V. SUMMARY AND CONCLUSION

"What a country chooses to save is what a country chooses to say about itself."

- Mollie Beattie

The construction sector is an important part of India's economy. It emits about 22 per cent of India's total annual CO_2 emissions as it is the major consumer of all non-renewable resources mankind consumes. Impacts considered from building materials could be addressed at different stages; from processing and manufacturing to logging and storage through installation and use. The construction of a newbuild home is estimated to gives off 50 tonnes of CO_2; contrarily the refurbishment of an existing one emits just 15 tonnes of CO_2 thereby making an initial saving of 35 tonnes of CO_2 per property. Reuse of older sites and buildings for new uses are a sustainable choice in building as it helps to conserve land, save energy, money and resources, preserve the heritage and provide employment thereby satisfying the triple bottom line of sustainability – Environmental, Economic and Social. This endeavor further obliges to the nation's call to preserve and reuse existing buildings citing environmental benefits. With this backdrop a study on **"Adaptive Reuse and Refurbishment of Buildings as Prospects for Sustainability"** was launched. The locale of the study was Coimbatore City chosen by convenience sampling. The broad objectives framed for the conduct of the study included:

- ***Assessing the views of architects and interior designers on adaptive reuse of buildings***
- ***Analyzing the pros and cons of preference for existing buildings to new construction***
- ***Examining the trend in the type of adaptive reuse practices in the City***
- ***Eliciting information from architects and interior designers regarding the use of eco-friendly materials in construction***
- ***Creating a database on the various creative ways of adapting and reusing existing buildings.***

An investigatory study showed that in recent years, the trend to refurbish for adaptive reuse is gaining momentum as commercial centers and business enterprises were on the lookout for spacious structures which are functionally obsolete for their original purpose. Capitalizing on zoning and building laws coupled with the real estate boom the practice has really reached its peak of recognition. An interview schedule was drafted for the study which was channelized enabling conduct of the three concrete phases, the findings of which are summarized as under the ensuing headings.

A. Refurbishment Projects – A good Take-off

This section is a documentation of the experiences of architects/interior designers who had accepted refurbishment projects.

- Architecture and Interior designing firms that were surveyed were established since 1981 till date. The firms established in the years 1991-2000 showed maximum representation (36%), followed by almost 30 per cent who had established between 2001 and 2010.
- Owned and rented buildings featured equally (50% each). Sole proprietorship firms represented maximum in owned and rented buildings (67% and 60% respectively) followed by partnership firms. They preferred to own and operate in buildings with larger built up areas (2001-5000 sq.ft). Firms operating on rental basis preferred to stay on the lower end of the scale (upto 2000 sq.ft.). Corporate firms preferred to operate in rented buildings with a built up area between 1001 and 3000 sq.ft.
- Maximum sole proprietorship and corporate firms had incurred initial investment upto ₹10 lakhs. Sole proprietorship firms predominated followed by partnership firms. Investment potential extended from ₹1 lakh - 15 lakhs. While corporate firms preferred the mid range (₹ 5-15 lakhs), 63 per cent among partnership firms had invested only below ₹ five lakhs. Evidently, nature of the firm, experience in the field and success stories spoke of their magnificence and henceforth their investment potential.
- Yearly turnover of ₹25 – 30 lakhs featured more among partnership and corporate firms while sole proprietorship firms showed turnover below ₹25 lakhs. Only 16 per cent of the total variation in annual turnover could be explained by the linear relationship between initial investment and annual turnover.
- More than three-fourths (77%) of the surveyed sample used only computer aided design while the others (23%) used both manual and CAD for designing purposes. It is clear that CAD was used either way and by all. AutoCAD was the most popular software amongst all professionals and was used by a maximum (90%) of the sample followed by 3D Studio Max (30%).
- While all the samples took up both new construction and refurbishment projects 63 per cent of the sample stated that it was very challenging to satisfy clients who demanded refurbishment and the rest felt it was the clients of new construction projects who were difficult to please.
- Architects and interior designers stated that 50 per cent of the clients approached them when they had to change or upgrade services like replacement of heating, ventilation and air-conditioning plant along with its pipe work, ducting, terminal units, controls and insulation.

Minor or cosmetic refurbishments were next in line (27%) of demand which included tasks like improving lighting, exterior painting and repair plus minor changes to the fittings.

