JOURNAL OF ENGINEERING AND APPLIED SCIENCE, VOL. 67, NO. 5, OCT. 2020, PP. 1019-1038
FACULTY OF ENGINEERING, CAIRO UNIVERSITY

ANALYTIC HIERARCHY PROCESS IN DECISION MAKING OF HERITAGE REUSE: SURSOCK PASHA

I. Z. DABOUH[1] AND M. EL SHAZLY[2]

ABSTRACT

Egyptian heritage is undeniably rich and largely diversified. This heritage is a witness of ancient civilizations and transfer its tremendous values, collective wisdom and memory of the people in the past, which should be documented, interpreted, and conserved for the public. The conservation of traditional residential architecture buildings is crucial in terms of sociocultural continuity. When they are no longer used for residential purpose, new functions should be assigned to them for the continuity of the heritage buildings. The process of selection of new buildings needs to consider different criteria in order to reach the optimum selection. This paper aims to present a suitable evaluation method to figure out the optimum solution using an integrated multi criteria decision making method. The most suitable tool is the analytical hierarchy process (AHP) that was developed by Thomas Saaty in 1970s. The selected software for this paper is Microsoft Excel. Sursock Pasha palace is selected as a case study. There are four suggested alternatives: hotel, museum, office building and mixed use. After using the AHP application, it was concluded that office building is the best choice with the highest value of 0.29 followed by mixed use building, museum, and hotel

KEYWORDS: Heritage conservation, Adaptive reuse, Sustainability, Analytic hierarchy process

1. INTRODUCTION

Existing heritage assets can transfer the knowledge of ancient civilizations to the current and future generations [1]. Over time, old buildings lose their efficiency and functions, so adaptive reuse become a must. The best reuse option to be selected is not easy and requires different considerations due to different involved parties and criteria. Figuring out the most appropriate selection method is an important factor in the adaptive reuse project. The series of selection problems can be categories as a multi decision making (MCMD), due to various items that should be considered. Point of view of

[1] Ph.D. Candidate, Department of Architecture, Faculty of Engineering, Cairo University, Giza, Egypt, ihabdabouh@hotmail.com
[2] Professor, Department of Architecture, Faculty of Engineering, Cairo University, Giza, Egypt.

conservation specialists, investors, beneficiaries, architects, town planners, civil engineers, structure specialists, soil mechanics specialists, geodesist, conservators, restaurateurs, archeologists and art historians must be considered. Decision makers also must consider the complex criteria of compatibility, reversibility, impact on infrastructure, degree of intervention, cost of adaptation, accessibility and economic benefits. All of the previous points must be taken into consideration in order to reach a successful adaptive reuse project. The goal of this paper is to present an effective tool that can serve the developers, architects, owners and Government to find out the optimum adaptive reuse options for our old heritage buildings. This research is based on the analytical deduction approach. The adopted methodology firstly reviews the factors that affect the selection of adaptive reuse with literature theory to produce a list of criteria that can help in the decision-making process. Secondly, the selected multi criteria are described and applied. Finally, the process is applied on Sursock PASHA Palace in Alexandria to find out the most optimum use for it.

2. ADAPTIVE REUSE OF HERITAGE BUILDINGS

This section will focus on studying the factors that affect the reuse project, and will consider them a baseline for determining assessment criteria that will guarantee the balance between the changes of building function and the heritage preservation process. According to the Royal Australian Institute of Architecture (2008), ICOMOS (2010), Department of Hong Kong (2012) and Wang and Zeng [2], new building use must be compatible with its heritage value, heritage structure and the spatio-physical characteristic and that compatibility can be used as an indicator of success of adaptive reuse project especially when project requirement analysis is well implemented. On the other hand, one of the most important success keys of optimum use, is to be economically efficient by making use of any available spaces in the asset, in order to achieve the economic goals of return on investment, cost adaptation, increase work efficiency, and increase number of visitors and tourists.

Since new building function depends on its location, accessibility and site conditions, therefore the new building function must be compatible with the surrounding conditions [3]. Social and environmental considerations are among the most important points that conservators must pay attention to [4]. New building use and function must serve the society and close the gap between them by contributing with people to raise up the level of social awareness and the importance of heritage buildings to the overall region and society [5].

3. ANALYTIC HIERARCHY PROCESS (AHP)

The analytic hierarchy process (AHP) was created in 1970s by Thomas L. Saaty. Since then, it is considered as one of the most common tools of multi- criteria decision making (MCDM). The (AHP) method has been used more than others by 35 percent, because it has several advantages and is easy to use [6]. In order to figure out the most effective alternative, the following AHP steps [3] should be followed and considered as shown in Fig. 1.

