International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-11 Issue-6, August 2022

Enhancement of Sustainable Adaptative Reusing in Historical Buildings (Case Study Abdeen & Baron Empain Palace)

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Abstract*: Egypt *faces a major problem out of the abundance in in the inherited buildings, that causes great loss of historic values. The author focusses on identifying the preservation needs for reconciling energy efficiency, achieving the new function in its best performance. The research goal is to retrieve the heritage by managing the optimal change occurred as a sustainable landmark. The research consists of three parts; the first part contains the introduction, recognition of a preservation methods. Second part is the theoretical part that discuss the preservation of inherited buildings. Third part shows the operation methods for sustainable reusing by design builder assessment tool, for being sufficient in addressing the Egyptian heritage according to NOUH principles, to upgrade the indoor environmental quality and upgrade the energy performance. The paper suggests different interventions internally, and externally within minimal additions, by applying transparent solar panels inside the inherited Empain Baron museum.

Keywords: Historical Building, Adaptative Reusing, Preservation, Energy Consumption, Sustainability, Thermal Performance.

I. INTRODUCTION

Adaptive reuse of inherited buildings as green buildings is rare in Egypt. There are some barriers facing reusing in Egypt, such as economic aspects, and its necessity in saving its value, beside the citizens awareness, and supervision of inherited building performance by its users, by following the adaptive principles relevant to its environmental context (Langston, C., Wong, F. K., Hui, E. C., & Shen, L. Y. 2008, Bienvenido-Huertas, D., León-Muñoz, M., Martín-del-Río, J. J., & Rubio-Bellido, C. 2021). The adaptative reusing starts in Egypt in the sixties till twentieth centuries. As some values of inherited buildings are lost (De la Torre, M. 2013), because of their owners are looking for the profit of land value, more than its inherited value. Egypt put limitations to remain the heritage value, known by NOUH principles, identifying the building national heritage aspects is essential with its events, or architectural style (De la Torre, M. 2013). There are needed requirements to readapt new function, especially how to cope with its basic materials (Rico, T. 2019). The research conducts some case studies of some palaces in Egypt that turn to be museums, such as Abdeen Palace, and Baron Palace. The challenge in readaptation is applying minor interventions, within minimal additions (Oppio, A., Bottero, M., & Ferretti, V. 2017). The research identifies the inherited building values in relation to its context, preservation principles, to evaluate it after reusing according to the integration, and physical aspects. The author suggests guidelines in evaluating the heritage buildings that reflects on the social, cultural, ecological and environmental purposes (Langston, C., Wong, F. K., Hui, E. C., & Shen, L. Y. 2008, Carter, B., & Grimwade, G.1997, Parga-Dans, E., González, P. A., & Enríquez, R. O. 2020). These case studies were analyzed upon the guidelines for preserving historic building, 2016 rules, as a scoring system from 1 to 5, comparing its structure treatment, using this score, (1=very bad, 2=bad, 3=good, 4=very good, 5=excellent). The main goal of reusing is to retrieve these buildings to its originality by being open museum, historic palaces as in United Kingdom, by following NOUH principles for restoration.

Manuscript received on 04 June 2022 | Revised Manuscript received on 12 June 2022 | Manuscript Accepted on 15 August 2022 | Manuscript published on 30 August 2022.

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II. PRESEVATION METHODS

Preservation is occupying a function in an inherited building, with maintaining its architectural identity (Alvarez, M. D., Yuksel, A., & Go, F. (Eds.). 2016, Prihatmanti, R., & Bahauddin, A. 2019), that respects its social, cultural benefits, as shown in Fig (1) [4]. The sustainable development is an essential solution for the environmental [16], and economical aspects (Chong, K. Y., & Balasingam, A. S. 2019). The inherited building represents the design, aesthetical value [20], the pioneer, art value, era distinguished art, the structure technique, the urban context, types of inherited materials, traditional building, social value, and the inherited building age (Rico, T. (2019, Parga-Dans, E., González, P. A., & Enríquez, R. O. 2020), (Bienvenido-Huertas, D., León-Muñoz, M., Martín-del-Río, J. J., & Rubio-Bellido, C. 2021). The image of the inherited building value is shown in its memory that served the area identity [9]. So, reworking on its physical form is crucial, as it is needed for future generations, that will reflect positively on the social impact, by conserving, and maintain its cultural value (Bienvenido-Huertas, D., León-Muñoz, M., Martín-del-Río, J. J., & Rubio-Bellido, C. 2021). The building deterioration needs lots of maintenance to revive it to its heritage value [20], such as strengthen its structure by restoration, to overcome any existed cracks or collapsing parts. As well as it needs renewal to update it to the needed requirements for the new function, by it with modern techniques.

(Elabd, N. M., Mansour, Y. M., & Khodier, L. M. 2021), such as firefighting, electricity, fire alarm, water sanitation, air-condition if it is needed, added it to completion or

rebuilding for the missing parts. To readapt the inherited buildings, we have to investigate its current circumstances, to identify its needs to be compatible with the new reusing function, especially if it needs structural, architectural changes, and how it will be implemented, or rebuilding the missing parts, as the original parts with distinguishing it without changing its value (De la Torre, M. 2013, Rico, T. 2019), as shown in Fig.1.

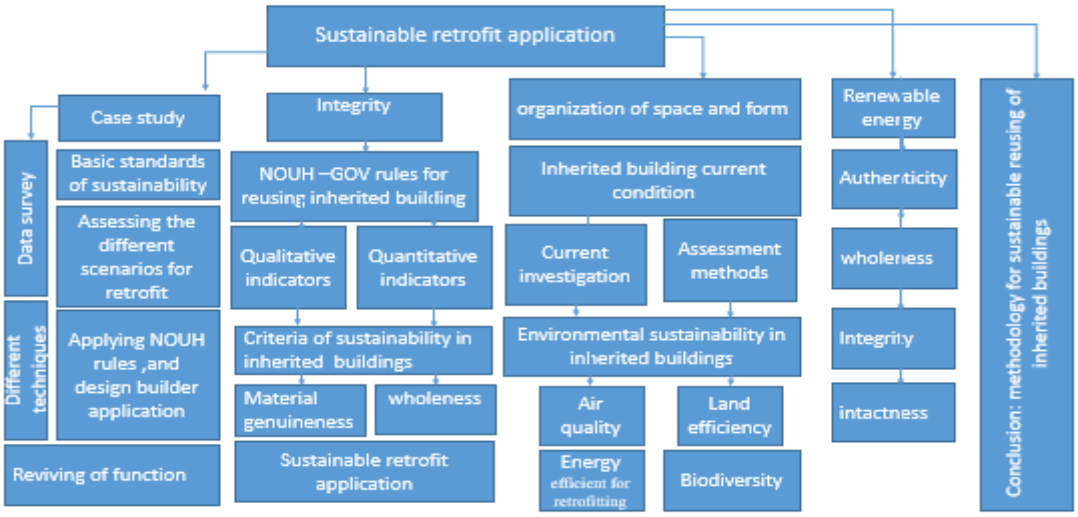

Figure .1. shows the suggested methodology of conserving historical buildings in a sustainable context, in heritage buildings, source: the researcher

III. TYPES OF HERITAGE BUILDING

Heritage buildings differ according to its architectural value, visual importance, and events. To encourage the tourism investment in Egypt (Lussetyowati, T. (2015, Chong, K. Y., & Balasingam, A. S. 2019), it needs to maintain its historical value by reusing it, to ensure its continuity. The author highlighted on these case studies by analyzing the palaces during 1952, that was given to the governmental entities, like Abdeen palace, and the other palace as Baron palace that is used as museum by now. To assess the reusing efficiency, by comparing between the original use without modifications, with the new reusing function with limited modifications aspects, to cope with our daily life, (Langston et al.,2008). The conflict facing re-adaptive reusing is the needed requirements for the new function that may affect its inherited value afterwards. So, the challenge is how to restore the inherited physical values without being changed, according to the Law 117 of year 1983 in Egypt. There must be approval from the Antiquities for any monument, following the regulations, (Akram and Broström, 2015). Many researches discuss the problems facing the reusing of historic buildings to protect the cultural aspects (Idris, M. Z., Mustaffa, N. B., & Yusoff, S. O. S. 2016, Strange, I., & Whitney, D. 2003), and to limit any changes (Internal or external) that may affects its inherited value to protect the building's authenticity. The institute of the historic building conservation, 2008 declares the size of alterations that can be accepted for adaptation, to accomplish harmony with the architectural new function. Hence following the regulations and guidelines for preserving historic building 2016 is too crucial (Bullen and Love 2011, stated that the design alteration, is perceived by its extension in historic building (Lussetyowati, T. 2015).