- Improving building aesthetics (67%), need to upgrade services (47%) and expanding usable floor area (43%) were the major reasons for refurbishment sought by clients, which architects diligently executed in their projects.
- Eighty seven per cent of the sample agreed that refurbishment projects required professional/technical acumen and skilled workers who could execute the project.
- All the samples followed a clear cut sequence of processes in assessing the condition of the existing buildings before refurbishment. They were apparently related to structural strength and stability whose requirements varied depending on the type of building, adaptive reuse and refurbishment. A maximum of 60 per cent reviewed the condition of the concrete to check if any dead weight could be added during refurbishment. Fifty seven per cent each of the sample assessed the reinforcements of external concrete surfaces and evaluated structural problems respectively.
- Client specificity (60%) followed by upgradation (40%) was the major criteria considered for changing existing systems during refurbishment. A meager 20 per cent had requested change as they found literally no functional requirement for these.
- Nature of difficulties during project execution extended from practical ones like loss of previous drawings/documents to difficulties related to those of human behaviour, for e.g. a nagging client. Maximum sample (60%) stated that frequent inputs from clients during the execution of the project disturbed the flow and schedule of the work. Almost 57 per cent of the sample faced budget constraints and 40 per cent felt that they were always pressed for time as the clients demanded projects to be completed in minimal time. Fifty three per cent were stressed due to dearth of skilled technicians and workers who could execute directions.
- To strike a balance between the pulse of clients (client behaviour) and the implementation on consideration (flexibility allowed) of procedural aspects (for refurbishment and new construction) responses were received.
    - ϕ Majority preferred to take up total contract. For new construction they offered consultancy services (33%) and/or charged on total cost or for labor. The concept was the reverse for those who had accepted refurbishment.
    - ϕ Eighty per cent of the clients had demanded to look into vastu concepts in both, be it refurbishment or new construction.
    - ϕ While 40 per cent of the clients were quite flexible and had readily accepted to acknowledge ideas of architects regarding refurbishment efforts, new construction

projects on the other hand saw that a vast proportion (70%) of clients to be adamant in their viewpoints.

- ϕ Only a negligible seven per cent were ready to accept hike in expenditure (irrespective of being a refurbishment or new construction project) while more than 55 per cent wanted the architects to conform to the given budget.
- ϕ Indigenous products and locally available materials satisfied even the special needs for majority of refurbishment (70%) and new construction projects (77%).
- ϕ Only quality (33%), durability (33%) and client preference (33%) guided material choices for refurbishment projects; quality (53%) and economy in purchase (40%) outnumbered all other criteria for new construction projects.

- Sixty per cent of the surveyed samples were aware of the concept and consequences of the carbon footprints caused by the construction process. Yet, none of them had kept track of or calculated the carbon emissions caused during construction.
- Sixty seven per cent of the surveyed sample (architects/interior designers) assured that they had advocated or had recommended the use of eco-friendly materials and techniques for both refurbishment and new construction projects. While 23 per cent tried to implement them in new construction projects alone, the others (10%) failed to do even that; they also stated that they did implement such techniques if specified or requested by the client.

Percolation of Green Concepts

- ***A vast number (83%) of samples had accepted that the use of energy saving lighting fixtures like LEDs featuring BEE star labels. Eighty per cent used either 'low' or 'no VOC' paints. Water saving and solar powered devices were used by less than 50 per cent of the sample. Thirty three per cent managed to recycle materials and components to reuse them in the projects. Comparatively focus on saving electrical energy received priority more than adoption of alternate energy sources in daily use.***
- ***Thirty seven per cent of the samples revealed that clients insisted on implementing green technology in the design and construction process. Maximum sample (60%) stated that clients were convinced by the architect or interior designer to implement green technology in their projects. Among the group studied 77 per cent claimed that clients hesitated to adopt green techniques due to its high initial investment and 50 per cent stated that clients were unsure of its durability.***
- Eighty per cent of the sample stated that they had acquired new clients as a result of the success of their previous projects.

B. Refurbished Edifices Affording Adaptive Reuse

The ensuing section reflects the feelings of the users of adaptive reuse buildings – the refurbished structures.

