of elements where self-healing is involved or expected and therefore, future lines of research should cover these points to ensure the safety of self-healing buildings elements.

6. CONCLUSION

1- To conclude the paper on sustainable and self-healing mechanism for architectural buildings. The designed building architecture has an open plan with an ample amount of flexible spaces with self healing and sustainability capabilities.
2- In the long run, buildings has to be sustainable. Sustainable architecture can be said to be an attitude.
3- The main purpose of architecture is to provide shelter, against all climatic changes to be bared by humans which this research provides insight.
4- For the implantation of this research work a well know tool Simulink was being used on open-source dataset for the evaluation. Sustainably has always been merged with building designs in architecture and has not been a separate issue.
5- Different type of architectures being evaluated for sustainability and self-healing mechanism in terms of performance, operations, smart material and surveillance factors.
6- We believe that the concept of sustainability with self-healing mechanism design primarily to conserve building which is provided in this paper.
7-The maximum performance is recorded for residential and industrial building at 92.45%, the smart material effectiveness in construction for residential stands at 91.34% and in the last the surveillance and scrutiny in proposed building for residential and storage stands at 90.87% respectively.

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