IV. CLASSIFICATION OF REUSING

It differs according to its chosen function; many aspects should be applied. As for the original function, it is required to maintain it without any modifications. On the other hand, for implementing new function (Prihatmanti, R., & Bahauddin, A.2019)., it needs to implement the modifications needed as modern techniques coping with the inherited value [20] to perform the adaptation (Idris, M. Z., Mustaffa, N. B., & Yusoff, S. O. S. 2016). The absence of the right adaptive reuse causes a great loss to the community, by having this complexity in applying it with different interventions, affecting the inherited building performance (Oppio, A., Bottero, M., & Ferretti, V. 2017). Most of Case studies differs according to its different available resources, with different priorities, and cultural importance. As each case face different constrains and priorities. Energy strategies for the historic buildings may be the same, but differ in its implementing methods and external form, to unify it with the existed architectural style (Prihatmanti, R., & Bahauddin, A. 2019). The conflict in applying these modern techniques, is coping it with maintenance strategies, shown in adding insulation layers, cooling system within maintaining its visual aspects as it was in the past. According to the Egyptian law of antiquities no.117, 1983, it is allowed to strengthen the inherited building structure by its main basic materials, such as stone walls, or traditional insulation methods (Fuentes, J. M. 2010), but not any hidden pipes in its inherited walls (Rico, T. 2019). So, the inherited buildings need air conditioning when it is reused by different function with high capacity, as converting it from palace into museums.

The author emphasis on this challenge in how to implement many privileges of sustainable systems (Elabd, N. M., Mansour, Y. M., & Khodier, L. M. (2021).

V.DECISION -MAKING FOR ADAPTATIVE REUSE

It is very important to assess the new function decision process before reusing it, to verify its efficiency impact by simulation (Oppio, A., Bottero, M., & Ferretti, V. 2017), and analysis relevant to its circumstances. The suggested solution scenario has to support the occupancy level. Most of historical buildings are sustainable in having normal

ventilation, and lighting, but the real conflict is after reusing, the building duty changes upon the occupancy level, and its newly needs as an adaptative reuse (Langston, C., Wong, F. K., Hui, E. C., & Shen, L. Y. 2008). The research goal is to generalize the sustainable inherited buildings as way of thinking (Farrag, N. M., & Abouhadid, M. 2018). Historical and inherited buildings is the cultural identity through time, and reference for contemporary buildings afterwards. The updated reusing is essential to retrieve the life cycle back again, that is based upon alterations and extensions. For future needs the approach of preservation aspects [3] is needed to be applied in an ideal form (Alvarez, M. D., Yuksel, A., & Go, F. 2016). The author suggests sustainable criteria (Pereira, R., Post, J. M., & Erkelens, P. A. 2004, October) according to the heritage principles, to achieve sustainability in historical building as a trend, referring to GOPP general organization for physical planning (Periera, R., Post, J. M., & Erkelens, P. A. (2004, October). The fundamentals needed for adaptive reusing of historical buildings is applying the adaptation rules and principles to choose the best adequate function, to save its heritage value. The author chooses the Baron Empain palace as a case study, to verify the efficiency of building performance after reusing, showing the percentage of restoration, support, renewal, update, strengthen, completion been applied, and the problems caused by the new function in reforming some internal walls inside the palace (Idris, M. Z., Mustaffa, N. B., & Yusoff, S. O. S. 2016). The complexity in readaptation is in having different point of view in taking the right decision, in its influence degree, by having minimal intervention, to follow the regulations in a flexible way, beside investigating the profit of readaptation by the developers (Alvarez, M. D., Yuksel, A., & Go, F. (Eds.). 2016), and stakeholders. The adaption is essential for the Economic aspects, as it cheaper to adapt it rather than to demolish it. The stakeholder plays a great role especially when he is the owner, as developers are not concerned that much with life cycle, rather than the capital cost, and financial return (Alvarez, M. D., Yuksel, A., & Go, F. 2016).

VI. REUSING OF INHERITED BUILDINGS IN DIFFERENT ACTIVITIES

It is an essential theme in saving our identity, and relevance to its cultural value. As the problem is that most of these building was reused by unsuitable function that affects it negatively. The author aim is to implement sustainable reusing instead of facing that lack in planning to save its historical value, based upon scientific methods. The author suggests solutions, upon the contribution with different analytic national inherited examples, to study its efficiency after reusing. There are limited researches that addresses this problem in sustainable way (Fuentes, J. M. 2010) [17]. The study methodology aims to achieve sustainability in all inherited buildings, build upon the analytic survey of historic buildings after reusing, and how to accommodate the new function in adequate way, as a national experience, and verify its efficiency (Ijla, A., & Broström, T. 2015) [18]. The adaptive reusing needs acceptable performance relating to maintenance procedures, guarantees of utilities, thermal comfort, and energy efficiency (Fuentes, J. M. (2010), (Oppio, A., Bottero, M., & Ferretti, V. 2017). The national organization for urban harmony's (NOUH) is the national assessment role in Egypt for studying the adaptative reuse. The research emphasis on the indoor environmental [16] of inherited buildings, and testify the air quality (Rani, P. 2015) [23], lighting, and acoustics on a widely approach (Farrag, N. M., & Abouhadid, M. 2018).

VII. THE ADAPTIVE REUSE THEORIES

The adaptive reuse mainly relayed upon the historical buildings value, structural safety, regardless the function or its typology. As this theme was existed during the renaissance, by converting lots of religious buildings into military contemporary buildings with different practice [10] (Ijla, A., & Broström, T. 2015). So adaptative reuse is the change applied to cope the new function in the inherited buildings. In the nineteenth, twentieth century lots of international council of monuments and sites (ICOMOS) take reusing as adaptation of new function in vernacular heritage [19] (Strange, I., & Whitney, D. 2003), Farrag, N. M., & Abouhadid, M. 2018). The Burra charter declared that the success of adaption in its impact on the inherited building and utilize the function in an efficient way. As NOUH rules focused on the integration of structure, safety conditions, and compatibility. Adaptation is limited by the cultural impact of the inherited building. There are lots of restrictions in dealing with the inherited physical properties, that represents a real challenge in implementing energy sustainability for energy saving, and thermal comfort inside it, in a specific way, especially if there is any sort of additional materials (Sustainability 2021, 13, 10531 4 of 26, Rico, T. 2019). Mainly the criteria of adaptation relayed upon compatibility, integrity, reversibility, and authenticity (Ijla, A., & Broström, T. 2015). UNESCO directed the world on the importance of world heritage [24], and conservation. All charters are made for conserving monuments, and sites from 1930 till now, known by the ICOMOS (International Center of Monuments and Sites). Mechtild Rössler (the pioneer in world heritage, Christina Cameron, Jukka Jokilehto, Fielden, and Bernard Fielden focused on the management of heritage conservation, and how to apply balance between reusing and conservation in the universe communities, to conserve the historical value (Lussetyowati, T. 2015). The adaptive reuse evaluation can be classified into off-site, and on-site criteria (Parga-Dans, E., González, P. A., & Enríquez, R. O. 2020). Where the on-site criteria (MacLean, M. G., Mason, R., Myers, D., & MacLean, M. 2005) are related to the compatibility of inherited building with its function, architectural identity [19], its era, construction adaptation [21], cultural, social significance, and its reflection on the community.
(Parga-Dans, E., González, P. A., & Enríquez, R. O. 2020).
On the other side the off-site evaluation is related to the accessibility, the recreational activities spaces, and the sustainability goals. Adaptation design is classified into initial design with the same function, or renovation of structure [11], out of its current state, having original form, or reshaping the form by extension as in Marriot palace, building two towers on its edges in asymmetrical way, that cause transformation in terms of strategy (MacLean, M. G., Mason, R., Myers, D., & MacLean, M. 2005).

