## Strategies for Sustainable Development in Libraries

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Abstract

*This study deals with sustainable development of green libraries. Storage problems can be solved by proper interiors and planned storage for physical resource in libraries. For electronic storage, increased efficiency, virtualization and cloud computing. Energy as a problem, it should be approached in two ways namely energy generation and consumption. Energy should be generated from renewable sources and eco-efficient consumption with conventional methods like energy efficient buildings with natural lighting and ventilation. On consumption approach, major part of energy is consumed in storage, maintenance of electronic resources in servers, temperature control, lighting, environment control, modern amenities like escalators, elevators, air conditioners etc.*

Keywords

Green Libraries. Sustainable developments; Storages
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## INTRODUCTION

Libraries was considered as store house of knowledge, but now in the era of electronic communication libraries have become without shelves and physical books considered as knowledge supermarkets. Varied library users ranging from kids to seniors, amateur to techno savvy are now knowledge consumers. Information and knowledge need to cater to assorted needs that have evolved now as product and process. Production, process or both can be planned for either existing or upcoming library.

### SEE Approach

Libraries and knowledge resource centers are facing many tribulations, which could be modified, solved, avoided or evolved. In the current scenario, among many problems **S**torage, **E**nergy and **E**nvironment (SEE) are taken for discussion. We should see (SEE) the root cause of the problems and solutions to these problems with a proportionate and perfect blend of modern and conventional technologies. which could be easily brought down if planned and implemented with judicial usage. Escalators operated in dual mode that can be automated or used as static stairs for climbing. It also saves space occupied by elevators built in addition with staircase. Environment plays a major role in inviting repetitive visitors and market the available information with tailor made solutions to suit specific needs of each knowledge customers. Hence, enhancement of atmosphere, serene surroundings, comfortable, ergonomically designed, interiors, free space for mobility etc. should be focused that attracts, like lush green interiors, fresh air, natural light, clean, tidy environment and better space management. But, these strategies need more dedicated planning, focused implementation and enthusiastic volunteering among users and stake holders. A schematic representation of flow of information and approach that could enhance the understanding is provided

## NEED FOR LIBRARIES TO BECOME ECO FRIENDLY

Global warming plays a major role in climate change, decreased bio-efficacy, yield, nutrition etc. for all. Psychological adaptation and physical evolution to the economic revolution, chemical emissions, health hazards, occupational environment, stress levels etc. has made every human being to think back on being ecofriendly. Libraries being a knowledge store

houses, also emits greenhouse gases considerably directly and indirectly.

***Ways of direct emissions to greenhouse gases***

1. Spraying of chemical pesticide and insecticide emits harmful chemical particles in air.
2. Generating heat from lights that glow, round the year, in all working hours, especially between shelves in stack area and reading hall.
3. To maintain temperature with in library air conditioners are installed. This again throws out heat generated by the machine.

***Indirect contribution made by library to global warming***

1. Consumption of electricity for infrastructure fittings like lights, fans and peripherals like computers, printers, air conditioners, room heaters and all other electronic devices. Electricity is produced from fossil fuels like carbon deposits, diesel and petrol. Production of energy from such fossil fuels emits lots of carbon-di-oxide, Sulphur-di-oxide etc. causing depletion of ozone layer.
2. Emissions from printing inks in books and other resources
3. Emissions from raw materials used in building materials like plastics, rubber, pasting, plastering, ply wood, binding materials etc.

Contributions to greenhouse emission gases are very silent from library but on whole it shows bulky figures. Many problems are to be addressed; still few can be easily sort with very little efforts. Few such problems in Library and Resource Centre (LRC) management are

1. Space organization
2. Management for physical and electronic storage
3. Back up and disaster recovery

**STORAGE**

Space organization in physical libraries is not just arranging of books in a classified order but also the accessibility to find, feel and read the book with shelving standards. A physical book of standard size will occupy a decent shelf space. Information explosion, printing and production technologies have flooded the availability of resources. Needs and demands have increased in folds with more interdisciplinary research. All these factors have made storage in physical libraries a problem. Traditionally these problems were managed by centralized storage; inter library lending, resource sharing, withdrawal of worn out books, weeding, copies sharing etc. Storage management in digital resources varies from size, share-ability, format, compatibility, transportability, technology up-gradation, convert-ability, adaptability, compression, extraction etc. With lots of above mentioned advantages and equally distributed disadvantages like minimum requirement of gadgets, energy, software, hardware, easy loss magnitudes, disaster recovery management etc. electronic resources or resources in electronic format co-exists with traditional books.

