JOURNAL OF ENGINEERING AND APPLIED SCIENCE, VOL. 65, NO. 6, DEC. 2018, PP. 423-445
FACULTY OF ENGINEERING, CAIRO UNIVERSITY

A FRAMEWORK FOR NEW ARCHITECTURAL ADDITIONS TO HERITAGE BUILDINGS

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ABSTRACT

As time passes, the heritage buildings need rehabilitation to meet the needs of current and future generations, while respecting its heritage value. Due to the physical, functional and/ or economic reasons, heritage buildings require architectural additions while adapting them to the contemporary conditions. For this reason, that the research seeks to establish a framework for using new additions to heritage buildings, therefore these additions should be compatible for achieving a harmony with use, construction, appearance of the original building. To achieve our aim, the study divided into two parts, the principles and considerations of conservation for heritage buildings in addition to design strategies for architectural additions and their types in terms of use, construction and appearance have been included in a theoretical study. Following the theoretical an analytical inductive approach has been adopted to analyze the levels of the new additions to heritage building by examining the selected examples that linking different addition types of mass transformation. Same examples have been analytically measured by the opinion of audiences through filling a survey to show the acceptance ratios according to the levels of addition to the original building.

KEYWORDS: Heritage building, additions, conservation principles, compatibility.

1. INTRODUCTION

1.1 Problem

The liable issue seems to be the search for employing the new additions to heritage building, as how these additions can be compatible to match the heritage building use, original construction, appearance after addition? As shown in Fig.1.

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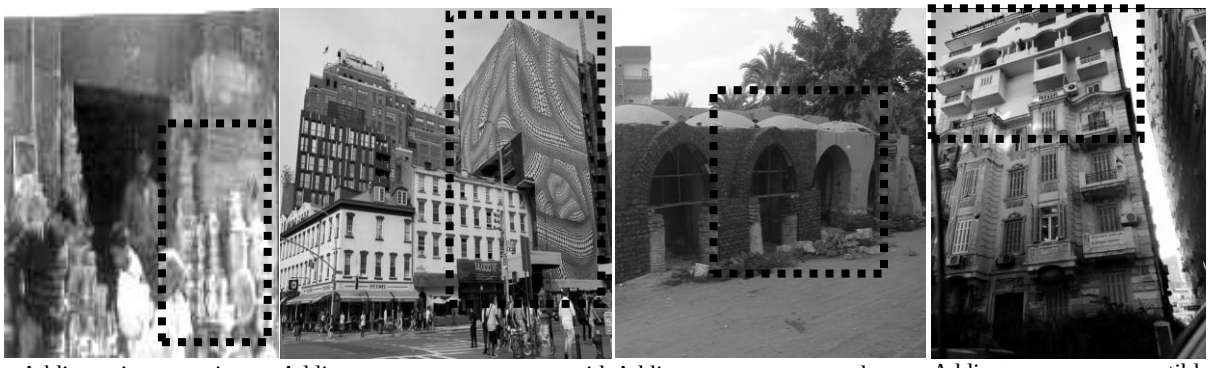


Adding inappropriate use to the original building. Cairo, Egypt. [Author]

Adding new mass with inappropriate appearance to the old building. New York, USA. [1]

Adding new structure element incompatible to the old. Gourna Village, Luxor. The most famous work, H. Fathy. [2]

Adding new compatible construction to the old, with inappropriate appearance. Alexandria, Egypt. [Author]

Fig.1. Some Aspects of the Problem, Source: [1-2].

1.2 Objectives

This research aims to establish a framework for using new additions to heritage buildings, therefore these additions should be compatible for achieving a harmony with use, construction, appearance of the original building. The purpose of this framework is to promote a better understanding of the design issues, the different possibilities of additions to heritage building and to assist architects design additions that will complement rather than compromise the heritage value of the original building. In addition, to examine the success of the selected additions according to use, construction, appearance to the original building.

1.3 Methodology

The suggested methodology is presented into theoretical and analytical studies. Firstly, theoretical study concerning the principles and considerations of conservation for heritage buildings and then studying design strategies for architectural additions. In addition, type of additions in terms of use, construction and appearance. Secondly, it has been adopted an analytical inductive approach to analyzing the levels of new additions to heritage building by examining the selected examples that linking different addition types of mass transformation. Same examples have been analytically

measured by the opinion of audiences through filling a survey to show the acceptance according to the levels of addition to the original building – as in Fig.2.

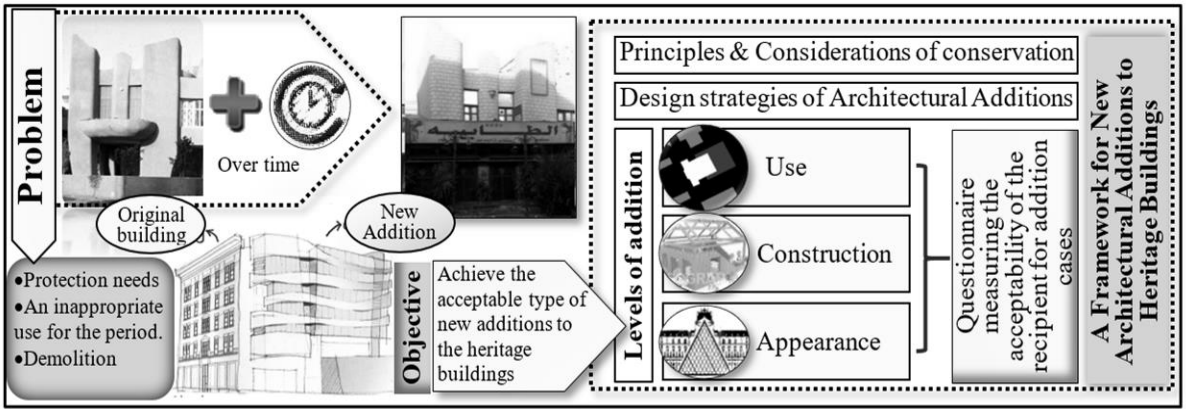


Fig. 2. Research Methodology, Source: [Author].

