GREEN AUDIT REPORT
2018-19

DEPARTMENT OF ENVIRONMENTAL SCIENCE,
SHIVAJI UNIVERSITY, KOLHAPUR

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FOREWORD

Today the world is facing problems like global warming, deforestation, urban smog, and unsafe drinking water which are leading to situation of climate change. All these environmental issues are discussed at global level but true fact is that regional or local activities are responsible to make such issues global. On the background of this scenario, higher education institutions like universities are expected to take lead role in environmental conservation and protection. Institutions must play an active role in creating and modelling solution for environmental problems.

Shivaji University, Kolhapur is committed to take lead role and create its own identity in the protection and conservation of environment. University has implemented eco-friendly practices to manage the available resources. As a part of such voluntary practices, internal environmental audit is conducted to evaluate the actual scenario on the campus.

Green auditing is systematic assessment of day to day activity with special reference to resource utilization and waste generation. It will assist to find out the eco-friendly and non-eco-friendly practices on the campus. The main objective of green auditing varies with the operational activities of the organization. In case of higher educational institutes like universities, green audit is an internal requirement. It is a path for management of environment to make the alterations in ongoing practices. It also promotes a good environmental management system and raises the awareness about the environmental conservation and its long term benefits. Implementation of environmental policy provides chance to exploitation of opportunities for better performance in the future and it will help to develop a sustainable campus.

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Over the past five years university has accepted various new and advanced technologies which are eco-friendly; such as self sufficiency in water by adapting watershed management, wastewater recycling, solar electricity project, solar water distillation plant, roof top rain water harvesting, biogas generation and RO water purification system for clean drinking water to all. Plantation of local and endemic plant species on campus is a big challenge that is accepted by the university. The university has installed solar electrical panels, electrical vehicle and no vehicle day on the campus to reduce its carbon emissions. With the National agendas, the university has taken Clean and Green Campus mission as well total ban on use of Plastic on the campus. The university has taken lead in 33 Crores Tree plantation and planted around eighteen thousand plus trees on campus which will support to reduce carbon foot prints of university.

I am very happy to forward this Green Audit Report 2018-19 of Shivaji University, Kolhapur. I must congratulate Prof. (Dr.) P. D. Raut and his team for efforts taken for the completion of such type of report. I hope the report will be helpful to all concerned in the university and will motivate all to put green steps ahead in future.

22 NOV 2019

(Devanand Shinde)
Vice-Chancellor

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MESSAGE...

In the changing scenario of climate change we, as the University recognize the severe strain that has been put on the mother Earth. In the face of the crisis that the world is now facing, excuses no longer stand and we must change policy and practice at every level in order to avert ecological catastrophe on a global scale.

Shivaji University has often been at the forefront of environmental campaigning, social change and international development. Shivaji University history is an evidence to that, providing the leadership, support and arena of debate for its members to become engaged and able to constantly question and challenge the existing status whilst pushing for progressive change. Green audit is an ethical and environmental stance has always been a shining example of this. During last academic year, university has conducted Green Audit for their academic departments, administrative buildings and support services. University has already taken some steps to conserve the energy as well as to avoid loss of energy through programs like No Vehicle Day, Solar panels, Electrical vehicle and Street Plays to aware students about No use of plastic, conservation of energy and biodiversity of campus.

University students, members and staff are committed to undertake this green audit as a means to continually improve its environmental performance and standards in recognition of the immediate and serious threat that climate change poses to the Earth and its population.

However, undertaking this audit is the first step towards the green approach and needs to be pushed for continuous improvement. The university should lead by example, to campaign and aim to change not just ourselves, but all those around us, from our students, faculty, staff of the University, academic institutions, society and ultimately, the world. It is with this bottom-up approach, combined with real and progressive governmental policy that we stand a chance to prevent runaway climate change.

I am very happy and congratulate Prof. (Dr.) P. D. Raut and his team for efforts taken for this Green Audit Report 2017-18 of Shivaji University, Kolhapur. Now, it becomes responsibility of all the stake holders of university to follow the proposed management plan suggested in the report to reduce our carbon foot prints.

Cdshirke

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Certificate

This is to certify that the Department of Environmental Science, Shivaji University, Kolhapur has conducted detailed "Green Audit" of "Shivaji University, Kolhapur" during the academic year 2018-2019. The green audit was conducted in accordance with the applicable standards prescribed by Central Pollution Control Board, New Delhi and Ministry of Environment, Forest and Climate Change, New Delhi. The audit involves water, wastewater, energy, air, green inventory, solid waste etc. and gives an 'Environmental Management Plan', which the university can follow to minimize impact on the institutional working framework. In an opinion and to the best of our information and according to the information given to us, said green audit gives a true and fair view in conformity with environmental auditing principles accepted in India.

23/11/2019

Professor and Head
Department of Environmental Science,
Shivaji University, Kolhapur.

EDITORIAL

In the Era of global warming and climate change every citizen has to reduce their own carbon foot prints to tackle with the adverse impacts of climate change. A green audit of any academic institution revels ways in which we can reduce energy consumption, water use and reduction in emission of carbon dioxide in the environment. It is a process to look into and ask ourselves whether we are also contributing to the degradation of the environment and if so, in what manner and how we can minimize this contribution and bring down to zero and preserve our environment for future generation. This process of green audit enables us to assess our life style, action and assess its impact on the environment.

Shivaji University administration has already taken a step towards the green approach and conducted green audit of university in the year 2014. As an outcome of this university has taken green steps to reduce its carbon foot prints by using electrical vehicles on campus, solar electrical panels and green computing in the administration and examination. The responsibility of carrying out the scientific green audit was given to Department of Environmental Science. The Department has followed the rules and regulation of Ministry of Environment and Forest, Govt. of India and Central Pollution Control Board, New Delhi. Focus was given to assess the consumption of energy, electricity, water as well as disposal of liquid waste, solid waste, hazardous waste, e-waste and an inventory of trees on campus is also prepared to check how much CO_2 is sequestered and O_2 is released.

A questionnaire was prepared based on the guidelines and format of CPCB, New Delhi to conduct green audit. The questionnaire included month, year, total number of students and employees, visitors of the department, average working days and office timings. The information related to consumption of resources like water, electricity and handling of solid and hazardous waste was collected in the formats from main building support services and departments. The data collected was grouped in four groups as Building Block A, B, C and D. The data collected was tabulated in Excel sheets and analyzed. The graphs of the analyzed data were prepared for getting quick idea of the status. Interpretation of the overall outcomes was made which incorporates primary and secondary data, references and interrelations within. Final report preparation was carried out using this interpretation to prepare environment management plan of university for next five years.

During the preparation of the ‘Green Audit Report-2018-19’ Hon. Vice-Chancellor, Hon. Pro-Vice Chancellor encouraged us with their full support. Registrar, Director, IQAC, Deans of faculties, and other officers of the university were also given support to carry out this work. All Heads of the department, Directors, Co-ordinators, In-charge of the support services and engineering section of the university also gave full co-operation.

I must also thank all my Faculty, Research Scholars and M.Sc. students of the Department of Environmental Science without whom this report could not have been completed.

I hope the efforts made will be helpful for university to take one green step ahead.

Dr. P.D. Raut
Professor and Head
Department of Environmental Science, Shivaji University, Kolhapur

CONTENTS

3.2.4	Water consumption at Building Block D
3.2.5	Yearly water consumption at Shivaji University
3.3	Sustainable Water Practices (SWP)
3.3.1	Watershed management practices at Shivaji university campus.
3.3.1. a	Farm ponds
3.3.1.b	De-sedimentation and Rejuvenation of well
3.3.1.c	Continuous contour trenches (CCT).
3.3.1.d	Recycling of water.
3.3.1.e	Mini Irrigation Tank.
3.3.1.f	Roof Top Rain Water Harvesting.
3.3.1.g	Water Filtration Plant.
3.3.1.h	Drip Irrigation and Sprinkler Irrigation.
3.3.1.i	Shiv Jal Yojana (Reverse Osmosis Plant)
3.4	Precautionary measures
4. Energy audit	
4.1	Electricity audit.
4.1.1	Electricity consumption in the Building Block A.
4.1.2	Electricity Consumption in Building Block B.
4.1.3	Electricity consumption at Building Block C.
4.1.4	Electricity consumption at Building Block D.
4.1.5	Preventive Measures.
4.2	Fuel Energy Audit.
4.2.1	Building Blocks A (Administrative building).
4.2.2	Building Block B (Science Departments).
4.2.3	Building Block C (Commerce, Humanities and Social Science).

4.2.4	Building Block D (Support Services).
4.2.5	Total fuel consumption on the university Campus.
4.2.6	Energy Conservation practices implemented at Shivaji University.
4.3	Fuel energy audit (LPG).
4.4	Precaution measures.
5. Solid waste audit	
5.1	Status of solid waste generation in various Building Blocks.
5.1.1	Status of solid waste generation in Building Block A.
5.1.2	Status of solid waste generation in Building Block B.
5.1.3	Status of solid waste generation in Building Block C.
5.1.4	Status of solid waste generation in Building Block D.
5.1.5	Status of Plastic waste generation in various Building Blocks of Shivaji University.
5.1.6	Status of paper waste generation in various Building Blocks of Shivaji University.
5.1.7	Status of biodegradable waste generation in Shivaji University.
5.2	Status of Hazardous -waste generation at various Building Blocks on university.
5.3	Status of E-waste generation on university campus
6. Ambient Air Quality Status	
6.1	National ambient air quality program (NAAQM)
6.2	Precautions Measures
6.3	Ambient noise monitoring status
6.4	Precautions Measures
7. Carbon Sequestration and Green Cover Inventory	
7.1	Carbon Sequestration
7.1.1	Need of study
7.1.2	Objectives
7.1.3	Methodology

List of Tables

Table No.6.2	Ambient Noise levels in Shivaji University, Kolhapur. Dist: Kolhapur.
Table no.7.1	Tree species with highest population
Table no.7.2	Total biomass in tons of first five tree species (Ton)
Table no.7. 3	Highest Carbon stock species in tons.

List of Graphs

Graph No.4.18	Total number of vehicles and their fuel consumption in all Building Blocks of university.
Graph No 4.19	Average fuel used in liters /day by four wheelers and two wheelers.
Graph No 4.20	LPG use in Science Departments and Support Services Sectors.
Graph No.5.1	Category wise solid waste generation at University (kg/month).
Graph No.5.2	Category wise solid waste at Building Block A.
Graph No.5.3	Category wise solid waste at Building Block B.
Graph No.5.4	Category wise Solid waste at Building Block C.
Graph No.5.5	Category wise Solid waste at Building Block D.
Graph No.5.6	Plastic waste at all Blocks at Shivaji university.
Graph No.5.7	Paper waste at Shivaji University.
Graph No.5.8	Biodegradable waste at canteen and hostel's eataries.
Graph No.5.9	E-waste at Shivaji university.
Graph No.6.1	Ambient air quality status in Shivaji University, Kolhapur, Dist: Kolhapur.
Graph No.6.2	Ambient Noise levels in Shivaji University, Kolhapur, Dist: Kolhapur.
Graph no. 7.1	Tree species with highest population.
Graph no.7. 2	Total biomass in tons of first five tree species.
Graph no.7.3:	Highest Carbon stock species in tons.

List of Photos

Abbreviations

AGB	Above Ground Biomass
CCT	Continuous contour trenches
CDM	Clean Developmental Mechanism
CF	Carbon Footprint
CFC	Common facility Centre
CFC	Common facility Centre
CO_2	Carbon dioxide
CPU	Central Processing Unit
CPU	Central Processing Unit
E	Waste
E.C	Electrical Conductivity
E-waste	Electronic waste
EIA	Environmental Impact Assessment
GHGs	Greenhouse Gases
GWP	Global Warming Potential
HVS	High Volume Sampler
ICT	Information and Communication Technology
IPCC	Intergovernmental Panel on Climate Change
Kl	Kiloliter
LPG	Liquefied Petroleum Gas
MIT	Mini Irrigation Tanks
Ml	Megaliter
MLD	Millions of liter /day
MPN	Most Probable Number
MW	Megawatt
NAAC	National Assessment and Accreditation Council
NAAQMP	National Ambient Air Quality Monitoring Programe
NOx	Nitrous oxide
Pg	Pentagram

RO	Reverse Osmosis
RSPM	Respirable Suspended Particulate Matter
SOx	Sulphur dioxide
SPM	Suspended Particulate Matter
SRPD	Secured Remote paper Delivery
STP	Sewage Treatment Plants
SUK	Shivaji University, Kolhapur
SWP	Sustainable Water Practices
TDS	Total Dissolved Solids
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

The Department of Environmental Science, Shivaji University, Kolhpaur conducted a "Green Audit" of Shivaji University, Kolhapur in the academic year 2018-19. Green auditing is the process of identifying and determining whether institutions practices are eco-friendly and sustainable. The main objective to carry out green audit is to check green practices followed by university and to conduct a well formulated audit report to understand where we stand on a scale of environmental soundness.

This is second attempt of Shivaji University to conduct green audit of university campus. Questionnaires prepared to conduct the green audit were based on the guidelines, rules, acts and formats set by Government of India, Ministry of Environment and Forest, New Delhi and Central Pollution Control Board, New Delhi. Questionnaires were prepared for solid waste, energy, water, hazardous waste and e-waste. For audit purpose and suitability analysis of data the study area is grouped as Building Block A including administrative buildings, Building Block B including Science and Technology Departments, Building Block C including Language and Humanities departments and Building Block D including Support Services. The audit was carried for solid waste, electricity and energy, water and wastewater, hazardous waste, air quality and green inventory including carbon sequestration and carbon foot prints. It also lists green initiatives taken by university to save environmental resources. The 'Green Audit' also gives a 'Environmental Management Plan'.

1. Solid Waste:

Solid waste generation and management is a burning issue. Unscientific handling of solid waste can create threats to everyone. The solid waste audit focused on volume, type and current management practice of solid waste generated in Shivaji University campus. The solid waste collected was paper waste, plastic, biodegradable waste, biomedical waste, construction waste, glass waste and other miscellaneous waste. The total solid waste collected in the campus is 3108.77 kg/month and 37305.24 kg/year. Paper waste is a major solid waste generated by all the departments. Old answer sheets, old bills and confidential reports are sent for shredding, pulping and recycling after completion of their preservation period. Plastic waste is generated by all departments, administrative sections as well as support services but it is not categorized at point source and sent for recycling. Metal and waste is stored and given to authorized vendors for further processing. Few glass bottles are reused in the laboratories. Biodegradable waste is used for composting at Vidhyarthi Bhavan

and some of the waste from main canteen is used for vermicomposting by students of Department of Environmental Science.

2. Electricity and energy audit:

Energy sources utilized by all the departments and services of university include electricity, liquid petroleum and LPG. Major use of energy is at office, canteen, hostel and laboratories for lighting, transportation, cooking and laboratory work. Electricity consumed by laboratory equipments is 50838.36 KW/week. Air conditioners used in the university consume 706.36 KW/week. Many of the departments and other services are using a LED lamps and tube lights which is reducing consumption of electricity. The street lights in front of main building is LED types which also save electricity. Number of four wheelers is 480 and they consume 10,500 liters of fuel/month whereas 4298 are two wheelers and they consume 47755.56 liters of fuel/month. University follows No Vehicle Day on first Saturday of every month means 1941.85 liters of fuel is saved every month; which is a very good green practice followed by the university.

3. Water and wastewater audit:

A water audit is an on-site survey and assessment to determine and improve efficiency of water use. The water used at bathrooms, toilets, laboratory, kitchen, garden, shower and other uses as well as leakages and over flow of water from overhead tanks is also been evaluated. The total use of water is 1894.85 liters/day. Major loss of water is through overflow of tanks and leakages. The major use of water is in toilets.

Shivaji University is the only university from the state of Maharashtra which is self sufficient in water. There are three tanks on the campus which supply water for regular use where as well on the campus supplies drinking water. There is also water filtration plant for filtration of water which supplies water for all facilities. For drinking purpose university has set up a Reverse Osmosis Plant (RO Plant) for clean drinking water for everybody on the campus. During flood situation in the month of August, 2019, university has supplied RO water to needy people from city free of cost. Roof top rain water harvesting is also been practiced and water collected been sent to water tanks on campus.

4. Hazardous waste audit:

A. Chemical waste:

Total chemical waste generated on the campus through Science laboratories is 40.80 kg/month in solid form and 242.5 liters/month in liquid form. Usually there is a practice in the laboratories to store these hazardous chemicals in the containers and cans for safe disposal.

B. E-waste:

E-waste generated in the university is of schedule II of CPCB, New Delhi. E-waste generated in the university is handled, treated and disposed in scientific way. E-waste handled by university is 45.16 kg/month and E-waste treated and disposed is 45.16 kg/month.

C. Air quality audit:

Air quality on the academic institute is very important for health of students, faculty and staff of university. The air pollution sources in the university campus are wind storm, pollen grains, natural dust, vehicular emissions, generators, fires and laboratory fumes. All these pollutants are measured by the Department of Environmental Science under the National Ambient Air Quality Monitoring Program (NAAQMP) of Central Pollution Control Board, New Delhi. The air pollutants monitored on regular basis are Sulphur dioxide (SO_2), Oxides of Nitrogen as NO_x, Suspended Particulate Matter (SPM) and Repairable Suspended Particulate Matter (RSPM) by High Volume Sample (HVS) as well as records of temperature, relative humidity are also been recorded for comparison. All the air quality parameters are within the standard limits of CPCB, New Delhi, suggesting ambient air quality of university campus is good.

As an academic institute university comes under silent zone where noise should be below 45 dB during day time. Therefore, the noise on the campus is also measured and found within the standard limits. Sometimes construction activities and road traffic increase the noise level on the campus.

D. Green inventory and carbon foot prints :

The green inventory was also carried out to know how green the university is. Students of Department of Environmental Science counted full grown trees on the campus which are 13,473 with 99 species and total biomass of 4233.69 tons. The total carbon sequestration on the campus is 293.72 tons per year and total oxygen released is 783.23 tons per year which is a good amount that is useful to keep university campus and surrounding fresh.

Simultaneously, university has taken many programs like green computing, SRPD and use of ICT in many official procedures has reduced carbon footprints of the university.

Environmental Management Plan:

Environmental Management Plan gives the strength, weaknesses and suggestions on the environmental issues of Shivaji University, Kolhapur. It also suggests about which area is to be given priority to improve upon. The green audit of university campus reveals that the university administration should take care of glass waste, wastewater, chemical waste and e-waste management on high priority as the ignorance to these will deteriorate the environment on the campus.

The entire exercise of green audit concluded that the university is keen on all the environmental issues. University have lot to gain by following links to work towards making a greener and more environmental friendly campus. Students, staff, faculty and administration working together will produce the best results raising awareness and helping to push the environmental friendly agenda beyond campus.

Chapter I
Introduction

1.1 Green Audit, a Tool for Environmental Protection and Conservation:

The modernization and industrialization are the two important outputs of twentieth century which have made human life more luxurious and comfortable. Simultaneously, they are responsible for voracious use of natural resources, exploitation of forests and wildlife, producing massive solid waste, polluting the scarce and sacred water resources and finally making our mother Earth ugly and inhospitable. Today, people are getting more familiar to the global issues like global warming, greenhouse effect, ozone depletion and climate change etc. Now, it is considered as a final call by mother Earth to walk on the path of sustainable development. The time has come to wake up, unite and combat together for sustainable environment.

Considering the present environmental problems of pollution and excess use of natural resources, Hon. Prime Minister, Shri. Narendra Modiji has declared the Mission of Swachch Bharat Abhiyan. Also, University Grants Commission has mentioned 'Green Campus, Clean Campus' mission mandatory for all higher educational institutes. As environmental sustainability is becoming an increasingly important issue for the nation, the role of higher educational institutions in relation to environmental sustainability is more prevalent.

Green Audit is the most efficient ecological tool to solve such environmental problems. It is a process of regular identification, quantification, documenting, reporting and monitoring of environmentally important components in a specified area. Through this process the regular environmental activities are monitored within and outside of the concerned sites which have direct and indirect impact on surroundings. Green audit can be one of the initiative for such institutes to account their energy, water resource use as well as wastewater, solid waste, E-waste, hazardous waste generation. Green Audit process can play an important role in promotion of environmental awareness and sensetization about resource use. It can create consciousness towards ecological values and ethics. Through green audit one can get direction about how to improve the condition of environment.

1.2 Need of Green auditing:

Green auditing is the process of identifying and determining whether institutions practices are eco-friendly and sustainable. Traditionally, we are good and efficient users of natural resources. But over the period of time excess use of resources like energy, water, chemicals are become habitual for everyone especially, in common areas. Now, it is necessary to check whether our processes are consuming more than required resources? Whether we are handling waste carefully? Green audit regulates all such practices and gives an efficient way of natural resource utilization. In the era of climate change and resource depletion it is necessary to verify the processes and convert it in to green and clean one. Green audit provides an approach for it. It also increases overall consciousness among the people working in institution towards an environment.

1.3 Goals of Green audit:

University has conducted a green audit with specific goals as:

1. Identification and documentation of green practices followed by university.
2. Identify strength and weakness in green practices.
3. Conduct a survey to know the ground reality about green practices.
4. Analyze and suggest solution for problems identified from survey.
5. Assess facility of different types of waste management.
6. Increase environmental awareness throughout campus.
7. Identify and assess environmental risk.
8. Motivates staff for optimized sustainable use of available resources.
9. The long term goal of the environmental audit program is to collect baseline data of environmental parameters and resolve environmental issue before they become problem.

1.4 Objectives of Green audit:

1. To examine the current practices which can impact on environment such as of resource utilization, waste management etc.
2. To identify and analyze significant environmental issues.
3. Setup goal, vision and mission for Green practices in campus.
4. Establish and implement Environmental Management in various departments.
5. Continuous assessment for betterment in performance in green practices and its evaluation.

6. To prepare an Environmental Statement Report on green practices followed by different departments, support services and administration building.

1.5 NAAC criteria VII Environmental Consciousness :

Universities are playing a key role in development of human resources worldwide. Higher education institutes campus run various activities with aim to percolate the knowledge along with practical dimension among the society. Likewise different technological problems higher education institutes also try to give solution for issues related to environment. Different types of evolutionary methods are used to assess the problem concerning environment. It includes Environmental Impact Assessment (EIA), Social Impact Assessment (SIA), Carbon Footprint Mapping, Green audit etc

National Assessment and Accreditation Council (NAAC) which is a self governing organization that declares the institutions as Grade according to the scores assigned at the time of accreditation of the institution. Green Audit has become mandatory procedure for educational institutes under Criterion VII of NAAC. The intention of green audit is to upgrade the environmental condition inside and around the institution. It is performed by considering environmental parameters like water and wastewater accounting, energy conservation, waste management, air, noise monitoring etc. for making the institution more eco-friendly.

Students are the major strength of any academic institution. Practicing green actions in any educational institution will inculcate the good habit of caring natural resources in students. Many environmental activities like plantation and nurturing saplings and trees, Cleanliness drives, Bird watching camps, No vehicle day, Rain water harvesting, etc. will make the students good citizen of the country. Through Green Audit, higher educational institutions can ensure that they contribute towards the reduction of Global warming through Carbon Footprint reduction measures.

1.6 Benefits of Green Audit to an Educational Institute:

There are many advantages of green audit to an Educational Institute:

- It would help to protect the environment in and around the campus.
- Recognize the cost saving methods through waste minimization and energy conservation.
- Find out the prevailing and forthcoming complications.

- Empower the organization to frame a better environmental performance.
- It portrays good image of institution through its clean and green campus.

  Finally, it will help to built positive impression for through green initiatives the upcoming NAAC visit.

1.7 Shivaji University, Kolhapur Maharashtra at a Glance:

Shivaji University, established in 1962, is named after the Great Maratha Warrior and founder of the Maratha empire Chhatrapati Shivaji. It was inaugurated on 18th November, 1962 by Dr. Radhakrishnan, the then President of India. One of the major objectives behind foundation of this University was to cater to the regional needs of South Maharashtra. The jurisdiction of the University is spread over three districts viz. Kolhapur, Sangli and Satara with strength of about 3,00,000 students studying in 280 affiliated colleges and recognised institutes. This region of Maharashtra boasts of rich and varied socio-cultural heritage. Under the innovative and socially reformist leadership of Chhatrapati Shahu Maharaj, the princely ruler of Kolhapur, the city had become at the beginning of this century, a focal point of educational opportunities for all classes and communities of South-Western Maharashtra, and northern parts of neighboring Karnataka. This is also land of Karmaveer Bhaurao Patil, who struggled for taking education to the masses by his innovative 'Earn and Learn' scheme. When the University was founded by the Shivaji University Act of 1962, the objectives set before the University included making opportunities of higher education accessible to rural youth, conducting fundamental and applied research in the field of science and humanities to ensure regional growth and development.