VIII. IMPLEMENTING SUSTAINABILITY IN INHERITED BUILDING TO UPGRADE THE ENERGY PERFORMANCE

The regular question is how to achieve the thermal comfort in inherited building, by using the same traditional materials (Rico, T. 2019). First, by studying the contents of the project, its orientation, percentage of solid, and void that affects its energy efficiency. In addition, analyzing the building envelope, ventilation elements, its wall thickness, and understanding the percentage of modification needed to enhance heat performance (Oppio, A., Bottero, M., & Ferretti, V. 2017). Green adaptation is great needed in inherited buildings, and lots of international conferences discuss the suitable guidelines and strategy to decrease the carbon footprint, such as ADAPSTAR that is used as an evaluation tool. There are lots of system that focus on green design, such as LEED and BREEAM, as a leadership for environmental design, that reflects by a holistic impact on the social, environmental, economic, physical, and technological themes (Elabd, N. M., Mansour, Y. M., & Khodier, L. M. 2021, Bolici, R., Leali, G., & Mirandola, S. 2020). One of the most crucial elements needed for conservation and reusing of historical buildings is, the study of climate, its effect on buildings, and the modifications needed to upgrade its performance. Although the sustainability is universally applied, but not applied that much in Egypt. The research follows the UNESCO [24], and UNDP (united union for preserving nature) guidelines for achieving the sustainability in inherited buildings, (Periera, R., Post, J. M., & Erkelens, P. A. 2004, October, & Rani, P. 2015). Beside other international association that focused on improving energy performance of inherited buildings, and guidelines for implementing air conditioning as in Italian association of air conditioning -AICARR guidelines, that consists of main basics of energy consumption, guidelines for designers for the energy enhancement, and monitoring organization 2014 (Kearsley, G. W., & Middleton, M. C. 2006) [22].

IX. INTERVENTION METHODS FOR HERITAGE

The intervention methods can be applied through maintaining the structure of the inherited building, without changing the building envelope, to achieve the thermal comfort, and upgrade the building performance. Then selecting the materials coping with the existed material for maintenance, as an effective solution for restoration, referring to EU cultural heritage (ENCULT), that merge between climate protection [2] and preservation. Monitoring process for the inherited building performance is so essential, to understand the priorities in conservation steps (Kearsley, G. W., & Middleton, M. C. 2006), (G. O. Young, 1964).

There are several themes in evaluating the environmental efficiency, adaptative reuse in relation to the occupancy level and its impact on the inherited building value. Adaptation in heritage building is changing its original use into efficient function, as 'retention' of the building structure. Adaptation activities has different terms as rehabilitation, refurbishment, re-living, renovation, conversion, revitalization, transformation, adaptive reuse, reinstatement, remodeling, retrofitting, restoration, and modernization of inherited buildings, (Farrag, N. M., & Abouhadid, M. 2018). However, it is crucial to occupy minor changes with flexibility in a small scale, to distinguish the internal changes through implementing new techniques as convertibility, without having dismantlability, nor disagreeability in applying reusing. Many expandability or dismantlability will change the heritage value, by having different changes, and additions in configuring the originality of the building, and it will affect it negatively afterwards (Prihatmanti, R., & Bahauddin, A. 2019).

X.ANALATIC PROCESS FPOR ADAPTIVE REUSE IN RELATION TO SUSTAINABILITY, ENERGY PERFORMANCE, AND VENTILATION

The study focused on Lifecycle restoration, Life-Sure, and sustainable approach that is built upon three theoretical fundamentals, defined as: sustainable functional efficiency; ▪energy saving oriented; and inherited building life-cycle, verifying its impact on the inherited building performance by simulation, to analyze its side effects, by using design builder program [11]. The demand of adding materials is to enhance energy performance that was limited, in order to preserve its heritage value with its architectural identity. Hence adding cooling system or upgrading the building envelope was restricted by nation rules, to protect the original ornaments and details. The author suggested transparent materials to be used, such as transparent PV cells upon the voids, added to the inherited building shell, as a suggestion to achieve the thermal comfort (Fuentes, J. M. 2010). Many researchers combined between simulation, and mathematical measurements, to decrease the deterioration, to cope with the needed requirements for climate change relevant to the inherited building contents [2]. The author emphasis on thermal comfort in the inherited building, while other researches focused on studying the efficiency of lighting system, and heat efficiency, referring to Florence Italy themes, using (TAS) as thermal analysis as a modeling tool. To quantify the values some researches, use mathematical equations to reduce the side effect of air conditioning, and study the wall insulation and heat transfer. As in Barcelona they use sunray penetration, to decrease the air-conditioning use. Mainly the research tries to apply different scenarios for implementing transparent solar panels on windows, for energy saving to light the museum, especially after reusing as most of the museum windows are closed by its basic wooden shatters to avoid glare in the museum, referring to a successful example in Alexandria, that used solar cells units in inherited buildings as a sustainable treatment [1].

XI. ANALYTIC METHODS FOR ADAPTIVE REUSE AS A MUSEUM IN NATIONAL CASE STUDIES IN EGYPT

The study analysis is based upon comparing these national case studies to analyze its building performance after reusing, in comparing to its original use, as retrofitting level. So first the author identifies the value of these inherited building and its reflection on urban context, with describing the retrofitting strategies applied to achieve the thermal comfort. (Bienvenido-Huertas, D., León-Muñoz, M., Martín-del-Río, J. J., & Rubio-Bellido, C. 2021). The analytic methods learned from these case studies, can be a guideline for readaptation process, in upgrading the inherited Buildings' performances by investigating the current situation, to understand the priority of the

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

design and construction elements needed [21], that can enhance green sustainable heritage with energy saving**.** These strategies vary upon its intervention level to the inherited buildings value. The privilege of these inherited buildings is in having thick walls for wall insulation, but for sure it is prohibited to change its windows, so the author search for transparent solar panels to be added to the original materials, and build the analysis on the simulation before and after intervention, without destroying its historical value [6].

A. Defining the Building Performance as an Objective

The suggested material for energy saving is men triple-insulated glass unit, luminescent solar concentrator, using PV cells, polymer waveguide, and chromophore as a sensitive transparent active layer that contains Tio2, and Agnew based composite electrode. So, its u factor = 2.54 w/m2 *k, where it has 12.7mm Agron gas, 3mm clear glass, and organic solar cell [1]. These modern techniques will help to upgrade building performance in a transparent way during summer and winter, as much as it is used on voids, it decreases the consumed energy. This preliminary methodology will fulfill the (POE) post occupancy evaluation strategy that relays on merging different compatible techniques in a subjective and objective theme. The subjective evaluation is built upon the occupant's questionnaire to verify its efficiency role as a cultural aspect [5]. Many researchers have used this assessment theme to utilize sustainability (Langston, C., Wong, F. K., Hui, E. C., & Shen, L. Y. 2008, Periera, R., Post, J. M., & Erkelens, P. A. 2004, October). The simulation, represents the hottest month in the year in Egypt, is July, and the coldest month is February. The study focused on studying the difference between inside and outside degrees, and its effect on the thermal comfort, to determine the efficiency of the adaptive reuse function, and its energy consumption. The thermal perceptions vary upon the suggested scenarios. The author determines the main variables happening in the inherited building after reusing with the same environment, shown in number of occupants, adaptive reusing impact, reflection of activity on thermal comfort, the efficiency of function, integration with the urban context, defining the existing barriers, and limitations, the value of inherited buildings, the provided safety, the maintenance, firefighting system, and integration with the structure. There is deviation in thermal comfort according to the environment and human factors, shown in PMV/PPD index (Kearsley, G. W., & Middleton, M. C. 2006). According to the ASHRAE (air-conditioning system), and international standards, PMV/PPD is relevant to the radiant temperature, humidity, function coping level, with the air temperature (Bienvenido-Huertas, D., León-Muñoz, M., Martín-del-Río, J. J., & Rubio-Bellido, C. 2021). Hot temperature represents number (3) in the thermal sensation, while cold represents (-3) in its Scale. (Ashare2005). The author determines the korba district climatic data, relayed upon USDOE united states department of energy and use it in the design builder, where the thermal comfort ranges between 30c, and 40c in summer, while in winter, its range between (18c and 22 c). The paper study the effect of new implemented material on the heritage thermal performance that can fulfill NOUH principle, adaptation level, urban context that is computable with the new function (Prihatmanti, R., & Bahauddin, A. 2019), by assessing the inherited value maintained, adaptation level, buildings material and its impact on the thermal comfort. Would the modern techniques cope with existed building material, to fulfill the reusing needs, the thermal comfort value, fulfilling NOUH principles, and historic building value or not? (Idris, M. Z., Mustaffa, N. B., & Yusoff, S. O. S. 2016) The author defines the limitations in the inherited case studies, its impact of reusing on social, environment, and cultural significance [5], integration of structure, compatibility of building after reusing, and accessibility. The researcher focusses on the Correlation Coefficient that represents the relationship between variables, the correlations' degree, showing the strong, and weak correlation, which is (between ±0.50 and ±1). Where the perfect degree is 1, and +1. while weak correlation value (-ve)**.**

B. The Scale of Changes for Readaptation

The added materials for adaptation should be distinguished from the original ones. The basic places should be without change, while other secondary places, may have added movable things like furniture, lighting, adequate to adapt reusing. It is required to remove any addition that cause any negative impact on the inherited buildings, to return it to its originality. Thus, it is preferable to fix and maintain the historical elements [6], rather than being replaced. It is crucial to maintain the original staircase. Hence, it is recommended to leave the old mechanical system, to show it as a part of the museum. Reusing requirements are classified into spatial needs of inherited buildings (architectural, mechanical, civil, historical, urban planning requirements, economic requirements, and social requirements. The social requirements are classified into human attitude towards the inherited building, socio economic aspects, and cultural aspects [5]. Regulatory requirements are classified into strict penal clauses, all the needed regulations, accomplishment of the reusing process. The civil requirements are shown in the structure system, with its identity. The urban planning requirements is shown in upgrading the urban identity, landscape, and accessibility. The economic requirements are assessed by the funding resources, and restoration management cost. The mechanical requirements are shown in firefighting systems, fire alarms, acoustics, water supply, air conditioning, lighting, and sanitation network.