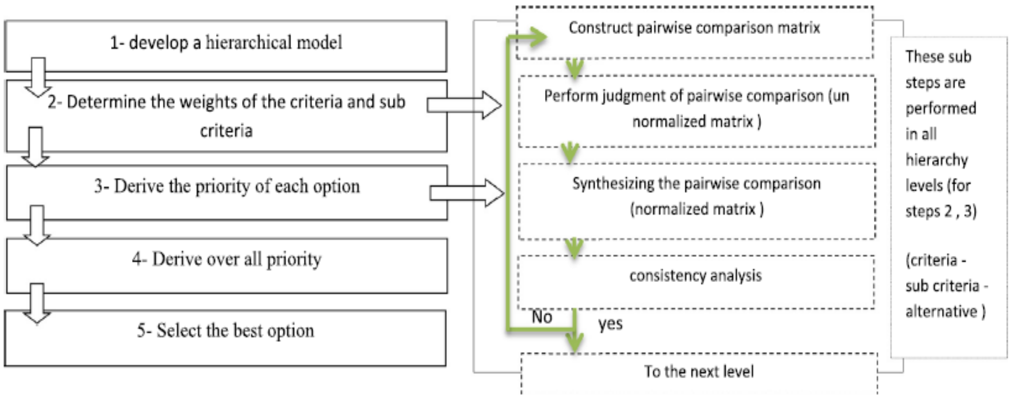


Fig. 1. The steps of the analytical hierarchy process (AHP).

4. CASE STUDY: SURSOCK PASHA PALACE

To be able to evaluate the case study, the elements of characteristics, heritage value, building materials, and the previous restoration project have to be identified in order to create a clear image about the building. This can help in the evaluation process and criteria assessment.

4.1 Historical Background and Architectural Value of the Building

The building was built in the 19th century and was owned by a rich Lebanese family descending from Sursock Pasha. Sursock Pasha was considered as one of the biggest businessmen in the 19th century. The building was used as a Governmental building, and now it is known as the National Union Bank. The building located in the heart of the city of Alexandria, at 85 El Horreya Road, Wasat District, Alexandria, Egypt. The building is classified as a heritage building with the coding number 0597 and is classified under Law 144 for 2006 for urban harmony as a building with unique architectural style [7], as shown in Table 1, and Figs. 2-6.

Fig. 2. Main palace elevation.

Fig. 3. Palace layout.

Table 1. Building details

Former Heritage Name	Current building owner	Building Erection date and architecture style	Building Address
Sursock Pasha palace	Union national bank	1890 - Neo-Renaissance style	85 El Horreya Road, Wasat District, Alexandria, Egypt
Urban harmony record number	Heritage building classification	Conservation General consultant	Conservation General contractor
0597	Code C	Center of Architectural designs.	The Arab Contractors “Osman Ahmed Osman and Co.”
Historical Value			
Time Indicator	19th century	Moral indicator	-Important historical era -Building didn’t suffer from too many changes
Architectural Value			
Unique architecture style	Reflect 19th century architecture	Has special architectural details	Has special ornaments
Symbolic Value			
Related to certain person who influenced society “Grand business man Sursock Pasha”			
Urban Value			
Building located inside historical area			
Building original Drawings and Areas			
Basement Area	387 m^2	Ground floor Area	855 m^2
First Floor Area	820 m^2	Roof Area	170 m^2

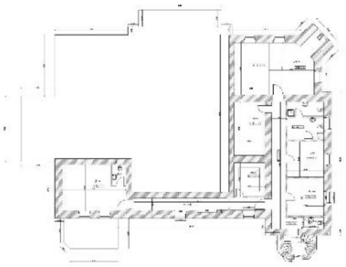


Fig. 4. Basement Floor Plan.

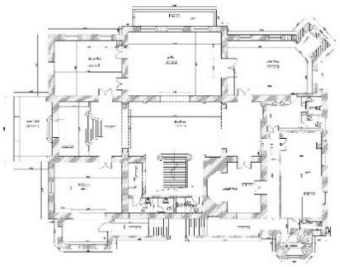


Fig. 5. Ground Floor Plan.

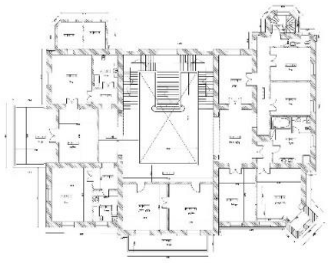


Fig. 6. First Floor Plan.

In 2015, a conservation project was conducted to convert the current palace into a branch for the United National Bank, an office building. In the next section, an analysis on whether the selected adaptive reuse option for the building was the best or, the decision makers could have made another choice. Also, the preservation actions that were applied on the building will be highlighted.

Egyptians from the 19th century had begun to follow European modes of classical revivalism [8]. Most of Egyptian buildings, were very similar to those erected in Paris or Rome, in their use of reinforced concrete, cement, steel, stone and plaster or decoration, of marbles, mosaics for steps and entrances, and increasingly elaborate iron-work.

4.2 Previous Conservation Project

In this section, previous conservation projects of buildings will be reviewed to find out the latest project assessment method and to obtain the corrective actions necessary to maintain the building.

4.2.1. Analysis and inspection

Table 2 summarizes the analysis and inspections carried out by the conservation team to understand the building's problems and disadvantages.

4.2.2. Planned solutions

According to the above diagnosis, analysis and building classification, the conservation team decided to follow up the method of rehabilitation and adaptive reuse. They obtained the required governmental approvals from the Ministry of Antiquity and the Association of Urban Harmony so that they could change the current use of the palace to be the new branch for United National Bank. Table 3 presents the planned solutions.

Table 2. Sample of analysis and inspections for the building.