In 1962, the University started functioning with 34 affiliated colleges and about 14,000 students with 5 Post-graduate Departments on the campus. Today, the number of affiliated colleges has gone up to 280 and students strength up to 3,00,000 with 34 Postgraduate Departments on campus. The University imparts education in 10 major faculties of Arts, Social Science, Science, Commerce, Education, Fine Arts, Law, Medicine, Ayurvedic Medicine, Engineering and Technology. The University consolidated its base in this phase by 'taking education to the people'. The recent phase of the University can be termed as "a pursuit of academic excellence". Since last 4-5 years, several attempts are being made to overcome the image of University as a regional University. Several steps have been taken to raise the standards of teaching and research so as to measure up to global standards. This is being achieved by exploring new areas of higher learning and research in rapidly

emerging fields like Industrial Chemistry, Space Science, Environmental Science, Bio-Chemistry, Sericulture, Polymer Chemistry and Computer Science, in addition to basic science disciplines. The University Department of Physics has been recently identified by UGC for its Special Assistance Programme and recognised as Department of Research Support. New research areas in these departments are Super conductors Energy, Bio-diversity and Bio-technology. The University has also established the University-Industry Interaction.

The faculties of Arts and Social Sciences are also gearing up to meet the demands of changing time. Establishment of Centre for Women's Studies and extension activities through Adult and Continuing Education and Shramik Vidyapeeth are indicators of this change. Department of Economics has been selected by UGC for its Special Assistance Programme. Departments of Sociology, Education, Geography, Physics and Economics are offering special courses in emerging areas like Environmental Science is also functioning actively. The University's efforts towards excellence are being recognized by the substantial grants received from funding agencies like UGC, DST, DBT etc. The indicator of recognition of University is collaborations with premier institutes in the country. Shivaji University has recently signed MoU with Bhabha Atomic Research Centre, Mumbai for research in Material Science. It has also joined hands with Indian Institute of Geo-Magnetism, Mumbai and industries like Phyto-Pharma. Prestigious institutes like Maharashtra Police Academy, Nashik and Centre for Social Studies, Surat have sought affiliation with the Shivaji University.

Shivaji University has been re-accredited by National Assessment and Accreditation Council (NAAC) Bangalore, with "A" Grade (CGPA-3.16) (2014). University has bagged the 28th position in the rankings announced by the National Institutional Ranking Framework (NIRF) of Union Ministry of Human Resource Development (MHRD). As per the INFLIBNET report, Shivaji University stands second in use of Nature publications Group's (NPG) e-journal usage in the country. Shivaji University has also signed MoU with Centre for Development of Advanced Computing (C-DAC), Pune. Under the agreement, the two institutions will exchange information and communication technology.

To sum up, the University which was founded primarily to cater to the regional aspirations has now geared up to transcend this regional image and emerging as one of the premier institutes of higher education and research in India.

Chapter II

Methodology

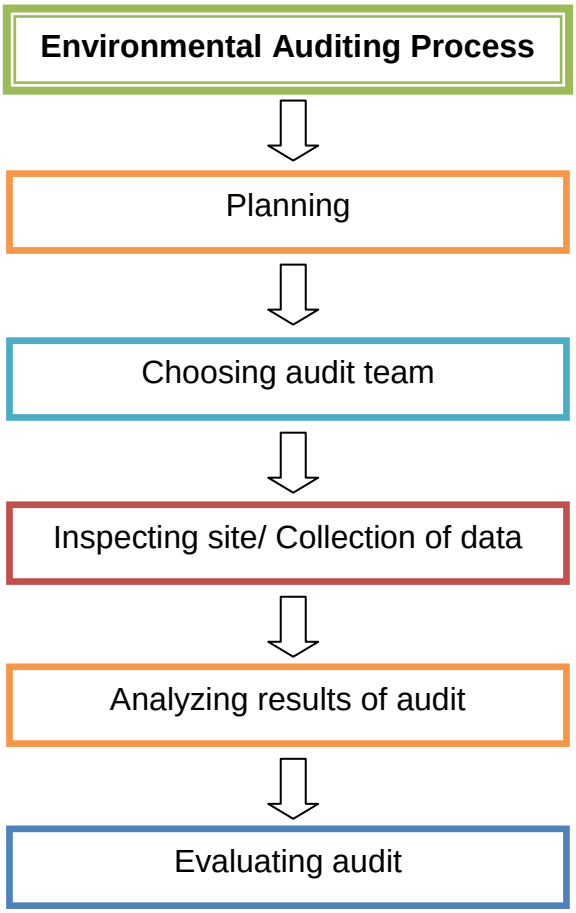
2.1 Background of Shivaji University Green Audit preparation:

Shivaji University has prepared its first Green audit report in the year 2014 during second cycle of NAAC accreditation. This was one of the first attempt in Maharashtra to prepare such pioneering document about the compilation of environmental status of any university. This report was very much appreciated by the NAAC Pear Team visited Shivaji University for second cycle accrediation. After preparation of this report, Department of Environmental Science has taken the responsibility to prepare the Green Audit Report for the colleges under Shivaji University territory. This Department has prepared more than ten Green Audit reports of colleges and prepared a guideline for preparation of these reports for others.

This is being the second attempt to conduct Green Audit of Shivaji University, Kolhapur campus; the report not only includes the data regarding the use of resources but also highlights the biodiversity status of University. The resource utilization of Water and Electricity, Solid waste generation, E waste, Hazardous waste, Noise and Air monitoring, wastewater generation etc. on university campus are studied through this Green Audit process. Besides, these observations, the report also includes the information about the social responsibility taken by Shivaji University during the flood situation in Kolhapur.

The audit process was carried out in three phases. At first, all the secondary data required for the study was collected from various sources, like concerned departments as engineering, garden etc. A broad reference work was carried out to clear the idea of green auditing. Different case studies and methodologies were studied and the following methodology was adopted for present audit.

The methodology of present study is based on onsite visits, the personal observations and questionnaires survey tool. Initially, based on data requirement, sets of questionnaires were prepared. The surveyors then visited all the departments of the university and the questionnaires were filled. The generated data is subsequently gathered and used for further analysis. From the outcome of the overall study, a final report is prepared.



2.2 Survey by Questionnaire:

Baseline data for green audit report preparation was collected by questionnaire survey method. Questionnaires prepared to conduct the green audit in the university campus is based on the guidelines, rules, acts and formats prepared by Ministry of Environment, Forest and Climate Change, New Delhi, Central Pollution Control Board and other statutory organizations. Most of the guidelines and formats are based on broad aspects and some of the issues or formats were not applicable for University campus. Therefore, using these guidelines and formats, combinations, modifications and restructuring was done and sets of questionnaires were prepared as solid waste, energy, water, hazardous waste, and e-waste.

All the questionnaires comprises of group of modules. The first module is related to the general information of the concerned department, which broadly includes name of the department, month and year, total number of students and employees, visitors of the department, average working days and office timings etc. The next module is related to the present consumption of resources like water, energy, or the handling of solid and hazardous

waste. Maintaining records of the handling of solid and hazardous waste is much important in green audit.

There are possibilities of loss of resources like water, energy due to improper maintenances and assessment of this kind of probability is necessary in green audit. One separate module is based on the questions related to this aspect. Another module is related to maintaining records, like records of disposal of solid waste, records of solid waste recovery etc. For better convenience of the surveyor, some statistics like, basic energy consumption characteristics for electrical equipment etc. was provided with the questionnaires itself.

2.3 Onsite visit and observations:

The Shivaji University has vast built up area comprising of various departments, administrative building, teachers and staff quarters, student hostels, guest house, sports complex and health centre. All these amenities have different kind of infrastructure as per their requirement. All these buildings were visited by the surveyors and the present condition is checked with the help of the questionnaires. Personal observations were made during the onsite visit. All the amenities were clubbed in as per their similarities and differences, which makes the survey and further analysis easier.

For the data compilation purpose the University Departments and support services were clubbed into Four Blocks and given coding as Building Block A, Building Block B, Building Block C and Building Block D. The details of the Blocks are as follows:

Table No. 2.1 Details of each block including the various departments

Sr. No.	Name of the Building Block	Code
1.	Administrative and Facilities Block	Building Block A
2.	Science and Technology	Building Block B
3.	Commerce, Humanities and Social Sciences	Building Block C
4.	Support Services	Building Block D

After collection of secondary data, the reviews related to each environmental factor were taken by the green audit team. The data was tabulated, analyzed and graphs were

prepared using computer. Depending upon the observations and data collected, interpretations were made. The lacunas and good practices were documented. The Environmental Management Plan (EMP) was prepared for the next academic year in order to have better environmental sensitization. Finally, all the information was compiled in the form of Green Audit Report.

2.4 Data analysis and final report preparation:

A proper analysis and presentation of data produced from work is a vital element. In case of green audit, the filled questionnaires of the survey from each group, were tabulated as per their modules, in Excel spreadsheets. The tabulated data is then used for further analysis. For better understanding of the results and to avoid complications, averages and percentages of the tables were calculated. Graphical representation of these results was made to give a quick idea of the status. Interpretation of the overall outcomes was made which incorporates all the primary and secondary data, references and interrelations within. Final report preparation was done using this interpretation.

Table No. 2.1 Categorisation of university departments and support services at Shivaji University Campus.

Building Block A	Administrative Building, Annex Building, Student Facility Centre, Distance Education.
Building Block B	Chemistry, Zoology, Botany, Physics, Electronics, Mathematics, Statistics, Biochemistry, Environmental Science, USIC, Geography, Industrial Chemistry, Applied Chemistry, Computer Science, Technology, Food Science and Technology, Biotechnology, Microbiology, School of Nanoscience and Technology.
Building Block C	Political Science, Sociology, Economics, History, Journalism and Mass Communication, Centre of Women studies, Adult and Continuing Education, Marathi, English, Hindi, Foreign Languages, Music and Dramatics, Education, Commerce and Management, Law, Gandhiyan Studies, Neharu studies, Dr. Ambedkar Studies, Community Development Centre, Social Exclusion and Inclusive Policies, Shahu Sanshodhan, YCSRD, Shivaji Maharaj Maratha History Centre, Bank of India Adhyasan, Bhagawan Mahavir Adhyasan, Vitthal Ramaji Shinde Adhyasan, Shardabai G. Pawar Adhyasan, Yashwantrao Chavan Adhyasan, Balasaheb Desai Adhyasan .
Building Block D	Library and Information Science, Barrister Khardekar Library, Sports, Internet, Ladies Hostel, Boys Hostel, Ladies Hostel, (Technology), Boys Hostel (Technology), Vidyardhi Bhawan, Guest house, Health Centre.

Chapter III
Water and Wastewater Audit

Water which is precious natural national resource available with fixed quantum. The availability of water is decreasing due to increasing population of nation, as per capita availability of utilizable water is going down. Due to ever rising standard of living of people, industrialization, urbanization, demand of fresh water is increasing day by day. The unabated discharge of industrial effluent in the available water bodies is reducing the quality of these ample sources of water continuously. Hence, the national mission on water conservation was declared by the then Hon. Prime Minister Narendra Modi as 'Jal Shakti Abhiyan' and appealed to all citizens to collectively address the problem of water shortage, by conserving every drop of water and suggested for conducting water audit for all sectors of water use.

Water audit can be defined as a qualitative and quantitative analysis of water consumption to identify means of reducing, reusing and recycling of water. Water Audit is nothing but an effective measure for minimizing losses, optimizing various uses and thus, enabling considerable conservation of water in irrigation sector, domestic, power and industrial as well. A water audit is a technique or method which makes possible to identify ways of conserving water by determining any inefficiencies in the system of water distribution. The measurement of water losses due to different uses in the system or any utility is essential to implement water conservation measures in such an establishment.

3.1 Importance of Water Audit:

- Systematic process
- May yield some surprising results
- Easier to work on solutions when the problems are identified.
- A tracking mechanism can be put into place.

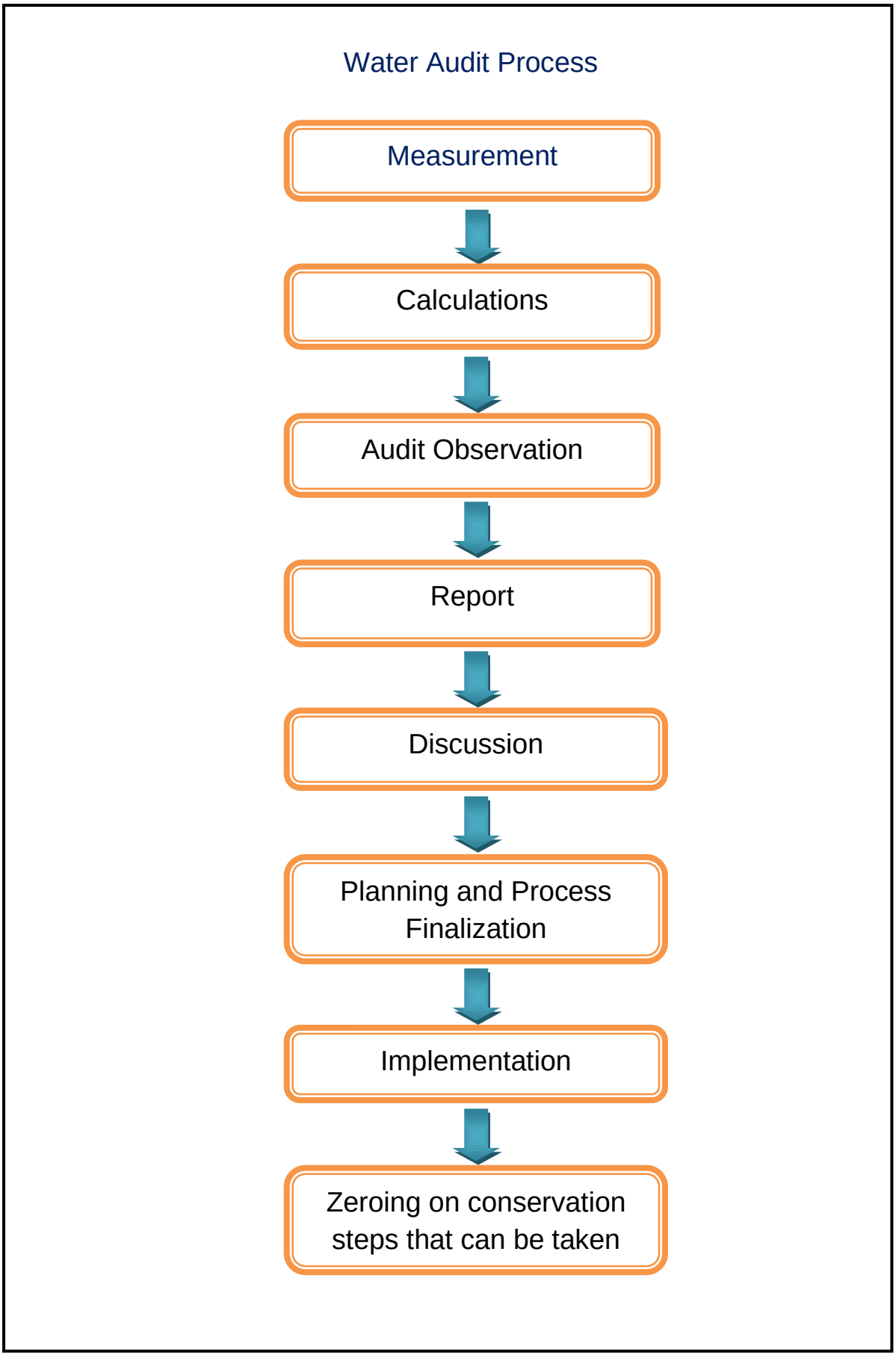
It is observed that a number of factors like climate, culture, food habits, work and working conditions, level and type of development, and physiology to determine the requirement of water. The community which has a population between 20,000 to 1,00,000 requires 100 to 150 liters per person (capita) per day. The communities with a population can consume over 1, 00,000 requires 150 to 200 liters person (capita) per day. As per the standards provided by WHO Regional office for South East Asia Schools require 2 liters per student; 10-15 liters per student if water-flushed toilets, Administration requires (Staff

accommodation not included) 50 liters per person per day, Staff accommodation requires 30 liters per person per day and for sanitation purposes it depends on technology.

3.2 Water Audit:

Water usage can be defined as water used for all activities which are carried out on campus from different water sources. This includes usage in all residential halls, academic buildings, on campus and on grounds. Wastewater is referred as the water which is transported off the campus. The wastewater includes sewerage, residence, hall water used in cooking, showering, clothes washing as well as wastewater from chemical and biological laboratories which ultimately going down in sink or drainage system.

Plate: 3.1 University water resources


Water Audit Process
Measurement
Calculations
Audit Observation
Report
Discussion
Planning and Process Finalization
Implementation
Zeroing on conservation steps that can be taken

3.3 Water consumption in the University:

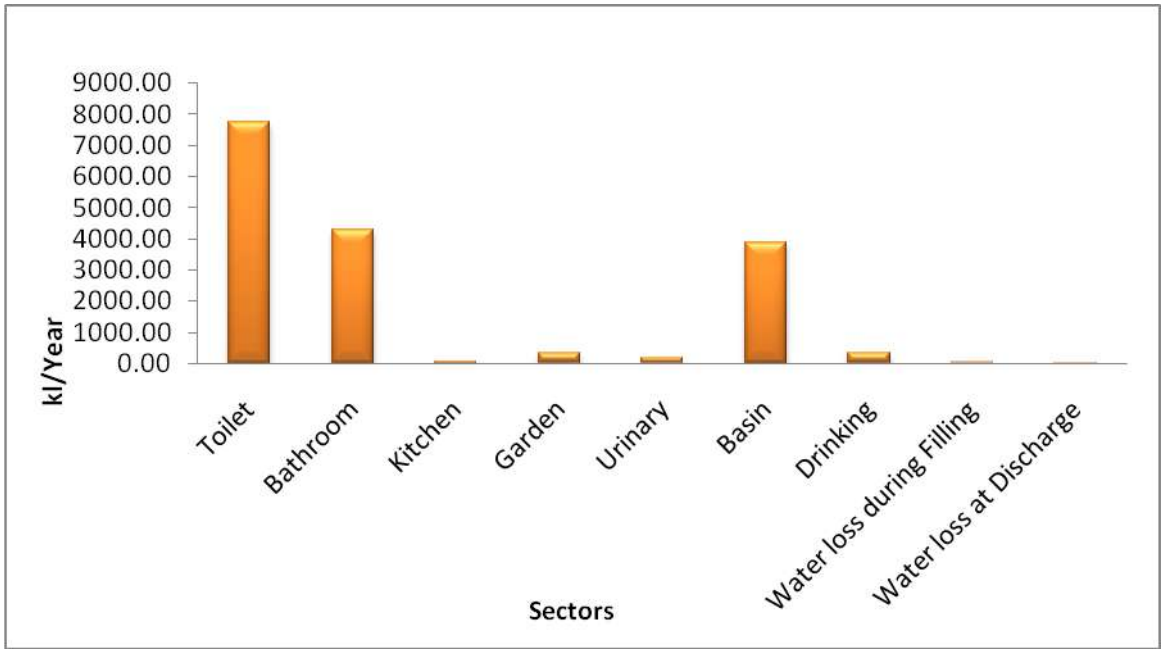
From the data collected for water audit of Shivaji University, Kolhapur, the water distribution and water consumption pattern is noticed as follows. The University departments are grouped in different groups as given in the methodology as a) Building Block A (Administrative Facilities) b) Building Block B (Science and Technology) c) Building Block C (Commerce, Humanities and Social science) and d) Building Block D (Support Services).

3.3.1 The water consumption at Building Block A:

Table No. 3.1: Sector wise use of water in Building Block A.

Sr. No.	Sector	Total Daily Use (liter)	Total yearly use (kl)	Percentage %
1	Bathroom	15905.89	4294.59	25.00
2	Toilet	28715.50	7753.19	46.00
4	Kitchen	199.76	53.94	0.32
5	Garden	1198.56	323.61	1.92
6	Urinals	680.43	183.72	1.09
7	Drinking	1248.50	337.10	2.00
8	Wash Basin	14289.08	3858.05	22.89
9	Water loss during filling	124.85	33.71	0.20
10	Water loss at discharge	62.42	16.85	0.10
Total		**62425.00**	**16854.75**	**100.00**

Graph No. 3.1 Total yearly water consumption at Building Block A



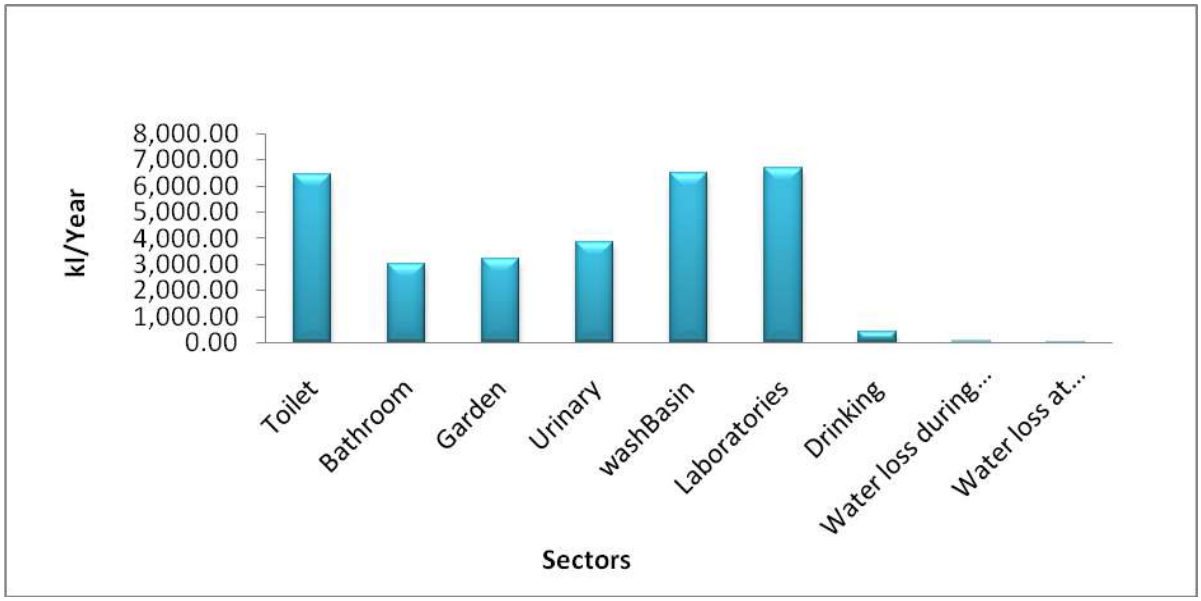
It is revealed from the data given in Table No. 3.1 and Graph No. 3.1 shows that total 62425 liters of water is used daily and 16854.75 kl yearly. In the Building Block A total five departments are involved which use water for bathrooms, toilet, drinking, washbasin, laboratory, kitchen and garden purpose. From above data it is observed that the maximum water consumption for toilet purpose is 28715.5 liters / day i.e. 7753.19 kl/year. Water for Bathrooms, Urinal and Kitchen consumed 4294.59 kl/year, 183.72 kl/year and 53.94 kl/year respectively. In the case of Garden, water used yearly is 323.61 kl while for drinking purpose less amount of water is required which is provided by R.O. water plant is 337.10 kl per year. Water loss during filling of water in tank was noted as 33.71 kl/year and water losses at discharge were found to be 16.85 kl/ year.

3.2.2. Water consumption at Building Block B:

Table No. 3.2 Sector wise use of water in Building Block B.

Sr. No.	Sector	Total daily use (liter)	Total yearly use (kl)	Percentage %
1	Bathroom	11161.19	3013.52	9.96
2	Toilet	23880.00	6449.33	21.32
3	Laboratories	24850	6709.50	22.19
4	Urinal	14286	3857.22	12.75
5	Garden	11960	3229.2	10.68
6	Drinking	1574.81	425.20	1.41
7	Wash Basin	24076	6500.52	21.50
8	Water loss during filling	148.59	40.12	0.13
9	Water loss at discharge	67.85	18.32	0.06
Total		**112004.44**	**30242.93**	**100**

Graph No. 3.2 Total water consumption at Building Block B yearly.



