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Sustainability Assessment of Adaptive Reuse Buildings in Kathmandu - A study of three cases in Patan

Kripa Shakya [a], Sudarshan Raj Tiwari [b]

[a, b] *Department of Architecture, Pulchowk Campus, IOE, Tribhuvan University, Nepal*
Corresponding Email: [a] kripasky@gmail.com, [b] srtiwari@ioe.edu.np

Abstract
Sustainable development is one of the dominant movements in the 21st century, especially in the sector of building and city design. Sustainability is not solely as an environmental concern, but also incorporates economic and social dimensions. Adaptive reuse is a building practice which offers multiple sustainability benefits compared to new construction. It contributes towards the concept of sustainable development as it promotes reusing as much as possible of the existing built structure by finding a different suitable use and reducing abandonment or destruction. Currently sustainability assessment is relevant mostly to new construction. The primary purpose of this research is the assessment of adaptive reuse projects in Patan in terms of factors based on existing literature and the context of Patan. Among the three projects considered in the study, two are repurposed hotels at Swotha area of Patan (Traditional homes and the Inn) and the other is a heritage center Yala Maya Kendra located at Patan Dhoka. The study is also an attempt to observe the methods and materials that are being used in the existing adaptive reuse buildings and its impacts. In overview it was found that complete new construction of similar built up area would consume 2.15 to 3 times of embodied energy and 2.62 times to 3.7 times of emitted carbon.

Keywords
Adaptive reuse, Sustainability, Traditional buildings, Embodied energy, Emitted carbon

1. Introduction

1.1 Background

Housing sector contributes significantly to the local economy but it is also becoming one of the most polluting sector and promoter of unsustainable living. At a global level, buildings and construction sector currently represents the largest share of 30% of total energy consumption, more than other sectors of industry and transportation. It consumes 12% of water consumption, 40% of waste to landfill and emits nearly 40% of energy-related CO2 emissions (IEA, 2017). Kathmandu is a thriving economic zone attracting people in search of better opportunities from all over the country. With increased population and unplanned development there is increased consumption of resource and energy. Thus rapid depletion in the environment and the quality of life is one of the major ongoing issues in the city.

Adaptive reuse can play an important role in the movement towards sustainability due to its simple reuse approach. As the process involves extending the life of the building with a changed use, it can be an effective strategy to improve sustainability of existing building. This is firmly supported by Rovers [1] with the justification that the existing building stock has the greatest potential to lower impact of construction significantly within the next 20 or 30 year. Restoring and repairing of existing buildings for continued use has become increasingly important in contemporary architectural practice today because of contemporary world's understanding of the need for sustainable development patterns, current economic need for less costly physical architectures and an ever increasing awareness of the benefits of retaining our architectural heritage [2]. Thus, unless the existing structures are considered, sustainability strategy of new building construction itself can not be sufficient to make significant improvement.

Breathing new life to existing buildings concerns not only environmental and economic aspects but also socio-cultural benefits. In Kathmandu, the new development mostly consists of ungracious replication

of concrete structures brought due to different factors such as access to new industrial materials and technology, mindset of strength, status stigma, lack of awareness among consumers, insufficient government effort etc. Such trend has brought a significant change in visual appearance of our cities and imposes a challenge to the approach to sustainability. The authenticity and harmony among the buildings that once used to be in our traditional settlements has now become an unrecoverable loss. The number of traditional buildings have rapidly decreased more so after the recent 2015 earthquake. Adaptive reuse can play an important role not only in avoiding wasteful process of reconstruction but also in the preservation of our traditional buildings, whose importance in the urban communities in today's time cannot be denied when with different parts of the world becoming more and more connected, loss of identity of a place is seen as buildings in different places have started looking all alike.

But, sustainability assessment currently is relevant mostly to new construction. Adaptation is generally perceived as more complex and costly process and more value is believed to be gained from new development. There is also the concept that there is need to demolish buildings simply because they are old and inefficient resulting in a demolition based development. Therefore study of practices that are being used and the applicability of such adaptive reuse building process in local context should be done, exploring both the merits and demerits which is the motivation for this study.