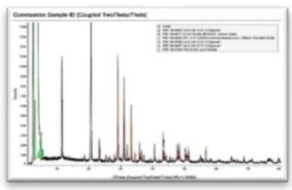
1. Ultraviolet fluorescence photography (UVR): is specific to the top most pigments or varnish. UVR is recognized as a useful tool to identify white pigments like titanium white, and zinc white, which shows a strong UV absorbance band and are thus identifiable for appearing very dark in the UVR image, especially when compared to other white pigments, namely lead white and lithophone, which appear bright [9].	 Ultra violet photography used to show the over paintings.
2. X-ray computed tomography (CT) analysis: is a powerful nondestructive testing technique for the whole 3D inspection of a sample. CT has been recently introduced in the field of Cultural Heritage diagnostics, in order to preserve the integrity of the object and gives morphological and physical information on its inner structure, to determine adequate conservation and restoration procedures [10].	 Some of x-ray analysis for building elements.
3. Microscopic analysis: Microscopic analysis used to identify fungi's, bacteria's, desalination, sterilizations, and destroyed materials.	

Table 3. Planned solutions.

1. External Facades conservation.	2. Internal ceiling conservation.
3. Destroyed carrying beams replacement.	4. Deteriorated floors conservation.
5. Internal walls conservation.	6. Marble and wooden elements conservation.
7. New control system.	8. New air handling system.
9. New lighting fixtures installation.	10. Walls insulation system.
11.Floors insulation system.	12.Electrical network upgrade.
13.Mechanical network upgrade.	14.heritage mosaic and brass conservation [7].

4.2.3. Conservation works

The process of building conservation included various items and elements conservation. Tables 4-7 show the most important conservation treatments.

Table 4. Conservation works, part 1.

1. Gypsum motifs conservation:		
Cleaning	Consolidation	Reinstatement
Cleaning is a routine procedure to remove harmful materials from elements surface. It had been done throughout soft brushes, sharp tools or packs according to each surface case, taking in consideration to not harm or scratch the decorative elements surface [11].	The consolidation process was applied by brush or spray with appropriate reinforcement and insulation materials far from sunlight or moisture [12].	The reinstatement process can be done by one of the following methods: 1-Refilling the missing parts. 2-create custom models for the missing parts in order to cast in place missing parts [12].
		
Gypsum motifs after and before conservation.		
2.Gypsum cantilever conservation:		
L-Shape angel brackets, were used to support gypsum cantlivers		
		
Gypsum cantilever conservation.		
3. Façade injection method		
Using medical needles or rubber tubes the façade injected with fillers to strengthen cracks and support façade elements		
		
External facades injection.		

Table 5. Conservation works, part 2.

4.Tearing Façade cracks

Metal clamps and mortar were used to cure cracks more than 3mm and one floor height. Longer cracks , steel mesh must be used with mortar

Tearing façade cracks process and installation.

5.Changing building skirt and basalt floors:

Building skirt and floors after and before.

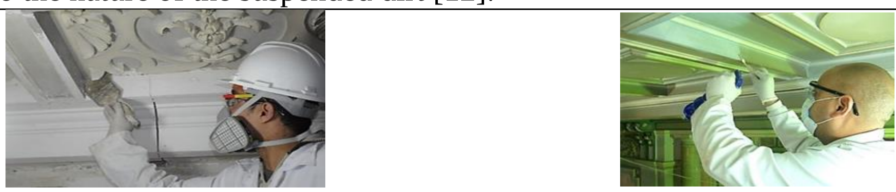
6.Facade plaster conservation:

New plaster layer applied consisting of three main layers as shown below.

External façade plaster cladding conservation layers.

7.Chemical cleaning for internal ceilings

Distilled water, Soap with ammonia, Lissabon with Water or Organic Solvents Such as Trichloroethylene, Ethyl alcohol, Methyl acetone, and other materials,were applied according to the nature of the suspended dirt [12].



Mechanical and chemical cleaning for internal ceilings.

8.Tearing Façade cracks

Tiny cracks consolidation followed out one of the following methods [12].
- Consolidation by Immersion
- Consolidation by injection
- Consolidation by brushing.
- Consolidation by spraying
- Consolidation by paper facing techniques.

Tiny cracks curing.

Table 6. Conservation works, part 3.

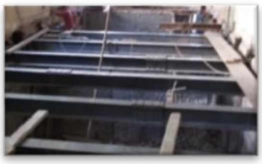
9. Investigating old motifs and decorations under covered paints
Using X-ray Computed Tomography (CT) analysis, an investigation process started to discover the old motifs and paint colors under the current paint which is deteriorated due to time impact, building usage and wrong renovation processes.
   Using x-ray to discover old paints – after and before photos.
10.Using carboxyl methyl cellulose to support and cure gypsum motifs:
the conservators used gauze wetted with carboxyl methyl cellulose, to supports the ceiling and, well cover the cracks.
   Using carboxymethyl cellulose to prepare ceiling gauze.
11.Using compressed and loose foam to support ceilings:
Light and strong ceiling molds were created with the same ceiling shapes using compressed and loose foam, to conserve and strengthen the ceiling.
   Ceiling after applying the protection layer.
12. Replacing destroyed ceiling beams
new cured and good isolated metal beams are fabricated and installed in situ to replace the old beams
    Installing new ceiling beams.