**DATA WAREHOUSING AND MINING**

Data warehousing is collection of data, categorizing, filtering, eliminating replica or duplicate data, format compatibility, security of data retrieval etc., when retrieved gives compact information. Data clipped through tools will compress it meaningfully shrinking the size. Further compression will help in minimized file storage. Data that are warehoused with ETL tools are then retrieved by data mining with simple queries. This facilitates timely decision making with more apt and relevant information in desired format.

**GREEN COMPUTING**

Green computing is acquisition, processing, storage and retrieval including hardware and software components in maximum efficiency with minimum energy utility, carbon foot print, emission of heat in production, usage, recyclability, biodegradability, safe disposability, reduced use of heavy, hazardous or precious metals etc. Green computing in common language is information communication technology sustainability or green IT. Few tools like DATAllegro, Kickfire has the capability to process exponentially more transactions with a smaller hardware footprint. Meanwhile, extreme data compression is currently being advertised by special DBMS like ParAccel, Vertica, which also results in a smaller hardware footprint.

**GREEN WARE**

Green computing classified as green process and green product. Green process engages minimal fossil fuel in production of equipment, and the green product utilizes biodegradable, bio-safe raw materials for production. Green ware is the concept of producing an electronic gadget in a more ecofriendly process. This can be further explained in three ways namely

- Process: manufacturing process, where the raw materials are standardized to green computing including distribution, packing etc.
- Procedure : procedure of production, software and hardware development
- Technology in production: from production, distribution and evaluation in usage etc.

Hardware and software that cater to the eco standards and materials are fully biodegradable when it is out of use, avoiding the usage of rare metals that are depleting, replacing other more cost and process efficient material for production etc. Wipro launches green pc which is made up of fully bio degradable or recyclable materials minimizes or eliminates the usage of hazardous materials or emissions.

**CLOUD COMPUTING AND VIRTUALIZATION**

Cloud computing and virtualization can put this problem an end. Though, many decentralized storage servers can put a heavy investment burden, many commercial cloud service providers with competitive rating for storage has made it more economical and viable as they provide service through centralized servers. Cloud computing is storing of digital information in a more secured format externally and retrieved on demand through a network.

Information can be in any format namely word, power point, excel, video, audio portable document format etc. But when it is in electronic form which is very different from physical form can be stored in any suitable electronic storage gadgets like pen drives, hard drives, CDs, DVDs, etc. Such storage is temporary and can be copied to many but cannot be remotely accessed. To avoid this hitch innovation in cloud storage has brought a break through by storing in a remote server configured with sophisticated storage drives by Cloud Storage service providers with an important advantage of security from hacking, phishing etc. through various stages and strategies.

**CLOUD IN LIBRARY CONTEXT**

After digitalization of libraries gained momentum, availability of resources in electronic format has become inevitable and vast. Therefore, organization cannot upgrade storage facility in the form of servers, too often to store the information that are available as e resources namely e journals, e-zines , e books etc. accessible by the users from remote location 24*7. But for procuring such resources educational and other institutions are spending enormous amount in the form of subscriptions and single purchase. In-turn, e-resource provider stores the information for which the subscription is paid with limited access. Access is provided to the user in the form of authenticated user name and password. If such user name and password is breached, the un authenticated user may login and download his own requirements and even misuse by undesirable circulation. Finally the institution will be held for copy right and other legal malpractices without their knowledge. Hence, libraries which intend to store in cloud should have multilevel security check in resource handling.

**MAJOR SECURITY ISSUES**

Though cloud is considered advantageous that individual servers, and came in to existence very earlier around 2006. But it is gaining momentum very recently because of the improved security checks and data security systems. Storage of mass data were prone to major security risks like breach of access, magnification of data, law and legal entity, responsibilities of users etc.