Small scale focus on recovering the deterioration happening by improving the material surface status, and have minimal extensions in small areas, that is called minor adaptation, but if the changes increased in its capacity through extension, alteration, structure, or removal of internal walls is called medium scale. According to NOUH principles small scale is permitted only, as whenever the scale of changes increases, the heritage identity is lost by the extreme changes in extensions and alterations, beside changing its original use. The economic requirements are assessed by the funding resources, and restoration management cost. The mechanical requirements are shown in firefighting systems, fire alarms, acoustics, water supply, air conditioning, lighting, and sanitation network. First, we analyze the physical features of the building through investigating the status of its original material, site features (urban context, less attachment, as it shows the ease of adaptation), services (divisions of space, as central distributing areas, corridors), plan shape (regular -irregular), and construction (wood-limestone-concrete) (MacLean, M. G., Mason, R., Myers, D., & MacLean, M. 2005).

XII. CASE STUDIES

The chosen case studies were selected upon its criteria, for its intervention, showing the scale of compatibility, the alterations that were applied, identifying its adaptation level; physical aspects, and inherited building circumstances. These additions were applied to cope with the updated function to achieve an effective contrast to comply the perfection in adaptation, to fulfill the adaptive strategies [13]. The author identifies the flexibility in relevant to the building size, to enlarge it for the new function, based upon maintain its uniqueness. Describe the addition happened in material, or appearance, and its impact on the heritage value. Most of the extensions reason is to comply the environmental thermal comfort, and for economic issues (Kearsley, G. W., & Middleton, M. C. 2006). Hence level 3 shows the conversion in its function, while level 4 shows the major alterations that enlarge its capacity in a large scale. The right decision for adaptation, is to distinguish the level of intervention and refurbishment, to its added value in retrieve the heritage building, whether socially (preserve sense of originality of space, physical attributes of heritage buildings, distinctive character), or economically, or environmentally (less energy consumption, urban context, energy saving, and life cycle cost). With the aim of retaining the historical buildings' personality and unique importance, thus conservation was the main way of caring and dealing with the changes [3], as heritage buildings were a unique resource of ethics. Through a Qualitative process, the study explained and discussed the affecting factors of adaptation principles and decision-making to identify strategies for heritage building's adaptation [13], that helped in analyzing some case studies with variable additions, to obtain proposed adaptive reuse principles [13]. Reusing in Empain palace faced lots of changes in the finishing as a refrubrishment intervention, with applying kisoks in the plasa for serving the museum (Strange, I., & Whitney, D. 2003), so it has meduim scale of alteration in its surface improvement, with major extensions in main areas, and insertion of internal walls inside the main halls to subdivide the exhibited halls, to increase the building capacity (Langston, C., Wong, F. K., Hui, E. C., & Shen, L. Y. 2008, Strange, I., & Whitney, D. 2003). The updated techaniques [12] were literal invention without its main style, on the contraty in Abdeen Palace [3] ,the extensions was invention coping with the original hertaige style in the oranmnets, where it is compitable and destinguished.The physical attributes changes in the site features (Parga-Dans, E., González, P. A., & Enríquez, R. O. 2020)., Modular flexibility, services location, (MacLean, M. G., Mason, R., Myers, D., & MacLean, M. 2005) .The internal intervention in Baron Palace was shown in its consolidation, infill, alighnment in the internal partitions, while the external interventions is shown in the boundaires, the edge, the corner ,and the inherted building features.All these interventions affects the Empain Palace in its environmental ,social and econmic value.The difficiency in reusing is consuming lots of energy in lighting an aircondition, where there is no energy cost saving , that reflects on the society. (De la Torre, M. 2013). The author finds that even after reusing [14] , the upper floor halls needs Hvac to ventillate the large occupancy of visitors. Reusing needs certain design considerations to be fulfilled in order to fulfil the required function, according to the needed changes, and identifying the alteration system and its side impact. The author investigates the level of the inherited building adaptation, regarding its capacity, and the internal changes affecting its value, and its performance. The author assesses building performance by using design builder, as an intervention of internal additions that were applied in the palace (Intentional opposition), and external intervention in the external plaza ,as the wooden added pergolas and kiosks that aren't coping with inherited palace style ,and hasn't save the continuity .So it was preferable to apply in outdoor gallery, reviving the same style of the palace to have contrast , showing it in a plan glass façade instead, to avoid blocking the palace view. The author suggests to apply modular flexibility in the outdoor to utilize the garden in a transparent vision (Kearsley, G. W., & Middleton, M. C. 2006)., as an approach for the internal exhibition. The adapted reusing function affects the economic, environmental, and social impact of the palace. Regarding social impact it respects the palace main access, but it decreases its value by polishing it, and by the new updated techniques that were added inadequate way that blocks the view of ornaments, valuable windows, and doors [3]. The positive impact of reusing is in maintaining the construction as it is [21], and enhance public access to identify the inherited values, in order to preserve it, and increase their loyalty. The author investigates the inherited building performance in order to upgrade its environmental impact, and apply it as a sustainable inherited building, to minimize the great consumed energy used in lighting, and in air conditioning system.

A.Identify the inherited buildings values

To identify its value, through its historic value, historic aspects, building age that represents a symbolic value, urban value, aesthetic architecture value, and social value. The social and environmental values (Mydland, L., & Grahn, W. 2012) are too important in continuing the heritage architectural value, based upon RIBA's energy assessment tool (50kwh/m3),
beside its aesthetical needs to unify its symbolic value in all the needed reusing requirements, coping with the building age, representing the art and architecture heritage in its urban context. The Empain Palace play an important role in placing the sustainable development goal as a hub in all inherited districts [7]. This needs analytic social aspects concerning the visitor behavior to the heritage conservation [3], and reduce the consuming energy up to 39% according to Leed to upgrade livability to the heritage.

The author highlights on applying limitations in readaptation and reusing of historical building by using Nouh principles to maintain its social value, with its traditions in an integrated way with its historical value, and compatible with the needed updated reusing requirements, and climate change [2]. Space and time are the most important factors that can evaluate any historical buildings as resilience factor.

B. The essential rehabilitation needed for inherited building

The reforming in the internal spaces of Empain palace wasn't adequate to its value, as there was duplication in circulation, for not having continuity in circulation from a hall to another, dividing huge halls into small subdivisions, by using fixed partitions in the flooring, that affects the visitor, as they couldn't feel space by these adding services that are not adequate to the

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formal plaza, which is a main approach to the Palace. The subtraction method happened in using the whole underground for services and security, and administrative offices, rather than exhibiting the main services of the palace, actually this subtraction affects its historic value, insufficient to its value as it hasn't respected its architectural style, ornaments, form, color, and material. So, the visitor couldn't imagine the originality of its historical image by these added architectural elements. The addition method wasn't good in mingling between the value of historic building, and added architectural elements needed for the new function. The architectural elements play an essential role in maintaining its identity shown its ornaments, form, material, and color. The real value of inherited building has to be maintained to its originality in order we can distinguish between old and maintained elements (Ijla, A., & Broström, T. 2015). The energy assessment for the site pavement of the palace was good, but needs more shading areas by landscape, instead of the build pergola, following the rules of urban heat island effect (UHIE) efficiency.