- One fifth of the sample firms were either owned or on lease respectively, but three-fifths were happily functioning in rented premises. Among the total sample, 60 per cent were partnership firms followed by 33 per cent which were run by sole proprietors.
- Owned buildings were preferred by a majority of sole proprietors, while partnership firms preferred rented or leased buildings respectively. Corporate and Government organisations preferred only rented spaces. Maximum representation was in buildings with built up area from between 1000 - 3000 sq.ft followed by 3000 - 5000 sq.ft.
- A maximum of 97 per cent of the sample maintained the setback provisions. All the samples acknowledged that the zoning ordinances permitted their respective type of operations. Twenty per cent of the sample had improvised the strength and safety of the structure of the building by reinforcing load bearing components with concrete and adding I-beams wherever necessary.
- The sample comprised of many genre of enterprise like showrooms, eateries, offices, healthcare and services. Among the total sample studied conversion was mostly preferred for use as eateries (40%) followed by showrooms (30%). Conversions in terms of refurbishment was predominantly found feasible with residences as they offered multiple options to convert them to showrooms, eateries, offices, healthcare and services.
- Out of the residences converted into other forms, eateries predominated (35%), with showrooms closely following in line (32%). Prospects for conversion to offices, healthcare and services were visualized by 11 per cent each respectively.
- Reasons stated by sole proprietors for using existing buildings that were owned or on lease were on common goals like saving time and money. Partnership firms, whether rented or leased analyzed it in dimensions like lower operation costs (due to low rent), convenience to set up workspaces, fitness of purpose, satisfaction of spaciousness and fitness of design to buildings. Corporate and Government offices thought only about saving on operation costs.
- Of the many reasons stated by the samples for choosing the particular building for reuse, locality, availability when needed and character of the building stole the show. Existing buildings on rental basis was much preferred.
- Maximum buildings (34%) that were adapted were 31- 40 years old followed by 28 per cent that were 21-30 years old. Three per cent of the sample preferred to occupy buildings earmarked for their architectural and heritage value - real value for money and a prestige issue.

- Improving aesthetics and usable floor space and modifying for intended use were the reasons cited, especially by those who meant it for tile and textile business. When residences were adopted for reuse, among all other reasons increasing usable floor space was comparatively less attempted. Eateries and hospitals either had been refurbished to qualify for regulatory mandates and /or to upgrade services respectively.
- Forty eight per cent of the samples had completed refurbishment within the minimum time allotment of three months followed by 26 per cent who took upto five months.
- Role of architects was patronized more in refurbishment projects especially among showrooms, eateries, healthcare and services categories where residences were chosen for adaptive reuse and where structural modifications required professional intervention. Services of interior designers were sought by tile showrooms, restaurants and salons. While a small percentage preferred engineers for the project, Government offices were found to have entrusted the job to local carpenters. Dependence on local expertise was a highlighting factor (63%).
- Design specifications were dictated only by 57 per cent of the samples. Attractive façade, small segregated spaces and ample 'setback' confirmed their decisions as cited by approximately 30, 24 and 22 per cent of the samples respectively.
- Showrooms, residences converted to eateries, offices, health care and services were different entities that required customer services on strategic scales as their prime motto. Therefore, the same emerged as the major reason for opting for refurbishment; but for all others it was only minor/cosmetic changes. Only restaurants required structural refurbishment. Above all, residences and theatres converted to restaurants exclusively required major refurbishment.
- All the samples retained the foundation and roof as of the original. Structural walls were retained by 77 per cent of the sample, and the envelope by 57 per cent. Almost 50 per cent had introduced a new ceiling (false ceiling) and 40 per cent had used the original one. Fifty seven per cent had replaced existing floors completely with a better alternative. Regarding partitions, 43 per cent had introduced something novel to segregate areas where needed.
- Existing doors were replaced with better alternatives by a maximum of 40 per cent of the sample; existing windows, on the other hand were retained by 53 per cent.
- New electrical and plumbing lines were laid satisfying current requirements and uses by 70 – 90 per cent of surveyed samples. While 91 per cent of the samples had made provisions to install new HVAC equipment as the old buildings did not have the required provisions, 93 per cent had replaced all the existing sanitary equipment with better alternatives and 27 per cent of the sample retained the existing stairs. 70 per cent had introduced security and surveillance systems like alarms, CCTV cameras and smoke detectors.