Table 7. Conservation works, part 4.

13.Electrical and mechanical network upgrade and replacement

Subject to new owner needs , new electro mechanical and infra structure networks have been installed to suite building new function and future needs [7].



Electrical and mechanical network installations.

14. Removing modern paints and restoring old paints and colors.

The conservators removed the current paints, then carried out investigation process to discover the old paints colors and composition, in order to simulate ancient building paints [7].

5. EVALUATION PROCESS

Based on the literature review, previous building analysis, and previous presentation works, the evaluation process may be conducted as per the following steps.

5.1 Develop a Hierarchical Model

The proposed criteria in Table 8 and Fig. 7 will be applied for the assessment of the case study.

5.1.1. Evaluation criteria

Table 8. Proposed criteria

Evaluation Criteria(R)	Sub Criteria
Social Value (R1) [13].	Meet the region needs and increase the quality of life (R11)
Environmental Value (R2) [14].	Congruity with land uses(R21)
	Accessibility of the building for disabled users, vehicles and pedestrians (R22)
Architectural Value (R3) [13].	Suitability of the new function with the building system and new space requirements (R31)
	Respect the building & ancient architectural features and ornaments (R32)
	Building physical stability (33)
	Respect region laws and building codes (R34)
Economic Value (R4) [13].	Economic impact on the building and district (R41)
	Adaptation cost (R42)
Cultural Value (R5) [13].	Protection and enhancement of heritage significance (R51)

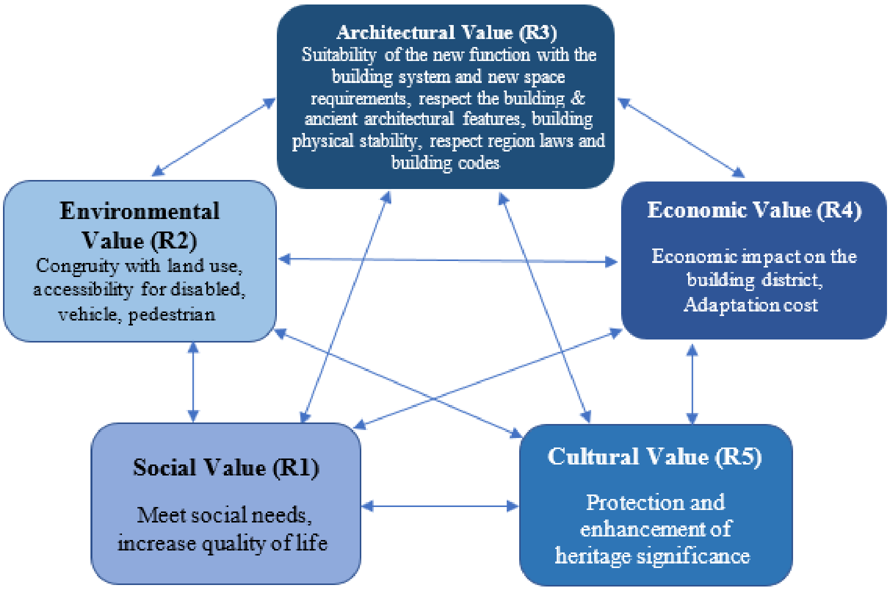


Fig. 7. Proposed criteria diagram.

5.1.2. Suggested project alternatives

From the above analysis the building can be used in four alternatives namely hotel, office building, museum or mixed-use building. The space program for each alternative will be determined according to Table 9.

Table 9. Suggested alternatives space program

Suggested space program for each floor	Alternatives			
	Hotel	Office Building (Current Use)	Museum	Mixed use building
Outdoor garden	Swimming pool and parking	Parking	Museum gardens, outdoor exhibitions	Parking and booths
Basement floor	Main Kitchen, Laundry, Stores, Control rooms and MEP rooms	Stores, Archives, control room and MEP rooms.	Stores, Control rooms and MEP Rooms	Toilets, stores, control rooms and MEP Rooms
Ground floor	Lobby, main restaurant, specialty restaurant, multipurpose room, toilets and shops	Lobby, reception, multipurpose room, toilets, lounge and offices	Main entrance, multipurpose room, exhibitions halls, toilets and cafeteria	Main entrance, toilets, retails shops, cafes
First floor	Hotel rooms, and service rooms	Offices, toilets, and service rooms	Exhibition halls, toilets, service rooms	Offices, toilets and service rooms
Roof plan	Hotel rooms, restaurant, gym, health center, and MEP rooms	Offices, service rooms, toilets and health center	Exhibition halls, cafeteria and MEP rooms.	Offices, service rooms, toilets and health center

From the previous points of evaluation criteria and suggested project alternatives, the following three levels may be drawn for the evaluation process hierarchy as shown in Fig. 8.