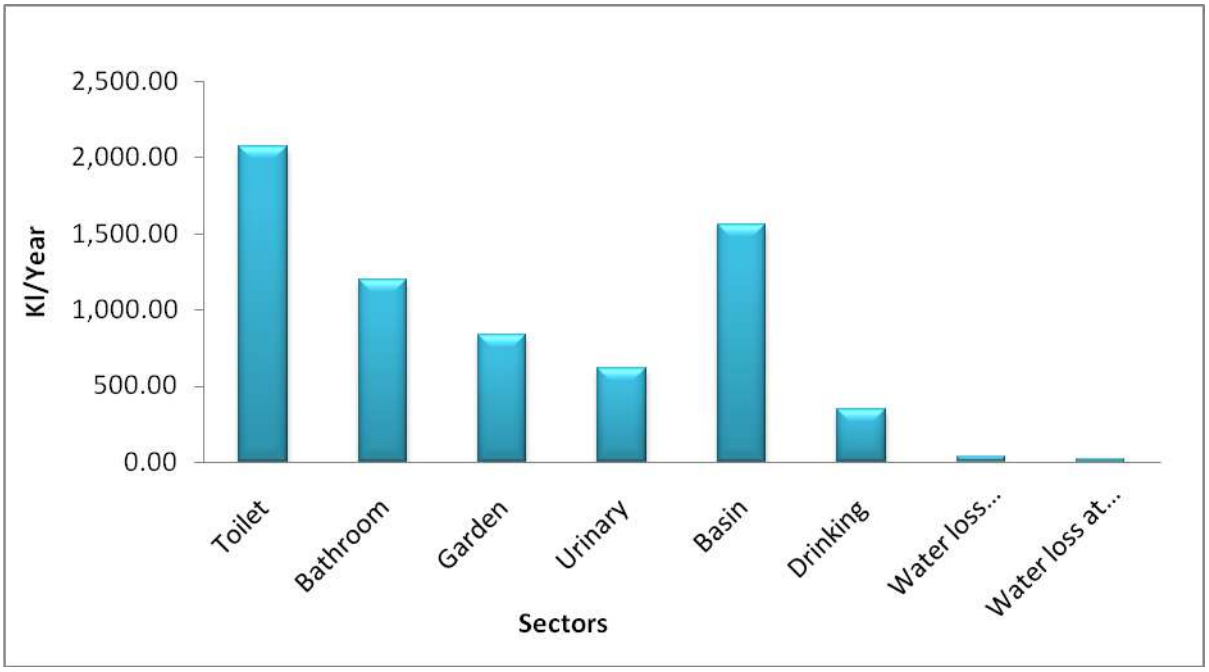
It is shown from the data given in Table No. 3.2 and Graph No. 3.2 that total 112004.44 liters water is used daily in Building Block B and 30242.93 kl yearly. In Building Block B water is used for bathroom, toilets, drinking, washbasin, laboratory, urinal and garden etc. purpose daily. From above data it is observed that the maximum water consumption was for laboratory purpose which is 24850 liters/ day i.e. 6709.50 kl/year. The next water requirement is for wash basin and toilet. For washbasin and toilet purpose water used is 24076 liters and 23880 liters of water required daily while 6,500.52 and 6,449.33 Kilo liters yearly. Other sectors like bathroom, urinal and garden shows daily water consumption 11161.19, 14286 and 11960 liters and yearly 3013.52, 3857.22 and 3229.2 Kiloliters respectively. In case of drinking purpose only 1574.81 liters while yearly 425.20 Kiloliters. Water loss during filling of water in tank was also noted as 148.59 liters/day i.e. 40.12 Kiloliters/year and water losses at discharge were found to be 67.85 liters /day i.e. 18.32 kl/ year.

3.2.3 Water consumption at Building Block C.

Table No. 3.3: Sector wise use of water in Building Block C.

Sr. No.	Sector	Total daily use (liter)	Total yearly use (kl)	Percentage %
1	Toilet	7672	2071.44	31.02
2	Bath room	4434	1197.18	17.93
3	Garden	3090	834.3	12.49
4	Urinal	2289	618.03	9.25
5	Wash Basin	5774	1558.98	23.34
6	Drinking	1279.85	345.56	5.17
7	Water loss during Filling	120.59	32.56	0.49
8	Water loss at Discharge	74.52	20.12	0.30
Total		**24733.96**	**6,678.17**	**100**

Graph No. 3.3 Total water consumption at Building Block C.



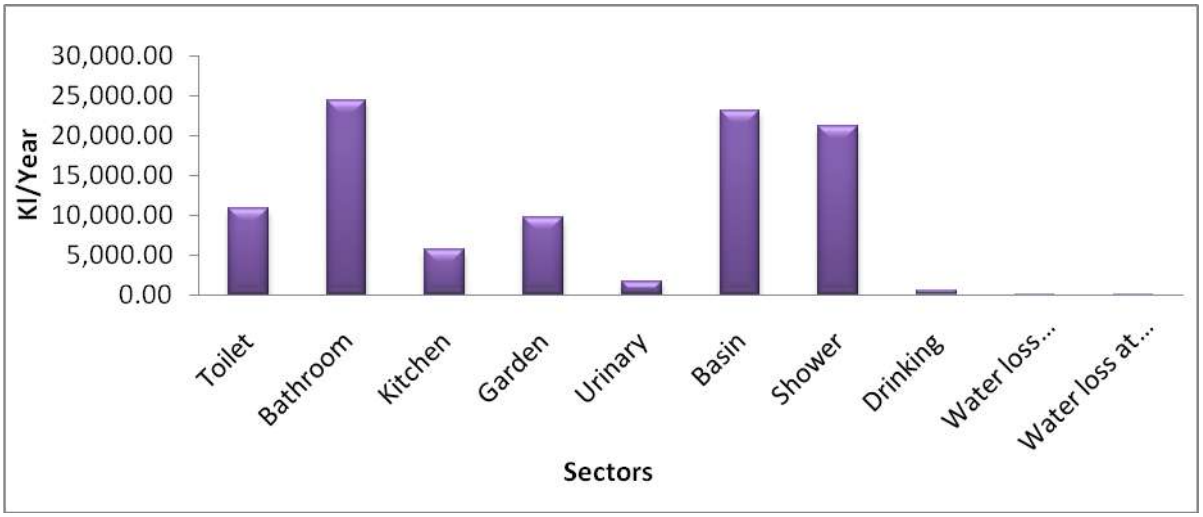
It is revealed from the data given in table no. 3.3 and Graph No. 3.3 shows that total 24733.96 liters water is used daily and 6,678.17 kl yearly. The Building Block C total nine departments are involved which use water for bathrooms, toilet, drinking, wash basin and garden purpose for daily and also calculated yearly. From above data it is observed that the maximum water consumption is for toilet purpose which is 7672 liters / day i.e. 2071.44 kl/year. After toilet next use of water is for wash basin and then bathrooms which consume 1558.98 kl/year and 1197.18 kl/year respectively. In case of urinal and garden water used yearly is 618.03 kl and 834.3 kl while for drinking purpose less amount of water is required which is provided by R.O water plant is 345.56 kl per year. Water loss during filling of water in tank was noted as 32.56 kl/year and water losses at discharge were found to be 20.12 Kl/ year.

3.2.4 Water consumption at Building Block D:

Table No. 3.4 Sector wise use of water in Building Block D.

Sr. No.	Sector	Total daily use (liter)	Total yearly use (kl)	Percentage %
1	Toilet	40302	10881.54	11.17
2	Bathroom	90617	24466.59	25.10
3	Kitchen	21152	5711.04	5.86
4	Garden	36060	9736.20	9.99
5	Urinal	6180	1668.60	1.71
6	Wash Basin	85711	23141.97	23.74
7	Shower	78694	21247.38	21.80
8	Drinking	2000.74	540.20	0.55
9	Water loss during Filling	167.148	45.13	0.05
10	Water loss at Discharge	82.44	22.26	0.02
Total		**360966.33**	**97460.91**	**100**

Graph No. 3.4 Total Yearly Water Consumption by Building Block D.



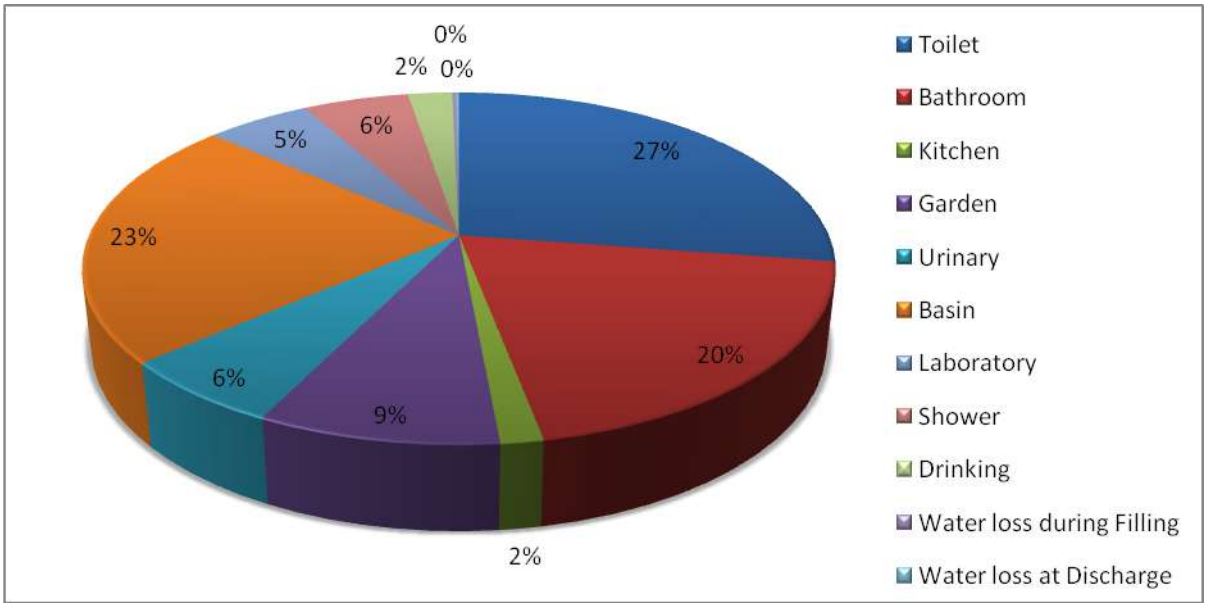
It is shown from the data given in Table No. 3.4 and Graph No. 3.4 that total 360966.33 liters of water is used daily in Building Block D and 97460.91 kl yearly. In Building Block D total 21 department data is collected. In Building Block D water is consumed for bathroom, toilets, drinking, wash basin, kitchen, shower, urinal and garden purpose daily. From the above data it is observed that the maximum water consumption is for bathroom purpose which is 90617 liters / day i.e. 24,466.59 kl/year. The next water requirement is for wash basin and shower. For wash basin and shower purpose 85711 liters and 78694 liters per day while 23141.97 and 21247.38 Kilo liters respectively per year. Other sectors like toilet, urinal and kitchen shows daily water consumption 40302, 62 and 21152 liters and yearly 10881.54, 1668.60 and 5,711.04 Kiloliters respectively. In case of garden purpose only 36060 liters and yearly 9,736.20 Kiloliters. For drinking purpose water is required 2000.74 liters per day while 540.20 Kiloliter / year. Water loss during filling of water in tank was also noted as 167.148 liters/day i.e. 45.13 Kiloliters/year and water losses at discharge were found to be 82.44 liters /day i.e. 22.26 kl/ year.

3.2.5 Yearly water consumption at Shivaji University:

Table No. 3.5 Sector wise use of water in Shivaji University.

Sr. No.	Sites	Water used in Ml/Year	%
1	Bathroom	32.97	19.62
2	Toilet	27.15	27.38
3	Urinary	6.32	6.20
4	Basin	35.26	23.04
5	Garden	14.12	8.77
6	Kitchen	5.76	1.55
7	Laboratory	6.50	5.38
8	Other	23.12	8.07
Total		**151.23**	**100**

Graph No. 3.5 Average yearly water consumption at Shivaji University, Kolhapur.



Graph No. 3.5 shows the total percent of water consumed by all the Building Blocks of Shivaji University, Kolhapur. The graph shows toilets, wash basin and bathrooms as the major sources of water utilization comprising 27.38 %, 23.04 %, and 19.62 % respectively. The other uses namely garden, urinals, laboratory and shower consume water with yearly water requirement of 8.77 %, 6.20 %, 5.38 % and 5.45 % respectively. In case of others includes water required for drinking perpose, water required for kitchen activity and loss of water during filling and during discharge. It was observed that the water required for drinking purpose is 2.28 % while for kitchen it is 1.55 %. In case of filling loss of water observed 0.22 % while during discharging water loss is about 0.12 % respectively.

3.3 Sustainable Water Practices (SWP):

3.3.1 Watershed management practices at Shivaji university campus.

Shivaji University, Kolhapur has become a front runner in water conservation and management of water available on the campus. Now, university is self reliant through decentralized water conservation and management practices. Following table shows the capacity of water reservoirs on campus in liters.

Table No. 3.6 Total capacity of Water Reservoirs on campus in Liter.

Sr.No	Sources	Capacity in Liters.
1	Bhasha Bhavan Lake	22.15 cr
2	Music Department Lake	5.20 cr
3	Sutar well	4.00 lakh
4	Well near Sports department	4.87 lakh
5	Well near Chemistry department	3.00 lakh
6	Well near Synthetic track	5.00 lakh
7	Shinde well	3.00 lakh
8	Three farm ponds	40.00 lakh

3.3.1. a Farm ponds:

Shivaji University has created three ponds to control pressure of flowing water. These ponds are created in such a manner to collect water serially, one after another and are connected to each other with trenches without use of plastic. The reservoirs have total capacity of 40 lakh liters with capacity of 5 lakh liters, 10 lakh liters and 25 lakh liters respectively.

Plate: 3.2 Creation of three farm ponds near Shiv tak connected with each other with trenches.

3.3.1.b De-sedimentation and Rejuvenation of well:

University campus is having eight wells out of which six wells are old. The university extract water from Sutar well in rainy season for potable water. Another well used by Botany Department to maintain their lead botanical garden. Remaining four wells remain unutilized. Two wells were dug in 2014 to meet water requirement and one of them is used for Boys hostel and another is used for Botany Department. University has decided to bring two (out of four unutilized wells) wells under use, this year. The well near Synthetic Track and another well (Shinde well) near Sutar well, were desedimented completely which earlier contained very less water. The work of desedimentation and rejuvenation was under taken after studying the underground water resources of these wells. Nearly 60 ft. and 30 ft. sludge was removed out of it, to activate ground water resources. During summer itself, water from few sources started activating wells. Though, quantity of water was small, it was a great success. After de-sedimentation those wells were constructed with compound wall to avoid any mishap The well full fills daily need of university of around 2 lakh liters of drinking water.

Plate: 3.2 De-sedimentation and Rejuvenation of well near Sport Department.

3.3.1.c Continuous contour trenches (CCT):

Few trenches were created to carry water towards various reservoirs on the campus. The civil engineering section created trenches of total length of 2.5 km without disturbing natural direction of water flow. Those included the trench from Chemistry Department to back side of Botany Department (390 mtr), Statistics Department to Bhasha Bhavan (510 mtr), Boys Hostel (West side) to farm pond (300 mtr), Electric substation to Printing Press (200 mtr). Also, four trenches of 315 mtr each were created from the West side of Synthetic Track towards Bhasha Bhavan lake (Total of 1260 mtr).

3.3.1.d Recycling of water:

Wastewater recycling was considered as the best option of water usage. Underlining this fact, Shivaji University has established two recycling plants in 2008-09 and 2013-14. First plant was established near Ladies hostel where 60 thousand liter water is recycled per day. Another plant of phytoremediation is established near Boy's hostel at Department of Technology, where 50 thousand liter water is recycled. This recycled water is used for the garden and campus beautification through drip lines across the gardens. The gardens of old and new library, garden adjacent to statue of Karmaveer Annabhau Patil, garden of Humanities building and North circle garden is irrigated with the recycled water from the recycling plant near Ladies Hostel. The gardens in the area of Department of Technology are irrigated with the recycled water from their hostel.

3.3.1. Design of STP on the campus

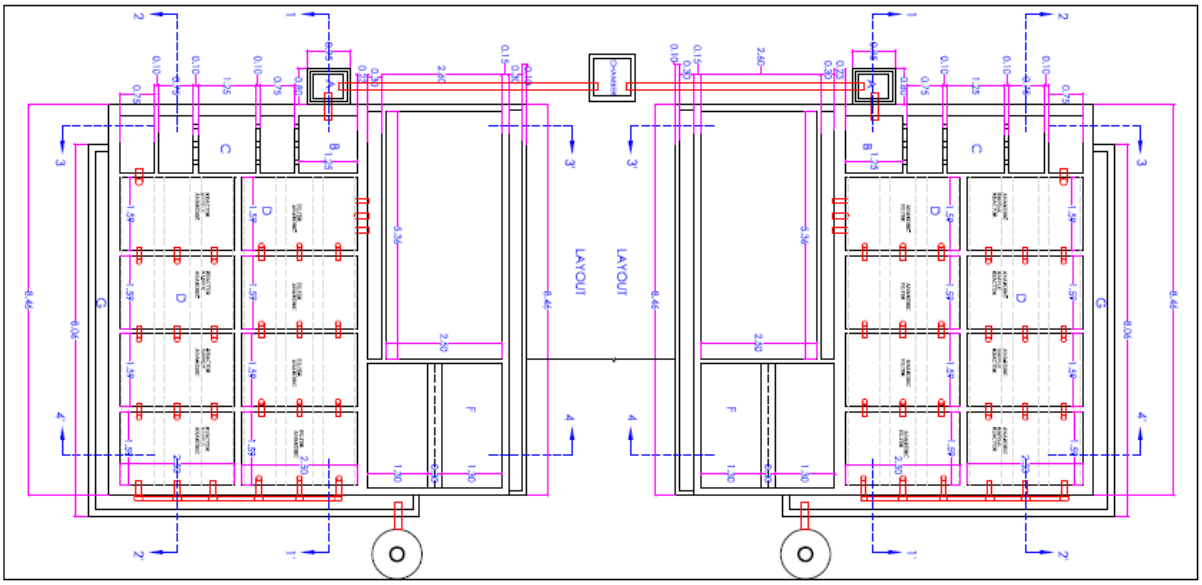


Plate: 3.3. Wastewater Treatment Plant

Plate: 3.4. Phytoremediation treatment for wastewater

3.3.1.e Mini Irrigation Tank:

University has constructed Mini Irrigation Tanks (MIT) behind Language Department tank which has capacity of 8.52 million cubic feet. When it fills to about 50% of capacity, it results in the recharging of wells, located down of the tank. The water from tank near Music department is supplied to ladies hostel, few departments, teachers' quarters, and garden.

Plate: 3.5. Shiv Jalashay Yojana (Mini Irrigation Tank) Behind Language Department.

3.3.1.f Roof Top Rain Water Harvesting:

The university program of rain water harvesting includes buildings on the campus, Nallah construction, canal contours and resuscitating of water springs in the different wells. The daily water need of the university is 5.5 lakh / liters and the university used to purchase water from Municipal Corporation. Roof top rain water harvesting is carried out at Main Administrative building, Humanities, all buildings of Science departments, Boy's and Girl's hostel and Aappasaheb Pawar Vidhyatri Bhavan. Additional water collected is diverted to the university constructed dams.

Plate: 3.6. Roof top rain water harvesting at Department of Environmental Science.

3.3.1.g Water Filtration Plant:

The university has campus as big as a village with its administrative setup and there is a need of treatment of water for drinking purpose. University has constructed Mini Water Treatment Plant (WTP) on the campus in 2008. This filter house (WTP) used to filter the well water into potable water was constructed near library building. Now the university campus use self filtered water throughout the year.

Plate: 3.7. Mini Water Treatment Plant (WTP)

3.3.1.h Drip Irrigation and Sprinkler Irrigation:

University has huge green campus of about 853 acres. Efforts have been made on to bring part of land under cultivation of medicinal plants as well as other productive plants through NSS and students of other departments. Drip irrigation and sprinkler irrigation system have been installed at 15 university gardens which helps to save water and nutrients by allowing water to drip slowly to the roots of plants. The goal is to place water directly into the root zone and minimize evaporation to save water.

Plate: 3.8. Drip Irrigation and Sprinkler Irrigation in University Garden

3.3.1.i Shiv Jal Yojana (Reverse Osmosis Plant) :

From 11th July, 2016, onwards Shivaji University started Shiv Jal Yojana Reverse Osmosis plant (RO plant) in the campus. The plant has 17 MLD capacity which helps to get pure water for drinking to all members of University and stopped using the water supply from Municipal Corporation. It will help to minimize the water born disease occurrence in the Girls and Boys hostel. The water is supplied by packing of sterile cans of water.

Plate: 3.9. 17 MLD capacity Reverse Osmosis (RO) Plant

The quality of water is monitored by Department of Environmental Science. Following table shows the physic-chemical parameters checked weekly by Department of Environmental Science of the university.

Table No. 3.7 List Physico-chemical Parameters of water checked by Department of Environmental Science.

Sr.No.	Parameter	Unit	Methods	WHO Standards
1	pH	-	IS 3025, part11	6.5 - 8.5
2	E.C	µmhos/cm	IS 3025, part14	-------
3	TDS	mg/lit	IS 3025, part15	500
4	Total Hardness	mg/lit	IS 3025, part21	300
5	Chloride	mg/lit	IS 3025, part32	250
6	MPN	0/100ml	---	0/100ml

Total six parameters of Inlet and purified water (RO) i.e. outlet water is analyzed every week of each month regularly. The university monitors the water at inlet and outlet of the

R.O. plant as well as at the disposal point for drinking. The instructions are given to the R.O. contractor as well as to Departments or sections to maintain cleanliness at the disposal point.

Table No. 3.7 Physic-chemical characters of R.O. water in the year 2018-19

Sr.No	Parameters	pH		E.C		TDS		Total Hardness		Chloride		MPN	
	Months	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
1	January	7.7	7.47	56	6	560	60	152	50	47.3	8.0	2	0
2	February	5.6	4.6	79	8	790	80	174	24	60.1	7.0	4	0
3	March	8.28	8.33	80	6	800	60	105	26	71.0	12.0	4	0
4	April	6.13	6.7	54	12	541	120	100	30	80.1	17.6	2	0
5	May	7.02	6.9	55	10	600	40	150	13	77.1	10.2	4	0
6	June	6.32	6.7	56	10	450	38	135	15	72.1	16.0	4	0
7	July	7.02	6.55	65	10	542	42	165	19	65.9	12.3	2	0
8	August	6.64	6.32	74	10	322	12	120	76	60.6	11.1	5	0
9	September	6.3	7.5	52	11	276	26	118	16	65.3	12.1	5	0
10	October	5.4	4.9	56	6	525	65	128	10	74.0	15.4	2	0
11	November	7.7	7.5	59	12	423	53	120	16	75.4	16.2	4	0
12	December	7.4	7.2	64	11	356	39	114	14	67.5	12.0	2	0

Table No. 3.7 shows the physico-chemical and microbiological analysis of RO water for 12 months in the year 2018-19 on the Shivaji University campus. In present table shows analysis of samples collected from inlets and outlets of RO treatment plant.

The samples are collected in sterile BOD bottles. The monthly analysis of various physic-chemical parameters were carried out by standards methods. Physico-chemical parameters like pH, EC, TDS, Hardness, Chloride and Microbial parameters like MPN were for analyzed for water samples. All the physic-chemical parameters are within the permissible limit of WHO. Most Probable Number (MPN) which suggest contamination of microorganisms is also zero suggesting probability of water.

3.4 Precautionary measures:

University should consider following precautionary measures for improving campus environment.

- Non-teaching staff or peons in the concerned section should take responsibility of monitoring the overflow of water tanks.
- Large amount of water is wasted during the practical process in Science laboratories. Designs of small water recycle system helps to reuse of water.
- Producing distilled water in the laboratories required large amount of water to distillate. To produce 1 liter of distilled water required more than 33 liters of water. To avoid more wastage university should design common distillation plant for Science Department.
- Reduce chemical waste formation in Chemistry laboratory, adopt the principles of green chemistry to reduce chemical waste.
- Pipes, overhead tanks and plumbing system should be maintained properly to reduce leakages and wastages of water.

Chapter IV

Energy audit

Energy is one of the major inputs for the economic development of any country. The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect. Also it can be said as "the strategy of adjusting and optimizing energy, using system and procedure so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems". The energy audit is key to a systematic approach for decision making in the area of energy management. It attempt to balance the total energy inputs with its use, and serve to identify all the energy streams in a facility.

4.1 Electricity audit:

Energy resources utilized by all the departments, support services and the administrative buildings of Shivaji University, Kolhapur campus include electricity and liquid petroleum. Major use of the energy is at office, canteen, hostel and laboratories, for lighting, transportation, cooking and workshop instruments. Shivaji University has installed solar power plant having a capacity of 180 kW. Electricity is also supplied to the University campus by Maharashtra State Electricity Board.