***law and privacy***

Fool-Proof information security architecture: Breach of standard from well protected security system was possible in earlier stages and there are many cases of such leakage mainly in the field of finance and insurance. Nowadays, security architecture is well build in such a way that it is not enough that one person can break the security of information secrecy. Defense in depth, exceptional monitoring,, continuous and regressive monitoring of information sharing habits, accessing, within limitations of each accessible member, etc. are monitored without a break. Many cloud service providers give access to users in gadget specific model. (Dawei Sun, 2011)

***Security issues in library context***

Mainly in special reference to library, access to personal records, e-resources, circulation, transaction of resources etc. are more identified breach of information. As library does not hold any other important resource like financial details security is considered second to operability and accessibility.

***Virtualization***

Virtualization of storage may affect users in connectivity when compared to traditional library

resources and if the network connectivity is interrupted it affects to accessibility to the resources. Moreover virtualization is the concept of multiple accesses to one resource at a time. Hence load and stress testing are done to all storages whether it is inter or intra connected. Operating response and retrieval time is tested with multiple virtual users.

***Few solutions to security breach in cloud storage.***

From the different sources, architecture and infrastructure, legal entities etc. few easy to implement techniques that can avoid breach of information in a more economical way are as follows.

***Time based solutions***

Time based login access should be given according to the shift timings, or class hour timings students or users access can be monitored or even restricted. This resembles the principle as in parental control options in modern television sets. Time between password and login name should be very minimum. Ideal window and data feeding time between passwords etc. can also be restricted

***Authentication based solutions***

Multiple window authentications with unique and complicated passwords can restrict the hackers from logger software. Multiple person authentication to site specific like two level login namely library professional and user should login in different stages so that the access can be easily monitored. This can be effectively practiced if it is implemented among staff access and no person will have all full administrator control or accessibility. It reflects that without the help of two or more persons one cannot access information and breach can be easily avoided. Complicated, retrievable, lengthy multi-functional or character with mixed arrangement or combinations can protect passwords to certain level etc. If passwords are auto generated, algorithm should be complicated such that the passwords with 8 characters are very unique

***Information based solutions***

Encryption decryption, limited decryption is the major and mostly practiced way to avoid security breach and information leakage. When all the data are stored in more authenticated way encrypted in multi model encryption breach of encryption becomes impossible even by the designer

***Image authentication***

Biometric and image authentication has also gained momentum nowadays because of its encrypted storage, replication or duplication is comparatively complicated when compared to other alphanumeric authentication.

***Limited number of access on per day basis***

If accessibility is restricted, for example in banking sector, employees once logged in whatever transactions taken place from that particular system till they log out will be taken under that particular employees responsibility. This gives added security through administrative and information responsibilities.

**Security audit**

Regular audit both through service providers from external source and user as internal source should be conducted. Policy framing and decision making can be simplified with this audit

***Calculated risk factor***

Information availability, its need on security, probability of breach factor, which sector of user can benefit out of breach, how it benefits, methods to restrict unauthorized access, etc. can answer lots on security breach system architecture. Working on possibility, nature of breaching, who may be interested, who will benefit out of it etc. Responsibilities, guarantees and penalties to users can rise the security as the user has to take responsibility if any unauthenticated information sharing occurs. Many advantages have driven the upward trend in users of cloud storage systems. Virtualization technique is automated compression and extraction of data that minimizes the space occupied by that particular resource. Virtualization adds to cloud computing making it more economical, with added advantage of security, disaster recovery, flexibility, immediate apportioning etc. If energy consumption is taken in to consideration by using modern green process or production technology with efficient energy management systems it can be considered as the best storage option.