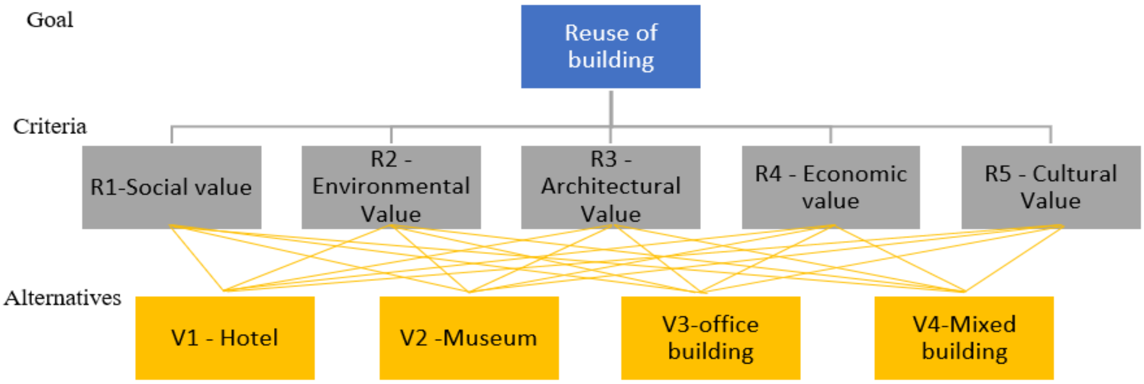


Fig. 8. Evaluation process hierarchy.

5.2 Determine the Weight of Each Criteria and Sub Criteria

5.2.1 Perform judgement of Pairwise comparison matrix (Un-normalized matrix)

In order to obtain the weight of each criteria in relation to the objectives, the criteria must be compared in pairs to show the importance of each criteria to the other criteria, using the common 9-point scale by Saaty [15] as shown in Table 10.

Table 10. Pairwise comparison scale.

Intensity of importance	Definition	Explanation
1	Equal importance	Two criteria contribute equally to the goal.
3	Weak importance of one over another	Experience and judgment slightly support one of the criteria over the other one
5	Strong or essential importance	Experience and judgement, strongly support one of the criteria over the other one.
7	Demonstrated importance	A criterion is considered strongly more important and its dominant
9	Extreme importance	The evidence showing one criterion to be more important than another is the heights possible order
2,4,6,8	Intermediate values between the two adjacent judgements	When compromise is needed
Reciprocals 1/3-1/5-1/7-1/9	If criteria I has one of the above numbers assigned to it when compared with criteria j, then j has the reciprocal value when compared with I	

According to the previous table all pairs of criteria are compared together, as per the following sequence: if criteria X and criteria Y are equal with respect to the goal, they take the value of 1. If criteria X took any other value like 3 or 5 or 7 or 9, criteria Y will be assigned the reciprocal value such as 1/3 or 1/5 or 1/7 or 1/9. The same treatment will be applied for the intermediate values 2, 4, 6, or 8. The evaluation criteria is not fixed and can be changed from one building to another according to the required goal and the building needs. The pairwise comparison can be conducted after detailed building analysis by architects or by group of experts such as historians, contractors, developers, managers and professionals. The following weights pairwise comparison have been applied on the current case study as shown in Table 11.

Table 11. Un-normalized criteria pairwise comparison.

Un-normalized	R1	R2		R3				R4		R5	Total	Average
	R11	R21	R22	R31	R32	R33	R34	R41	R42	R51		
R11	1.00	0.33	0.33	0.20	0.20	1.00	1.00	0.33	0.33	0.33	5.07	0.51
R21	3.00	1.00	1.00	1.00	1.00	1.00	1.00	0.33	0.33	0.33	10.00	1.00
R22	3.00	1.00	1.00	1.00	1.00	1.00	1.00	0.33	0.33	0.33	10.00	1.00
R31	5.00	1.00	1.00	1.00	1.00	0.33	1.00	0.50	0.50	0.20	11.53	1.15
R32	5.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50	0.50	0.20	12.20	1.22
R33	1.00	1.00	1.00	3.00	1.00	1.00	1.00	0.50	0.50	0.20	10.20	1.02
R34	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50	0.50	0.20	8.20	0.82
R41	3.00	3.00	1.00	2.00	2.00	2.00	2.00	1.00	1.00	0.33	17.33	1.73
R42	3.00	3.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00	0.33	19.33	1.93
R51	3.00	3.00	3.00	5.00	5.00	5.00	5.00	3.00	3.00	1.00	36.00	3.60
Total	28.00	15.33	13.33	17.20	15.20	15.33	16.00	8.00	8.00	3.47	139.87	13.99

5.2.2 Synthesizing the criteria pairwise comparison (normalized matrix)

The process of normalization means that, the sum of each column cells equals to one. Each column will be normalized using Eq. (1), where X= normalized value of each required cell in the table matrix, S= total sum of un-normalized column values and N= un-normalized value of each required cell in table matrix. After normalization, the average weight of each local criteria is obtained using Eq. (2). Table 12 shows the normalized values of Table 10 for the case study.

$$X = \left(\frac{1}{S}\right) \times (N) \quad (1)$$

$$average\ of\ each\ row\ = \frac{total\ sum\ of\ each\ row\ value}{number\ of\ row\ items} \quad (2)$$