XIII. THE SUGGESTED SOLUTIONS IN UPGRADING ENERGY EFFICIENCY OF INHERITED PALACE

The author suggested these steps as follows to achieve the needed energy efficiency, as adding double glazing in all external opening with transparent PVC cells, implement thermal insulation, adding energy saving for lighting the museum by photovoltaic panels on the roof, as a suggested solution on the dome external skin too to determine the needed energy, and upgrade building performance efficiency, without changing its appearance .The research emphasis on three scenarios in assessing palace thermal performance, first scenario analyzing the same fact conditions with having AC in the ground, and underground floor only, second scenario is avoiding using AC in the whole palace, third scenario implementing AC in the first floor to achieve the thermal comfort zone by using TASEDSL energy model .By this solution the author succeeded in comparing the energy consumed per each scenario, then verify the efficiency of building performance using transparent solar panels to overcome the shortage in energy.

A.Nation Limitations facing the inherited building

What are NOUH standards, how to achieve the ideal adaptation of inherited building has the adaptive reusing affected any internal or external changes that affects the inherited building value? Is there any flexibility in applying reusing, whether through the spaces, or inherited building material? Has the adapted reusing achieved the needed thermal comfort? Has reusing followed NOUH principles, and identify the shortage facing? What is the added value to the inherited building after reusing? (Fuentes, J. M. (2010), (Prihatmanti, R., & Bahauddin, A. 2019). The research analyzes the main indicators that affects the energy consumption in the existed historical palaces after reusing [14], and assess its efficiency, represented in the led spotlight, led bulbs, led strips, ceiling lamps, led spotlights, and measure its energy kwh/year, HVAC, VRF multi dual sensing (48HP, or 26 HP, with inverter, and its effect on the thermal comfort inside the halls.

B. Measuring the energy consumption in the inherited building

The paper investigates the efficiency of inherited building function after reusing, by measuring the energy consumption indoor, by using designer builder as a simulation program, to upgrade its performance. The research suggested a questionnaire for visitors to quantify the building performance after reusing, as shown in these questions, such as: Would the visitor recognize the difference between the original parts, and maintained parts? Define the historical value of the palace after visiting it [14], and what affected you most as a visitor? Are there any educational activities in the museum? Are there any landmarks for the museum nearby?, What is your opinion as a visitor, and as a critic concerning the updated restoration that took place in the palace internal and external elevations?, Is there any continuation for the internal circulation inside the palace, or it has duplication, out having dead ends?, Have you visited the whole floors inside the palace, or there are some floors not allowed to visit it?, Is there good interaction provided between activities inside the palace, What is your opinion regarding the palace after reusing, Does the updated function reflect on the social, environmental and cultural impact, and what are the constrains facing it to achieve it?,

Does the inherited building have other reused function [15], or one compatible function only? Does the updated techniques regarding safety, firefighting, air-conditioning applied in a proper way or not?, Does the updated function of inherited building fulfil NOUH principles in integration, and maintaining its value?, Does the inherited building location accessible to the visitors, and what are the limitations?

The working hours in the museum are 9 hrs. daily from (9:00 till 16:00), (231 hrs.) per month. The percentage of occupancy visitors are 100 person per hour.

To measure the energy consumption, through the total number of hrs the museum is working relevant to the occupancy percentage, is it overcoming the total cost of restoration, which is 175 million Egyptian pounds, and what is the annual revenue amounts after saving the energy consumption after adding transparent solar panels.

XIV. RESEARCH CONTRIBUTION

The barriers facing the reusing of inherited buildings how to provide maximum number of spaces, with freedom in using the new function is an important issue. To apply these essential needs is by maintaining the internal form without any changes, and preserve its elevations, and structure system. How to achieve the maximum energy saving per floor, and in the external plaza too, beside adding the updated needed equipment's, such as HVAC and lighting.

A.First case study, Abdeen Palace

1863 AD - 1873 AD- Style: Built in 1863 by Egyptian, Italian, French and Turkish architects. The palace's garden was added in 1921 by "Sultan Fuad I" on an area of 20 feddans. The palace has 2 stories, out of which: Upper floors are reserved for foreign dignitaries for their visiting stays. Lower floors are totally held as Museum. Its area is about 24 acres, as shown in Fig .2. The palace took ten years to build, and was carried out by Engineer De Corel Wel Rousseou in the nineteenth century, which is very similar to the Tuileries

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Palace (Palais des Tuileries) with its front courtyard, which was called the Place de la Concorde. Abdeen Palace marks the inception of modern Cairo.

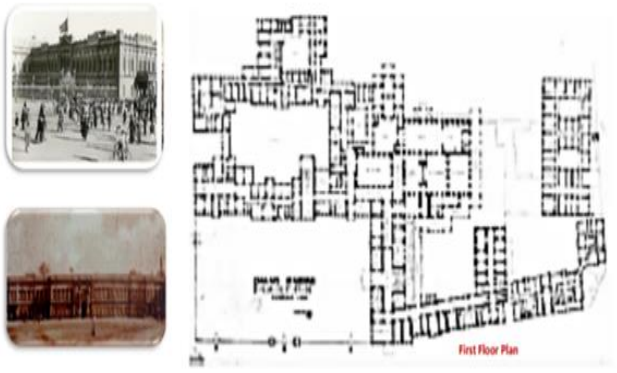


Figure.2. shows Abdeen Palace before reusing in its urban context, source: the researcher

The palace became the seat of government in Egypt following Khedive Ismail Pasha in nineteenth century and took over the rule of more than 100 years, five of them being the dynasty of Mohammed Ali Pasha and the last of them was the ruling of King Farouk. After the revolution of July 1952, many parts of the palace were opened as a museum for the public & some areas as government offices. In 1980's the former president, Hosny Mubarak ordered to return the historical and artistic value of the palace. The Palace was well preserved although it passed through many generations and many phases, but it was kept as its original identity. The general style of the palace is the Neo-Renaissance style mixed with some elements of (Neo Classicism) and the halls were characterized by eclecticism or laconic style, where each suite had its own style. This palace was built in the style of the neo-French Renaissance, as evidenced by some elements of neo classicism. The Saray was built on two floors, and contains about 500 rooms in addition to multiple corridors. Current Occupations: A presidential palace and there is a museum, as shown in Fig (3). The reusing was good in maintaining the palace as it was, and unifying the updated techniques like AC with the same historical motifs, to cope with its historical identity, rather than being odd in shape. The presence of a unidirectional design axis in the urban context highlights on its historical aesthetical value. The recent boundaries in its urban context increase the visual axial spine for the historical palace to be seen from all streets. Aesthetic value is great preserved in Abdeen palace shown in the Monumental Scale, derived from architecture classical style. The pillars were maintained as it was showing the value of Corinthian, Ionic, and composite columns. The central entrance was good maintained by upgrading the plaza surrounding the palace. The decorative iron gates were good maintained, restoring its historical value using the same materials using copper and bronze crafts in a decorative way. The palace is a good example for sustainable heritage, for maintaining its usage as a resident for president, where it is good natural illuminated by its large window openings with colored glazing or a wooden sash. Conservative Criticism is applied in the maintenance applied in the wooden ceiling. The construction material was maintained as its originality, iron, cement that was brought from France. The adaptative reuse [15] was effective relating to the cultural function, the reservation applied internally by implementing air conditioning and lighting in adequate way to its originality, coping with its architectural style, that can be distinguished.

Figure.3. shows Abdeen Palace layout after reusing, showing the change happened in its urban context, source: the researcher.

The restoration and sustainability increase the livability, and walkability in the urban context of the historical palace, by measuring the number of visitors before and after reusing, and the added integrated capabilities for the users, beside the renovated landscape that increase the cultural; sustainability to the historical palace to provide good economic assets and upgrade the urban heat island effect (UHIE), as shown in Fig.3. Regarding the environmental assessment, its efficiency is measured by measuring the energy consumed in the site's pavement after restoration, and the energy consumed internally using (HVAC) units and updated equipment's in the palace as energy record the number/types of lamps.

As most of the lighting are light strips displayed in a linear way, beside led spotlights hidden tin the motifs as shown in Fig.4., added to it VRF multi v5, HVAC, relevant to the number of visitors per hour and the palace occupancy to define its economic sustainability from the percentage of energy consumed, and the percentage of total cost of restoration, and the revenue amount per year. The percentage of lighting turns to be highest percentage in energy consumption //9kwh/yr./floor). The internal and external intervention applied in Abdeen palace was too effective, and accomplished clean energy indoor and outdoor, in enhancing sustainable community development in upgrading the cultural, economic, and social sustainable aspects [7].