2 ARCHITECTURAL ADDITIONS TO THE HERITAGE BUILDINGS

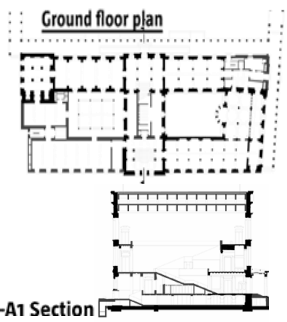
2.1 Principles and Considerations of Conservation Using a New Additions

Some authorities in different countries are making policies to manage change, including adaptation, when assessing development of heritage buildings. Such policies contain standard criteria to help ensure that an architectural addition has minimal impact on a building's heritage values, such as retaining the building façade, seeking a new use for the building that is compatible with its original use [3-4]. The General principles and considerations for conservation of using new additions include minimize changes, make changes reversible, maintain evidence of age and distinguish between new and old [5], An addition should play a subordinate role, it should not dominate the original building as a result of its scale, materials or location, and should not overlay main elevations. Where an addition form is built beside a main elevation it should generally be lower than, and set back behind, that façade. Design an addition to be compatible with the heritage building in mass‹ materials, color, and relationship of solids to voids in the exterior walls. Fire escape routes may be needed an external escape stair, it should be located as reversibly and inconspicuously as possible, and not on main elevations [6-8].

2.2 Design Strategies of Using New Architectural Additions

Brookner and Stone developed three strategies of building reuse based on the extent of integration between the host building and the new elements of addition. These strategies are intervention, insertion, and installation While Bollack divides adaptive reuse projects design into five strategies which are: wraps, weavings, juxtapositions, parasites, and insertions [9-10]. Table 1 shows the strategies definitions.

Table 1. Design Strategies of Using New Architectural Additions, Source: [9-11]

Installation (wrap, parasite, juxtaposition)	The old and new buildings exist independently. The new elements design may be influenced by the existing building but they are not necessarily compatible with it.	 
Insertion	A new, independent element that is suited exactly to the existing envelope. It is constructed to fit and is located within the boundaries of the existing building	  
Intervention (weaving)	The existing structure undergoes major transformations so that it can no longer exist independently. The old and the new additions are completely integrated	 

2.3 Levels of Additions of the Heritage Buildings

In this part of study, the vocabulary of architectural addition and its relation to the heritage building are studied in terms of use, construction and appearance.

2.3.1 Types of addition influencing the heritage building use

The new additions in this level to the original building have three possibilities: 1) The same original use; 2) New use is compatible with its original use; and 3) New use differentiating with the original use of the building heritage [12, 9].

2.3.2 Types of addition influencing the construction of the heritage building

In this level, new additions can be classified according to: 1) Elements and size of the additions “treatments, transparent membrane, structures to cover courtyard, lightweight structures, adding-new volumes, mezzanines and floors-to the existing building, adding new separate building”; 2) Adding new materials should appropriate structural integrity and choice of materials should revitalize and enrich the existing building, these materials like “stone, brick, wood, concrete, steel, glass, etc.”; 3) Constructions works: Structural system, finishes, electrical, lighting, plumbing, mechanical, heating and cooling fighting fire system, Security [13, 9].

2.3.3 Types of additions influencing the appearance of the heritage building

The Addition impact includes three main aspects as the following: 1) Different types in the location of the new addition to the original building “exterior- on top of original building, interior- in plans, courtyard surrounding of the original building, underground the original building”; 2) Analysis for the vocabularies of addition (plan shape-geometric, irregular or freeform; Façade-material color and texture, realistic aesthetics, natural aesthetics “proportionality, diversity, etc.”, engineering aesthetics “organization, rhythm, etc.”, high-tech values “luxury, height, etc.”, the values of deconstructive beauty “non-linearity, complexity & chose, surprise” [7, 14-16].

3 THE ANALYTICAL STUDY FOR THE LEVELS OF NEW ADDITIONS TO THE HERITAGE BUILDING

The selected case studies have been classified in terms of the transformation of form by types of addition, that defined from the visual aspects by Ching [17], then measuring the acceptance of audiences for these new additions to the original building. The case studies have been selected according to the criteria defined the variety of levels of new additions to the heritage building, either design strategies for use specific new additions, diversity between international and local examples, new additions are contemporary examples. This study has adopted a questionnaire using visual images for selected case studies, it has been delivered by social media networks and direct interviews. The questionnaire was directed to a variety of participants (110), The participants' ratio is in the field of architecture 13%, In the field of architectural academic 52%, students in architectural department 4%, others 31%, the following Tables 2-6, show the analysis of the selected case studies. Each table includes building images that associated with a specific transformation type where additions serving the different use of the buildings. Also, it defines data about studied building like (a type of use, country, construction date, the designer name). While Tables 7-9 compare between items of each level according to an outcome of the theoretical study, also the ratio of acceptance of the addition in each level for all case studies in this research which will be evaluated later in this study. The remaining of the questionnaire data reported in the form of graphs to study the results and relations between the case studies to reach the findings as in Figs. 3, 4.

3.1 Case Studies

This part of the study shows the analysis of the selected case studies classified according to using addition by intertwined volumes as in Tables 2, 3, Using addition by surface to surface as in Table 4, Using addition by no contact (spatial tension) as in Table 5 and finally using addition some of the architectural vocabularies and its effects as in Table 6.

Table 2. Case Studies of Heritage Buildings Using Addition by Intertwined Volumes, Source: [18-22].