- The façade was renewed by 47 per cent who preferred the existing look and replaced with better options by 23 per cent of the sample. While 47 per cent renewed the interior wall finishes 37 per cent added finishes to undressed walls. A good 33 per cent retained the existing landscape while an equal proportion had introduced landscape on bare grounds.
- While 53 per cent of the sample did not require any extension, the others said that they required extension. Of the 47 per cent that required extension, buildings with a built up area between 3000 and 5000 square feet and those used for converting to showrooms and eateries required maximum extension. It was however surprising to know that even palatial residences with a built up area between 11,000 and 13,000 square feet also required extension.
- Of the many factors that warranted refurbishment, inadequacy in the number of emergency exits was a problem faced by half the samples studied followed by insufficiency in natural lighting (40%). Problems related to vastu (20%) followed next.
- Maximum representation in expenditure incurred for refurbishment was in the below ₹ 20 lakhs category. There was a moderate uphill (positive) relationship between the built up area and the expenditure incurred to refurbish that area. Evidently it showed an increase in the built up area leading to a corresponding increase in expenditure.
- Irrespective of whether the premise was owned, rented or on lease, the study revealed that the samples showed willingness to part with only upto ₹ 20 lakhs for refurbishment, but those who had the support from fellow partners had ventured to invest higher, even upto ₹ one crore.
- Despite the original use, refurbishment as showrooms (kitchen and bathroom, furniture and jewellery) and eateries (restaurants) on a larger scale demanded investment over and above the minimum – below ₹ 20 lakhs spent by others, though many had spent only that much.
- Type of refurbishment ranged from minor or cosmetic changes to major changes in the structural components itself. Expenditure incurred was higher for installing services in the refurbished spaces (51%), followed by minor/cosmetic changes (33%). Only ten per cent had spent above ₹40 lakhs to a crore for major refurbishments.
- Only 37 per cent of the samples were aware and practiced the use of eco friendly materials for construction and refurbishment. ***The alternate hypothesis set for the study is hence rejected.***
- A good 91 per cent comprising mostly, owners of restaurants, followed by cafes had installed automatic water level controller circuit systems to save energy and water. Solar water heaters were installed by 27 per cent in restaurants and salons to reduce conventional energy use.
- Eco friendly aspects incorporated included efforts on Site & facility management, Water efficiency, Energy efficiency, other sustainability concepts and Innovation. A considerably

good 97 and 93 per cent of the sample had focused on energy efficiency by using BEE star labeled lighting fixtures and HVAC equipment (Air Conditioners) respectively. Eighty seven per cent of the samples managed to isolate all their polluting equipment and systems so that it would not cause any discomfort to the people.

- Of the 77 per cent who had installed intelligent systems to enhance the building's performance, 87 per cent had installed CCTV cameras, 27 per cent each installed access control systems and automatic water level controller circuits and 17 per cent installed smoke detectors.
- A major portion of the sample used generators to harness power during power cuts and 33 per cent had installed both generator and UPS to aid during load shedding. UPS was used as power backup by a minimum of 13 per cent of the sample.
- Problems faced by owners during the execution of the refurbishment project seemed to be no different than the ones of a new construction. More than one half of the sample stated that they had to expend more than the budget they had estimated. Delay in project completion and irregularity in work were the complaints of 47 and 33 per cent of the samples respectively.
- Fifty per cent of the sample stated that they were satisfied with the present functioning of the building, others had different notions. Of the 50 per cent who were experiencing problems almost $3/4^{th}$ of the sample stated that water seepage was a major problem.
- Among the sample surveyed, 47 per cent expressed that they felt no disadvantage in reusing an existing building after refurbishment. Partnership firms seemed to have a winning situation as a maximum sample revealed no disadvantage in reusing existing buildings and so did all the corporate firms that were a part of the sample. Maximum single ownership firms (30%) felt that imperfections in construction like weak walls, dry walls, surface imperfections, flawed construction procedures were major disadvantages. Twenty six per cent and cent per cent of partnership firms and Government organisations respectively felt that they had to compromise on the size of rooms or segregated spaces whether too big or small for the required function.