1.2 Objectives

The research intends to study adaptive reuse practice as a means of achieving sustainability in buildings in case of Kathmandu Valley. The specific objectives to carry out the study are as follows:

1. To identify the changes and the materials and techniques that are being used in the adaptive reuse buildings in present context

2. To compare different aspects of adaptive reuse buildings obtained from literature with findings in context of Kathmandu Valley

3. To assess the physical and socio-cultural impacts of adaptive reuse buildings

2. Literature Review

Study of available literature related to sustainability and adaptive reuse was done for an overview of different aspects of topic and existing knowledge gaps. It also acts as a base to form the theoretical framework and later for the interpretation of the results.

2.1 Sustainable buildings

Different models of sustainability highlight the inter-relationship amongst the three pillars: environmental, social and economic. It has also been referred to as 3Ps concept, planet, people and prosperity, congruent with the three pillars. A project cannot be regarded as sustainable if any of the aspect is neglected. The different dimensions can have different indicators and parameters attached to them which are powerful tools to study buildings performance criterias. There are six main relevant features widely used to achieve sustainability in buildings.

1. Site and surroundings
2. Energy efficiency and renewable energy use
3. Water consumption
4. Indoor environmental quality
5. Materials use and management
6. Integrated design approach.

2.2 Adaptive reuse

Adaptive reuse is a process that adapts disused or ineffective buildings for new purpose by new or existing owners, retaining the historic features as much as possible of the original building while upgrading the performance to suit modern standards and changing user requirements [3] It is premised mostly on changing the use or function of buildings as the needs of the economies and societies that originally gave them birth evolve. Using an adaptive reuse model can prolong a building's life, from cradle-to-grave, by retaining all or most of the building system, including the structure, the shell and even the interior materials [4]. The existing building stock is an important physical, economic, social and cultural capital that should not be wasted, a concept described as 'urban ore' by Chusid [5]. Reuse is often associated only with the economy related to the process and it oversees aspects of building and the neighborhood community. Revitalizing the existing built buildings by finding a new use or purpose can

also be a useful resource to a community by keeping neighborhoods occupied and vital [6].

There is also a debate split between the two opposing perspectives, the protection and preservation of the monument and its condition by Ruskin and the upgrading restorative approach of Eugene Viollet le Duc. Different methodologies have also been distinguished proposing different methods that can be used to allow to adapt buildings whilst producing no confusion as to what was old and what was new, namely archaeological restoration' (for antique monuments), 'picturesque restoration' (for medieval monuments) and architectural restoration' (for renaissance and other monuments), to be applied depending on the nature of the specific project [2]. It includes concepts such as differentiating between the style, construction materials, suppressing of decorations, exhibiting removed old pieces, describing the restoration on the monument etc (ibid).

Aggressive belief in modern architecture and new techniques have caused retention of existing architecture to be seen as a barrier to progress and a hindrance to the regeneration of older urban areas. There are arguments by building owners and developers for the process to often be uneconomic and sometimes require substantial refurbishment to make them meet current sustainability standards. Adaptive reuse has come to the mainstream architectural practice today also due to the increasing concern for the environment. Vernacular architecture and industrial buildings have also been reconsidered in conservation with time. One of the important contributors to the rise of the concept has also been the cost of land [7]. Today the approaches and opinions on what 'adaptive reuse' actually is, are more diverse and operates at the interface of architecture, interior design, conservation and planning. The phenomenon is both challenged and driven by ecological, economic, social, cultural, technical and political concerns.

2.3 Factors of Adaptive Reuse buildings

Physical factors for extending the useful life of existing building should include adaptation strategies that combine durability and environmental impact initiatives [8]. Environmental factors compared to social factors are more clear and focused. It mainly focuses on emissions and embodied energy in the built structure. The continuous use of buildings with interventions to accommodate the changes leads to wise use of the expended energy and resources, saving additional resources for alternate process of demolition and reconstruction.