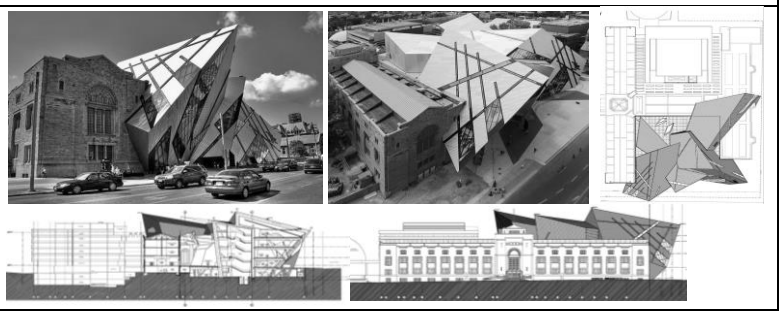
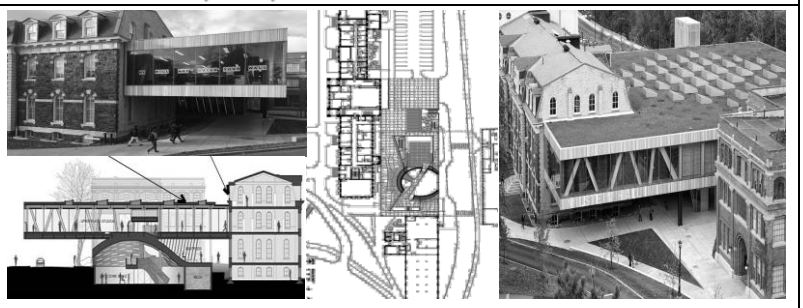
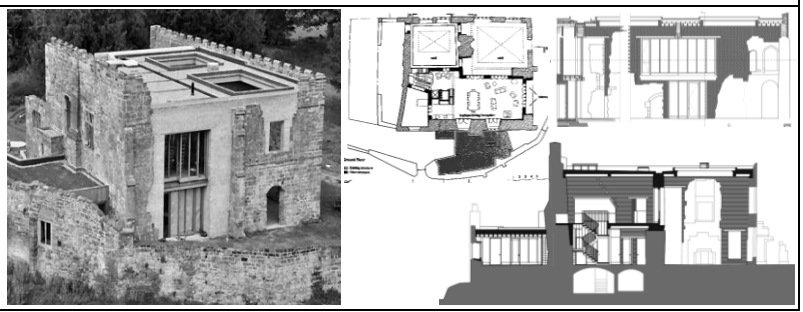
Building description	Addition by intertwined volumes
1- Royal Ontario Museum(ROM), Canada, the building's five intersecting metal-clad volumes, Studio Daniel libeskind,2007 [18]	
2- Milstein Hall. Cornell university, 2009-2011, Ithaca, New york, U.S.A, Architect: OMA and KHA architects, LLC [19]	
3- Kennington Water Tower, to convert to a single-family home London [20]	
4- D-House Urban Sandwich, Housefrom1930, Addition turns brick A-frame to green box, Poland [21]	
5- Astley Castle, Witherford Watson Mann Architects, 2013, Warwickshire, Uk [22]	

Table 3. Case Study of Heritage Buildings Using Addition by Intertwined Volumes, Source: [23-27].

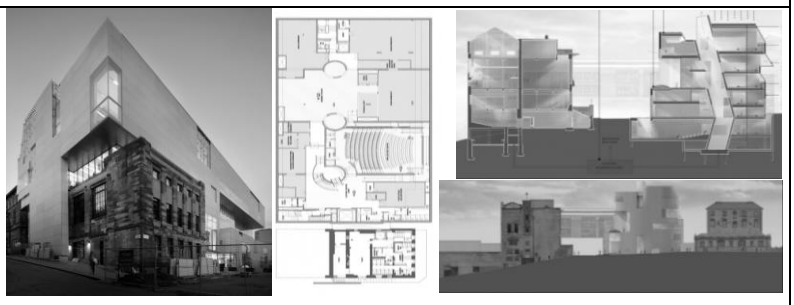
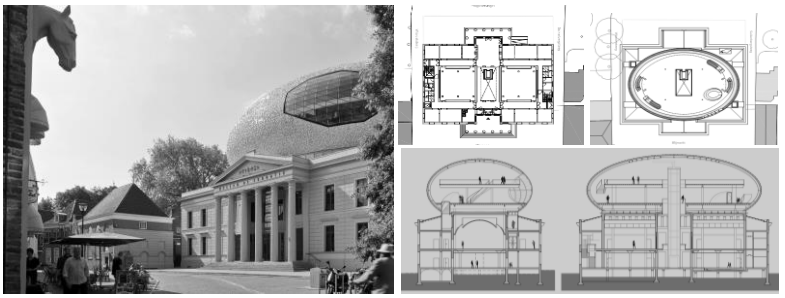
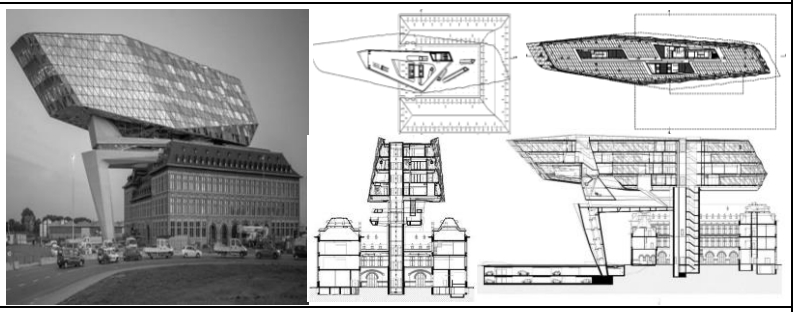
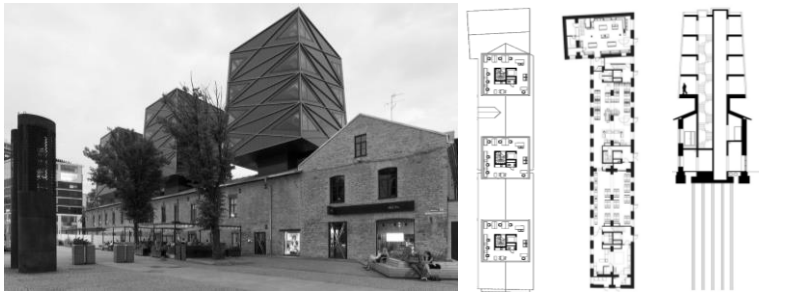
Building description	Addition by intertwined volumes
6- Reid Building, School of the Arts, University of Glasgow 1894-2014 designed by Stephen hall.UK. [23]	
7- Museum De Fundatie Zwolle, Palace of justice (Blijmarkt courthouse) Netherlands, 1838, Bierman henket architects, 2013. [24]	
8- Antwerp Port House, Zaha Hadid architects Brussel, Belgium date of renovation: 2016. [25]	
9- Rotermann Carpenter's Workshop ,19th century, Tallinn, Estonia, by Koko.2009 office building in a historic industrial quarter [26]	
10-Glass farm, a traditional schijndel farm 1980 features a printed glass façade, mixed-use development 2013, contributed by MVRDV, Holland [27]	

Table 4. Case Study of Heritage Buildings Using Addition by Surface to Surface Contact, Source: [28-32].