Virtualization is separating resource or request from physical infrastructure and delivery from other or intermediary source. This is mainly used to maximize the utilization of existing physical and network

components of IT infrastructure provided in the organization. To enhance to security from hacking, intrusion through intermediary software protected with complicated password. Virtualization can be particularly implemented for security purposes alone in high-end secured information environment, utilization especially in banking, insurance, e-commerce functionalities. In virtualization, compression and extraction of information stored in clouds have multilevel access control. This gives high security layers that cannot be hacked easily because malicious virus and other cyber-attacks cannot identify the system which works as virtual machine (VM) or original client. Moreover, in the client and server model of networking servers cannot be used as clients but in virtualization client can be run on the server virtually in dual mode. Thus it maximizes the utilization of hardware.

**ADVANTAGES OF VIRTUALIZATION**

1. Maximizing the utilization of existing infrastructure.
2. Multilevel security check for access
3. Minimizing the investment cost and economy in recurring cost at least by 40% of investment in space, physical components. Infrastructure, energy, maintenance etc.

**DIFFERENT WAYS OF VIRTUALIZATION**
**VIRTUAL OPERATING SYSTEM LAYERING**

Systems with built in operating system is partitioned and another OS is operated parallel. For e.g. and easy understanding an application with Microsoft windows as operating system can work with application run on ubuntu operating system on parallel mode. For live experience latest live cd release with integrated KOHA, DSPACE, MOODLE< DRUPAL etc. can run on virtualizing the operating system with partitioning the hard drive and loading ubuntu operating system and open KOHA and similar applications built to run on ubuntu.

Free space available in the hard drive installed in the system may be very small which may not be enough to store large data. In this case immediate proportioning or partitioning is not possible in existing environment. If virtualization is implemented through application like VMWare, Xen Project etc. the available space from the system is layered giving virtual memory space, therefore giving more space for storage. Actually when virtualization is installed the size of the files are compressed to minimum possible without any notification and stored in a small space or free idle space from any other virtual machine will be utilized. Thus with minimum space maximum storage is possible. But the compression of data while storing or extraction of data on retrieving or accessing will not be reflected and it is automated with the software integrated with VM software.

**Network Virtualization**

Available network connection is virtualized that enhances the connectivity and data transfer rate. If a system is not directly connected to internet, but connected to intranet, where a server or s client is connected to internet, the client can be used as a virtual system by other virtual users to access internet.

**Physical Virtualization**

Physical components can be shared from the available system through network by virtualizing the physical component to needed system. For example a DVD drive installed in system no 1 can be virtually installed and utilized in system no 4 through network without connecting to that particular system and utilizing the existing facility.

**Virtual machine migration**

According to the load and requirement, connected servers are virtually compensated by virtually transferring the data or application from one server to another server where the load is comparatively less or idle. This facility is time base automation or can even be implemented according to the requirement.
Doubling the quality and quantity of physical and network components is possible by software that supports compression, extraction and multiplication process, whichever is necessary. Software and its supporting tools are available both in commercial model e.g. VMWare and in free open access namely Xen Project

Virtualization technique is an emerging genie in meaningful compression and extraction. One of the constraint that should be noted is it is more economical on installation of bigger servers with capacity of more than 5Tb for single user with around 50 virtual users. Hence, any organization planning to network and implement high end IT infrastructure can install virtual servers through software and gain a lot on managing resources

**Energy**

Steady increase in cost of energy has forced users, government and producers to discover new means and methods to generate and meet the uptrend of increased energy consumption. To put an end to the financial crisis arising out of major apportioning of finance for the energy, many have turned heads towards decentralized energy generation from renewable sources like solar power, wind energy etc. Modern mantra of Reduce, Reuse and Recycle has been propagated and now adapted as the need of the hour.Features like wider adaption of technology, continuous improvements, increased demand, mass production, reduced cost, minimum investment, maintenance free etc. have made solar power generation more popular, environment and user friendly when compared to other renewable decentralized energy generation plants.

**Energy efficient buildings**

Energy efficiency is utilizing energy in an economic way. This can be discussed in two stages, namely production stage and utilization stage. Eco friendly production is utilizing minimum energy and maximizing the results in production for eg. building materials that has a minimal carbon foot print. Eco friendly utilization is architecturally structuring or designing the building that can give natural ventilation, lighting, temperature control etc. that use minimal energy on regular use. Efficiently designed and architectural structured building can save lot of energy and carbon foot prints. Few examples taken from libraries around the globe can exhibit the reality.