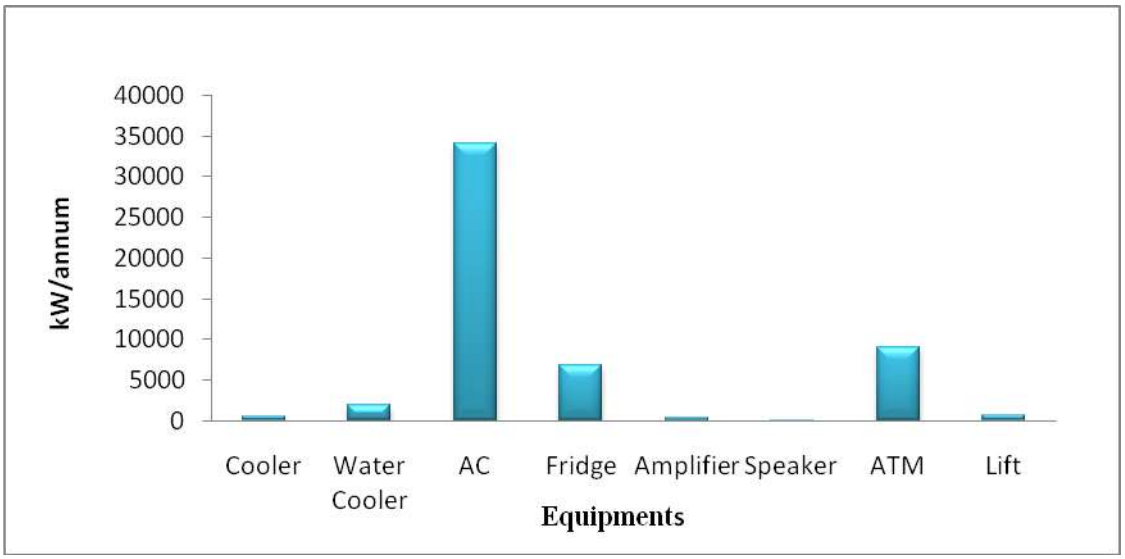
4.1.1 Electricity consumption in the Building Block A:

Building Block A includes Main building, Annex, Examination centre I, Exam centre II, Distance Education. The calculations are based on the data collected from all these buildings and actual observations taken at the site. The collected data shows that all Building Block A have maximum number of major electricity consuming equipments and consumption is 83.49 MW/Annum.

Table No. 4.1: Electricity consumption by major equipments in the Building Block A.

Sr. No.	Equipment	Unit	kW/annum
1	Cooler	4	480
2	Water Cooler	3	1,987.20
3	AC	34	34,020.00
4	Fridge	2	6,854.40
5	Amplifier	2	399.84
6	Speaker	4	76.16
7	ATM	2	9,000.00
8	Lift	3	677.28
Total		**27**	**83,494.90**

Graph No.4.1: Electricity consumed by major equipments in the Building Block A.



The electricity consumption by major electricity consuming equipments in the Building Block A is 83494.9 kW/annum. As major electricity consuming equipments number of AC is 34

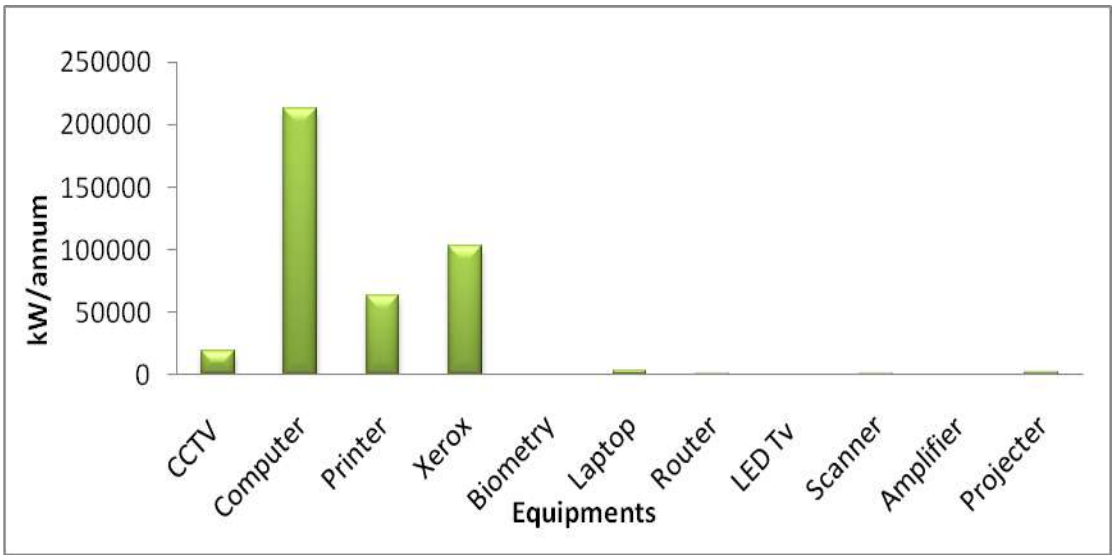
than other equipments and hence, also the electricity consumed by major electricity consuming equipments is highest i.e. 34020 kW/annum. Number of fridge is 2 and the electricity consumption is 6854.4 kW/annum. It is followed by water cooler 1987.2 kW/annum and ATM 9000 kW/annum, lift 677.28 kW/annum and cooler 480 kW/annum respectively.

Similarly, to analyze the electricity consumption of office equipments like computers, printers, laptops were also considered.

Table No. 4.2: Office equipments and their electricity consumption in Building Block A.

Sr. No.	Equipment	Number	kW/annum
1	Computer	512	2,13,248.00
2	Printer	107	63,665.00
3	Projector	7	2023.00
4	Laptop	36	3427.20
5	Scanner	3	612.00
6	CCTV	332	18963.00
7	Biometry Machine	6	51.00
8	Xerox machine	42	102816.00
9	Router	24	822.528
10	LED TV	8	326.40
11	Amplifier	2	244.80
Total		**1079**	**4,06,200.00**

Graph No. 4.2: Office equipments and their electricity consumption in Building Block A.



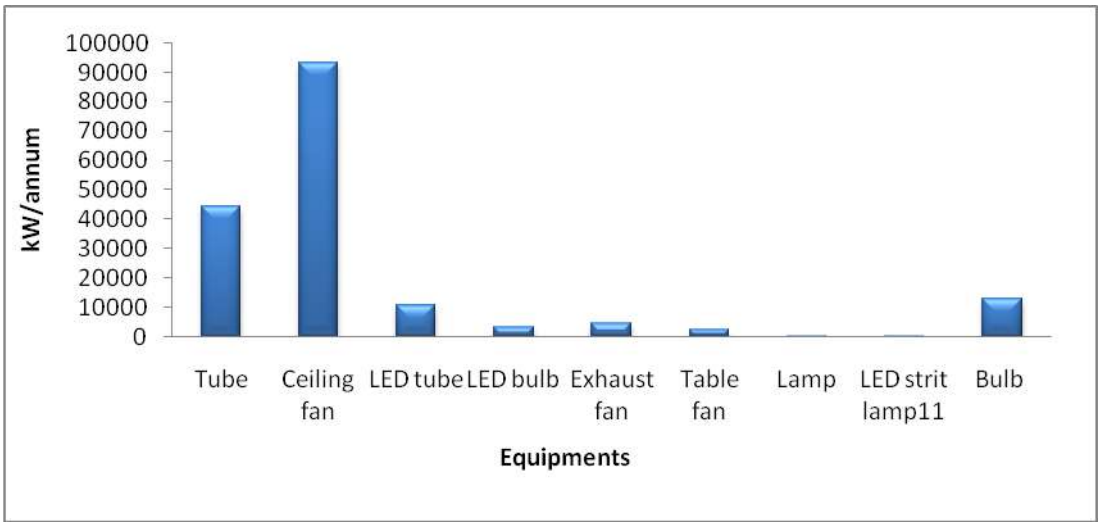
Total number of office equipments consuming electricity at all departments is 406.20 MW/annum. As office equipment, and number of computers is highest i.e. 512 than Printers, Laptops, LCD projectors and Xerox machine, the electricity consumed by computers is maximum i.e. 213248 kW/annum followed by Printers 63665 kW/annum, Xerox machine 102816 kW/annum, CCTV 18963 kW/annum, Laptop 3427.2 kW/annum respectively. Other equipments like biometry machine, scanner, amplifier, router etc, number is less and therefore, their consumption is also less.

Similarly, to analyze the electricity consumption, lights and fans and other illumination equipments were also considered.

Table No. 4.3: Number of fluorescent tubes, bulbs and fans and their electricity consumption in Building Block A.

Sr. No.	Equipments	Number	kW/annum
1	Tube	870	44,370.00
2	Ceiling Fan	608	93,024.00
3	Exhaust Fan	40	4,624.00
4	LED Tube	443	10,844.60
5	LED bulb	302	3,491.12
6	Table fan	27	2,643.84
7	Lamp	32	217.60
8	LED street light	511	101.73
9	Bulb	60	13,096.80
Total		**2440**	**1,72,414.00**

Graph No.4.3: Electrical Equipments and their Electricity Consumption in Building Block A.



Maximum use of electricity is for lighting and fans in all the buildings in Building Block A. The total number of tubes is 870 and their consumption is 44370 kW/annum. The total number of ceiling fans is 608 and their electricity consumption is highest i.e. 93024 kW/annum and also the electricity consumed by LED tube, bulb is maximum i.e. 10844.6 kW/annum and 13096.8 kW/annum respectively. The consumption of other equipments such as table fan, lamp and exhaust fan number is very small as compared to other equipments.

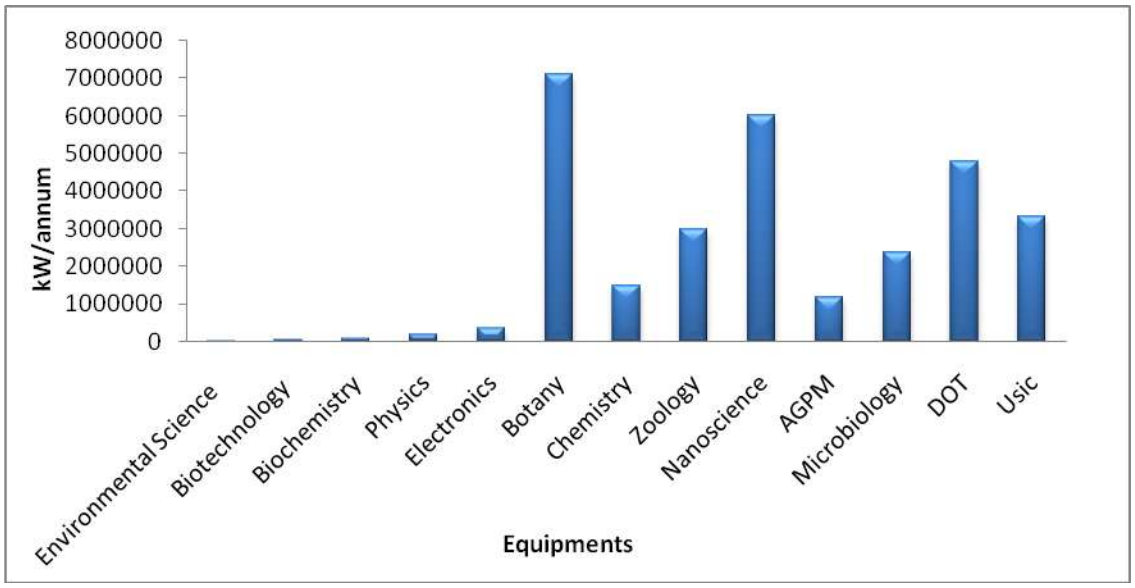
4.1.2 Electricity Consumption in Building Block B.

Electricity is utilized at all Science Departments as many equipments are used in laboratory and some of them are run every day for 24 hrs. Total 30,035 MW/annum of electricity is consumed in the laboratories alone.

Table No.4.4: Electricity consumed by laboratory equipments in Building Block B.

Sr. No.	Department	Equipments	kW/annum
1	Environmental Science	73	26,405.25
2	Biotechnology	70	48,131.00
3	Biochemistry	70	90,101.25
4	Physics	122	1,91,042.80
5	Electronics	48	3,72,796.00
6	Botany	193	71,02,100.00
7	Chemistry	125	15,00,770.00
8	Zoology	101	29,96,572.00
9	Nanoscience	100	60,04,459.00
10	Microbiology	20	23,79,676.00
11	DOT	265	47,84,507.00
12	AGPM	27	11,98,037.00
13	USIC	35	33,40,500.00
Total		**1249**	**3,00,35,097.00**

Graph No 4.4: Electricity consumed by laboratory equipments in Building Block B.

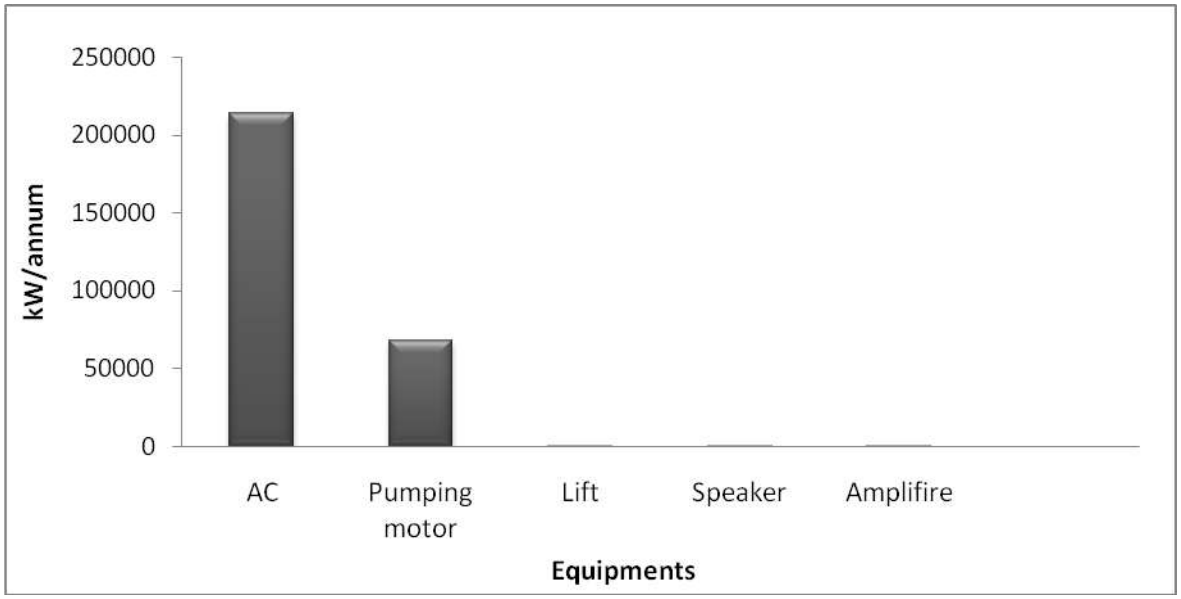


Botany Department has 193 laboratory equipment units and thus utilizes highest electricity 71,02,100 kW/annum. Equipments from School of Nanoscience consume second highest electricity consumption i.e. 60,04,459 kW/annum and their number of laboratory equipment is 100. Department of Technology has maximum lab equipments i.e. 265 but their electricity consumption is comparatively lower than Botany and Nanoscience department i.e. 47,84,507 kW/annum. Department of Environmental Science shows lowest electricity consumption i.e. 26,405.25 kW/annum and total number of equipments are 73. Followed by Zoology i.e. 29,96,572 kW/annum, AGPM i.e. 11,98,037 kW/annum, Microbiology i.e. 23,79,676 kW/annum, USIC i.e. 33,40,500 kW/annum etc.

Table No. 4.5: Electricity consumption by major electricity consuming equipments.

Sr. no	Equipments	Number	kW/ annum
1	Air conditioner (AC)	56	214200
2	Amplifier	1	5.95
3	Pumping motor	20	68000
4	Speaker	20	49
5	Lift	1	340
Total		**98**	**282595**

Graph No. 4.5: Electricity consumption by major electricity consuming equipments.



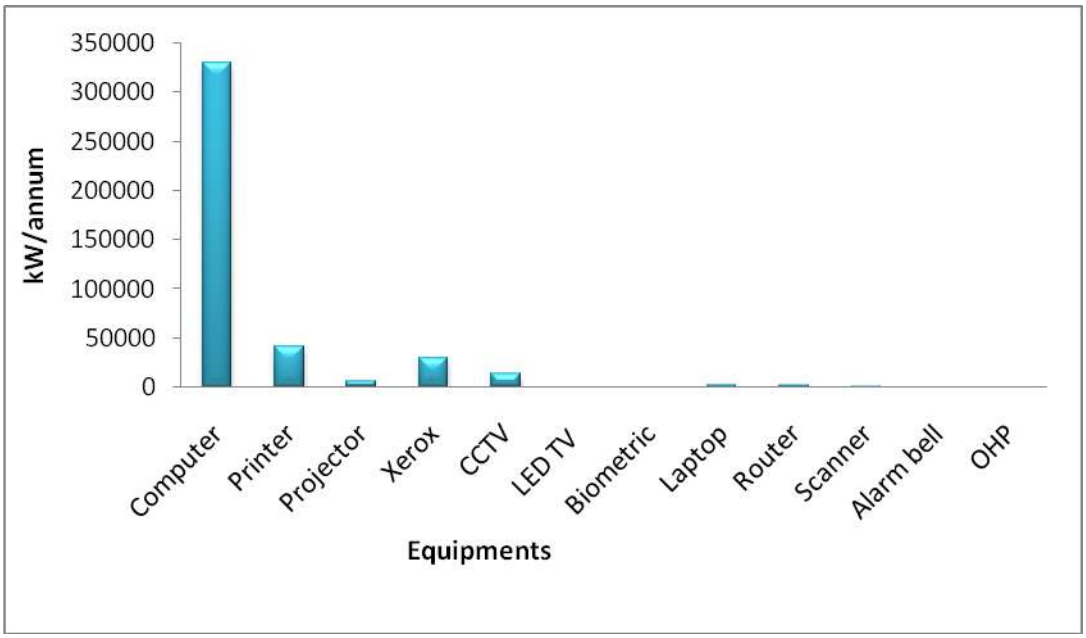
Total 282.59 MW/annum of electricity is consumed by all Air Conditioners, Pumping Motors, Amplifiers, Speakers and Lift in Building Block B. In this block 56 Air conditioners utilize maximum electricity of 2,14,200 kW/annum also 20 pumping motors are consume 68,000

kW/annum. This is followed by Lift i.e. 340 kW/annum, Amplifiers i.e. 5.95 kW/annum, and Speakers i.e. 49 kW/annum.

Table No. 4.6: Office equipments and their electricity consumption in Building Block B.

Sr. No.	Equipment	Number	kW/annum
1	Computer	925	330225.00
2	Printer	141	41947.50
3	Projector	41	5924.50
4	Laptop	82	2927.40
5	Scanner	5	680.00
6	CCTV	239	13651.70
7	Biometry Machine	10	13.60
8	Xerox Machine	16	30464.00
9	Router	60	2056.32
10	LED TV	11	134.64
11	Alarm bell	10	1224.00
12	OHP	1	56.10
Total		**1532**	**428082.00**

Graph No.4.6: Office equipments and their electricity consumption in Building Block B.

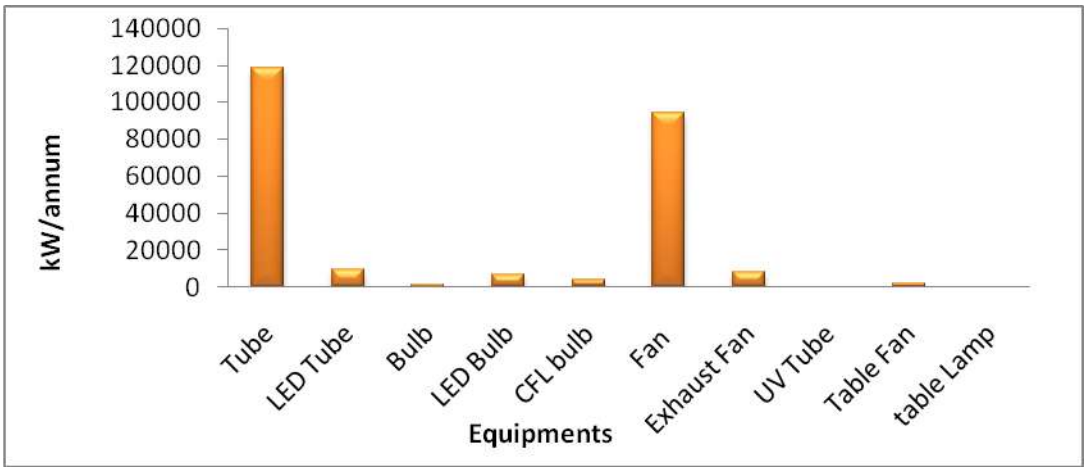


Total number of office equipments at all Science departments i.e. Building Block B electricity consumption is 428.08MW/annum. As office equipments, number of computers is highest i.e. 925 than Printers, Laptops, LCD projectors and Xerox machines. The electricity consumption by computers is also maximum i.e. 3,30,225 kW/annum followed by Printers 41,947.5 kW/ annum, Xerox machines 30,464 kW/annum, CCTV 13,651.7 kW/annum, Laptop 2,927.4 kW/annum respectively and other equipments like biometry machine, scanner and routers etc. consumption is less.

Table No. 4.7: Number of fluorescent tubes, bulbs and fans and their electricity consumption in Building Block B.

Sr. No.	Equipments	Number	kW/annum
1	Tube	1987	118227.00
2	Bulb	21	1713.60
3	LED Tube	396	9424.80
4	LED Bulb	280	6664.00
5	CFL Bulb	140	3808.00
6	Fan	1056	94248.00
7	Table fan	27	1927.80
8	UV tube	1	3.06
9	Exhaust Fan	88	8138.24
Total		**4000**	**244168**

Graph No.4.7: Number of fluorescent tubes, bulbs and fans and their electricity consumption in Building Block B.



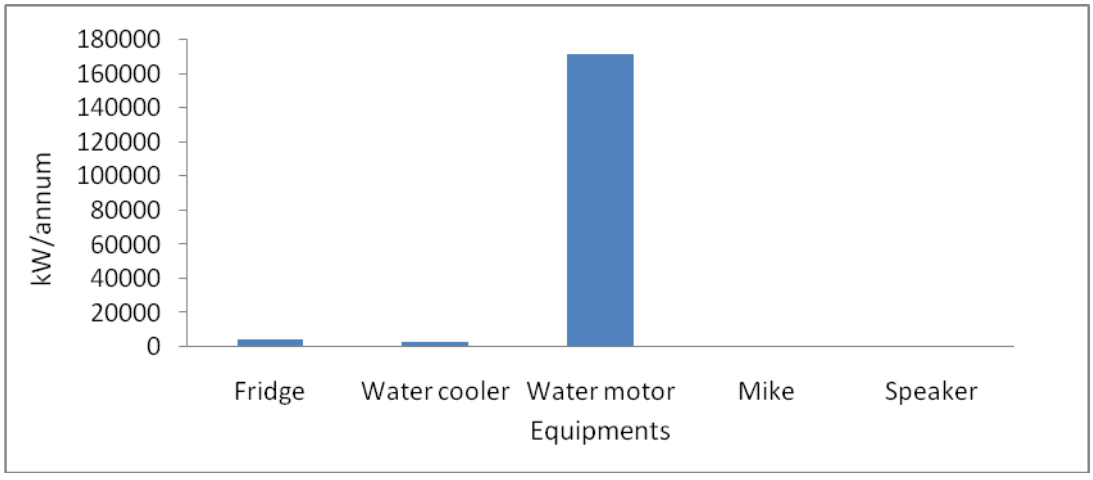
The total number of fluorescent tubes is highest i.e. 1987 and their electricity consumption is also highest i.e. 1,18,227 kW/annum. In the Building Block B total number of fans is 1056 and their electricity consumption is maximum i.e. 94,248 kW/annum. Followed by LED tubes i.e. 9,424.8 kW/annum, LED bulb i.e. 6,664 kW/annum, CFL bulb i.e. 3,808 kW/annum, Exhaust fan i.e. 8,138.24 kW/annum respectively and other equipment i.e. table fan, table lamp, bulb etc. but their electricity consumption is less.

4.1.3 Electricity consumption in Building Block C.

Table No. 4.8: Electricity consumption by major electricity consuming equipments in Building Block C.

Sr. no	Equipments	Number	kW/ annum
1	Fridge	4	4896
2	Water cooler	4	2815.2
3	Motor	8	171360
4	Mike	4	40.8
5	Speaker	19	387.6
Total		**39**	**179500**

Graph No. 4.8: Electricity consumption by major electricity consuming equipments in Building Block C.