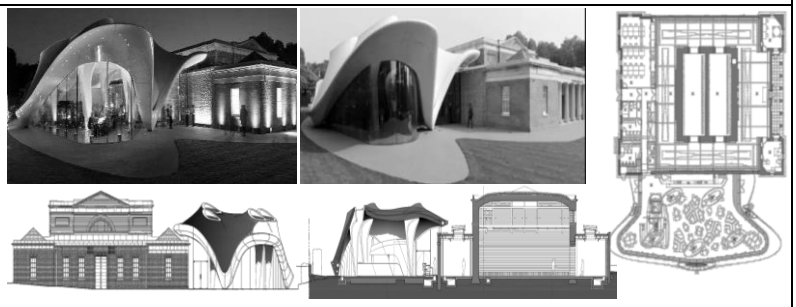
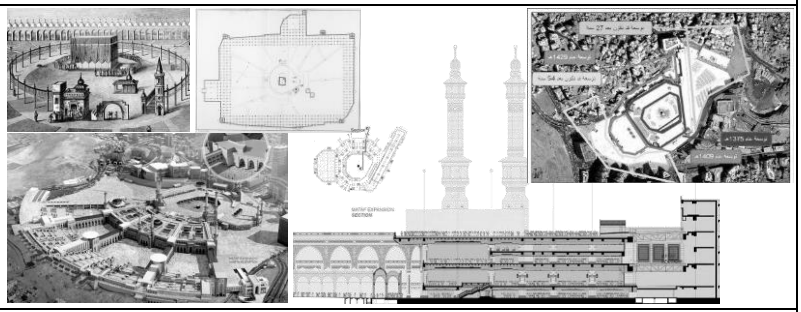
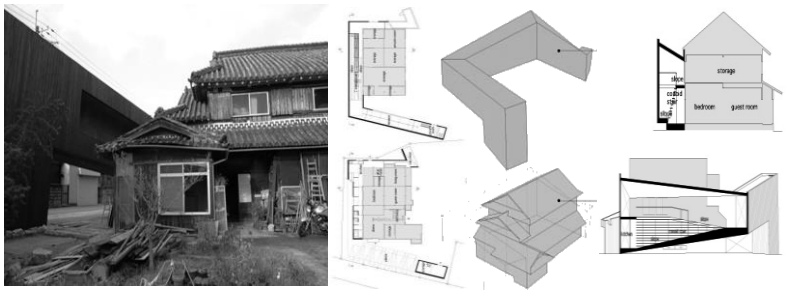
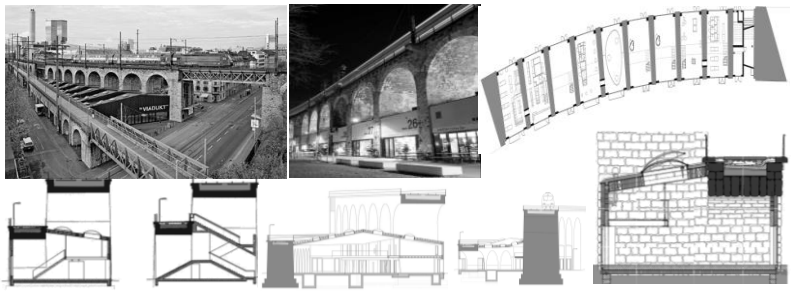
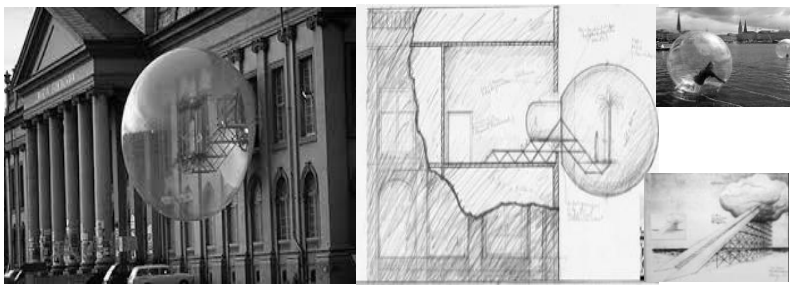
Building description	Addition by surface to surface contact
11-Restaurant 2013 an annex to the nearby serpentine gallery1805. Kensington gardens, London, Zaha Hadid, Patrick Schumacher [28]	
12-Expansion of the holy mosque in Makkah, Saudi Arabia, Architect Saudi ballading group [29]	
13-Haikai House, Akashi City, Hyogo, Japan 300-year-old Japanese house wrapped in a modern home, by Katsuhiro Miyamoto & Associates,2007, [30]	
14-Viaduct Arches, late 19th-century Zurich, historic railway viaduct arches transformed into a trendy shopping district.2010, design firm EM2N [31]	
15-Museum of arts and Crafts Hamburg-Germany. by Haus-Rucker- “Architectural utopia reloaded,” [32]	

Table 5. Case Study of Heritage Buildings Using Addition by No Contact (spatial tension), Source: [33-37].