Architectural design of Seattle National library, Waalsek Rook Library, is that all the floors are bright with natural light and no artificial lighting is not required in any part of the of the library. So naturally lighted and well ventilated library can save around 50-60% of energy consumption. The architecture involves additional capital investment once, but the benefits can be harvested till the life of building say around 100 years. Difference in investment between construction and architectural construction will be recovered from saving cost on electricity comparatively in a ecofriendly way in around 15-20 years of time. Therefore saving on electricity for the rest of life of the building can be utilized for further development in a greener way.

**Renewable energy and its sources**

Reuse, Recycle, Reduce is the need of the hour as energy consumption and co2 emission plays a major role in global warming, extinction of rare species, imbalance in biodiversity etc. Renewable energy sources that are available in nature can be harvested all the year round, at smaller regular intervals that will not deplete. Few sources to mention which are predominantly used are

- Solar power
- Wind energy
- Hydro power
- Biomass energy
- Hydrogen
- Geo thermal and
- Ocean energy

**Solar energy**

In countries like India gifted with rich solar power as a source of renewable energy throughout the stretch and round the year if utilized properly power shut downs, heavy investment on fossil fuel research, source searching, refining etc. can be avoided. At average calculations, investments on erecting solar power panels can be recovered by savings from electricity bills, within 6 to 8 years but production continues. Life of installed power panels are estimated from 25 to 60 years depending on the quality and maintenance. Saving more than 10% to 20 % of total budget every year in library and this saved fund can be utilized for improved collection development. (Shahan, 2012)(DeKunder, 2011)

**Advantages of solar power as the main source of renewable energy are**

- Available round the year
- Needs simple infrastructures exposed to sun
- Low annual maintenance costs
- Produced during day time and can be stored for utilizing during night time
- Can be invariably utilized for all electronic appliances
- Recovery of investment is possible, and when compared to life of structures it gains for around 30 to 50 years of electricity bills
- Noise, smell free silent energy production
- No transmission cost as it is consumed locally

- Total power requirements can be met with calculated installation (Lee, 2012)
- With net meter excess produced energy can be supplied to others and earn revenue from it

**Table showing indicative list of libraries that have already implemented solar power plants**

| Sl.no | Name of the library | Link |
|---|---|---|
| **1.** | Schertz library | http://www.mysanantonio.com/community/northeast/news/article/Schertz-library-going-green-with-solar-power-1334291.php |
| **2.** | Texas' West Irving Library | http://www.ktsm.com/news/texas-library-runs-sunshine |
| **3.** | Ballard Library | http://www.greenroofs.org/boston/index.php?page=ballardwin |
| **4.** | Taiwan | http://www.businessgreen.com/bg/news/1806716/taiwan-starts-construction-solar-powered-library |
| **5.** | New Haven library | http://nhregister.com/articles/2012/03/11/news/new_haven/doc4f5d6a96f1c5a590260977.txt |
| **6.** | Lighthouse Point Park, Common Ground High School | http://www.newhavenindependent.org/index.php/archives/entry/solar/ |
| **7.** | Barnard Environmental School | http://www.sunviewer.net/portals/Barnard/ |

*Table showing List of electrical appliances and its power consumption in a domestic estimation of cost recovery analysis for a library reading room measuring 1000 sq.ft.*

| Sl,no | Name of the appliance | Quantity used in a small library in nos | Power consumption on per unit basis | Power consumption per unit in watts |
|---|---|---|---|---|
| 1. | Tube light | 4 | 40*4 | 160 |
| 2. | Fans | 2 | 250*2 | 500 |
| 3. | Computer | 4 | 600*4 | 2400 |
| 4. | Printer | 1 | 500*1 | 500 |
| 5. | Total | | **Wind energy** | 3560 |

**Investment requirement on solar power panel installation**

- Approximately power required = 4000 W
- 1 W of solar panel cost = Rs. 100
- 4000 W of Solar panel cost = Rs. 4,00,000
- Inverter and structure cost = Rs. 6,00,000
- cost of solar panel power system = Rs. 10,00,000
- After 30% govt. subsidy =Rs.7,00,000