Table 1: Embodied Energy per unit mass and CO2 Emission of Building Materials (Jones & Hammond, 2008)

SN	Material	Embodied Energy (Mj/kg)	CO2 Emission (kg/kg)
1	Plastics	80.50	-
2	Aluminum	155.00	0.24
3	Steel	24.40	1.77
4	Glass	15.00	0.85
5	Ceramics	10.00	0.65
6	Timber	8.50	0.46
7	Lime	5.50	0.74
8	Cement	4.60	0.83
9	Brick	3.00	0.22
10	Concrete	0.95	0.13
11	Soil	0.45	0.023
12	Aggregate	0.10	0.005
13	Stone	0.10	0.005

The calculation of embodied energy and emissions is as follows:

Embodied Energy= Quantity of Material * Embodied Energy Coefficient

CO2 Emission (MT) = Quantity of Material * Carbon Emission

Most of the cases for the adaptive reuse of the buildings are influenced by the means of economy. Interventions are sought to fit as per the needs and contexts where economic benefits can be obtained from. The economic values in the adaptive reuse can be discussed in two topics – the cost of intervention to fit the need and contexts and the economic benefits hence generated [9]. Overall the literature includes the process being improved by the context but is rarely researching the impacts of reuse on the infrastructure, centers, etc. Compared to new construction adapted buildings are generally considered to improve the urban context less. But the scenario may differ as per the varying markets and policies around the globe.

Social-cultural connections to buildings are also one of the determining factors for successful adaptive reuse projects. Valuable information are associated with the building worth conserving like the continued familiarity and identity of the urban environment, the conservation of the history associated with the building and the retained knowledge of past construction methods. Conservation is the best

practice to preserve the socio-cultural values associated but there is also contradictory need to consider the viability of economy, usage demands, changing services and utilities, structural integrities of the buildings. Thus, the degree of change to be allowed and the significance of the existing socio-cultural values embedded in the building are always debated, specifically when traditional building is dealt with.

2.4 Scenario of Adaptive Reuse buildings in Kathmandu Valley

In case of Kathmandu, some traditional buildings having heritage value are found to have been converted for various uses. Many of the old durbars from Rana period are being used for government offices, hotels, banks, security headquarters and some Malla period buildings have been converted into living museums, boutique hotels, restaurants or shops. Adaptive reuse in case of privately owned traditional building are fewer in number and very few such buildings remain to be saved. Although, the conversions of commercial buildings into other functioning are practiced, the conversions of residential buildings into commercial buildings is popular. Such cases are found more in the core areas where much value can be generated from commercialization of such properties. The economic factors play a key role to influence and guide the adaptive reuse in the valley, similar to the examples found around the globe.

The key institutions concerned in the process include the residing institutions in the building, the local authority (municipalities) and the Department of Archaeology. The structures when converted are to follow conservational approaches. But varying practices are found where strong lines to delineate the conservational instances are contradictory. Also, political power-play and interests are sometimes mixed in the debate. By-laws and building codes also still do not successfully address the issues of adaptive reuse of buildings in the valley. The procedure for consents and permits for reinstatements are debatable often mixed with less relevancy and less know-how of the rules and regulations. Thus, the social and environmental values associated with the process of conversions are vulnerable to be missed out.

3. Methodology

3.1 Research paradigm

The research is based on pragmatic paradigm as it demands a methodology that is suitable particularly to get a comprehensive understanding of the issue in the best possible manner. The ontology of the research is that adaptive reuse is also one of the means that should be considered to achieve sustainability in buildings. To understand this issue, the epistemology would be information from primary sources such as designers or experts of the practice and owners or users of adaptive reuse buildings, as well as secondary sources such as books, publications, reports, articles, and websites. The research uses an inductive approach as it begins with specific observations and proceeds to a generalized conclusion. It uses explanatory and descriptive techniques to explain the existing situation of the various issues of adaptive reuse cases in the Kathmandu Valley. To carry out this study, case study strategy with both qualitative and quantitative methods are used focusing on the contemporary events.

3.2 Research design

The objective of this research is to understand the physical and socio-cultural impacts of the adaptive reuse scenario which entails a study on the existing practices. Literature and analysis of the ground reality scenario were referred for considering different parameters and indicators flexible for different building typology. The parameters and the indicators have been mentioned in table 2.

3.3 Methods of data collection

Primary Data Collection: In depth interviews, semi structure questionnaires, direct observation, photographs and site measurements are the primary methods where interview of the architects (Ar Prabal Thapa and Dr. Rohit Ranjitkar) and managers was conducted for the traditional homes and the Inn at Swotha where as interview of the owner (Journalist/author Kanak Mani Dixit and staff member was conducted for Yala Maya Kendra.