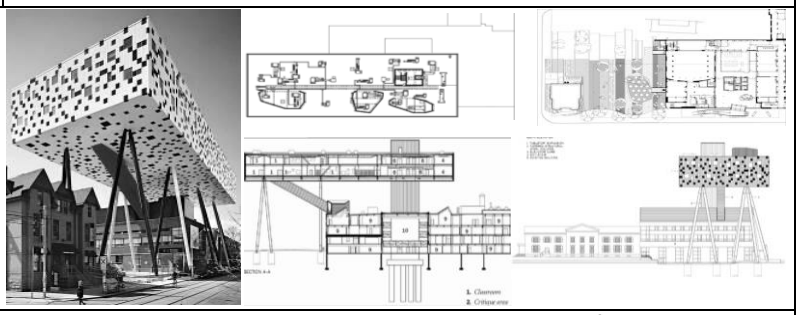
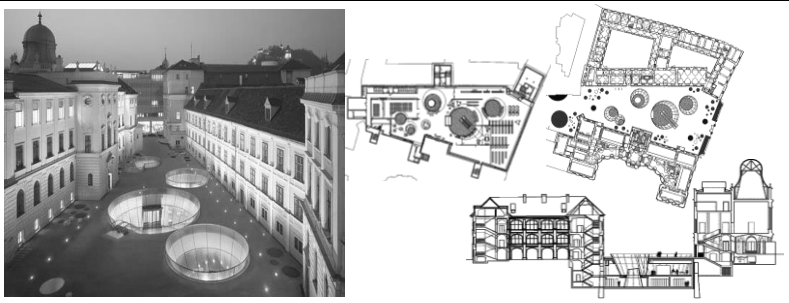
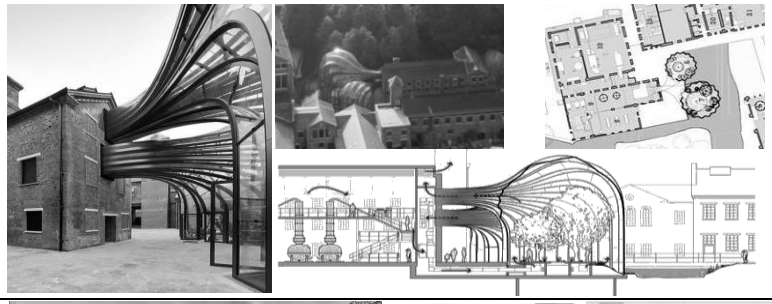
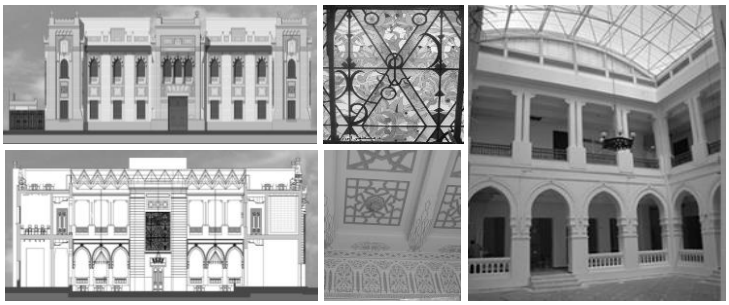
Building description	Addition by no contact (spatial tension)
16-Sharp center at the Ontario college of art & design, Toronto,2003, [33]	
17-Joanneum Museum extension and refurbishment, Graz (Austria), old building 1811, Architects: Nieto Sobejano arquitectos, eep architekten, 2011[34]	
18-The Bombay sapphire distillery, Glass houses award winning BREEAM, Heatherwick studio, Laverstoke, Hampshire, UK, 2014, [35]	
19-The british museum - world conservation and exhibitions centre, by Rogers stirk harbour + Partners, extension to the museum of 1907-2014. [36]	
20-Museum of Suez Canal history2014, Fernand delesibs palace1859, Ismailia, add a separate mass to display delesibs vehicle. [37]	

Table 6. Case Study of Heritage Buildings Using Addition Some of Architectural Vocabularies and its Effects, Source: [38-42].

Building description	Addition by Architectural vocabularies
21-The palace of fine art Cairo, Egypt, 1998. [38]	
22-Sky stage, Frederick arts council, Maryland, historic building (1762) was damaged by a major fire in 2010, Now a center for free arts and culture, by Heather Clark [39]	
23- Damanhur creation center, 2013. Old city council building and turn it into a creativity center. Upgrade building, equipment and it restores the facades and interiors. [40]	
24-"Open borders courtyards and porticoes", Milan university, Italy, 2016. Exhibition, material P.A.T.I. ETFE polymer, design ma yansong &others [41]	
25- Hammam tanbali, Cairo, refurbishing the building to its original use, while providing it with the necessary protection measures; installing modern techniques in restoration [42]	

This step of the study shows comparative analysis between case studies based on the use of architectural additions, its ratios of acceptance, its design strategies, and the extent effect of the use in acceptance as illustrated in Table 7.

Table 7. Analysis of Case Studies Based on the Use of Architectural Additions, Its Ratios of Acceptance and its Design Strategies, Source: Authors.

Case study buildings			Relationships between Architectural Additions & Heritage Building																							
			Intertwined volumes										Surface to surface contact					No contact (spatial tension)					Architectural vocabularies				
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Relation new use with the original use	The same original use																									
	New use is compatible with its original use																									
	New use differentiating with the original use																									
	Ratio of additions based on the use		14.7	34.3	50	27.5	39.6	25.7	27.5	33.7	35.6	51.5	32.7	62	32	67.6	24.5	29.3	51	34.7	34.3	45.5	64.7	39	52	46.1	48.5
Design strategies	installation	wrap																									
		parasite																									
		Juxta-position																									
	Insertion																									
	Intervention																									

Then the comparative analysis between case studies based on the construction of architectural additions (Material, Construction works, Elements & size of the additional building) and its ratios of acceptance as illustrated in Table 8.

Table 8. Analysis of Case Study Based on the Construction of Architectural Additions and its Ratios of Acceptance, Source: Authors.

		Material			Construction works									Size of the addition								Ratio of architectural additions based on construction
	Case study buildings	same original material	Different of original material	Harmonize with original	Structural system	Finishes	Electrical	Lighting	Plumbing	Mechanical	Heating & cooling	Fighting Fire Systems	Security systems	Treatments	Parts of building	Transparent membrane	Structures to cover courtyard	Lightweight structures	Adding-new volumes	Mezzanines & floors-	New full separate building	
intertwined volumes	1		■		■	■	■	■	■	■	■	■	■							■	■		19.6
	2		■		■	■	■	■	■	■	■	■	■							■	■		32.4
	3		■	■		■	■	■	■	■	■	■		■	■					■	■		29.4
	4		■		■		■	■	■		■	■		■							■		21.6
	5	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■						29.7
	6		■		■	■	■	■	■	■	■	■		■						■		■	29.7
	7		■		■	■	■	■	■	■	■	■	■	■				■	■	■	■		31.4
	8		■		■	■	■	■	■	■	■	■	■							■		■	49.5
	9		■		■	■	■	■	■	■	■	■	■	■						■		■	34.7
	10		■	■	■	■	■	■	■	■	■	■				■		■	■				46.5
surface to surface contact	11		■	■	■	■	■	■	■	■	■	■				■						■	38.6
	12	■	■	■	■	■	■	■	■	■	■	■	■	■					■	■	■	■	30
	13	■		■	■	■	■	■	■		■											■	18
	14		■	■	■	■	■	■	■	■	■	■	■	■	■				■				36.3
	15		■		■										■			■					41.2
no contact (spatial tension)	16		■		■	■	■	■	■	■	■	■			■							■	45.5
	17	■	■	■	■	■	■	■	■	■	■	■	■	■			■		■	■	■		39.2
	18		■		■	■	■	■	■	■	■	■	■	■				■				■	52.5
	19		■	■	■	■	■	■	■	■	■	■										■	21.6
	20	■			■	■	■	■	■		■	■	■	■								■	17.8
Architectural vocabularies	21		■	■		■	■	■	■	■	■	■	■		■								24.5
	22		■	■	■		■	■						■	■								26
	23		■			■	■	■	■			■	■	■			■						37
	24		■	■		■												■					45.1
	25	■		■	■	■	■	■	■	■	■	■	■	■									22.7