C. Redefined Purpose – "Adaptive reuse" - tradeoff – A win-win situation

- Decline of certain types of business and human activities and their impacts, for instance, e-shopping on warehousing needs, home theatres on cinema halls and the like have brought such structures down to use by the needy for alternate purposes. The five buildings selected for the case study had performed their function and had grown into disuse due to ***functional, physical, aesthetic and economic obsolescence.***
- All the chosen buildings belonged to the category of ***adaptability across use and user*** where in the building adapted to a whole new function and also adapted to the requirements of a

completely new user after refurbishment. Overt observation also proved that the buildings selected were quite strong, hence qualified for long lasting service.

- The buildings were converted either from residential or commercial settings to their present commercial setting. They required refurbishments for common reasons like improving building aesthetics and fitness to purpose and types of refurbishment (major and services) so that they could perform for the redefined purpose. The selected buildings definitely had a face lift and had emerged as visual landmarks attracting very good clientele-those from elite groups too. ***Evidently they had added value to the City's landscape as well as revenue too.***
- Eco friendly components and practices like installation of water efficient fixtures, energy efficient lighting and HVAC fixtures, rain water harvesting plant, using low VOC paints and the retaining, repairing and repurposing of various building components have helped the samples to reduce the damage caused to the environment, which otherwise would have been the case if the building were to be demolished and rebuilt. ***The efforts had helped in saving both operating and embodied energy.*** Value addition by means of introduction of various intelligent systems also helped make the buildings energy efficient.
- All the samples stand testimony to the fact that they had all earnestly tried to retain maximum components and gone in only for visible repairs to renew them, to adhere to the literal meaning of the term 'refurbishment'. One case had even tried repurposing the waste that had emerged too to make useful components. ***It can be concluded that these adaptive reuse projects hence had integrated the five principles of adaptive reuse into the repurposing process and had contributed to the nation's call for being green tech savvy.***
- Debris from atleast 30 buildings and especially five case studies had not polluted the environment and by not demolishing structures they have saved the environment from the embodied energy that would have been vented out of the structures if demolished. They have also managed to save energy and water too.
- The conversions realized have been quite creative and appropriate. They had capitalized well on the expanse of the spaces available (especially what is not necessary for residential purpose) to more functional spaces which can also end up very lucrative. All the five structures speak of how resourcefully they can lend themselves to be when it comes to adaptive reuse.
- The study has thus proved that both external and internal influences have had an impact on the refurbishment projects.
- ***The study had thus proved that all the samples benefitted in terms of all the three types of sustainability and had also successfully followed all the five principles of sustainable design. Hence it is proved that 'adaptive reuse' and refurbishment are good prospects for sustainability.***

Conclusion

The findings revealed that after incorporating required changes the samples were able to derive the desired contentment in the adaptive reuse of the buildings for the redefined purposes and make their buildings role model structures for perfectly blending traditional architecture and beauty with contemporary 3R's concepts. The samples have tried to attune their efforts based on the ***9R's*** by **restoring** the buildings and **renewing** its components, thereby **reducing** waste. They have also tried to **recover** and **recycle** whatever possible to **replenish** stocks to be **reused**. All these R's could only be pulled into the effort because the samples attempted to **rethink** about their duty to **replace** the present environment with a cleaner and healthier one. These stand as strong evidences for proving that adaptive reuse through refurbishment can render well to the practice of ***9 R's*** in 'building use', at the same time contribute generously to reduce pollution, debris dumping, and use of operating and embodied energy.

Recommendations

Based on the highlights of the study the investigator puts forth the following recommendations:

- ***Professionals of the design field should create more awareness by orienting consumers on eco friendly options.***
- ***Consumers and professionals should work as a team so that the efforts from both the players can drive the nation to sustainability through 'Adaptive Reuse' prospects.***
- ***Design students should craft innovative methods and ways to reuse buildings and suggest methods to recycle its components to reduce the carbon footprint.***
- ***Research scholars can take up studies to compare and strike a balance among components of a building, the demolition of which let out maximum embodied energy into the environment; this may curtail demolition of that component by all who attempt refurbishment.***
- ***The government can issue perks and subsidies for building reuse to patronize adaptive reuse on one hand and to be active participants in the Nations' race towards reducing carbon footprints.***

This exercise definitely can help in environmental protection and sustainability in the long run. Despite these, it is clear that they couldn't do full justice to the 'eco-friendly' concept. Yet it is a green signal, a beckon call for others to follow. The covered sample had made a good start. Let all pledge to follow as it can lead us to attain sustainability as -

"The proper use of science is not to conquer nature but to live in it."

- Barry Commoner