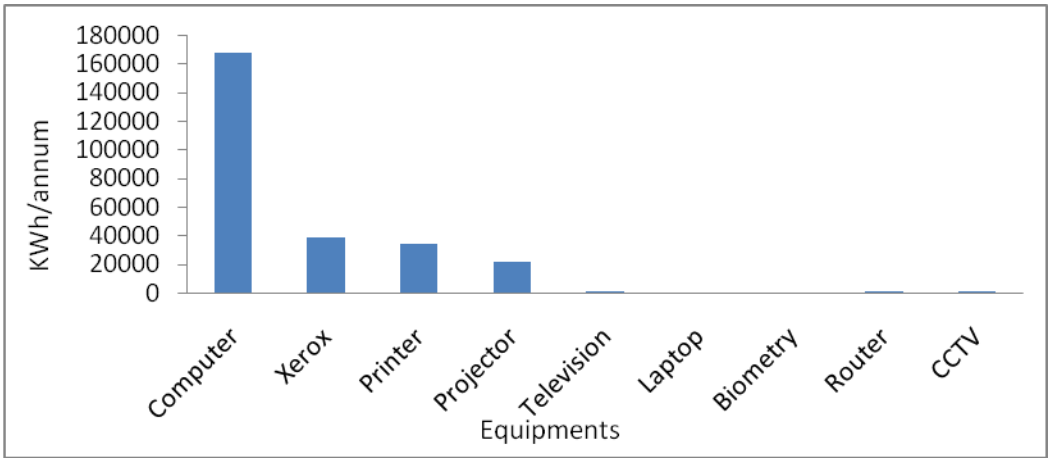


Total 179.50 MW/annum ofyticirtcele is consumed by all fridge, pumping motor, water cooler, speaker and mike in Building Block C. In this Block 8 motors utilize maximum electricity of 1,71,360 kW/annum, 4 water cooler consume 2,815.2kW/annum which is followed by fridges i.e. 4,896 kW/annum and speakers i.e. 387.6 kW/annum.

Table No. 4.9: Office equipments and their electricity consumption in Building Block C.

Sr. No.	Equipment	Number	kW/annum
1	Computer	469	167433.00
2	Xerox Machine	14	38080.00
3	Printer	81	34425.00
4	Projector	37	21386.00
5	Television	11	1346.40
6	Laptop	2	171.36
7	Biometry Machine	2	24.00
8	Router	30	1028.16
9	CCTV	15	856.80
Total		**661**	**264751.00**

Graph No.4.9: Office equipments and their electricity consumption in Building Block C.

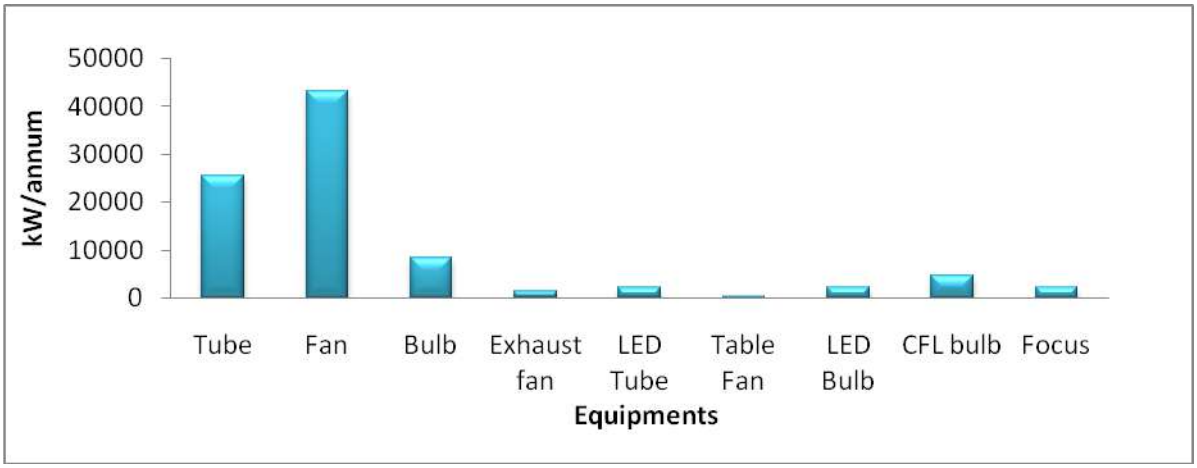


The electricity consumption of office equipments at all buildings from Building Block C is 264.75MW/annum. In the office equipments the number of computers is highest i.e. 469 than Printers, Laptops, Projectors and Xerox machine and hence, the electricity consumed by computers is also maximum i.e. 1,67,433 kW/annum followed by Printers 34,425 kW/annum, Xerox machine 38,080 kW/annum respectively and other equipment like biometry machine, CCTV, Laptop, scanner and number is less and therefore, their consumption is less.

Table No.4.10: Number of Fluorescent Tubes, Bulbs and Fans and their electricity consumption in Building Block C.

Sr. No.	Equipments	Number	kW/annum
1	Tube	714	25849.80
2	Fan	423	43146.00
3	Bulb	103	8404.80
4	Exhaust fan	19	1405.70
5	LED Tube	162	2203.20
6	Table fan	8	489.60
7	LED Bulb	174	2366.40
8	CFL Bulb	142	4828.00
9	Focus	34	2427.60
Total		**1779**	**90761.10**

Graph No.4.10: Number of fluorescent tubes, bulbs and fans and their electricity consumption in Building Block C.



The total number of fluorescent tube is highest i.e. 714 and their electricity consumption is 25,849.8 kW/annum. Total number of fans in Building Block C is 423 and their electricity consumption is maximum i.e. 43,146 kW/annum. It is followed by LED tubes i.e. 2,203.2kW/annum, LED Bulb i.e. 2,366.4 kW/annum, CFL Bulb i.e. 4,828 kW/annum, Exhaust fans i.e. 1,405.7 kW/annum respectively. The equipments like table fan, table lamp, bulb are less in number and their consumption is less as compared to other equipments.

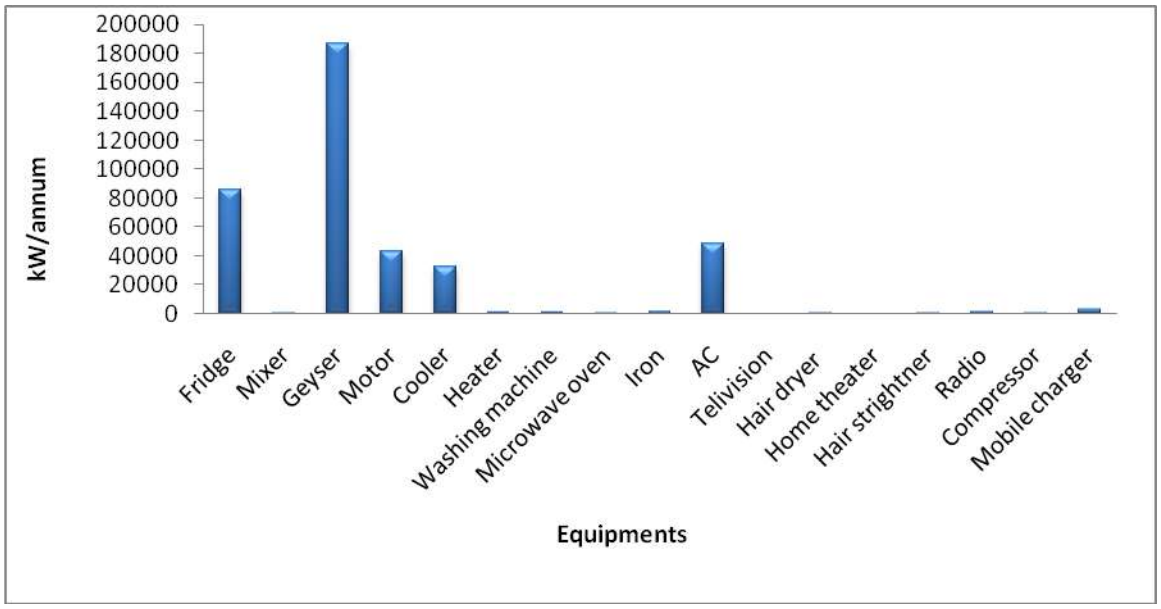
4.1.4 Electricity consumption at Building Block D:

Building Block D includes Support services like Ladies hostel, Boy's hostel, Canteen, Gymkhana, Library , Quarters, Guest House and Health centre the collected data shows that the Support services has maximum number of major electricity consuming equipments and electricity consumption is 408.09 MW/**a**nnum.

Table No.4.11: Electricity consumed per annum by major equipments in Building Block D.

Sr. No.	Equipment	Number	kW/annum
1	Fridge	25	85680.00
2	Mixer	79	537.20
3	Geyser	98	186592.00
4	Motor	25	44640.00
5	Cooler	10	32844.00
6	Heater	2	1020.00
7	Washing Machine	29	1133.90
8	Microwave oven	10	212.50
9	Iron	46	1876.80
10	AC	10	48600.00
11	Television	92	110.40
12	Hair dryer	6	204.00
13	Home theater	5	89.25
14	Hair straightener	7	124.95
15	Radio	40	1428.00
16	Compressor	1	495.00
17	Mobile charger	3000	2856.00
18	Lift	1	340.00
19	other	26	1104.83
Total		**3518**	**408088.87**

Graph No.4.11: Electricity consumption by major instruments in Building Block D.



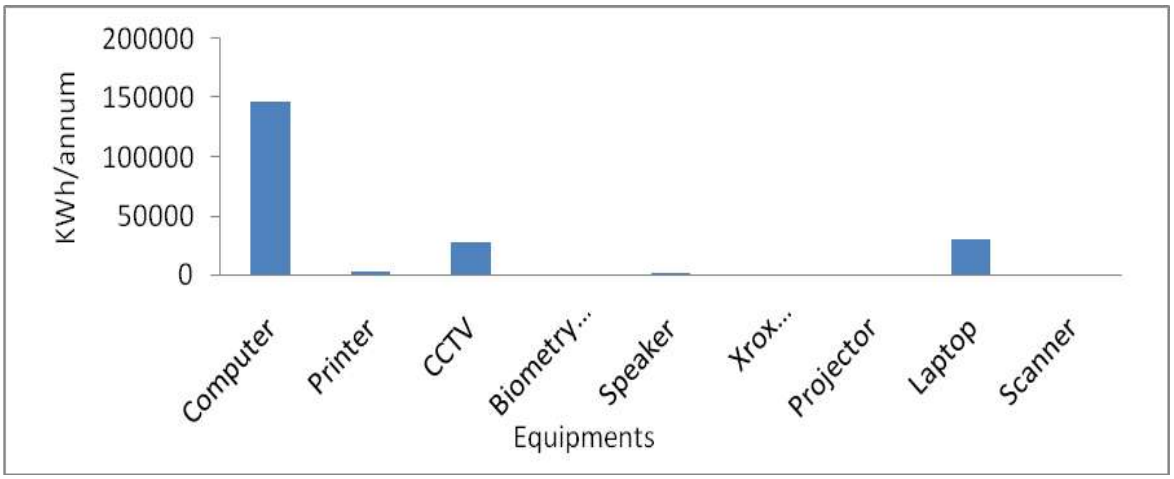
Total number of major electricity consuming equipments in Building Block D is 3518 and electricity consumption is 4,08,088.87 kW/annum. Major electricity consuming equipments, number of Geyser is 98 and electricity consumption is highest i.e. 1,86,592 kW/annum. Number of fridge is 25 in Building Block D but the electricity consumption is maximum i.e. 85,680 kW/annum which is followed by Motors i.e. 44,640 kW/annum, Cooler i.e. 32,844 kW/annum, AC i.e.48,600 kWh/annum respectively and other equipment like radio, mixer, heater, washing machine, microwave oven, Iron, AC, television, hair dryer, home theatre, hair straightener, mobile charger, lift, compressor etc. are less in number and therefore, their consumption is less.

Similarly, the electricity consumption of office equipments like computers, printers, laptops were also considered.

Table No. 4.12:Office equipments and their electricity consumption in Building Block D.

Sr. No.	Equipment	Number	kW/annum
1	Computer	352	146608
2	Printer	64	3808
3	CCTV	490	27988.8
4	Biometry machine	12	171.36
5	Speaker	23	2737
6	Xrox machine	22	1196.8
7	Projector	7	1416.1
8	Laptop	320	30464
9	Scanner	7	1904
10	Router	59	3092.54
Total		**1356**	**216308.1**

Graph No. 4.12: Office equipments and their electricity consumption in Building Block D.



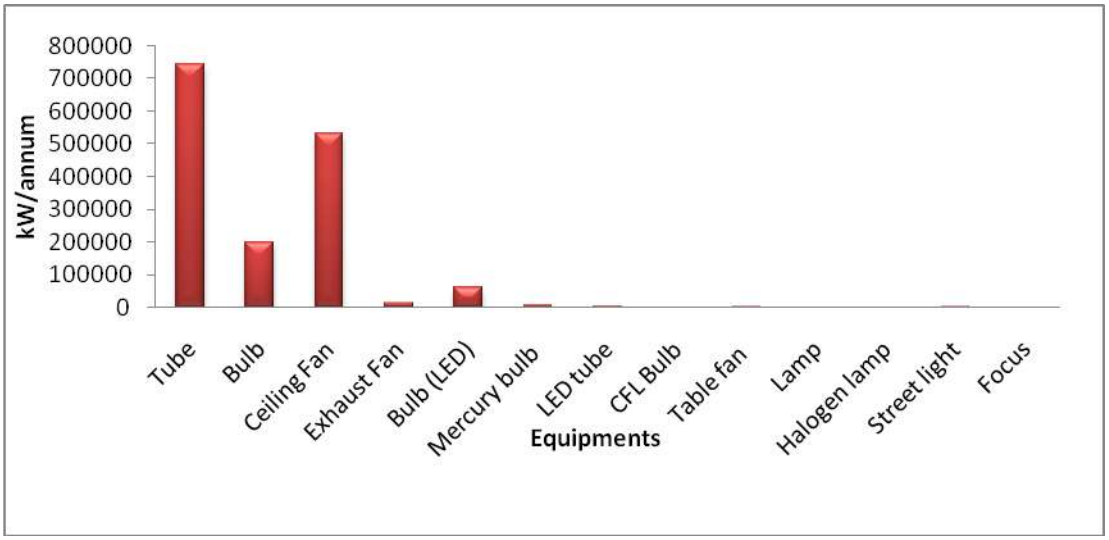
Total number of office equipments in Building Block D is 1356 and electricity consumption is 216.31 MW/annum. Computers number is 352 and electricity consumption is maximum i.e. 1,46,608 kW/annum, followed by Laptop i.e.30,464 kW/annum, CCTV i.e. 27,988.8kW/annum respectively and the equipment like printer, biometry machine, speaker, Xerox machine, projector, scanner, router etc. as their number is less and consumption is respectively less.

Similarly, to analyze the electricity consumption, lights and fans were also considered.

Table No. 4.13: Number of fluorescent tubes, bulbs and fans and their electricity consumption in Building Block D.

Sr. No.	Equipments	Number	kW/annum
1	Tube	4333	742502.88
2	Bulb	1168	200148.48
3	Ceiling Fan	1984	531216.00
4	Exhaust fan	105	13594.56
5	Bulb (LED)	325	61880.00
6	Mercury bulb	30	7711.20
7	LED tube	134	4556.00
8	CFL bulb	1	228.48
9	Table fan	24	1713.60
10	Lamp	41	409.84
11	Halogen lamp	12	685.44
12	Street Light	40	2284.80
13	Focus	1	46.240
Total		**8198**	**1566977.50**

Graph No.4.13: Number of fluorescent tubes, bulbs and fans and their electricity consumption Building Block D.



The total number of fluorescent tubes is 4,333 and their electricity consumption is 7,42,502.88 kW/annum. The total number of ceiling fans is 1984 and their electricity consumption is 5,31,216 kW/annum, which is followed by exhaust fans i.e. 13,594.56 kW/annum LED bulb i.e.61,880 kW/annum, bulbs i.e. 61,880 kW/annum respectively and equipments like mercury bulb, LED tube, CFL bulb, table fan, lamp, halogen lamp, street light, and focus etc. number is less and therefore, their consumption is comparatively less.

4.1.5 Preventive Measures:

- University has many areas where lighting is not required at all times. Installing sensor based lighting in such areas can generate massive rewards. This is one of the easiest ways to save energy at university.
- If most systems in computer laboratory and instrumentation laboratory are based on old technology, they might be consuming more power than new technology.
- Replacing old computers and instruments with ones having energy efficiency certifications is the easiest way to conserve energy at university.
- By installing more solar energy panels generate more electricity and minimize their electricity bill. In the hostels increases use of solar water heater is needed.

- Investment in solar lights for outdoor lighting can generate long term benefits.
- A huge amount of energy is wasted because no one really cares about switching off the fans and lights when not required. Hence, planning workshops on energy conservation to educate students, faculty and staff can generate huge results.
- Unplug overhead projectors, computers, and smart boards when not in use. This simple way to conserve energy can help save large amount of power and money in the long run.

4.2 Fuel Energy Audit:

The fuel energy audit determines the approximate use of petrol or diesel by the vehicles inside the university. It also includes the efforts taken by the university to conserve the fuel.

The conventional source of fuel for the vehicle is petrol and diesel. Maximum students, teaching and non teaching staff of university and visitors use two wheeler and four wheeler vehicles. So, the data regarding fuel utilization for students, teaching and non teaching staff of university and visitor are monitored in the study. For the purpose of the fuel energy audit the entire university campus with infrastructure is divided into following groups. With respect to the mentioned classes the survey was carried out regarding the petrol/diesel fuel use in by students, teaching and non teaching staff and visitors coming with vehicles on the campus.

Sr. No.	Buildings Blocks
1	A (Administrative building)
2	B (Science departments)
3	C (Commerce, Humanities and Social science)
4	D (Support services)

4.2.1 Building Blocks A (Administrative building):

It includes buildings of Main building, Examination Section, Annex building and Distance Education building.

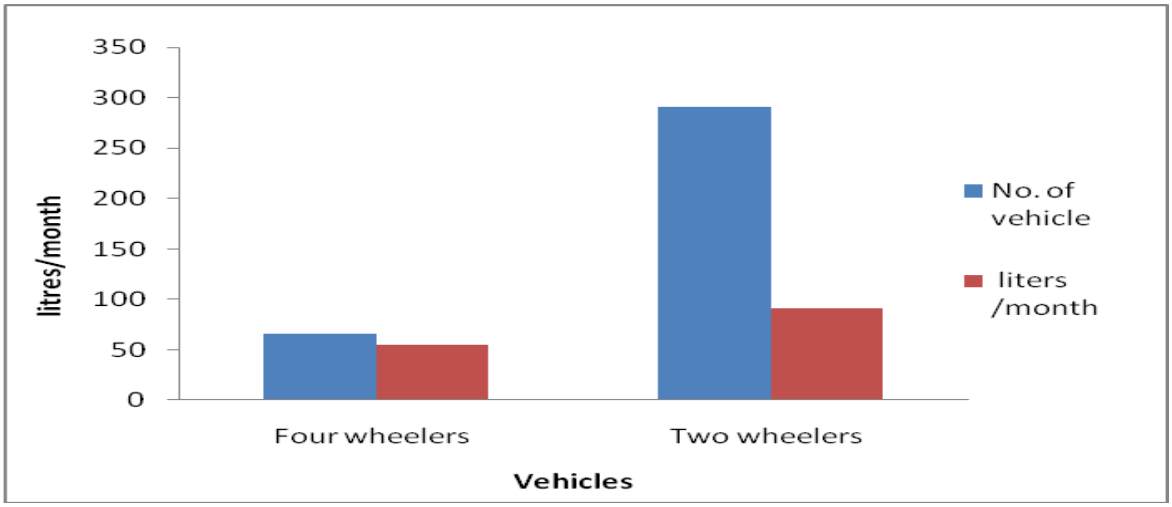
Building block A consists of following sections of the university:-

Sr. No	Departments in Building Blocks A
1	Examination Section building
2	Annex building
3	Main building
4	Distance Education building

Table No. 4.14:- Number of vehicles and their fuel consumption at Building Block A.

Sr. No.	Vehicle	Four wheelers	Two wheelers	Total fuel liters/month	Total fuel liters/year
1	No. of vehicles	66	291	145.94	1,751.25
2	Average liters of fuel/month	55	90.93		
3	Maximum	Main building 26.67 lit/month	Main building 44.68 lit/month		
4	Minimum	Distance Education building 7.5 lit/month	Annex building 11.87 lit/month		

Graph No. 4.14: Number of vehicles and their fuel consumption at Building Block A



The vehicles coming to building block A includes buildings like university main building, Annex building, Examination building and Distance Education building. The vehicle coming to this building as regular and visitor's vehicle includes 66 four wheelers and 291 two wheelers daily. The average fuel consumed by four wheelers is 55 lit/month and 90.93 lit/ month by two wheelers. The maximum fuel consumed is 26.67 lit/ month by four wheelers coming to the main building and 44.68 lit/ month by two wheelers coming to the Main building. The minimum fuel consumed is 7.5 lit/ month by four wheeler visiting to the Distance Education building and 11.87 lit/ month is consumed by two wheelers coming to the Annex building. The total fuel consumed by the vehicles coming to the Building Block A is 145.94 lit/month and 1,751.25 lit/ year by both two wheelers and four wheelers.

4.2.2 Building Block B (Science Departments)

It includes Departments such as Environmental Science, Botany, Microbiology, Physics, Biotechnology, School of Nano Science and Technology, Chemistry, Agrochemicals and Pest Management, Zoology, Biochemistry, Computer Science, Technology, Electronics, Mathematics, Statistics, Food Science and Technology, Geography, USIC, Computer Science, and Department of Technology (DoT).

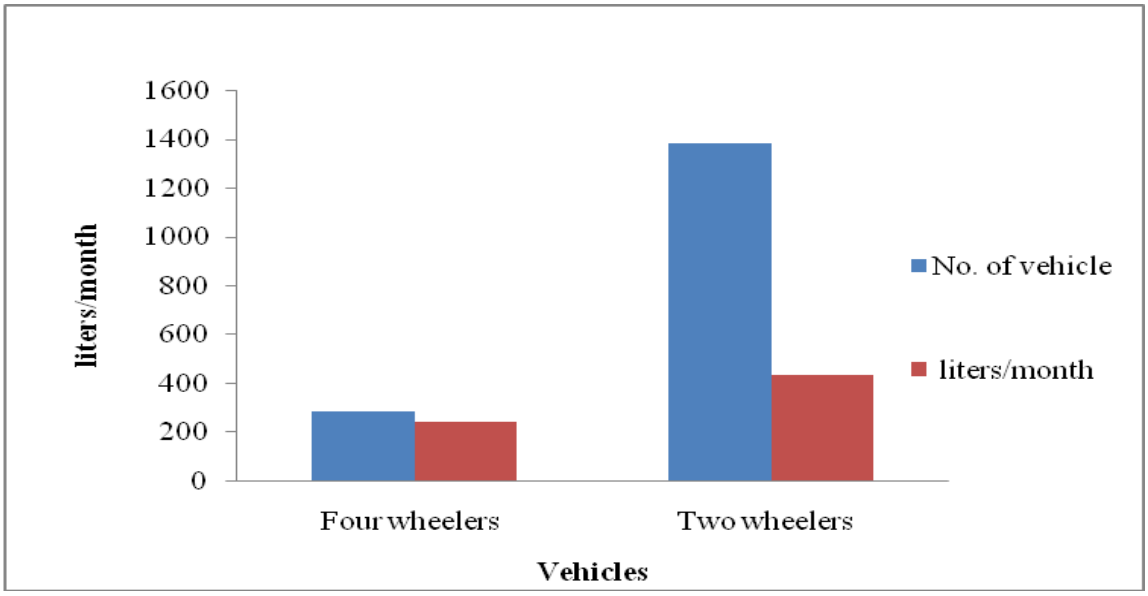
Building Block B consists of following Departments of University:

Sr. No	Departments Name	Sr. No	Departments Name
1	Environment Science	10	Bio-chemistry
2	Botany	11	Electronics
3	Microbiology	12	Statistics
4	Physics	13	Geography
5	Biotechnology	14	USIC
6	Zoology	15	Computer Science
7	Chemistry	16	Department of Technology
8	School of Nano Science and Technology	17	Food Science and Technology
9	AGPM		

Table No. 4.15: Number of vehicles and their fuel consumption at Building Block B.

Sr. No.	Vehicle	Four wheelers	Two wheelers	Total fuel consumption lit/month	Total fuel lit/year
1	No. of vehicle	285	1,382	**669.38**	**8,032.50**
2	Average liters of fuel/month	237.5	431.87		
3	Maximum lit/month	DOT 95.83 lit/month	DOT 103.75 lit/month		
4	Minimum lit/month	AGPM 2.5 lit/month	Electronics 3.75 lit/month		

Graph No. 4.15: Number of vehicles and their fuel consumption at Building Block B.



The vehicles coming to the Building Block B which includes various Science and Technology departments including University Science Instrumentation Centre. The vehicles coming to these buildings regularly and visitor vehicles include 285 four wheelers and 1,382 two

wheelers daily. The average fuel used by four wheelers is 237.50 lit/month and 431.87 lit/month by two wheelers. The maximum fuel consumed is 95.83 lit/month by four wheelers coming to the Department of Technology and 103.75 lit/month by two wheelers coming to the Department of Technology. The minimum fuel consumed is 2.5 lit/month by four wheelers visiting AGPM department and 3.75 lit / month is consumed by two wheelers coming to the Electronics department. The total fuel consumed by the vehicles coming to the Building Block B 669.38 lit/month and 8,032.51 lit/year by two wheelers and four wheelers respectively.