The table below shows a comparative analysis between case studies based on the appearance of architectural additions and its ratios of acceptance illustrated in Table 9.

Table 9. Analysis Case Study Based on the Appearance of Architectural Additions and its Ratios of Acceptance, Source: Authors.

Relationships between Architectural Additions & heritage buildings	Case study buildings	Location of Add.				Plan's shape after addition			Façade's shape after addition			Abstraction & simplicity(Realistic aesthetics)	Natural aesthetics				Engineering aesthetics				High-tech values			The values of deconstructive beauty			Ratio of architectural additions based on appearance
		Exterior- on top of original building	Interior- in plan	Courtyard surrounding the original	Underground the original building	geometric	Irregular	Freeform	Material (harmony)	Color (harmony)	Texture(harmony)		Regulation and compatibility	Proportionality	Diversity	Equilibrium and symmetry values	Organization	Unity	Repetition	Rhythm	Height	Dazzling	Dower and luxury	Non-linearity	Complexity & chaos	Surprise	
intertwined volumes	1	■	■			■		■				■										■		■	■	■	85.3
	2	■	■			■				■		■	■					■			■	■	■				61.8
	3	■	■	■		■						■	■	■				■									63.7
	4	■				■						■	■			■				■							74.5
	5	■	■	■		■			■	■	■	■	■	■		■	■	■									72.3
	6	■				■						■			■	■	■				■						84.2
	7	■					■			■		■									■						81.4
	8	■	■					■				■	■		■	■		■	■	■	■	■		■		■	66.3
	9	■	■			■						■	■			■	■	■	■	■							68.3
	10	■	■			■			■	■	■	■	■	■			■	■	■	■							64.4
surface to surface contact	11	■	■					■		■		■							■	■		■		■		■	75.2
	12	■	■	■		■				■	■	■	■	■	■	■	■	■	■	■	■		■				69
	13	■		■			■			■	■	■	■				■	■									70
	14	■	■			■			■	■	■	■	■	■			■	■	■	■							68.6
	15	■				■						■			■							■				■	73.5
no contact (spatial tension)	16	■		■		■	■					■	■		■				■	■	■	■					78.8
	17		■	■	■		■			■	■	■			■	■	■	■	■	■				■			79.4
	18	■		■		■						■			■	■	■	■				■					73.3
	19	■		■	■	■				■	■	■	■	■			■	■	■	■							80.4
	20			■		■			■	■	■	■			■	■	■										74.3
Architectural vocabularies	21	■	■	■			■		■	■	■		■	■	■			■	■	■							74.5
	22	■		■				■	■	■	■				■			■	■	■				■	■		74
	23		■			■						■	■				■										70
	24			■			■					■	■				■	■	■	■		■				■	69.6
	25	■	■			■			■	■	■	■															63.9

Graphs below show the participants' ratios for study questionnaire and the extent of an acceptance of a new addition as in Fig. 3, the participants' ratios and the extent of an acceptance based on (use, construction, and appearance) as in Fig. 4.

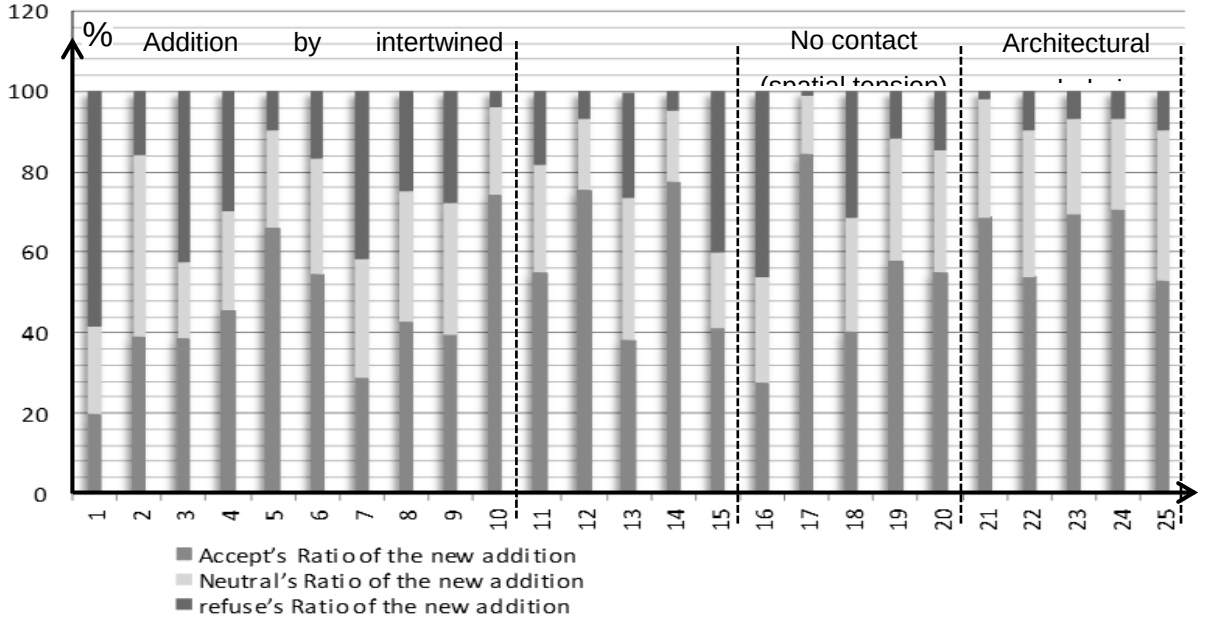


Fig. 3. Participants' ratios for Study Questionnaire and the acceptance ratios [Authors].