Secondary Data Collection: Books, publications, reports, websites, drawings and old photographs are the secondary methods.

Table 2: Framework for research

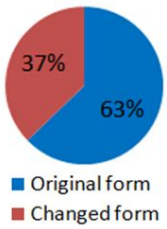
Dimension	Parameters
Physical aspect	Mapping of physical changes – Form and structure, Strategies of adaptive reuse Inventory of materials – Repair and reuse of salvage, Embodied energy and emitted carbon Land occupancy Greenery Other services added – water, heating, light, fuel, safety Passive strategy and renewable energy – orientation, ventilation, light, solar, rain Waste
Socio-cultural aspect	Occupancy Ownership Development Changes in surrounding/Gentrificaion Relation to the community Local craftsmanship Preservation of originality/Sense of place Revitalization
Economic aspect	Built area Cost Payback period Operation Expansion Provision of Subsidy

4. Findings

Information of the three cases was collected in accordance to the physical and socio-cultural framework of the research.

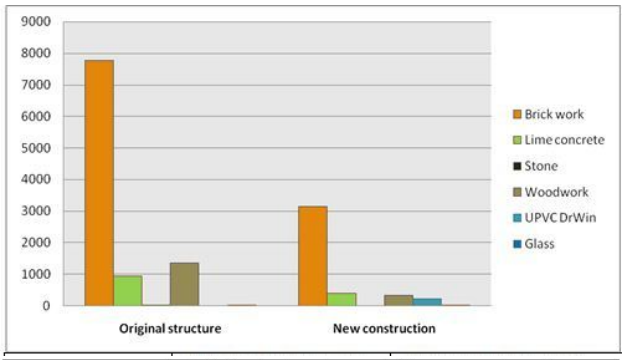
4.1 Physical aspect

The study of change in physical form and material use were studied for the calculation of embodied energy and emitted carbon of retained structure and new construction. Similar calculation was also done for case of complete new construction for an idea of overall savings in energy and emissions.



SN	Item	Original structure	New structure	Total area
1	GF	760	970	1730
2	1F	704	56	760
3	2F	704	56	760
4	3F	704	56	760
5	4F	-	564	564
	Total	**2,872 (62.8%)**	**1,702 (37.2%)**	**4,574**

Figure 1: Change in form in terms of area in Traditional homes

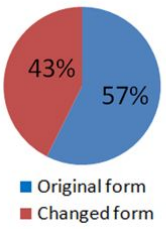


	Original structure	New construction
Brick work	7785.94	3149.94
Lime/Cement concrete	948.13	400.8
Stone	17.6	-
Wood work	1352.76	336.7
UPVC Dr/wn	-	228
Glass	24.72	20.28

Figure 2: Material consumption in original retention and new construction in Traditional homes

Table 3: Summary of embodied energy and emitted carbon of original retention and new construction in Traditional homes

	Original structure	New construction	Complete new construction
Area (Sft)	2872(62.8%)	1702 (37.2%)	4574
Embodied Energy (GJ)	1287 (68%)	629 (32%)	1851 (3 times)
		1924	
Emitted Carbon (kg)	92,400(65%)	49,900 (35%)	182,540 (3.7X)
		142,300	

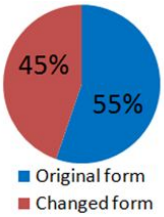


SN	Item	Original structure	New structure	Total area
1	GF	1128.2	811.8	1940
2	1F	1076	554	1630
3	2F	1076	149	1226
4	3F	529	697	1226
5	4F	-	611	611
6	**Total**	**3,808 (57.4%)**	**2,824 (42.5%)**	**6,633**

Figure 3: Change in form in terms of area in The Inn

Table 4: Summary of embodied energy and emitted carbon of original retention and new construction in The Inn

	Original structure	New construction	Complete new construction
Area (Sft)	3808(57.4%)	2824(42.5%)	6633
Embodied Energy (GJ)	1337 (51%)	1283 (49%)	2761.8 (2.15X)
		2620	
Emitted Carbon (kg)	95,915 (47%)	103,279 (53%)	270,9950 (2.62X)
		199,194	