4.2.3 Building Block C (Commerce, Humanities and Social Science)

Building Block C includes departments such as Political Science, Sociology, Economics, History, Centre for Women Studies, Marathi, Hindi, Foreign Language, English, Music and Dramatics, Mass Communication, Dr. Babasaheb Ambedkar Centre for Research and Development, Law, Journalism, YCSRD, Shahu Shanshodan Kendra, Lok Vikas Kendra, Commerce and Management, Centre for Social Exclusion and Inclusive Policy, Gandhi Study Centre, Nehru Study Centre, and Yashwantrav Chavan Adyasan.

Building Block C consists of following departments of university:

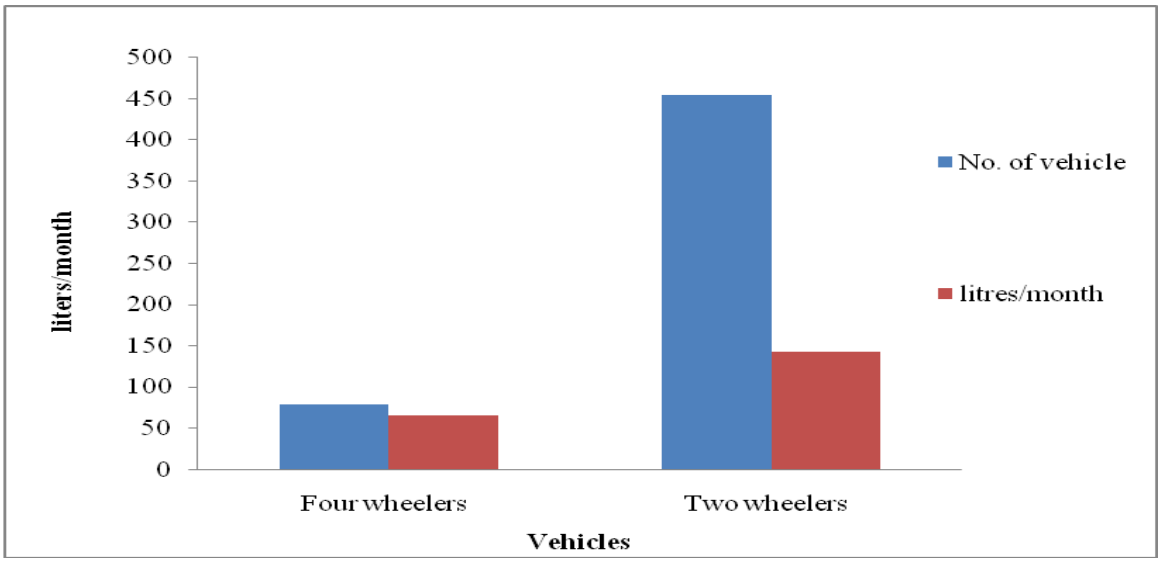
Sr. No.	Departments in Building Block C
1	Political Science
2	Sociology
3	Economics
4	History
5	Centre for Women Studies
6	Marathi
7	Hindi
8	Foreign Language
9	English
10	Music and Dramatics
11	Mass Comunication

12	Dr. Babasaheb Ambedkar Centre for Research Development
13	Law
14	Journalism
15	YCSRD
16	Shahu Shanshodan Kendr
17	Lok Vikas Kendr
18	Commerce and Management
19	Centre for Social Exclusion and Inclusive Policy
20	Gandhi Study Centre
21	Nehru Study Centre
22	Yashwantrav Chavan Adyasan

Table No.4.16: Number of vehicles and their fuel consumption at Building Block C

Sr. No.	Vehicle	Four wheelers	Two wheelers	Total Fuel consumption lit/month	Total fuel lit/year
1	No. of vehicle	79	455	**208.02**	**2,496.26**
2	Average liters of fuel/month	65.83	142.18		
3	Maximum lit/month	Marathi Department 8.34 lit/month	Economics 14.37 lit/month		
4	Minimum lit/month	Lok Vikas Kendr 0.84 lit/month	Gandhi Study Centre 2.18 lit/month		

Graph No. 4.16: Number of vehicles and their fuel consumption at Building Block C



The vehicles coming to the Building Block C include various departments coming under Commerce, Humanities and Social Sciences. The vehicles coming to these building regularly and visitors vehicles include 79 four wheelers and 455 two wheelers daily. The average fuel used by four wheelers is 65.83 lit/ month and 142.18 lit/month by two wheelers. The maximum fuel consumed is 8.34 lit/month by four wheelers coming to the Marathi Department and 14.37 lit/month by two wheelers coming to the department of Economics. The minimum fuel consumed is 0.84 lit /month by four wheelers visiting Lok Vikas Kendra and 2.18 lit/ month consumed by two wheelers coming to the Gandhi Study Centre. The total fuel consumed by the vehicles coming to the Building Block C is 208.02 lit/ month and 2,496.26 lit/ year by two wheelers and four wheelers.

4.2.4 Building Block D (Support Services)

Building Block D it includes Department of Sports, Library, B. K. Khardekar library, Internet unit, Girls Hostel, Boys Hostel, Vidhyarthi Bhavan, Guest house, Health Centre.

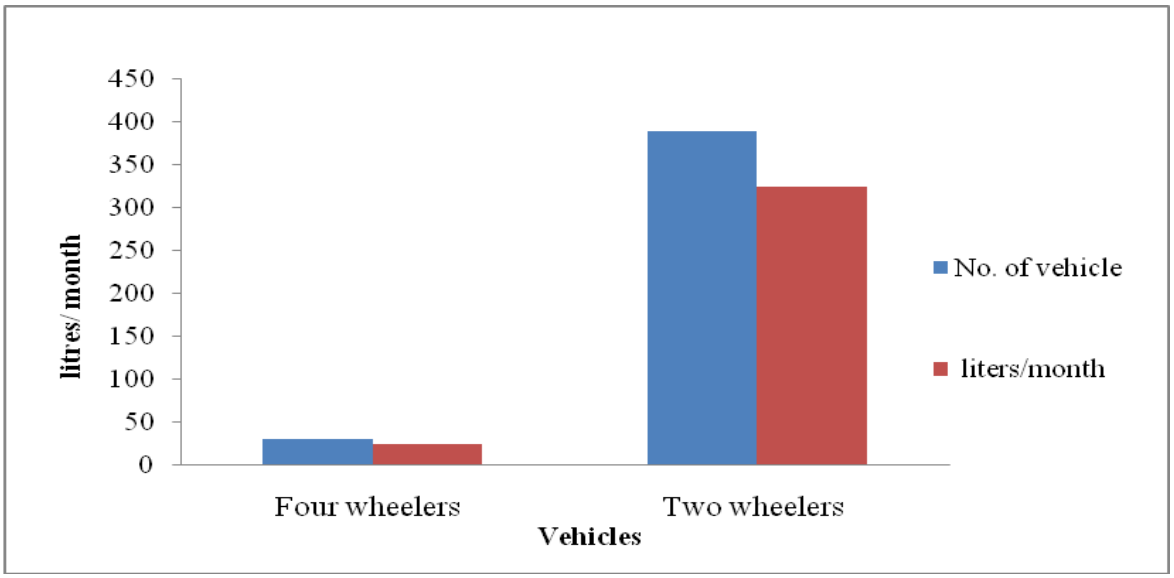
Building D consists of following departments of university:-

Sr. No	Departments in Building Block D
1	Sports
2	Library
3	B. K. Khardekar Library
4	Internet
5	Girls Hostel
6	Boys Hostel
7	Vidhyarthi Bhavan
8	Guest House
9	Health Centre

Table No. 4.17: Number of vehicles and their fuel consumption at Building Block D.

Sr.No	Vehicle	Four wheelers	Two wheelers	Total Fuel liters/ month	Total Fuel liters/year
1	No. of vehicle	29	388	347.5	4,170
2	Average liters of fuel/Month	24.16	323.33		
3	Maximum lit/month	Guest house 5.83 lit/month	Library 35 lit/month		
4	Minimum lit/month	Vidhyarthi Bhavan 0.83 lit/month	Sports 3.43 lit/month		

Graph No. 4.17: Number of vehicles and their fuel consumption at Building Block D.



The vehicles coming to the Building Block D includes buildings of all support services of the university. The vehicles coming to these buildings regularly and visitors vehicles include 29 four wheelers and 388 two wheelers daily. The average fuel use by four wheelers is 24.16 lit/ month and 323.33 lit/ month by two wheelers. The maximum fuel consumed is 5.83 lit/ month by four wheelers coming to the university Guest House and 35 lit/month by two wheelers coming to the B. B. K. Library. The minimum fuel consumed is 0.83 lit/month by four wheelers visiting Vidhyarthi Bhavan and 3.43 lit/month is consumed by two wheelers coming to the Sports department. The total fuel consumed by the vehicles coming to the Building Block D is 347.5 lit/ month and 4,170 lit/ year by two wheelers and four wheelers respectively.

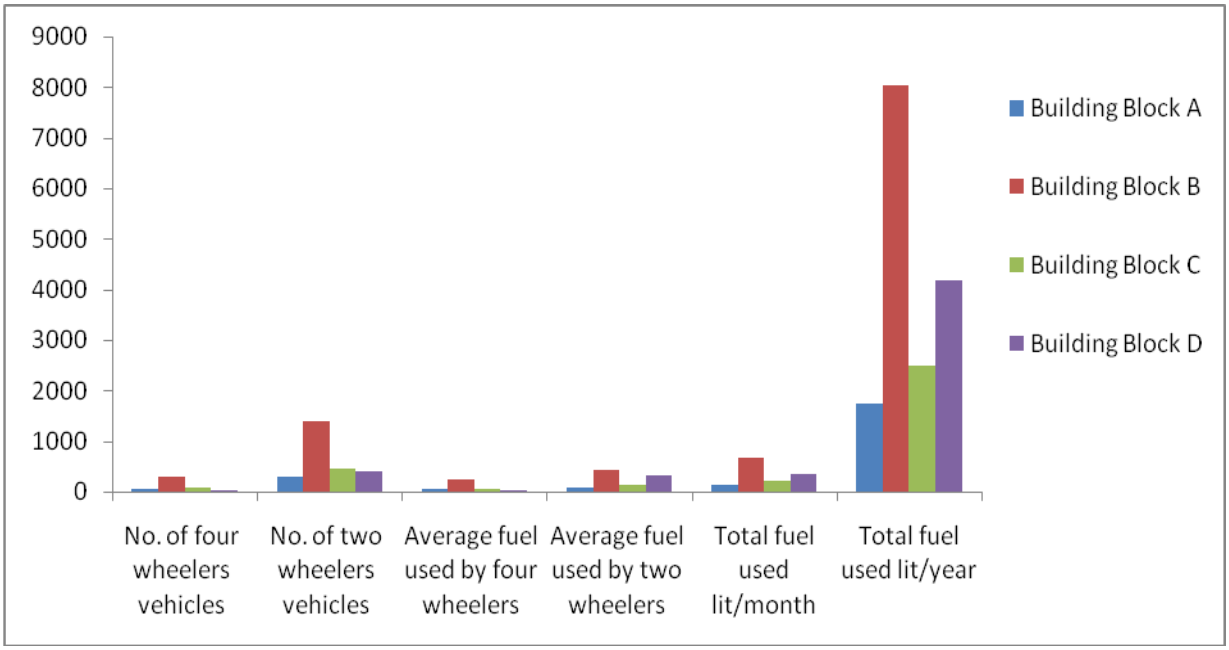
4.2.5 Total fuel consumption on the university campus:

Shivaji University campus is divided into four Building Block as A,B,C,D for smooth collection of data regarding vehicles recorded as two wheelers and four wheelers as well as the vehicles used by staff, faculty, students and the vehicles of visitors coming to the various departments and facilities for the student. While considering the floating vehicles of visitors to each departments and facilities was collected from the gate vehicle record register as well as with the discussion to student, staff and faculty regarding visitors coming to them with vehicle.

Table No. 4.18: Total number of vehicles and their fuel consumption in all Building Blocks of university.

Sr. No	Building sectors	No. of four wheelers vehicles	No. of two wheelers vehicles	Average fuel used by four wheelers/ month	Average fuel used by two wheelers/month	Total fuel used lit/month	Total fuel used lit/year
1	**Building Block A**	66	291	55	90.93	145.94	1,751.28
2	**Building Block B**	285	1,382	237.5	431.87	669.38	8,032.56
3	**Building Block C**	79	455	65.83	142.18	208.02	2,496.24
4	**Building Block D**	29	388	24.16	323.33	347.5	4,170
Total		**459**	**2,516**	**382.49**	**988.31**	**1,370.84**	**16,450.08**

From all the data collected by approved formats, it was found that 459 four wheelers and 2,516 two wheelers visit university campus daily. The consumption of fuel by four wheelers is 382.49 lit/month and 988.31 lit/month by two wheelers. The total consumption of fuel is 1,370.84 lit/month and 1,6450.08 lit/years consumed on the campus. The use of 1,370.84 lit/month of fuel release 146.51 kg/lit of CO_2 where as 16,450.08 lit/year fuel emits 38,328.68 kg/lit of carbon dioxide per year. To sequester this CO_2 which is released by the vehicles requires 1,758.19 number of additional trees to be grown on campus or other remedies like electric vehicles, sharing of the vehicles, use of bicycles and the activities on the campus which can be carried out by E-media be encouraged.



Graph No. 4.18: Total number of vehicles and their fuel consumption in all Building Blocks of university.

4.2.6 Energy conservation practices implemented at Shivaji University:

The administration of Shivaji University is very keen on saving electricity and fuel which is been used on the campus. The university has implemented some unique ideas like 'No Vehicle Day', electrical vehicles on campus, LED lights on campus and installation of Biogas plant at Vidhyarthi Bhavan Building. The various departments also conducted energy conservation awareness programmes, motivation of students, staff and faculty to use public vehicles and programmes like PUC are conducted by various departments.

Following are some of the practices followed by university on the campus to conserve energy and fuel.

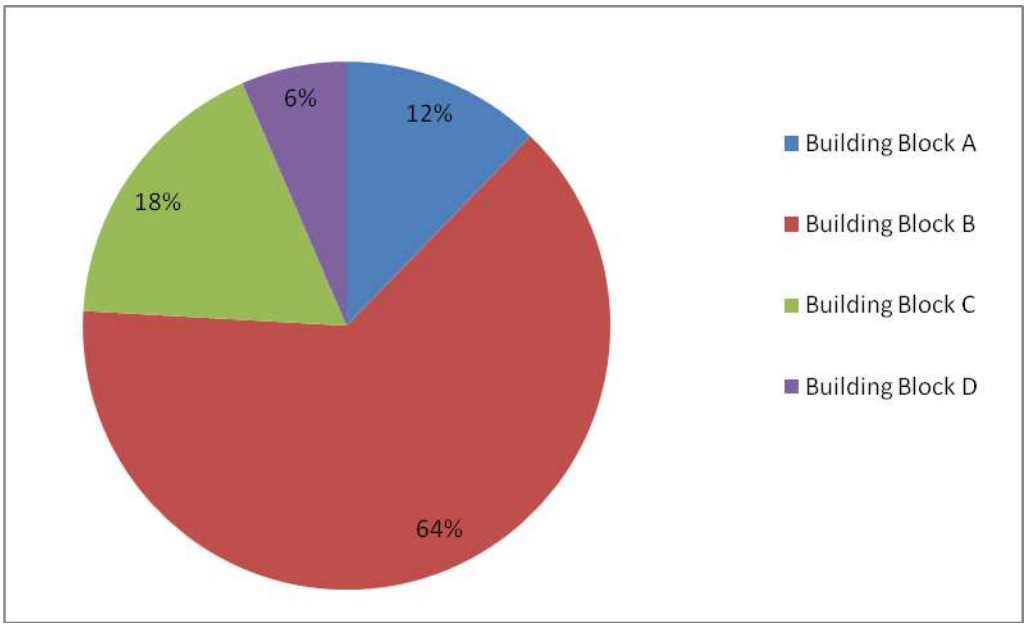
a. No Vehicle Day:

The concept of 'No Vehicle Day' is to reduce emission of CO_2 by minimum use of vehicles on the campus. On the first Saturday of every month 'No Vehicle Day' is observed on the campus since 2013. During this No vehicle Day the vehicles of student, staff, faculty and visitors are not allowed to move on the campus and only essential service vehicles are allowed on the campus.

Table No. 4.19: Average fuel used in liters/day by four wheelers and two wheelers.

Sr. No.	Building Block	Average fuel used litres/day four wheelers	Average fuel used litres/day two wheelers	Total fuel used litres/day
1	Building Block A	1.83	3.63	5.47
2	Building Block B	9.5	17.27	26.77
3	Building Block C	2.63	5.68	8.32
4	Building Block D	0.96	4.85	5.81
Total		**14.93**	**31.45**	**46.38**

Graph No. 4.19: Average fuel used in liters /day by four wheelers and two wheelers.



During this 'No Vehicle Day' the use of four wheelers save 14.93 liters of fuel and two wheeler save 31.45 lit of fuel. In total 46.38 liters of the fuel is saved to be used for vehicles on the campus. This saves 110.85 kg/lit of CO_2 to be released in the environment which is a very good step taken up by a university towards saving our environment. This practice can be replicated by other organisation, institutes and academic institution to reduce CO_2 to Save Earth.

b. Use of Electrical cars in the university campus:

This is another initiative taken by university to save fuel as well as save campus environment. The university has purchased two electric cars which are used on the campus for internal transport of officers, faculty, staff, students and visitors coming to the university. It needs 6 hrs charging for battery on which the car runs for around 30 - 40 km.

Plate No: 4.1. Inoguration of Electric car in University Campus

Plate No: 4.2. Electric Car

c. Solar electricity generation-

Shivaji University under RUSA programme purchased and installed 180 KW Solar power plants for generation of electricity on the terrace of main administrative building. This 180 kilowatt electricity produced is fed to MSEB feeder line with electric meter and the same units of electricity will be deducted from the electricity bill of university. There is ample scope to generate solar electricity on the campus.

d. Use of LED lights

With the time university has taken a policy decision to replace all florescent, CFL bulbs, sodium bulbs, and tubes by LED bulbs and tubes. These LED bulbs and tube lights will reduce consumption of electricity.

e. Energy Conservation Programmes

The energy conservation programmes are conducted in various departments like Environmental Science, Energy Technology, Department of Technology etc. A unique programme of Petroleum ministry named PCRA energy conservation programme is conducted in Department of Environment Science and Department of Energy Technology. The electricity week is also observed in the university through Engineering Section.

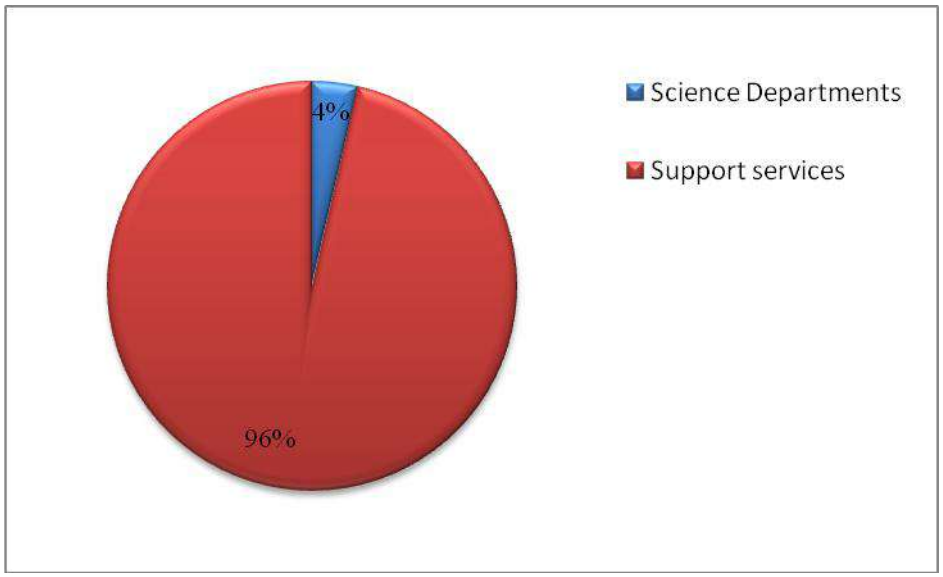
4.3 Fuel energy audit (LPG):

LPG is one of the major important source of energy used in Shivaji Unviersity for various purposes. LPG is mostly required for the laboratory work in Science departments of university and support services including hostel mees, guest house and canteens of university. The description of the use of LPG in university is as follows.

Table No. 4.20 LPG use in Science Departments and Support services Sectors

Sr. No.	Sectors	Kg/annum
1	Science Departments	1192.8
2	Support Services	32,049.4
Total		**33,242.2**

Graph No. 4.20 LPG use in Science Departments and Support Services Sectors



Maximum LPG use is in Support services. It is used as a fuel for canteen, hostel mess, and guest house and staff quarters. The total consumption of LPG is 32,049.4 kg/annum. In the Science departments for laboratory purpose consumption of LPG is 1,192.8 kg/annum.

4.4 Precaution measures

1) No Vehicle day is one of the activities conducted by university which is helpful for the fuel conservation practices. The university needs to continue this activity.
2) The university has purchased and using two electric cars for internal transportation. This activity also conserves the fuel and implements the use of non conventional energy resources. University need to purchase more electric vehicles for internal transport in the university campus.
3) The university needs to arrange the energy conservation program for the purpose of awareness of fuel energy conservation and motivation of students for use of non conventional energy devices.
4) Also need to motivate the students, teaching and non teaching staff to use public vehicles for the transport as well as to take the proper maintenance of the vehicles, so that vehicles consume less quantity of fuel.
5) University needs to use alternative sources instead of use of LPG (Non conventional sources) for laboratory and other sources.

Chapter V

Solid Waste Audit

Solid waste is the unwanted or useless solid material generated from the human activities in residential, industrial or commercial area. Solid waste management reduce or eliminates the adverse impact on the environment and human health. A number of processes are involved in efficiently managing waste for a organisation. It is necessary to manage the solid waste properly to reduce the load on waste management system.

Solid waste generation and its management is a burning issue in current days. The rate of generation of solid waste is very high and yet we do not have adequate technology to manage the generated waste. Unscientific handling of solid waste can create threats to public health and environmental safety issues. Thus, it is necessary to manage the solid waste properly to reduce the load on waste management system. The purpose of this audit is to find out the quantity, volume, type and current management practice of solid waste generation in the Shivaji University campus. This report will help for further solid waste management and to go for green campus development.

5.1 Generation of solid waste in Shivaji University, Kolhapur:

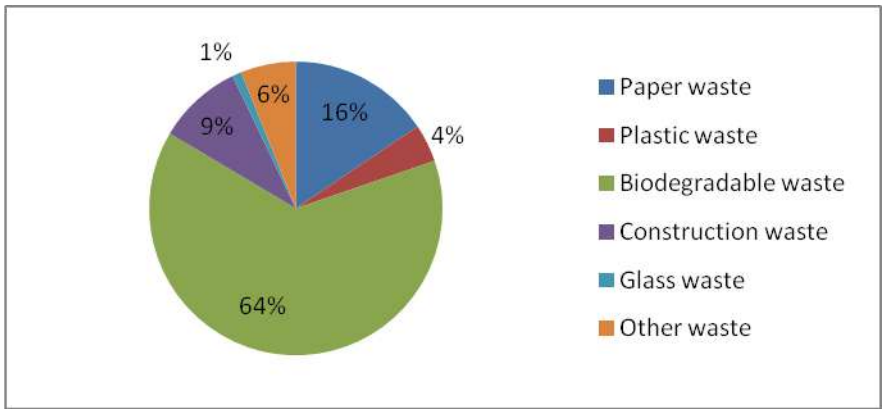
Shivaji University campus solid waste data is collected from Building Block A, Building Block B, Building Block C, Building Block D along with support services. There are different types of waste are recorded such as paper waste, plastic waste, biodegradable waste, construction waste and glass waste etc.

Status of solid waste generation in Shivaji University Campus:

Table No. 5.1: Category wise solid waste generation at University (kg / month)

Category of waste	Paper waste	Plastic waste	Biodegradable waste	Construction waste	Glass waste	Other waste	Total waste kg/month	Total waste kg/year
Quantity	484.34	129.33	1983.15	291.4	31.16	189.38	**3108.77**	**37305.24**
percentage	15.58	04.16	63.79	09.37	1.00	6.09	100	

Graph No.5.1 solid waste generation at university campus



During the study period total 3108 kg/month of solid waste is generated. Among this highest quantity of solid waste is biodegradable waste and it is 1938.15 kg/month, which is 63.79 % of total solid waste. Paper waste is at second place amounting 484.34 kg/month and is 15.58%. Glass waste is lowest and is 31.16 kg/month and is 1%. The total waste generated on university campus is 7305.24 kg/year and 37.31 tones /year.

Table No. 5.2: Departments generating highest and lowest quantity of solid waste.