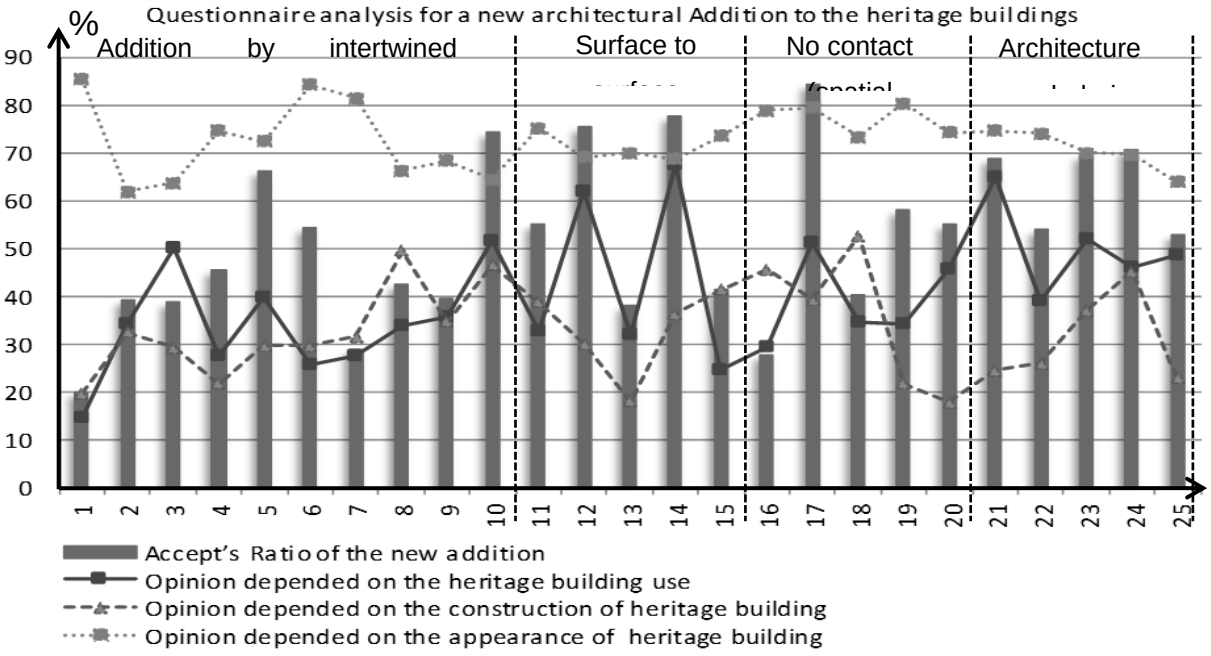


Fig. 4. Participants' ratios for Study Questionnaire [Authors].

3.2 Results and Discussion

Appearance is the highest factor of acceptance among participants as in Fig. 4. From the data analysis it has been observed that for specific buildings (#12, 14, and 21) most recipients have selected appearance and use due to the innovation in the area utilization and/or the importance of building function. The highest building selected for its appearance is building (#17) where the original building was preserving its appearance by adding underground structure. The building with lower frequency is (#1) due to the contrast of the addition to the original building (which is corresponding to the principles and considerations of design architectural additions). Architecture additions for most of the buildings have achieved the compatibility with the values of Natural & Engineering aesthetics. Building that used high-tech values or values of deconstructive beauty have no specific trend, some have refused (#2) others, some received moderate acceptance (#8) while others (#11, 12) received high acceptance due to the dominance of use and construction level and the addition appearance did not change the original building appearance (new vision for the principles and considerations of design architectural additions). Plan's shape after addition, a free form plans are more acceptable in arena of arts and museums, while geometric & regular plans are more suitable for service functions such as education, housing, and multi-function buildings. Most of Façade's shape after addition is in harmony with the original building in terms of material, color, and texture. But using contrast seems a risk, for example, it was the reason for the rejection of (#1) and the acceptance of (#18).

The use is the second factor influencing participants' acceptance of for buildings as illustrated in Fig. 4 & Table 7. Most buildings have been the same original use or new compatible use with its original use except building (#3, 9, 14, 18) which have a new use different than the original use. Building (#14) has received the highest acceptance score for getting optimal utilization of space, urban perspective, as well as performing the original use.

Participant acceptance for construction was under condition of addition by Intertwined Volumes. Most of the additions have utilized different material different from of original one. However, most of them were accepted. This could be due to the same color of old and new material. Most cases have used all construction works for rehabilitation and adaptive reuse for the modern era. It has been noted that building 8, 18 have the highest acceptance ratio for construction although the contrast in construction with the original building. On the contrary, building (#11) is different in the construction system but with neutral effect on participants, the actual effect was due to appearance. This was due to the addition was light construction, and consistent in color with the original building (new vision for the principles and considerations of the design of architectural additions). In the case of adding architecture vocabularies, some participants did not realize the type of addition.

The study showed that most of the examples of the analytical study are consistent with the principles and considerations of conservation and design strategies of using new additions. But there are situations that differ with these principles, and yet have been accepted and successful because of their achievement of an integrated performance of levels (use, construction, and appearance).

Based on the theoretical study, analyzing case studies and the survey results, Fig. 5 is presenting the suggested framework to be considered as a guideline when renovating or rehabilitating heritage buildings to make sure that the addition will be compatible with the original building as in the Figure below.