SN	Item	Original structure	New structure	Total area
1	GF	7602	2958	10560
2	1F	645	3710	4355
6	**Total**	**8,247 (55.3%)**	**6,668 (44.7%)**	**14,915**

Figure 4: Change in form in terms of area in Yala Maya Kendra

Table 5: Summary of embodied energy and emitted carbon of original retention and new construction in Yala Maya Kendra

	Original structure	New construction	Complete new construction
Area (sft)	8247 (55.3%)	6668 (44.7%)	14,915
Embodied Energy (GJ)	6149 (59.4%)	4102 (40.6%)	10,084 (2.4 times)
		10,352	
Emitted Carbon (kg)	505,720 (59%)	351,432 (41%)	987,523 (2.81X)
		857,152	

In case of Traditional homes and Yala Maya Kendra, in comparison to share of original and new structure, i.e. (63% - 37% and 55% - 45% respectively), the share of embodied energy and emitted carbon of old retention seems to be higher i.e. 68% and 65% in The traditional homes and 59.4% and 59% and in Yala Maya Kendra. It could be due to the use of higher quantity of materials in traditional construction technology compared to new construction method and also reuse of some materials in the added areas. And the share of embodied energy and emitted carbon of new construction is found to be lesser i.e. 32% and 35% in The traditional homes and 40.6% and 41% and in Yala Maya Kendra. Contrary to it, in case of The Inn where the share of original and new structure is 57% - 43%, the share of embodied energy and emitted carbon of new construction is found to be higher i.e. 49% and 53% respectively indicating more physical alteration and use of similar quantity of materials as in traditional technology. In terms of retention of original structure in terms of area, The traditional homes and The inn were found to retain more of original structure i.e. 68% and 57% respectively where as Yala Maya Kendra was found to retain only 55%.

But in overview it was found that complete new construction of similar built up area would consume 2.15 times (in case of The Inn) to 3 times (in case of The traditional homes) of embodied energy and 2.62 times (in case of The Inn) to 3.7 times (in case of The traditional homes) of emitted carbon indicating more saving of resources by The Traditional homes and least by The Inn. Saving of resources in Traditional homes could be connected with the ownership of the adapted function, which was not privately owned by the developer but was a rental property.

Figure 5: Photographs of Traditional homes, The inn and Yala Maya Kendra before adaptation

Figure 6: Traditional homes, The inn and Yala Maya Kendra after the adaptation process

Similarly, study of other physical factors such as technical aspects and incorporation of sustainability aspects were also studied to assess the inclusion of modern facilities and sustainability aspects in development of the adaptive reuse cases. The findings have been shown in Table 6.

Findings related to physical aspects were as follows:

- Alterations were found to have been made in studied building not just in single phase but in two or more phases throughout the building history
- The structure of buildings considered for adaptive reuse were in fairly good condition which avoided extra complications and cost during the adaptive reuse process. The nature of load bearing buildings allowed for convenient repair of parts
- Adaptive reuse in private buildings has been done using intervention strategy where the old and the new are not separate entity but are intertwined. The use of contemporary materials are found in additions and repair works in the

Table 6: Comparative study of different aspects of physical dimension

Physical dimension	Traditional Homes	The Inn	Yala Maya Kendra
Age	1930s (80 years)	1930s (80 years)	1920s (30-70 years)
Change in function	Similar function	Similar function	From storage to public use
Change in form/envelop, Land addition	No addition in form, Roof altered for orientation and visual appearance	No addition in form, Roof altered for visual appearance	Addition of built up area and upper floors
Foundation	No changes in original areas	No changes in original areas	No changes in original areas
Old and new materials	Some distinction in exterior and interiors	Some distinction in exterior and interiors	Distinct distinction, External aesthetics mainly maintained
Greenery	Present in some amount	Absent	Present as central element
Passive strategy/renewable sources	Natural light, ventilation, solar heating, rain water, use of shared transportation resources	Natural light, ventilation, solar heating, use of shared transportation resources	Natural light, ventilation, PV panels (but not in operation)
Waste management	Absent	Absent	Absent
Use of non renewable fuel sources	Present	Present	Present
Differently able access	Absent	Absent	Absent

existing building, its extent depending from moderate to high use

- Though adaptive reuse itself is environmental sustainable means in terms of resource use and emitted carbon not much other environment friendly measures in design and operation phase have been used in such buildings in case of Kathmandu
- The traditional buildings as they have been regularly maintained were not much damaged in the recent 2015 earthquake, contrary to the common belief about the strength of traditional buildings