**Cost analysis**

- Daily power consumption = 4 units x 8 hours = 32 units/day
- Monthly power consumption = 32 x 30 = 960 units/month
- 1 unit cost = Rs. 7.00 per unit (commercial)
- Monthly current bill = app 1000 units *Rs.7.00 per unit is Rs.7000.00
- Yearly current bill is Rs. 7000.00 * 12 months is Rs.84,000.00
- Total investment is paid back in 100 months i.e. around8.5 years but the life of installation varies from 40=60 years
- After 8.5 years saving on electricity bill is dividend on investment at the rate of Rs.7000.00 per month

According to media sources this year especially in southern districts of Tamilnadu production of power from wind mills has avoided power shut and produced more than needed. This again shows that India is gifted with another pollution free source of energy from wind mills. Comparatively this source is seasonal. Research and development can give fruitful results on mass storage of produced electricity the power problem in India and between states will be solved.

**Features**

- Seasonal
- Requires large infrastructures
- Heavy investments
- Storage of produced electricity is not possible
- Requires large land area
- As the windmills are too higher maintenance is adhoc

Wind energy can also be utilized not just by energy production from wind panels but also by installation of ventilators.

**Environment**

Atmosphere and surroundings including interiors, furniture, space management etc. plays a major role in inviting library users and knowledge customers to LRCs. Library with rich collections but poorly maintained library welcomes dust and pests, but not users. Often in library chemical pesticides are used, that helps in maintaining physical media but the environment and air inside the library become toxic. In such days libraries are kept closed for maintenance and cleaning. Even pregnant women and children are advised to keep away from such toxic pesticides and insecticides at least for a week.

**Organic pesticides**

Organic pesticide helps to avoid such chemical exposure and toxic atmosphere. They are formulated from extractions of Neem, cloves, cinnamon in addition with permissible household chemicals like camphor, moth balls etc. Such pest control will help to maintain physical books and print media as well as indoor plants and maintain a harmony.

**Indoor plants**

Indoor planting is keeping garden inside the rooms for giving lush green colour to room, fresh air, and pollution free environment. This not only attracts users but also gives hygienic and natural cool environment encouraging visitors for healthy and comfortable reading. Library users prefer a room decorated with plants and fountain naturally cooled. This gives a silent, serene environment to concentrate resulting in attracting users to stay for hours together reading comfortably. Materials used in construction and indoor fittings and fixture will release odour, toxic chemicals and pollutants in air. Intensive research on indoor plants and their capacity to absorb air pollution from chemicals released by building materials were proved to be best natural pollution control method.

Green roofing is the new technique that helps to maintain temperature inside the building naturally. This has been introduced in Boston National Library eliminating the cost of cooling systems and gives enhanced look, temperature control naturally. Greening the environment and producing more oxygen.

**Benefits of green roofing and indoor plantations**

- Ecologically maintains temperature
- Utilizes flood water naturally
- Reduces CO2 emissions from fossil fuel production and consumption
- Reuses waste materials
- Salvages and decompose the organic wastes
- Generates renewable pollution free green energy
- Supplies oxygen to environment and saves ozone depletion
- Absorbs sound and so reduces noise pollution
- Absorbs pollutants and dust particles like cigar smoke etc. and reduces air pollution levels and gives clean air for breathing
- Produces oxygen helps in air circulation in more populated rooms

**How to reduce carbon foot print as a library professional**

Library with information and communication technology sharing a major part of future world of innovations and discoveries has the responsibility to reduce greenhouse gases emission and global warming by pressing the foot as slightly as possible on carbon usage. Few practically feasible ways are

- Reuse the one side printed paper
- Reduce prints from electronic resources. Restrict print unless required.
- Make communications through electronic media like mails, letters etc.
- Use common announcement procedure to give instruction to all at a time than by mails
- Switch off fans, coolers, lights whenever possible
- Use modern technologies like cloud and virtualization for storing
- Maximize energy generation than utilization on all possible ways.
- Use materials, products and process which are eco-friendly.

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