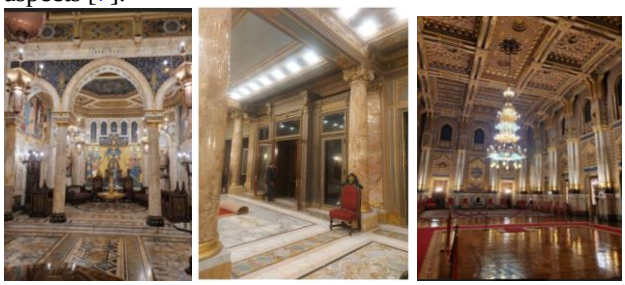


Figure.4. shows the lighting in internal halls of Abdeen Palace, using Led light strips, and lighting lamps in ceiling after reusing, source: the researcher

B. Second case study, Baron Palace

Th Empain Baron palace's value shown in its visual importance to the city, its location has a great important authority in being in the hub of the district, beside the internal luxury in its internal ornaments' elements, its architectural value, being distinguished from all the types of buildings in Egypt, where it is unique by its significance style in forming among its urban context.

Figure.5. shows the Baron palace urban context before, and after reusing, source: the researcher

Case study: Project name Baron Palace, Location is in Oruba, Al-Park, New Egypt Section, Cairo Governorate, Egypt, Year:1907-19011, Area is 6 feddans, built up area is 1205 m2, Owner: Supreme Council of Antiquities, Designer: Alexandre Marcel, Floors: 2, Architecture style is Hindu,

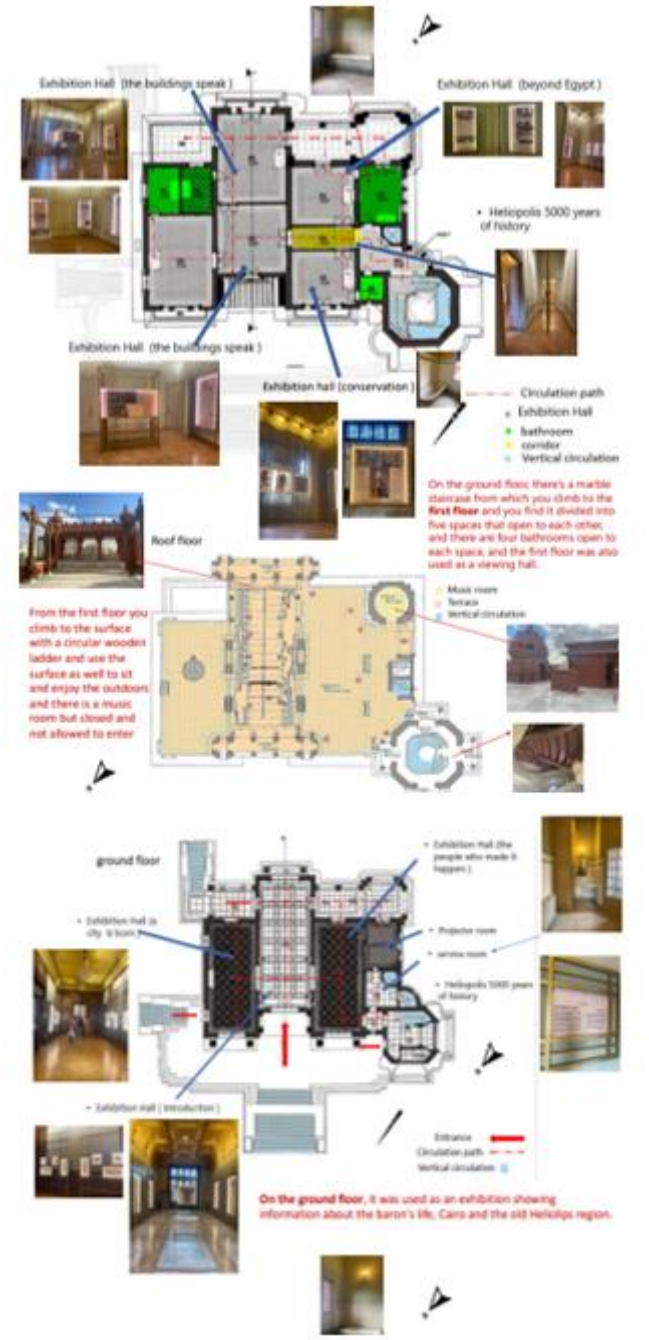


Figure.6. shows Baron palace ground, and roof floor after reusing, and the updated techniques, subdivisions applied to cope with museum function, source the researcher.

European.Built by Belgian Baron Eduard Imban, in "Heliopolis", and the design was in the style of the Hindu-European architecture of the French architect Alexander Marcel the construction of the palace began in 1906 and opened in 1911. There are 3 entrances, the main entrance, as shown in Fig.5. that was located on main road leading to Cairo International Airport (Orouba Street) in the New Egypt neighbourhood, surrounded by four streets of its four directions: Al-Orouba, Ibn Battuta, Ibn Jubeir and Hassan Sadiq.

The Basilica was designed to be in the central plan of Heliopolis having four paths on its axis, one leading to the Baron Empain palace, other to the race track, to a hotel and also to the market area & mosque. It was distinguishing by the desert color "earthy color", chose the burnt bricks, symbolism criticism, as shown in Fig.5. The palace has a rare statues and artifacts made accurately from precious metals, including those brought by the Baron from India such as Buddha statues and legendary dragons, including a European-style white marble with Greek and Roman features. Design of the palace was inspired by the Baron from the Angkor Wat temple `in Cambodia and the Hindu temples of Orissa. No series deformations were noticed in the walls or ceilings. The great damage was in the basement ceiling, and the first floors because of the rain fall water.

Figure.7. shows Baron Palace before, and after reusing, and its reflection on the urban context source: the researcher.

In the basement floor, the ceiling was suffering from great damage, especially in the stairs connecting the palace with the garden. Other deterioration happened through being abandoned for long time without maintenance, besides Being used by Satanists, writing on its walls using sprays, breaking the glass in doors and windows, added to it the deterioration of the wooden finishing, falling of plaster, and missed parts of the roof flooring. The maintenance happened in strengthening the structure of the ceilings, restoration of facades, and decorative elements. The preservation happened in adding the missing doors and windows and remove all plaster ceilings and cornices, as shown in Fig .7. The Restoration was applied in maintaining the marble columns, wooden doors, metal windows, ornate iron windows in the main facades, and renewing the underground floor after reusing as shown in Fig .7**.** The restoration work was carried out taking into account the originality standards of the palace by removing the iron fences that were built around the palace in 2006 due to their poor condition, and replicate it by the same design as the original walls, as shown in Fig.8.

Fig .8. shows the internal inventions shown in the artificial lighting, with central AC I the underground floor of Empain Palace, after reusing and preservation, source: the researcher

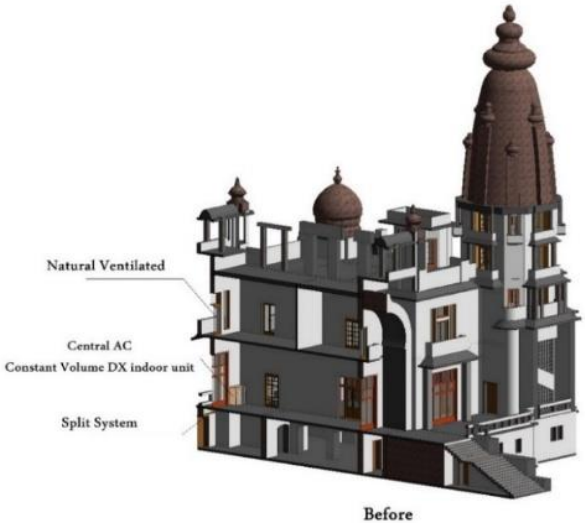


Fig .9. shows air-conditioning in the underground and ground floor in Empain Palace after reusing, source: the researcher.