Table 12. Normalized Criteria Pairwise Comparison

Un-normalized	R1	R2		R3				R4		R5	Total	Average
	R11	R21	R22	R31	R32	R33	R34	R41	R42	R51		
R11	0.036	0.022	0.025	0.012	0.013	0.065	0.063	0.04	0.04	0.096	0.41	0.04
R21	0.107	0.065	0.075	0.058	0.066	0.065	0.063	0.04	0.04	0.096	0.68	0.07
R22	0.107	0.065	0.075	0.058	0.066	0.065	0.063	0.04	0.04	0.096	0.68	0.07
R31	0.179	0.065	0.075	0.058	0.066	0.022	0.063	0.06	0.06	0.058	0.71	0.07
R32	0.179	0.065	0.075	0.058	0.066	0.065	0.063	0.06	0.06	0.058	0.75	0.08
R33	0.036	0.065	0.075	0.174	0.066	0.065	0.065	0.06	0.06	0.058	0.73	0.07
R34	0.036	0.065	0.075	0.058	0.066	0.065	0.063	0.06	0.06	0.058	0.61	0.06
R41	0.107	0.196	0.075	0.116	0.132	0.130	0.125	0.12	0.12	0.096	1.23	0.12
R42	0.107	0.196	0.225	0.116	0.132	0.130	0.125	0.12	0.12	0.096	1.38	0.14
R51	0.107	0.196	0.225	0.291	0.329	0.326	0.313	0.37	0.37	0.288	2.82	0.28
Total	1	1	1	1	1	1	1	1	1	1	10	1

5.2.3 Consistency analysis

The consistency analysis is used to check whether the calculated values are correct or not, in order to evaluate the consistency ratio according to the following steps:

1. Calculate the weighted sum value
   - a- To calculate the weighted sum value, in normalized matrix of Table 11, each value in the column is multiplied with its criteria value.
   - b- Calculate the sum of values in each row
2. Calculate lambda max (λ_{max})
   - a- In Table 11, each criteria weight is placed next to the weighted sum value
   - b- Lambda (λ) for each row is obtained by calculating the ratio of weighted sum value to the criteria value for each row
   - c- Lambda max (λ_{max}) is obtained by averaging all previous lambda values.
3. Calculate consistency index (C.I) to measure the degree of consistency in the previous matrix, according to Eq. (3).

$$C.I = (\lambda\ max - n) / (n\text{-}1), \text{ where n is the number of criteria factors} \tag{3}$$

4. Calculate the consistency ratio from Eq. (4).

$$\text{Consistency ratio (C.R) = Consistency index (C.I) / Random consistency index (RCI)} \tag{4}$$

Where random consistency index is generated randomly from a square matrix as shown in Table 13.

Table 13. The Random Consistency Index (RCI).

N	3	4	5	6	7	8	9	10	11	12	13	14	15
RCI	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

The value of RCI for n less than three is zero and they are not shown in the table, generally, C.R of 0.10 or less (for n≥5), 0.09 or less (for n=4), 0.05 or less (for n=3) is considered acceptable. Otherwise, the relative importance of each objectives will be revised to improve the judgmental consistency. Table 14 shows the consistency analysis for the case study.

Table 14. Criteria pairwise consistency.

Un-normalized	R1	R2		R3				R4		R5	Weighted sum value	Criteria weights	Lambda (λ)
	R11	R21	R22	R31	R32	R33	R34	R41	R42	R51			
R11	0.04	0.02	0.02	0.01	0.02	0.07	0.06	0.04	0.05	0.09	0.43	0.04	10.39
R21	0.12	0.07	0.07	0.07	0.08	0.07	0.06	0.04	0.05	0.09	0.72	0.07	10.63
R22	0.12	0.07	0.07	0.07	0.08	0.07	0.06	0.04	0.05	0.09	0.72	0.07	10.63
R31	0.21	0.07	0.07	0.07	0.08	0.02	0.06	0.06	0.07	0.06	0.76	0.07	10.73
R32	0.21	0.07	0.07	0.07	0.08	0.07	0.06	0.06	0.07	0.06	0.81	0.08	10.75
R33	0.04	0.07	0.07	0.21	0.08	0.07	0.06	0.06	0.07	0.06	0.79	0.07	10.81
R34	0.04	0.07	0.07	0.07	0.08	0.07	0.06	0.06	0.07	0.06	0.64	0.06	10.55
R41	0.12	0.20	0.07	0.14	0.15	0.15	0.12	0.12	0.14	0.09	1.31	0.12	10.68
R42	0.12	0.20	0.20	0.14	0.15	0.15	0.12	0.12	0.14	0.09	1.45	0.14	10.50
R51	0.12	0.20	0.20	0.35	0.38	0.36	0.31	0.37	0.41	0.28	3.00	0.28	10.60
Total	1.16	1.04	0.90	1.22	1.14	1.11	0.98	0.98	1.10	0.98	10.62	1.00	106.26

λ max = 10.63 Consistency index (C.I) = 0.0696
Consistency Ratio (C.R) = 0.0467

5.3 Determine the Weights of the Alternatives

5.3.1 Alternatives judgement of pairwise comparison matrix (Un-normalized matrix)

In this phase, the decision maker finds out the local priorities of each alternative using a 9-point scale to recognize them from the overall priorities, which will be calculated in the final step as shown in Table 15.

Table 15. Un-normalized alternatives pairwise comparison.