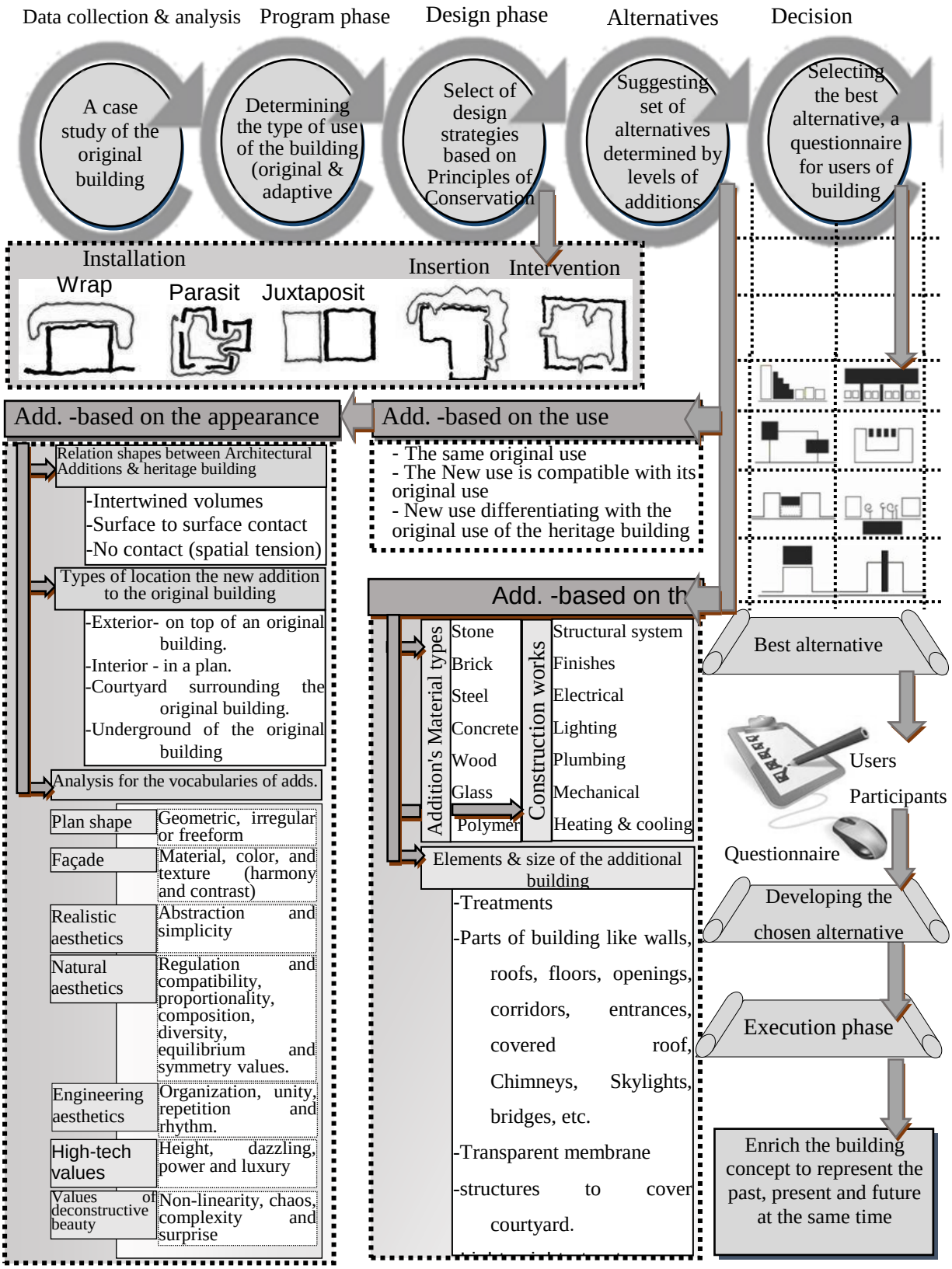


Fig. 5. A Framework for New Architectural Additions to Heritage Buildings [Authors]

4. CONCLUSIONS

In order to create a framework for new architectural additions to heritage buildings to achieve a final form appearance that reflects and preserve the original building and can be used in a manner compatible with the present and able to apply changes and adaptable for future use. This concept can be achieved through a multi-step phases that are compatible with the design process:

1) data collection & analysis: It represents the case study of the original building, its use and its structural system and follows period of time where building has been established with the values of that time; 2) The program phase: Determining the type of use of the building (original, integrated or adaptive) and design fundamentals and finally the required construction works to renovate building use whereas the final result commensurate with the present age; 3) The design phase: this phase is concerned with the selection of design strategies of using new architectural additions based on Principles and Considerations of Conservation and on the status of the original building and its appearance; 4) Alternatives phase: suggesting a set of alternatives determined by levels of additions; 5) Decision making and selecting the best alternative that achieves the highest result. A preliminary questionnaire of sketches of the chosen alternative can also be done (as in this study). The sample should include the participants and users of the building under study. Questionnaire results can help in developing enhancement for the chosen alternative before execution phase.

5. RECOMMENDATION

- This framework should be used as a guide when assessing development applications for adaptation or rehabilitation projects.
- The principles and considerations of conservation should be revisited from time to time to accommodate new technologies that directly affecting levels of addition (use, construction and appearance).

- This circle of evolution will provide architectural addition to heritage building with new visions and renewal process to enrich the building concept to represent the past, present and future at the same time.

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إطار عمل لاستخدام الإضافات المعمارية الجديدة فى المبانى التراثية

يهدف البحث إلى وضع إطار لاستخدام الإضافات الجديدة للمبان التراثية، بحيث تكون متوافقة مع الاستخدام والبناء ومظهر المبنى الأصلى، وينقسم البحث إلى الدراسة النظرية المتعلقة بمبادئ واعتبارات الحفاظ للمبانى التراثية، ودراسة استراتيجيات التصميم للإضافات المعمارية وأنواعها من حيث الاستخدام والبناء والمظهر، ثم الدراسة التحليلية باستقراء وتحليل مستويات الإضافات الجديدة فى المبانى التراثية من خلال تحليل الأمثلة المختارة التى تربط أنواع الإضافة المختلفة بأساليب التحول والتغيير فى الشكل باستخدام الاضافة وأنواعها من الناحية البصرية، ثم تحليل نفس الأمثلة من خلال رأى الجمهور باستخدام نموذج الاستبيان لقياس مدى قبول الاضافة الجديدة ذلك طبقاً لمستوى أو مستويات إضافتها إلى المبنى الأصلى.