So the author finds that even after reusing this inherted building needs to reserve the embodied energy, to decrease the consumed energy,and implement Hvac in the upper floor in adequate way to fullfill the principles of reusing. Reusing needs certain design considerations to be fulfilled in order to fulfil the required function, according to the needed changes, and identifying the alteration system and its side impact. The building respects the urban fabric and the surrounding buildings in terms of height and classic style. It Preserves the archaeological value of the palace is in restoring it. The distinctive design of the palace has made the surrounding area a strong tourist attraction. The negative impact of reusing in having a great Lack of suitable parking space that led to congestion of the surrounded roads. The internal circulation inside the palace, wasn't effectively good, by having lots of partitions that subdivide the halls, beside ruining the value of the inherited building by making holes for the HVAC system, led lighting, some partitions block the view of the inherited ornaments. The physical elements needed for reusing inside the museum aren't modular flexible, especially for the services location. The author classified the interventions that took place inside Empain palace after reusing. The internal interventions were by blocking some existed opening in the terraces, to avoid the wasted area in circulation, to enhance a good area for the exhibition, having alignment between them, by implementing corner partitions to have a continuous museum circulation. Lots of restoration were applied in the palace using same material, with new techniques that are distinguished inside, as well as renewal is provided in the technical equipment needed inside the palace, such as electricity, HVAC system, water, firefighting, sanitation networks, fire alarm, and internet, as shown in Fig .9. The palace was built from stone, with large huge windows that cause glare for the readapted museum. After reusing, the museum blocks these windows by wooden shutters and put partitions in front of it, exhibiting the district heritage, where the visitor couldn't recognize the palace openings.

The interpretative structure maintenance was good in maintaining the space value, using technical skills to strength the fences and building from grey water affection. The retrofitting level was standard, not that deep in reusing it as a museum, as shown in Fig .7. The ground floor includes a large lounge and three rooms, one for hospitality and the other for the dining table, and the third is dedicated to playing billiards. The first floor, consists of a large lounge and four bedrooms with parquet floors, each with its own bathroom, which is covered with slabs of mosaics in orange and red blue colors. On the roof there is a music room, a large seating area and rooftop walls with floral and animal drawings and fairy objects, and climbs into it by a ladder made of rosewood. The reusing function in the Empain Palace is converting it from palace, into museum with its administrative offices in the underground floor.The conversion of the site into a tourist area has led to the interception of neighbors and surrounding residents seeking a quiet residential area. To justify the most appropriate solution is to decrease energy consumption by applying different scenarios using design builder as an important intervention to comply, as shown in Table I, II & III. The author assesses building performance by using design builder [8], as an intervention of internal additions that were applied in the palace (Intentional opposition), and external intervention in the external plaza, as the wooden pergolas and kiosks that aren't coping with inherited palace style. So, it was preferable to apply in outdoor gallery, reviving the same style of the palace to have contrast, showing it in a plan glass façade instead, to avoid blocking the palace view. So, the author suggests to apply modular flexibility in the outdoor to utilize the garden in a transparent vision (Kearsley, G. W., & Middleton, M. C. 2006)., as an approach for the internal exhibition. The adapted reusing function affects the economic, environmental, and social impact of the palace.

Regarding social impact it respects the palace main access, but it decreases its value by polishing it, and by the new updated techniques that were added inadequate way that blocks the view of ornaments, valuable windows, and doors. The positive impact of reusing is in maintaining the construction as it is, and enhance public access to identify the inherited values (Mydland, L., & Grahn, W. 2012), and increase their loyalty. The author investigates the inherited building performance in order to upgrade its environmental impact, and apply it as a sustainable inherited building, to minimize the great consumed energy used in lighting, and in air conditioning system by adding double glazing in all external opening ,with transparent PVC cells , implement thermal insulation , adding energy saving for lighting the museum, and photovoltaic panels on the roof as a suggested solution on the dome external skin too to determine the needed energy ,and upgrade building performance efficiency, without changing its appearance.(Fuentes, J. M. (2010), (Prihatmanti, R., & Bahauddin, A. 2019).

XV. MEASURING THE ENERGY CONSUMPTION IN THE INHERITED BUILDING

The paper investigates the efficiency of inherited building function after reusing, by measuring the energy consumption indoor, by using designer builder as a simulation program, to upgrade its performance. The research suggested a questionnaire for visitors to quantify the building performance after reusing, as shown in these questions, such as: Would the visitor recognize the difference between the original parts, and maintained parts? Define the historical value of the palace after visiting it, and what affected you most as a visitor? Are there any educational activities in the museum? Are there any landmarks for the museum nearby?, What is your opinion as a visitor, and as a critic concerning the updated restoration that took place in the palace internal and external elevations?, Is there any continuation for the internal circulation inside the palace, or it has duplication, out having dead ends?, Have you visited the whole floors inside the palace, or there are some floors not allowed to visit it?, Is there good interaction provided between activities inside the palace, what is your opinion regarding the palace after reusing, Does the updated function reflect on the social, environmental and cultural impact, and what are the constrains facing it to achieve it?, Does the inherited building have other reused function [15], or one compatible function only?, Does the updated techniques regarding safety [3], firefighting, air-conditioning applied in a proper way or not?, Does the updated function of inherited building fulfill NOUH principles in integration, and maintaining its value?, Does the inherited building location accessible to the visitors, and what are the limitations'. The author answers this question by analytic analysis using design builder simulation to quantify the percentage of energy consumed per each floor relevant to the occupants, space and time duration, as shown in Table I, TT, and III.

The reforming in the internal spaces of Empain palace wasn't adequate to its value, as there was duplication in circulation, for not having continuity in circulation from a hall to another, dividing huge halls into small subdivisions, by using fixed partitions in the flooring, that affects the visitor, as they couldn't feel space by these adding services that are not adequate to the formal plaza, which is a main approach to the palace. The subtraction method happened in using the whole underground for services and security, and administrative offices, rather than exhibiting the main services of the palace, actually this subtraction affects its historic value, insufficient to its value as it hasn't respected its architecture style. The visitor couldn't imagine the originality of its historical image by these added architecture elements. The addition method mingles between the value of historic building, and added architectural elements needed for the new function. The architectural elements play an essential role in maintaining its identity shown its ornaments, form, material, and color [9]. The real value of inherited building has to be maintained to its originality in order we can distinguish between old and new, into museum. The internal suggested interventions are adding embedded PV cell wooden frame, as a transparent renewable sheet on the existed window frames, to maintain its colored window heritage value, second scenario is adding solar cable to the perforated wooden frame with glazing, added to the JV-and NIR sensitive active cells, as shown in Fig.10.

Table I. shows the base case as a constant AC system, in the ground floor, natural ventilation in the first floor, added to suggested PV cells inside the Empain Palace museum, source the researcher.

Base Case : Constant DX AC system Ground Floor + Natural Ventilated First Floor + Transperant PV cells on voids (window glazing)	Floor	Basement	Ground Floor	First Floor	Total
	Room Electricity (kwh)	5199	3610	4193	13002
	Lighting (kwh)	16756	11542	13430	41728
	Cooling (Electricity)(kwh)	4040	14081	0	18121
	Renewable Energy added to the currenrt status (kwh)	4992	23936	14278	43206
	Shortage for needed energy	21003	5297	3345	29645
	Shortage Ratio = 29645/72851 = 40.7 %				
	Saving Ratio = 43206/72852 = 59.3 %				
	Air Temperature (°C)	23..	23.44..	24.9..	

Table II. shows case 3, showing the suggested VRF, AC system in the ground, first and underground floor, within transparent PV cells on windows and Indian dome shell

Case No.	total energy consumption	Renewable Energy generated by Transparent PV cells
Case 1: Base Case (G.F HVAC only)	72851	43206
Case 2: G.F & F.F HVAC	74878	43206
Case 3: G.F & F.F HVAC	74878	88646

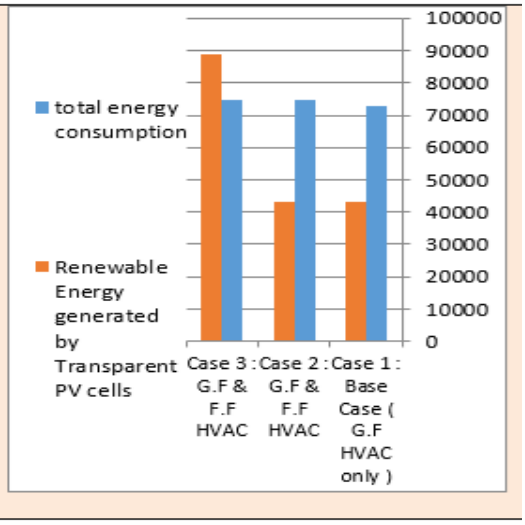
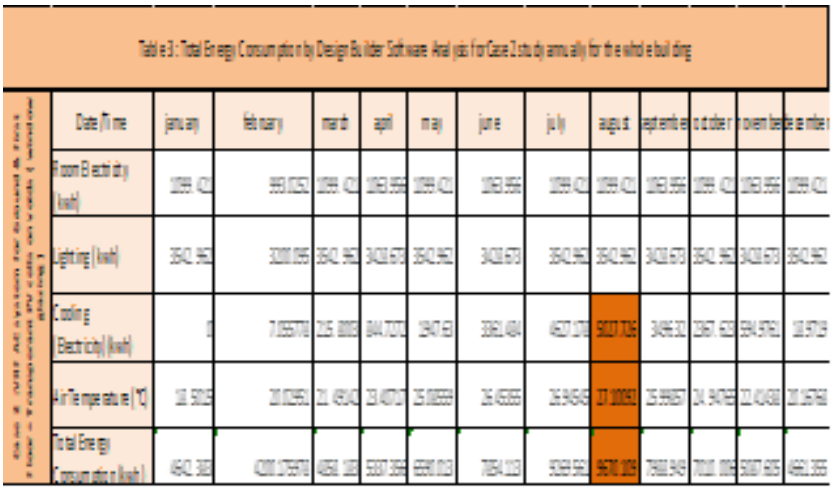