Un-normalized	R1	R2		R3				R4		R5	Total	Average
	R11	R21	R22	R31	R32	R33	R34	R41	R42	R51		
V1-Hotel	1.00	5.00	7.00	5.00	7.00	5.00	1.00	9.00	1.00	5.00	46.00	4.60
V2-Museum	7.00	7.00	7.00	7.00	9.00	3.00	3.00	5.00	5.00	9.00	62.00	6.20
V3-Office building	4.00	7.00	7.00	7.00	9.00	5.00	7.00	9.00	9.00	7.00	71.00	7.10
V4-mixed use building	5.00	7.00	7.00	5.00	9.00	5.00	7.00	9.00	9.00	7.00	70.00	7.00
Total	17	26	28	24	34	18	18	32	24	28	249	24.9

5.3.2 Synthesizing alternatives pairwise comparison matrix (normalized matrix)

The previous alternatives table will be normalized, with the same equations in the previous section to generate each alternative weight as shown in Table 16.

Table 16. Normalized alternatives pairwise comparison.

Un-normalized	R1	R2		R3				R4		R5	Total	Average
	R11	R21	R22	R31	R32	R33	R34	R41	R42	R51		
V1-Hotel	0.059	0.192	0.250	0.208	0.206	0.278	0.056	0.281	0.042	0.179	1.75	0.18

Table 17. Normalized alternatives pairwise comparison, (Cont.).

V2-Museum	0.412	0.269	0.250	0.292	0.265	0.167	0.167	0.156	0.208	0.321	2.51	0.25
V3-Office building	0.235	0.269	0.250	0.292	0.265	0.278	0.389	0.281	0.375	0.250	2.88	0.29
V4-mixed use building	0.294	0.269	0.250	0.208	0.265	0.278	0.389	0.281	0.375	0.250	2.86	0.29
Total	1	1	1	1	1	1	1	1	1	1	10	1

5.4 Derive Overall Priorities

In this final step, the decision maker calculates the overall priorities for each option to reach for the option with the highest value, which will be consider the best choice as shown in Table 17.

Table 18. Overall priorities table.

Normalized	R1	R2		R3				R4		R5	Criteria weights		Overall priority	
	R11	R21	R22	R31	R32	R33	R34	R41	R42	R51				
V1	0.059	0.192	0.250	0.208	0.206	0.278	0.056	0.281	0.042	0.179	R11	0.04	V1-Hotel	0.18
V2	0.412	0.269	0.250	0.292	0.265	0.167	0.167	0.156	0.208	0.321	R21	0.07	V2-Museum	0.25
V3	0.235	0.269	0.250	0.292	0.265	0.278	0.389	0.281	0.375	0.250	R22	0.07	V3-Office building	0.29
V4	0.294	0.269	0.250	0.208	0.265	0.278	0.389	0.281	0.375	0.250	R31	0.07	V4-mixed use building	0.28
											R32	0.08		
											R33	0.07		
											R34	0.06		
											R41	0.12		
											R42	0.14		
											R51	0.28		
Total	1	1	1	1	1	1	1	1	1	1		1		1

5.5 Select the Best Option

The results of the priorities of the suggested alternatives were (V1-hotel = 0.18), (V2-Museum = 0.25), (V3- office building = 0.29), (V4-mixed use building = 0.28). Accordingly, “V3-Ofiice building” is the best choice, which is the current building use.

6. EVALUATION RESULTS

According to the building analysis and the previous conservation project, it was found that the conservators chose the best reuse option for the building adaptation and maintained the high value of the building and site. In the same time, the owner succeeded to get the highest profit possible. The results showed that the most suitable reuse alternative, is the current use office building followed by mixed use building, museum and hotel as shown in Fig. 9.

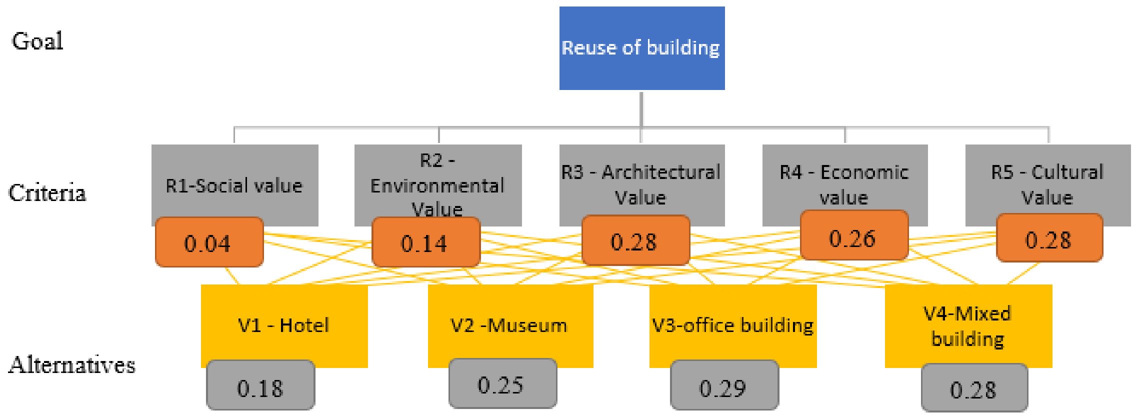


Fig. 9. Summary of analytic hierarchy process

7. CONCLUSIONS

This paper aims to introduce an effective decision-making tool for complex problems of decision making concerning the adaptive reuse selection of heritage buildings, in order to maintain our current heritage, while achieving the highest profit possible for heritage owners. It increases the quality of life and maintain the beautiful ancient architecture language in its environmental context. The used criteria weights in the case study can be changed from project to another according to the project nature and project goal. In order to generate effective assessment criteria, deep understanding of the selected heritage is a most to be able to determine heritage values, heritage condition, weaknesses that threaten the heritage structure and strength. When applying the AHP decision making method on Sursock Pasha Palace, the results showed that the most effective reuse option is office building, while it showed that cultural values and architectural values criteria were of the same level of importance, followed by the economical values, environmental values and social values.