4.2 Socio-cultural aspect

Aspect concerned with the different stakeholders such as owners, users and community were considered in the socio cultural aspect:

- In case of gentrification, owners of residential buildings were found already migrated to other areas in search of better opportunities since the properties belonged mostly to well off families in city centers. The properties were being rented to different tenants.
- Also involvement of people having some sort of attachment to and awareness of importance of traditional heritage were found in cases of adaptive reuse buildings such as the developer in the case of Traditional homes, owner/architect in case of The Inn and owner himself in the case of Yala Maya Kendra.
- In case of Yala Maya Kendra, the building has greater historical importance with factors such as history of housing of backside areas of Baggikhana and Ghodatabela during the period of Rana regime, attachment to the monument Patan Dhoka, presence of remains of Malla period boundary wall of the city.
- Thought the projects were driven by commercial purposes, adaptive reuse seems to have improved the condition of the buildings in case of Traditional homes and The Inn which somewhat justifies the process and socio-cultural purpose of the adaptation.

Table 7: Comparative study of different aspects of socio-cultural dimension

Socio-cultural dimension	Traditional Homes	The Inn	Yala Maya Kendra
Occupancy status	Owner previously moved to outskirts, Rent to tenants	One of the owners abroad, Rent to tenants	Store and out house of Rana palace Shree Durbar
Ownership	Original Pradhan family	Bought by developer	Dixit family (Kanak Mani Dixit, Kunda Dixit
Development	Partnership between architect and owner	New owner is also the architect	Existing owner
Change in surrounding/ gentrification	Many other projects but also only façade treatment	Many other projects but also only façade treatment	Gentrification in nearby settlements already existing, Change to commercial area
Functional to local people	Local employment, Indirectly through tourism development	Some distinction in exterior and interiors	Distinct distinction, External aesthetics mainly maintained
Local craftsmanship	Preference given	Preference given	Absent
Preservation of originality/ sense of place	Moderate modern addition, lack of maintenance in space planning	Moderate modern addition, lack of maintenance in space planning	Change in function, Distinct modern addition, Preference to external aesthetics
Revitalization	Example building in Swotha	Example building in Swotha	Ambience

4.3 Economic aspect

The economic aspect of the adaptive reuse mostly deals with the cost of intervention and the economic benefits hence generated is shown in Table 8.

Table 8: Comparative study of different aspects of economic dimension

Economic dimension	Traditional Homes	The Inn	Yala Maya Kendra
Built area (sft)	2872 (+1702) = 4574	3803 (+2824) = 6632	8274 (+6668) =14,915
Cost of adaptation	1 crore	1.8 crore	-
Payback period	1.5 years	4 – 5 years	-
Operation	Since 2010 (11 years now)	Since 2013 (8 years now)	1951 - 1994 (26 years now)
Expansion	2 units in adjacent building	No expansion	Expansion in upper floor
Provision of subsidy	Absent	Absent	Absent

5. Conclusions and Recommendations

In case of adaptive reuse of buildings in Kathmandu, the extent of balance between the environmental, economic, socio-cultural and technical factors were found in varying degrees depending upon the individual cases. The process was mostly found to be environmental sustainable in terms of resource use and emitted carbon but other measures for sustainability still have not been given enough preference. The inclusion of such aspects, even if beginning with simple measures can further improve the performance of such buildings.

In terms of social preference such process is still not given preference by owners and developers due to which there is limited awareness of the advantages and importance of the process among people. So limited examples of such buildings exist, more so in the case of private building. Today very few such buildings remain to be saved and so consideration to preservation of such buildings must be given immediate attention. More study needs to be carried out related to the field of sustainable adaptive reuse. There is also a need of giving the process a priority by the government to utilize its benefits in maximum possible method.

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