Table III. shows, total energy consumption annually for the whole building for case 3 with the VR, AC system for all floors, with transparent PV cells according to NOUH, by design builder, source: the researcher



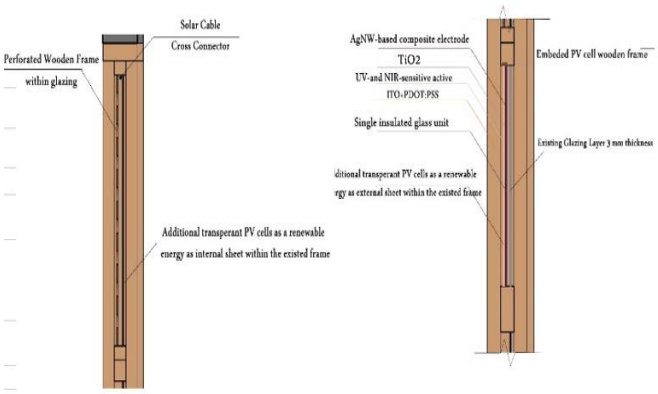


Fig.10. shows section for the suggested sustainability added to the existed colored windows, by adding transparent PV cells, in the Empain Palace after reusing, source: the researcher.

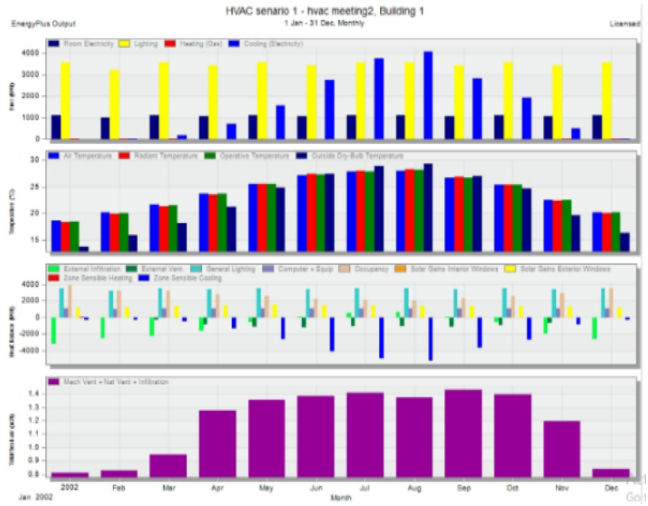


Fig 11. shows the percentage of consumption for heating, lighting, and cooling, where highest consumption in July in the Empain Palace, source the researche

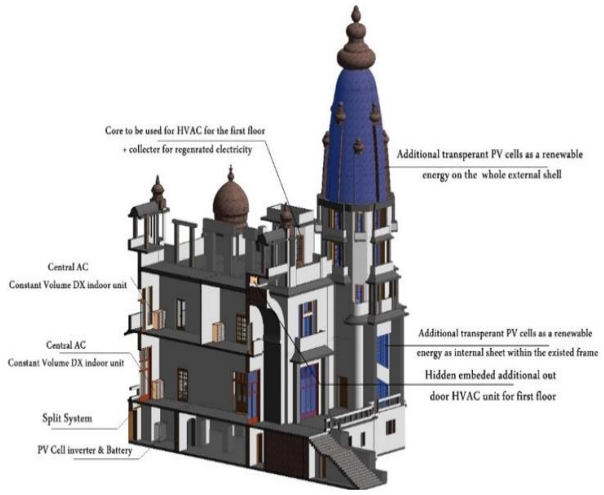


Fig 12. shows the thermal performance annually after readapted function, inside Emapin Palace by using modern techniques and its impact using central AC, source the author. source: the researcher.

Table IV. shows the comparative analysis between Abdeen Palace and Baron Palace, regarding the energy consumption, and the suggested sustainable assessment role, source the researcher

Table [5] shows the comparative analysis between Abdeen Palace and Baron Palace, regarding the energy consumption, and the suggested sustainable assesment role, source the researcher					
Sustainable hertiage indicator	Abdeen Palace	Baron Palace	Sustainable hertiage indicator	Abdeen Palace	Baron Palace
Structure treatment, using this score,	5	3	Aesthetic architecture value	5	3
Building adaptation decision-making	5	2	Inherited building features.	5	4
Fulfilling Egyptian law of antiquities–no.117, 1983	4	3	Historic aspects	5	4
Performance after reusing	3	2	Mechanical	3	3
Restoration	4	3	Civil	3	3
Support	3	3	Historical, & Urban planning	3	2
Renewal	5	2	Economic requirements, and Regulatory requirements.	3	3
Update	3	3	Social requirements	4	3
Strengthen	3	4	Human attitude towards the inherited building.	4	4
Completion	3	3	Socio economic aspects	4	3
Maintenance procedures,	5	3	Cultural aspects	5	4
Guarantees of utilities	4	3	Urban identity	4	4
Thermal comfort	3	3	Landscape	4	2
Energy efficiency	3	2	Accessibility	3	4
Historical value on-site criteria.	4	3	Restoration management cost	3	3
Historical value off-site criteria	3	2	Less attachment	3	4
The occupancy level and its	3	3	Ease of adaptation divisions of space	4	2
The efficiency of function	4	3	Central distributing areas	4	4
Integration with the urban context	4	3	Plan shape (regular)	4	4
Defining the existing barriers	4	3	Alignment, or new extension,	3	3
Firefighting system	4	4	Misalignment	0	0
Integration with the structure	4	3	Interior	5	1
Coping with NOUH principle	4	3	The intentional addition	4	2
Correlation Coefficient represents	3	2	Oppositional intervention.	3	2
The relationship between variables			External interventions	4	3
Architectural, requirements	3	2	Impact on the inherited building value	4	2

XVI. RESULT AND DISCUSSION

The conflict wasn't only in consuming energy, but in being incompatible in using its inherited landscape, that affects its heritage value. The author suggests a rigid adaptative reuse methodology to measure the energy consumption, as it is essential in verifying the effectiveness of new function. The simulation shows the great need of worming in winter, and air-conditioning in summer and air-conditioning in summer due the large number of occupants. The author defined the thermal comfort indicators to achieve thermal comfort zone, (Prihatmanti, R., & Bahauddin, A. 2019), environmentally [16], culture, and social impact, within identifying stakeholders, based upon multiple approach of reusing according to Francesco Leccese et al., 2021, to examine the additional factors impact on the heritage upon relayed upon physical attributes, according to its urban context, (Prihatmanti, R., & Bahauddin, A. 2019).

XVII. CONCLUSION

The adaptation of new function is efficiently good as a museum in the (Baron palace, and Abdeen palace), for having lots of positive interventions. The adaptive reuse has lots of variables that are shown in the literature review study, shown in in the association factors, build upon ICOMOS charters to cope with NOUH principles.

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The holistic approach is more successful in Abdeen palace rather than Baron Palace for its external and internal intervention that maintain its value, as shown in Fig .11, & Fig.12. In Baron Palace doesn't have enough flexibility in the span, limited by its area as shown in Table IV. The partitions of the museums, and subdivisions decrease the feeling of space portions, that decrease the heritage value, as shown in Fig.13. Where the adaptation in the external intervention wasn't effective, by adding kiosks aligned on both sides of the palace plaza, that decrease its heritage value as formality's garden, and symmetrical axial spin. Regarding the Baron palace performance, after reusing wasn't that good, for the energy consumed in lighting, and air conditioning, relevant to the number of occupants. The different scenarios were suggested by the author using transparent PV cells, and the percentage differs upon its exposure on the shell, through simulation by Design builder. It is obvious to understand the adaptive function impact on the heritage value, and its contribution to cope with the adaptative purpose, and to assess its thermal comfort, as shown in Fig .11. (Prihatmanti, R., & Bahauddin, A. 2019).

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