DECLARATION OF CONFLICT OF INTERESTS

The authors have declared no conflict of interests.

REFERENCES

1. Abdallah, M. R., "The Role of Advanced Modern Technology in the Re-utilization of Heritage Buildings", Journal of Engineering and Applied Science, Vol. 65, No. 3, pp. 159-181, 2018.
2. Wang, H. J., "Multi-Objective Decision-Making Process for Reuse Selection of Heritage Buildings", Department of Architecture, National Taiwan University of Science and Technology , Taiwan, 2009.
3. Haroun, H. A. F., "Multi-Criteria Decision Making for Adaptive Reuse of Heritage Buildings: Aziza Fahmy Palace, Alexandria, Egypt", Alexandria Engineering Journal , Vol. 58, No. 58, pp. 467-478, 2019.
4. Shehata, W. T. A., "A Frame Work for The Comprehensive Assessment of The Adaptive Reuse of Heritage Buildings in Historical Cairo", M. Sc., Arab Academy for Science ,Technology and Martime Transport , Cairo, Egypt, 2014.
5. Aydin, D., "Evaluation of Domestic Architecture Via The Context of Sustainability: Cases From Konya City Center", International Journal of Architectural Research, Vol. 9, No. 1, pp. 305-317, 2015 .
6. Mardani, A., "Multiple Criteria Decision-Making Techniques and Their Applications, A Review of The Literature from 2000 to 2014", Journal of Economic Research-Ekonomska Istraz Ivanja, Vol. 28, No. 1, pp. 516-571, 2015.
7. Contractors, T. A., "The Project of Conservation and Rehabilitation of Sursock PASHA Palace", The Arab Contractors, Palaces Conservation Section, Osman Ahmed Osman and Co., Cairo , 2015.
8. Elhabashi, A. E., "The Building of Auguste Perret in Alexandria: A Case for Preservation of Modern", University of Philadelphia, 1994.
9. Cosentino A., "Practical Notes on Ultraviolet Technical Photography for Art Examination", Cultural Heritage Science Journal, Vol. 21, No. 1, pp. 53-62, 2015.
10. Morigi, M. P., "Application of X-ray Computed Tomography to Cultural Heritage Diagnostics", Journal of Applied Physics, Vol. 100, No. 1, pp. 653-661, 2010.
11. Price, C. A., “Stone Conservation an Overview of Current Research” , Second Edition, Los Angeles, The Getty Conservation Institute, 2010.
12. AlMahari, S. A., “Conservation of Historic Buildings , Buildings From Muharraq”, Government of Sharjah, United Arab Emirates, 2017.

13. Günçe, K., "Assessment of Adaptive Reuse Practices Through User Experiences: Traditional Houses in TheWalled City of Nicosia", Sustainability Journal, Vol. 11, No. 540, pp. 1-14, 2019.
14. Shehada, Z. M. M, "Developing Methodology for Adaptive Reuse: Case Study of The Heritage Buildings in Palastine", International Journal of Architecture Research, Vol. 9, No. 2, pp. 216-229, 2015.
15. Mongkut P., "Evaluation of Alternatives in Transportation Planning Using Multistakeholders Multi-objectives AHP Modeling", M. Sc., Sirindhorn International Institute of Technology, Thailand, 28 May 2014.

دور عملية التسلسل الهرمي التحليلي في اتخاذ قرار إعادة الاستخدام للمباني التراثية: قصر سرسق باشا

تعتبر مصـــر من أكبر الدول في العالم الغنية بالثروة العمرانية التراثية والتي تعتبر نتاج للعديد من الحضـــارات الســـابقة التي مرت على البلاد. وفي إطار اتجاهات الدولة الجادة في الحفاظ على التراث المعماري من خلال إعادة استخدام المباني التراثية المهجورة والغير مستغله بشكل جيد. فإن عملية تحديد الاســتخدام الجديد الأمثل للمبني من أصــعب الأمور والتي يتوقف عليها بشــكل مباشــر نجاح او فشــل المشــروع، وذلك لان عملية الاختيار تحتاج إلى دراســة وحســم مجموعه من المعايير المختلفة والمتعددة والمتعلقة بعملية الترميم وإعادة الاســـتخدام وذلك للوصـــول لأفضـــل بديل ممكن. وعليه فإن هذه الورقة البحثية تهدف إلى تقديم طريقه علمية وعملية تساعد في عمليات اتخاذ القرار الخاصة بالتراث وهي طريقة التسلسل الهرمي التحليلي والتي تم تطبيقها على قصر سرسق باشا بالإسكندرية وذلك لتحديد مدي ملائمة الاستخدام الجديد وهل هو أفضل الاختيارات المتاحة ام لا.