Waste	Quantity	Department	Quantity kg/month	Quantity kg/year
Paper waste	Max.	Main building	101.94	1,223.28
	Min	USIC	00.10	1.20
Plastic waste	Max.	Quarters	24.75	297.00
	Min	Foreign language	00.10	1.20
Biodegradable waste	Max.	Girls hostel	600.00	7,200
	Min	Economics	00.30	3.60
Construction waste	Max.	Quarters	120.00	1,440
	Min	Annex building	00.20	2.40
Glass waste	Max.	Chemistry	07.00	84.00
	Min	Distance Education	00.20	2.40

Quarters are generating highest amount of paper waste amongst the other departments. Quarters are generating highest plastic and Girls hostel is generated highest biodegradable-waste as compared to other departments. Department of Chemistry is producing more glass waste.

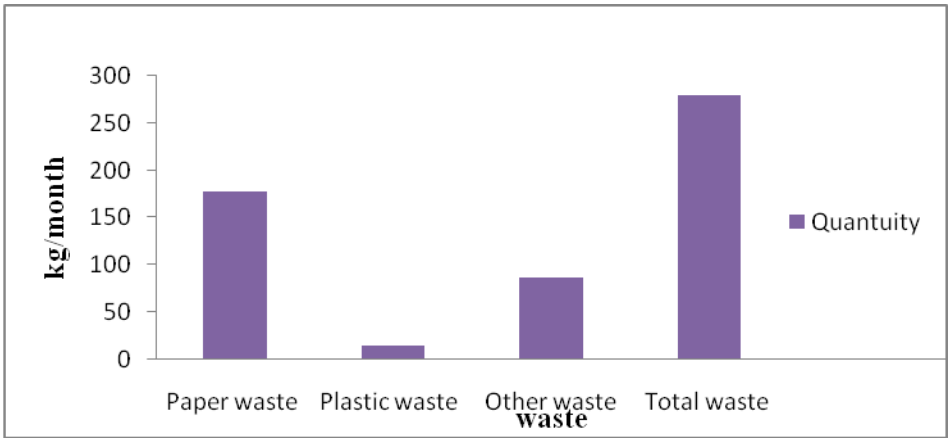
5.2. Status of solid waste generation in various Building Blocks:

5.2.1 Status of solid waste generation in Building Block A

Table No. 5.3: Category wise solid waste generation at Building Block A (kg / month)

Category of waste	Paper waste	Plastic waste	Biodegradable waste	Construc-tion waste	Glass waste	Other waste	Total waste kg/month	Total waste kg/year
Quantity	177.94	14.45	0.10	1.40	0.30	87.5	**281.69**	**3380.28**
Percentage	63.16	05.12	0.03	0.50	0.10	31.06	100	

Graph no. 5.2 Catagorywise solid waste at Building Block A



Building Block A generated maximum amount of paper waste. Biodegradable waste is minimum in Building Block A whereas construction, plastic and glass wastes are negligible. It is 281.69 kg/month and 3380.28 kg/year.

Table No. 5.4: solid waste generation at Building Block A

Sr. No.	Solid waste generation at Building Block A	Department	Quantity (kg / month)	Quantity (kg / year)
1	Maximum solid waste generating department	Store Section(101) in administration Building	60.01	720.12
2	Minimum solid waste generating department	Inward outward section in administration building	0.01	0.12

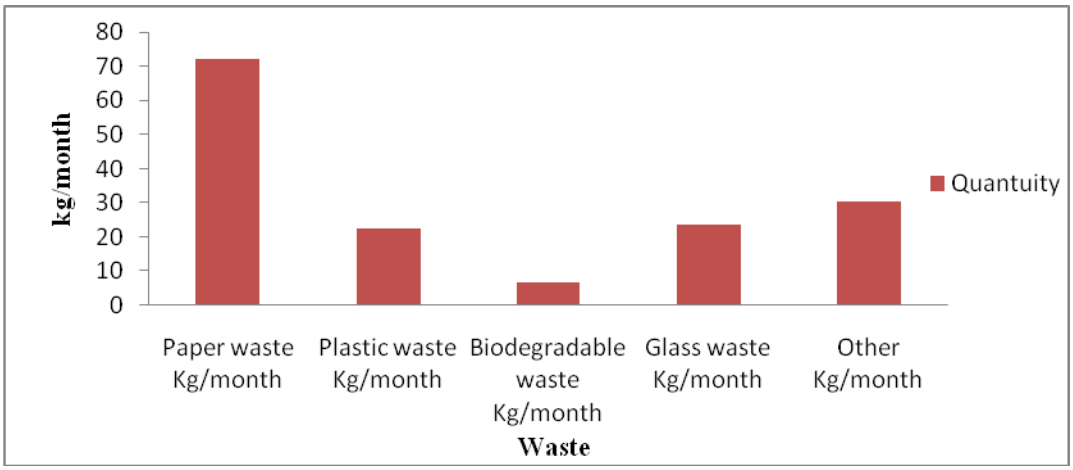
Table No. 5.4 shows that amongst Building Block A Stores section Room No. (101) in Main Building is generating highest amount of solid waste. It includes paper waste and Inward Outward section in main building is generating lowest solid waste per month. The Building Block A generated 281.69 kg of total waste in a month. Among the total waste 63.16 % which includes is paper waste which is around 177.94 kg. At second position is other waste i.e.31.06%, Plastic, glass and other type of waste is negligible. Building Block A generates no biodegradable waste.

5.2.2 Status of solid waste generation in Building Block B:

Table No. 5.5: Category wise solid waste generation at Building Block B (kg / month)

Category of waste	Paper waste Kg/month	Plastic waste Kg/month	Biodegradable waste Kg/month	Construction waste Kg/month	Glass waste Kg/month	Other Kg/ month	Total waste kg/ Month	Total waste kg/year
Quantity	**72.069**	22.63	6.70	0.00	23.66	30.33	**155.39**	**1864.68**
Percentage	46.37	14.56	4.31	0.00	15.22	19.51	100	

Graph no.5.3 Category wise solid waste at Building Block B



The data collected from the Building Block B reflects that paper waste and glass waste generated in the departments is higher as compared to other category of waste. Paper waste shows highest generation due to student's activity. However, glass waste is a periodical type of waste generated every month. Glass waste is most of the time from laboratories, breakage of glassware's. Other than this construction and plastic waste is also important waste generated at its minimum. Construction waste is negligible. About 155.38 kg of total solid waste has generated in Science and Technology Block per month from which 72.06 kg per month waste is Paper waste and Bio-degradable waste is 6.70 Kg per month. The total solid waste generated in Building Block B is 1864.868 kg/year.

Table No. 5.6: Solid Waste Generation at Building Block B

Solid waste generation at Building Block B (kg /month)	Department	Quantity kg /month	Quantity kg/year
Maximum Solid waste generating Department	Zoology	15.88	190.56
Minimum Solid waste generating Department	USIC	0.10	1.20

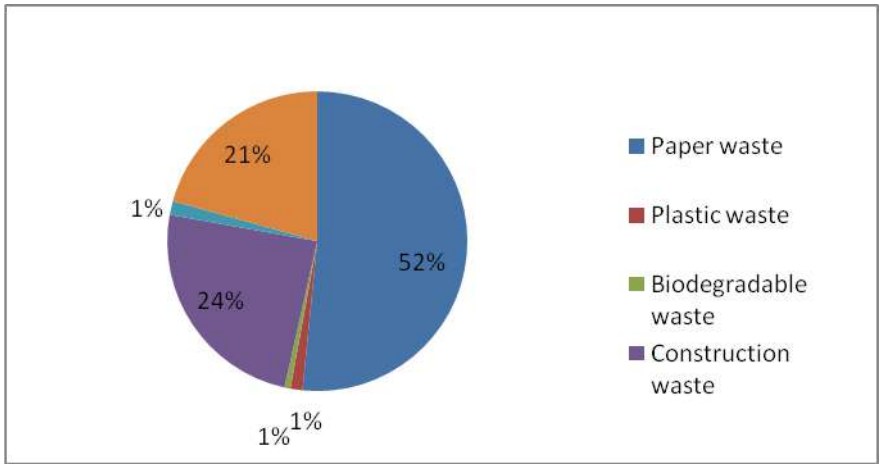
Department of Zoology is generating highest amount of solid waste i.e. 15.88 kg in a particular month among Building Block B. Department of USIC is generating very less solid waste i.e. 0.10 kg per month.

5.2.3 Status of solid waste generation in Building Block C

Table No. 5.7: Category wise solid waste generation at Building Block C (kg / month):

Category of waste	Paper waste	Plastic waste	Biodegradable waste	Construction waste	Glass waste	Other waste	Total waste kg/ month	Total waste kg/year
Quantity	106.08	02.70	01.30	50.00	03.10	42.5	**201.69**	**2420.28**
Percentage	5200	01.31	0.63	24.30	01.50	20.66	100	

Graph no. 5.4 Category wise solid waste at Building Block C



Generation of paper waste is highest at the in Building Block C. As these are all Arts and Social Science departments no laboratory work is involved and hence very negligible quantity of glass waste is generated.

Table No.5.8 Solid waste generation at Building Block C

Sr.No.	Solid waste generation at Building Block C	Department	Quantity in (kg / month)
1	Maximum solid waste generating Department	Social Exclusion and Inclusion Policy	52.08
2	Minimum solid waste generating Department	YCSRD	0.1

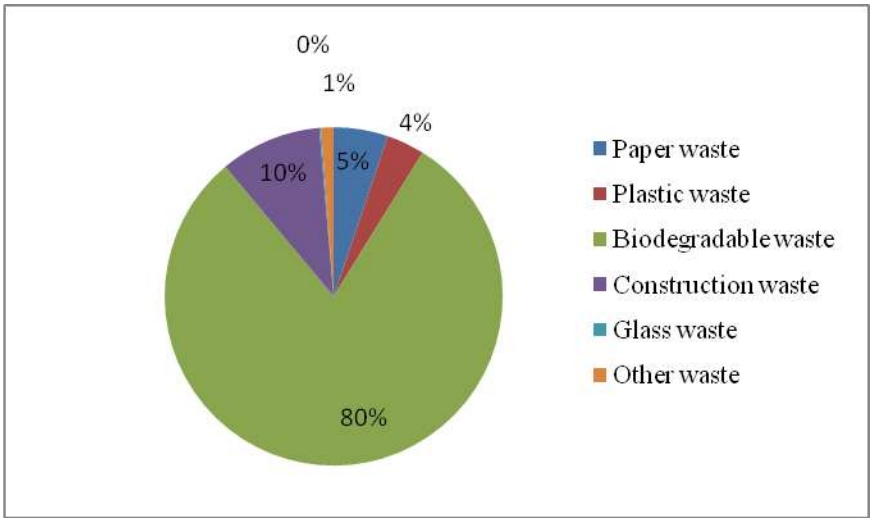
Table No.5.8 shows that among the Building Block C, Department of Social Exclusion and Inclusion Policy is producing highest amount of solid waste and is 52.08 kg per month whereas Department of YCSRD is producing lowest quantity solid waste i.e.0.10 kg/month. The total amount of solid waste generated in Building Block C is 201.69 kg/month and 2420.28 kg/year.

5.2.4 Status of solid waste generation in Building Block D:

Table No. 5.9: Category Wise Solid Waste Generation at Building Block D (kg / month):

Category of waste	Paper waste	Plastic waste	Biodegradable waste	Construction waste	Glass waste	Other waste	Total waste kg/month	Total waste kg/year
Quantity	128.26	89.55	1975	240	4.1	29.5	**2466.41**	**29596.92**
Percentage	5.2	3.63	80.05	9.73	0.16	1.19	100	

Graph no. 5.5 Category wise Solid waste at Building Block D



Biodegradable- waste generation is maximum in university support services as it includes Guest House, Canteen, hostel mess etc. Generation of plastic waste is comparatively low as compared to other departments. Glass and other type of wastes are negligible and construction waste is generated in a particular month at Building Block D.

Table No.5.10: Solid Waste Generation at Building Block D:

Sr. No.	Solid waste generation at Building Block D.	Department	Quantity in (kg / month)
1	Maximum	Girls hostel	627.00
2	Minimum	Internet Centre	00.50

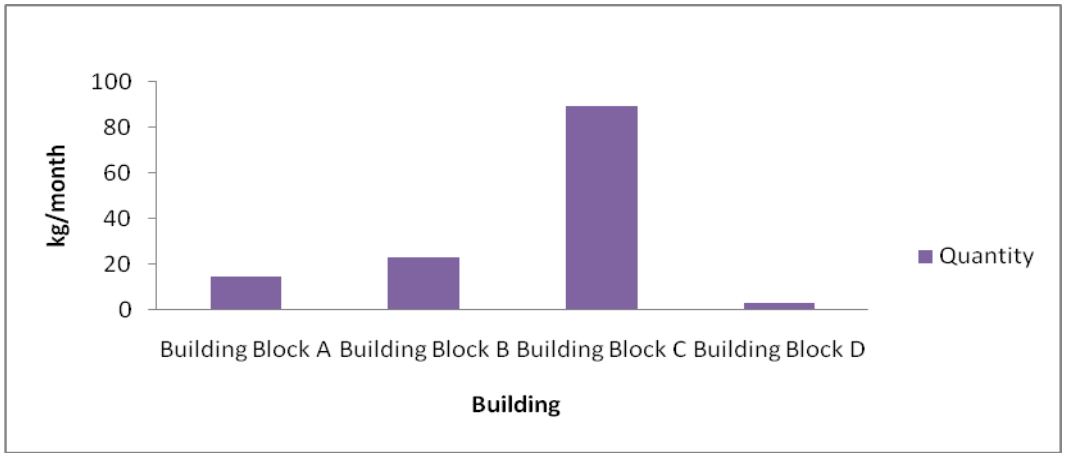
Table No.5.10 shows among the Building Block D, Girls hostel is generating maximum solid waste which is biodegradable and Internet Centre, Building Block D, CFC are producing lowest quantity of solid waste. Total solid waste in Building Block D generated is 2466.41 kg / month and 24596.92 kg/year.

5.2.5 Status of Plastic waste generation in various Building Blocks of Shivaji University.

Table No. 5.11 Plastic waste generation and its distribution at various departments (kg/month)

Plastic Waste	Building Block A	Building Block B	Building Block C	Building Block D	Total kg/month	Total kg/year
Quantity	14.45	2.7	22.63	89.55	**129.33**	**1552**
Percentage	11.17	2.09	17.5	69.24	**100**	

Graph no. 5.6 Plastic waste at all Blocks at Shivaji university



Total 129.33 kg/month and 1,552kg/year of plastic waste is generated in the campus, Support services i.e. Building Block D is producing maximum i.e. 89.55 kg/month and 1074.6 kg/year.

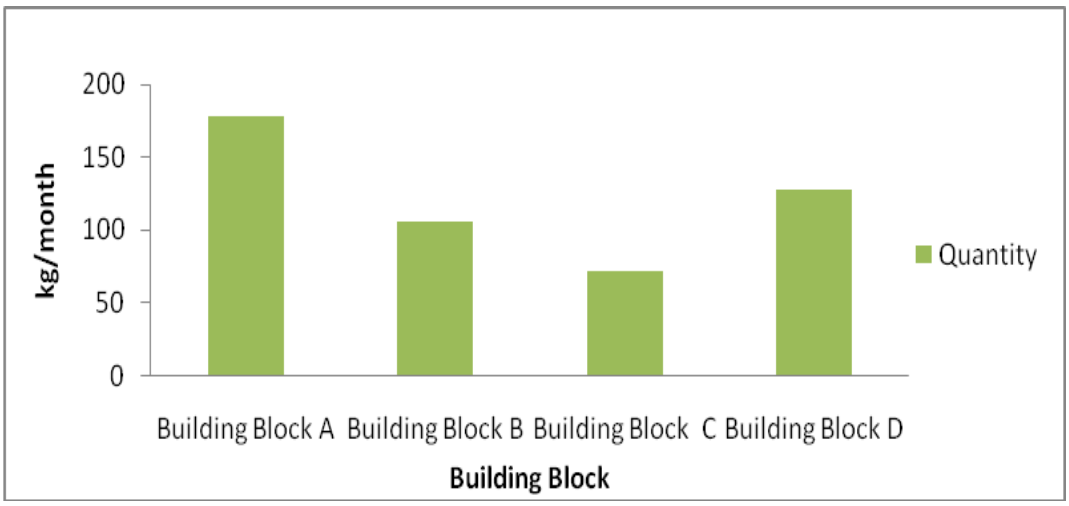
5.2.6 Status of paper waste generation in various Building Blocks of Shivaji University.

Table No. 5.12 Paper waste generation and its distribution at all Building Block (kg/month)

Department	Building Block A	Building Block B	Building Block C	Building Block D	Total Kg/month	Total Kg/ Annum
Quantity	177.94	106.08	72.069	128.26	**484.35**	**5,812.19**
Percentage	36.73	21.90	14.87	26.48	100	

Table No.5.12 shows paper waste generation Which is maximum in Building Block A i.e. 177.94 kg/ month. Building Block B shows minimum amount of waste i.e.72.06 kg/ month. Total paper waste generated on university campus in all Blocks is 484.34 kg/month and 5812.08 kg/annum.

Graph no.5.7 Paper waste at Shivaji University



5.2.7 Status of biodegradable waste generation in Shivaji University

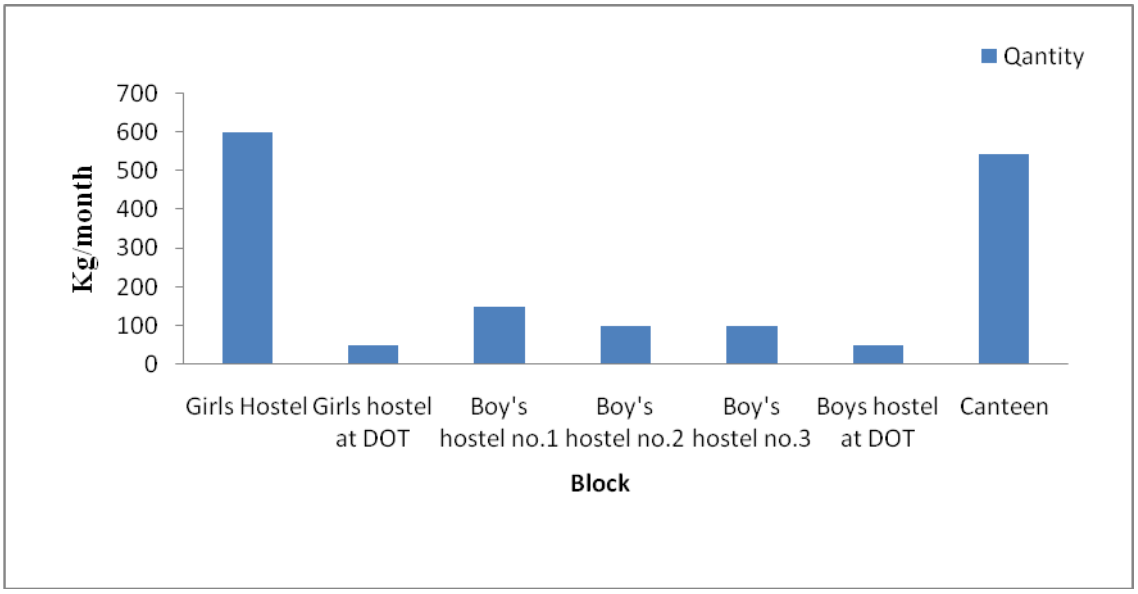
Table No. 5.13 Biodegradable waste generation in Shivaji University (kg/month)

Hostels and canteens	Girls Hostel	Girls hostel at DOT	Boy's hostel no.1	Boy's hostel no.2	Boy's hostel no.3	Boys hostel DOT	Canteen	Total kg/ month	Total kg/ Year
Quantity	627.0	50.0	150.0	100.0	100.0	50.0	545.0	**1595.0**	**19,140.00**
Percentage	37.61	3.13	09.40	06.26	06.26	03.13	34.16	**100**	

There are three mess in the hostel and number of girls are more than thousand and therefore, comparatively generation biodegradable is more.

Table No.5.13 shows biodegradable waste generation in Girl's hostel which is maximum about 627 kg per month. Subsequent to girls hostel canteen has about is 545 kg per month. Total biodegradable solid waste formed in the university campus is 1595 kg/month and 19,140 kg/year .

Graph no.5.8 Biodegradable waste at canteen and hostel's mess.



5.3 Status of Hazardous waste generation at various Building Blocks on university:

A hazardous waste is a solid, liquid, or gaseous material that displays either a “Hazardous Characteristic” or is specifically “listed” by name as a hazardous waste. Characteristic wastes are not listed specifically by their chemical name but they are regulated as hazardous wastes and Toxicity. Hazardous waste includes various chemicals generated in the laboratories of Science Departments and biomedical waste from Health Centre. It is in the form of liquid as wells in solid state. Since, only specific section generates hazardous waste, about nine departments have been included (Table No. 1.14).

Table No.5.14 shows Hazardous waste generated at university campus (kg). Chemistry department generated maximum amount of chemical and hazardous solid waste from laboratories and other sources and is about 1 kg/month. The Department of Biotechnology and Environmental Science generated about 0.1kgs and 0.5kgs, whereas Microbiology department generated 0.5 kg . Hazardous waste in the form of liquid is also been generated by these departments. Chemistry generates 9 liters of liquid hazardous waste. It was followed by Department of Agro Chemicals and Pest Management which is 5 lit. Health Centre of university also adds to solid waste in the form of bio medical and plastic waste. Biomedical waste includes blood urine samples cotton etc. and plastic waste with injection syringe ,vials and needles as 4 - 5 kg/week all these are in about 20 to 25 kg per month and given to Kolhapur Municipal Corporation for safe disposal.

Table No. 5.14 Hazardous waste generation at Shivaji University:

Sr. No.	Department	Quantity (kg}	Quantity (liter)
1	Chemistry	1	09
2	Biochemistry	4	04
3	Biotechnology	0.1	-
4	Food Science	0.2	-
5	Zoology	0.16	-
6	Physics	0.02	-
7	Botony	-	01
8	Environmental Science	0.5	-
9	Agpm	-	05
10	Microbiology	0.5	-

5.3 Status of E-waste generation on university campus:

Generation of e-waste is apparent in every educational institute. Especially, at the university level where there are several equipments and instruments used for administrative as well as for scientific execution. Computers, Printers and Xerox machines are must for the administrative and research work. The wires required for the connectivity also gets included in the e-waste. More usage of these electronic as well as electrical materials generates huge amount of e-waste. Similarly, various scientific equipments and instruments get worn out with time. These too contribute to the e- waste.

E-waste include monitor, CPU, key board, electric wire, printer. Paperless work increase load on computer and therefore it is a need to reduce e-waste by repairing all these electric equipment . There is a need to reuse and recycling of electronic equipments and material .

Major source of e-waste generation are at the Building Block B of the university. Building Block B generated highest quantity of e-waste i.e. 27.22 kg/month compared to other departments. It is followed by Building Block A which generated 20.96 kg/month of e-waste. Building Block D

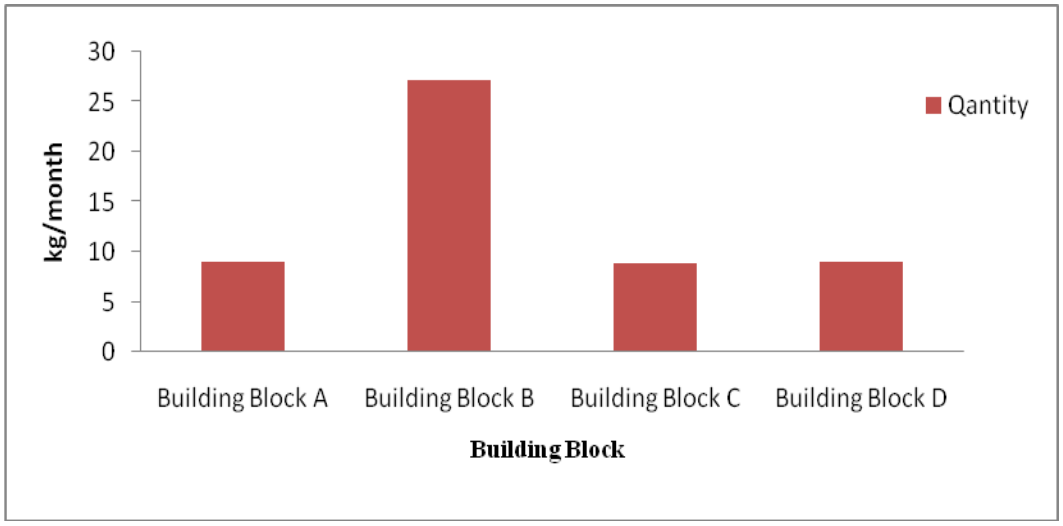
generated about 9.00 kg/month and Building Block C generated 8.90 kg per month. At university level all e-waste is collected at one place and by tendering process it is given to authorized e-waste disposal agency.

Table No.5.15 show Summary of e-waste generation and its disposal. The total amount of e-waste generated disposed by various Building Blocks of University is 66.08 kg / month.

Table No. 5.15 E-waste generation on Shivaji University campus.

Department	Waste handled (kg/month)	waste treated and disposed (kg/month)
Building Block B	27.22	27.22
Building Block A	20.96	20.96
Building Block D	9.00	9.00
Building Block C	8.90	8.90
Total	66.08	66.08

Graph no.5.9 E-waste at Shivaji university



Preventive Measures by university:

1) Paper waste is generated by all departments. Especially, building Block A is using more one one side papers for printing and writing which is a good practices.
2) Answer sheets, old bills and confidential reports are sent for shredding, pulping and recycling after completion of their preservation period.
3) University has banned signal use plastic for any administrative as well as other purpose and therefore very less amount of plastic waste is generated in the University.
4) Metal scrap is segregated separately by respective departments and sent for recycling.
5) Biodegradable waste is a major solid waste generated in campus is mostly from canteen, hostels and guest house kitchens. Canteen waste is collected and some biodegradable waste is treated by composting process.
6) Vidyarthi Bhavan , Hostel mess waste is used for composting.
7) Glass waste is generated from laboratory mainly in the form of bottles; Many times bottles are reused for storing of other chemicals.
8) Shivaji university has approximately 1,348,914 save paper sheet per year through paperless convocation application, photocopy of answer sheet ,circulars, interaction with colleges etc online with Shivaji university and it is very effective. It saves number of trees per year and reduces Carbon foot print of 5.6168 ton CO_2.
9) Building Block B have maximum e waste due to Computer laboratory, MCA and other courses. E-waste generated at Shivaji University send to recycle and reuse.
10) Hazardous waste generated in solid and liquid state during experiments in laboratory at Building Block B is disposed properly.

Chapter VI

Ambient Air Quality Status

Shivaji University is situated on south direction and at the edge of the administrative boundary of the Kolhapur Municipal Corporation. The air pollution sources in the university campus are due to the natural process like wind, pollen grains and natural dust. There are also anthropogenic activities like vehicular activity, generators, fires and laboratory fumes and construction activity are causing air pollution in the university campus. Shivaji University campus is a green campus. University campus observed minimum air pollution as compared to other National Ambient Air Pollution Centers located in Kolhapur city.

6.1. National ambient air quality program (NAAQM)

Central Pollution Control Board, New Delhi initiated National Ambient Air Quality Monitoring (NAAQM) programme in the year 1984 to get spatial and temporal variation of ambient air concentrations for a wide range of pollutants that are considered relevant for evolving strategic management plan. The program was subsequently renamed as NAMP (National Air Quality Monitoring Program). Under NAMP, three air pollutants viz., Sulphur dioxide (SO_2), Nitrogen dioxides (NO_2) and Respirable Suspended Particulate Matter (RSPM/PM_{10}) have been identified for regular monitoring at three locations. Monitoring of pollutants is carried out for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter) with a frequency of twice a week, to have 104 observations in a year as per CPCB monitoring protocol.

Department of Environmental Science, Shivaji University, Kolhapur is one of the air pollution monitoring stations for National Ambient Air Quality Monitoring Program, Central Pollution Control Board, New Delhi. One Respirable Dust Sampler (RDS) machine is installed at the Department of Environmental Science. This machine continuously runs two days in a week and minimum 104 days over the year. Department of Environmental Science monitors the changes in ambient air quality throughout the year.

Ambient air quality in the Shivaji University is given in the Table No. 6.1 and Graph No. 6.1.

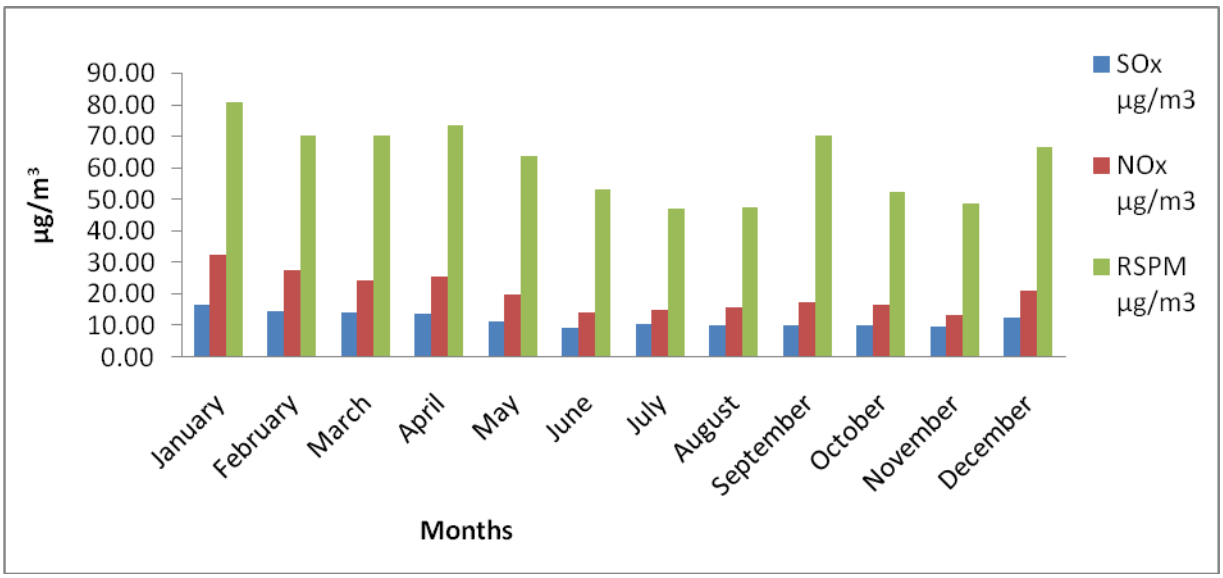
Table no. 6.1. Ambient Air Quality status in Shivaji University, Kolhapur, Dist: Kolhapur.

Air Quality Status of Shivaji University Year 2018										
Sr. No	Parameters→ / Month ↓	SOx µg/m^3			NOx µg/m^3			RSPM µg/m^3		
		min	max	avg	min	max	avg	min	max	Avg
1	January	10.48	22.84	16.61	21.69	42.28	32.63	58.33	100.00	80.86
2	February	9.01	22.42	14.73	14.52	42.65	27.44	52.08	91.67	70.31
3	March	8.38	19.06	14.18	12.13	34.93	24.16	52.08	93.75	70.10
4	April	8.59	17.77	13.68	16.55	34.35	25.71	50.00	91.67	73.57
5	May	6.78	17.07	11.45	11.52	31.67	19.90	45.83	83.33	63.50
6	June	5.14	13.56	9.50	7.20	22.01	14.38	37.50	70.83	53.17
7	July	4.68	15.43	10.45	7.12	22.42	14.97	33.33	58.33	47.07
8	August	5.14	14.03	10.20	8.02	24.06	15.86	35.42	60.42	47.38
9	September	4.91	14.73	10.06	8.43	26.53	17.32	50.00	87.50	70.23
10	October	4.76	15.72	10.03	7.91	25.43	16.73	33.33	66.67	52.16
11	November	4.34	14.69	9.90	6.22	24.49	13.57	29.17	62.50	48.69
12	December	6.41	17.79	12.49	11.11	30.89	21.09	45.83	81.25	66.32
13	Annual Results	4.34	22.84	11.94	6.22	42.65	20.31	29.17	100.00	61.95
CPCB Standards		50			40			60		

Central Pollution Control Board, New Delhi has set guidelines to monitor and analyze the air pollution quality parameters of Kolhapur city. The reason being the tree cover on campus leading to absorb CO_2 and releasing O_2 to become lung of Kolhapur city. Result shows that Shivaji University Campus air quality status is good as compared to other locations. The Table

No. 6.1 shows that the Sulphur dioxide, Nitrogen dioxide except RSPM (Respirable Suspended Particulate Matter) below standard values given by Central Pollution Control Board.

Graph No. 6.1. Ambient air quality status in Shivaji University, Kolhapur, Dist: Kolhapur.



The graph No. 6.1 shows the air pollution decreases in rainy season and higher in other seasons. Air quality on University Campus is moderately polluted because of wind direction and transportation.

6.2 Precautionary measures:

1. Ban on open solid waste burning on Shivaji university campus.
2. Ban on grass burning in summer season.
3. Use of bicycles for transportation in the campus.
4. Avoid using diesel generators.
5. Use of BS-IV vehicles.

6.3 Ambient noise monitoring status:

Shivaji University is located adjacent of old Pune - Bengalore National highway. The major source of noise on university is automobile noise. The human communication and transportation are producing high level sound. Building construction and excavation work can also cause considerable noise emissions. A variety of sound come from JCB, dumpers, welding, hammering, boring and other work processes going on the campus.

Ambient noise monitoring was carried out in different areas of Shivaji University campus like at University campus entry, Departments, Mechanical working places, Canteens, Boys and Girls hostels. The sampling was carried out using calibrated Sound Level Meter (AZ 8921) by logarithmic scale in Decibels (dB). The noise readings were collected in the University campus and calculated. The details of noise status in University campus are given below in the Table No. 6.3 and Graph No. 6.3

Photo No 6.1 Noise Monitoring at university campus.

Table No. 6.2. Ambient Noise levels in Shivaji University, Kolhapur. Dist: Kolhapur.

Sr.No	Department Name	Leq (dB) Day time
1	Department of Environmental Science	66.70
2	Department of Chemistry	60.68
3	Department of Physics	50.58
4	Department of Mathematics	49.80
5	Department of Geography	59.08
6	Humanity Building	59.74
7	Department of Technology	65.99
8	Department of Nano Science	63.36
9	Department of Education	59.54
10	Department of Music	53.44
11	Department of Law	53.14
12	Main Building	63.98
13	Barr. Balasaheb Kardekar Library	59.33
14	MBA Canteen	65.98
15	Main Canteen	71.00
16	Exam Building No.1	58.24
17	Press (Machine Department)	77.79
18	Press (Sieving Department)	81.16
19	Ladies Hostel	55.06
20	Boys Hostel	61.42
21	Main Gate	65.06
22	Gate No.2	67.08
23	CSIBER Gate	72.31
24	Gate No. 8	72.33
25	Consumer Store	49.23
26	Health Center	53.29
27	Noise Standard for day time	50.00

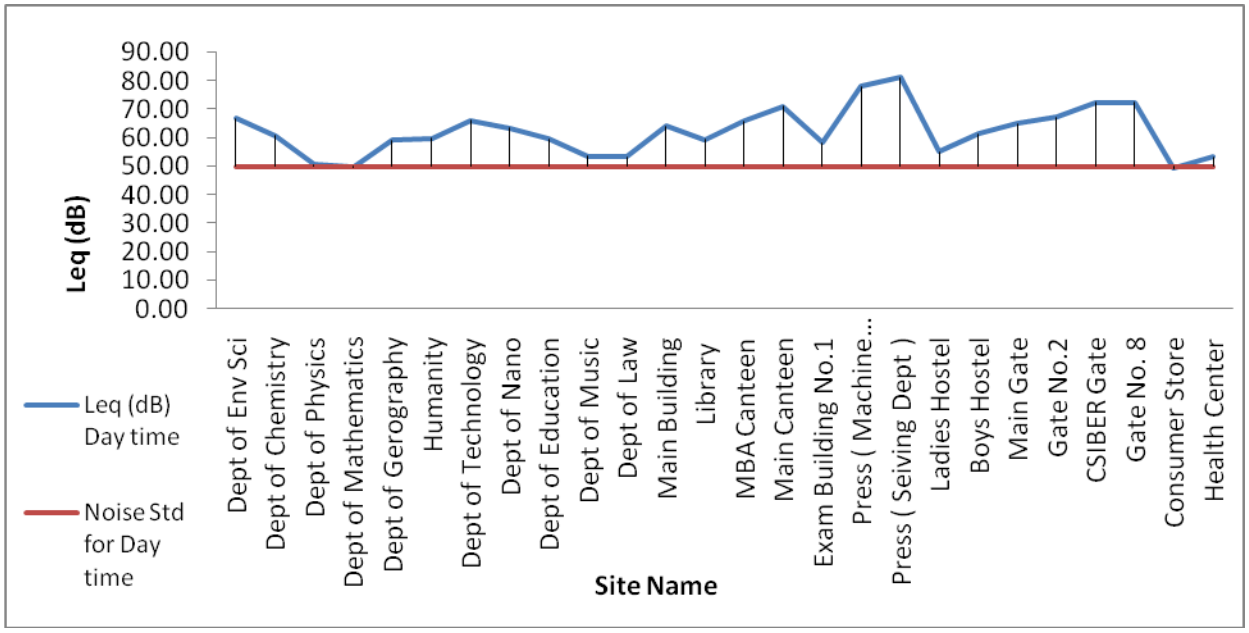
Note: - 1. All parameters expressed in dB (A) Leq.

2. Monitoring is carried during day time.

3. Day time is from 6.00 a.m. to 10.00 p.m.

The university campus comes under silent zone for noise pollution and therefore, limit for noise during day time is 50 dB. It has been observed that except consumer store area on university campus where as other areas show a rise in noise. Maximum rise in noise was observed in Printing Press area due to working of Printing Press machines, the other areas include the entrance gates where traffic noise on road is detected. Overall, though University Campus comes in silent zone, it is found that the noise levels are exceeded and there is a need to take measures putting boards mentioning 'Silent Zone' and ' No Honking'.

Graph No. 6.2 Ambient Noise levels in Shivaji University, Kolhapur, Dist: Kolhapur.



The graph No. 6.2 shows that the Printing Press area and University entrance gate found major noise levels as compared to other University areas. The printing press machines need some action plan to reduce noise.

6.4 Precautionary measures

1. Use acoustic rooms for heavy printing machines.
2. Proper maintain once of machines installed in press.
3. Use rubber mats for machine vibration and sound.

Chapter VII

Carbon Sequestration and Green cover inventory

Carbon is the basis of life on mother Earth. It is incorporated into the plants through photosynthesis, consumed by animal species through the food, present in the form of carbon dioxide ($CO_{2)}$ the atmosphere, locked into the rocks as limestone and compressed into the different fossil fuels such as coal and oil. As CO_2 level in the atmosphere continue to increase, most climate designs or project that the oceans of the world and trees will keep soaking up more than half CO_2 . The plants on land and in the sea, taken up carbon by over many years increased the percentage discharged during decay, and this increased carbon became locked away as fossil fuels beneath the surface of the planet.

The starting of the 21st century brought growing concern about global warming, climate change, food security, poverty and population growth. In the 21st century more carbon has been released into the atmosphere than that has been absorbed. CO_2 is a principle component causing global warming. Atmospheric carbon dioxide levels have increased to 40 % from preindustrial levels to more than 390 parts per million CO_2. On this background it is a need of time to cover the research areas interrelated with climate change.

The "Carbon Sequestration and Green cover inventory" is a current status of tree cover and vegetation carbon storage assessment of area under Shivaji University campus. In an era of climate change and global warming carbon emission, carbon footprints, carbon sequestration, adaptations, mitigation are the keywords in academia. Carbon sequestration is a process of converting atmospheric carbon i.e. CO_2 in to other sinks of carbon such as vegetation, soil, ocean etc. in various forms to mitigate global warming audit is one of the important clauses of Kyoto Protocol.

7.1 Carbon Sequestration

7.1.1 Need of study

While transforming ourselves from regional university to global university it is a responsibility of such universities to face the global future challenges and try to find out possible solutions for them. It is a social and environmental responsibility of Government Institutes, Universities, National and International Organizations to respond positively for various global issues at local level and should percolate the generated knowledge in to the society. Global

warming and climate change are current environmental issues need to be addressed scientifically and efficiently. As Universities are provided with skilful human resource supported by analytical infrastructure, it is our duty to bring such ideas in practice. While understanding the call of time the Department of Environmental Science, Shivaji University has decided to enumerate the green cover of Shivaji University campus and quantify the carbon sequestration of existing tree population.

7.1.2 Objectives:

1. To study woody green cover of Shivaji University campus.
2. To study species diversity of woody vegetation in the University campus.
3. To understand biomass and carbon stock accumulated by woody vegetation in the University campus.
4. To explore carbon sequestration potential of woody vegetation in the University campus.
5. To explore potential of woody vegetation of the University campus as an oxygen source.
6. To measure canopy cover of the trees on the University campus.

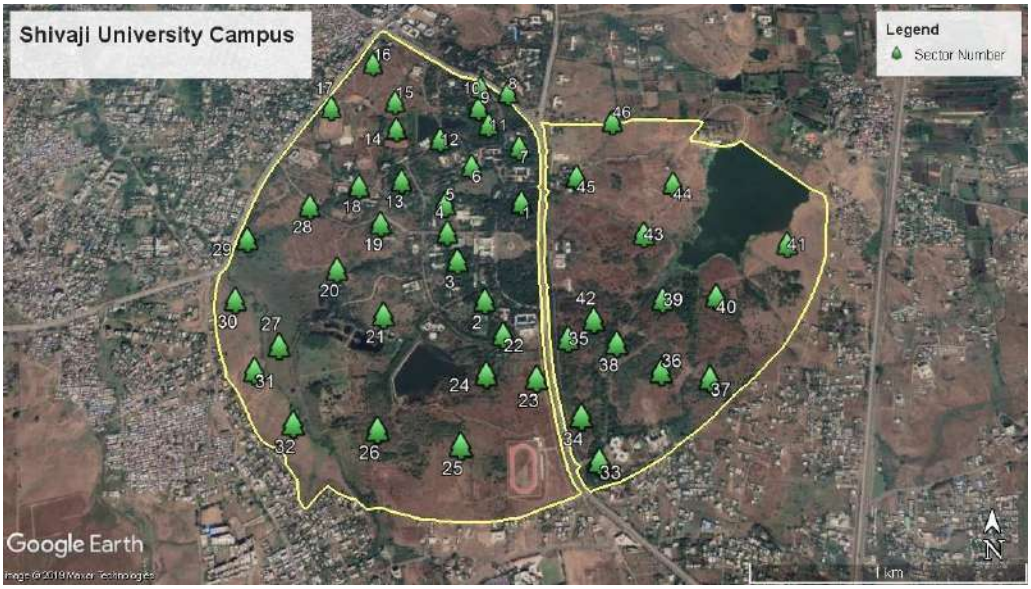
7.1.3 Material and Methodology:

7.1.3.1 Study Area:

Shivaji University, Kolhapur (SUK) is situated at South-West side of Maharashtra at 160 40’31.81”N and 740 15’12.10”E, in the outskirts of Kolhapur city and it is at the altitude of 607 m above mean sea level. Shivaji University covers an area of about 853 ha. The major area of the campus is covered with vegetation.

Lush green campus of Shivaji University

Satellite image of Shivaji University campus with tree census sectors



Source: Google Earth

7.1.3.2 Field survey:

Current tree census methodology has been adopted from the guidelines set by Indian Institute of Remote Sensing, Dheharadoon, Govt. of India.

University campus area of 853 acres is divided into 46 sectors with the help of Google Earth. Around 100 M.Sc. Environmental Science students were involved in the field survey. Team of 4 students was made and one sector was allocated to a team. A team is provided with a measuring tape, chalks, writing pad and tree census form. A tree with girth (circumference of tree) more than 10 cm at chest level and height more than 4 feet were considered as tree and taken for enumeration. Girth of each tree was measured with the help of tape and approximate height by visual method. Identification of tree species was done with the help of field guides, web source and with the help of expertise of Botany Department of University.

7.1.3.3 Data Analysis:

All the collected data was tabulated and analyzed with the help of MS- Excel spreadsheets and objected findings were extracted by using various factors given by Intergovernmental Panel on Climate Change (IPCC).

All the tabulated data is analyzed by following standard formulae.

A. Measurement of circumference of the tree:

To estimate the biomass of the each individual tree species non- destructive method was used. To calculate the circumference Diameter at Breast Height (DBH) can be determined by measuring tree Girth at Breast Height (GBH), approximately at 1.3 meter from the ground. The Girth at Breast Height of trees having diameter which greater than 10 centimeters were measured directly by measuring tape.

B. Height measurement:

Tree height is the important factor for the calculating tree biomass and evaluating tree life history. There are number of different methods which are used for the measurement of tree heights from the ground. For the present tree census, the height of individual tree is measured by visual method.

C. Above Ground Biomass (ABG) of tree:

The above ground biomass is the most abundant and visible pool of carbon in its all the forms. The above ground biomass of tree includes branches, stem, fruit, whole shoot and flowers.

The specific wood density is used from the standard guidelines. By using the above formula the AGB of all the tree species were calculated. The total above ground biomass is calculated by using the formulae,

D. Estimation of carbon:

Generally, in any plant species the 50 % of its biomass is considered as the carbon.

E. Determination of weight of carbon dioxide (CO_2) sequestrated in the tree:

Trees are the autotrophs, which make their own food by using photosynthesis. They took CO_2 and release O_2. The sequestrated CO_2 is calculated by using the Carbon Sequestration Factor is used given by the standard guidelines by IPCC.

7.1.3.4 Canopy cover:

Canopy cover is measured by using standard guidelines. A canopy cover of tree is measured by tape using crown area cover. All the collected data was tabulated and analyzed with the help of MS- Excel spreadsheets.

The crown cover areas of the trees were measured during the day time. The diameter of crown at its widest point (A) as well as the diameter of the crown perpendicular to its widest point (B) was measured in feets. The average diameter of the crown was calculated. Using the average diameter canopy cover area was estimated.

7.1.4 Findings:

- **Total number of trees enumerated in Shivaji University campus:**

The total 853 acres area of Shivaji University Campus is divided into 46 sectors. Total 13,473 numbers of trees with 10 cm or more girth and height 4 ft or more have been enumerated. Girth and height of every tree has been measured by using tailoring tape and chalks.

- **Total No. of tree species identified in Shivaji University campus:**

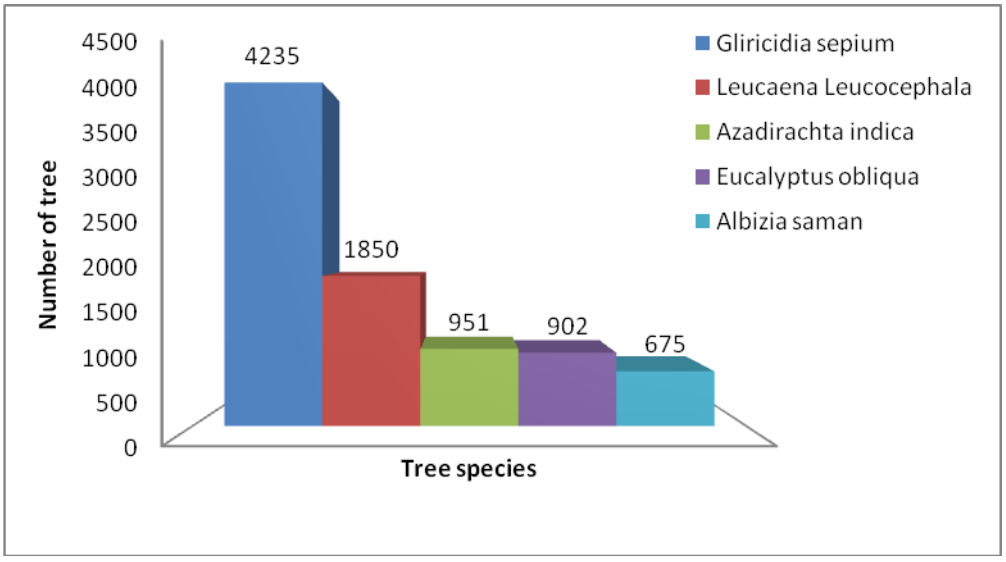
There are total 99 tree species have been identified during the census. It shows rich plant diversity on campus.

7.1.4.1 Tree species with highest population:

Table no.7.1: Tree species with highest population

Sr. No	Botanical Name	Common Name	Number
1	*Gliricidia sepium*	Giripushap	4235
2	*Leucaena leucocephala*	Subabhul	1850
3	*Azadirachta indica*	Neem	951
4	*Eucalyptus obliqua*	Nilgiri	902
5	*Albizia saman*	Rain tree	675

Graph no. 7.1: Tree species with highest population



The tree species with highest population is *Gliricidia sepium* accompanied by *Leucaena leucocephala*. Though both the species are non- indigenous in nature both are contributing much in biomass generation and as Gliricidia is highly deciduous in nature it adds large amount of biomass in soil every year. Both plants are multipurpose in nature as they provides fuel wood, fodder *Leucaena leucocephala*, biomass and helps in carbon sequestration. Followed to this *Azadirachta indica* is a species placed at third place which is indigenous in

nature. As compared to the Green cover inventory report 2014, total 53 *Azadirachta indica* trees are newly added in the record. *Azadirachta indica* is a medicinal plant species and also provides shelter to bird species. On the other hand as compared to Green inventory report 2014, 104 trees are added in the *Eucalyptus oblique* plant which is also medicinal plant species. Overall the population of woody trees on the Shivaji University Campus is increased by 256 as compared to Green cover inventory report 2014.

7.1.4.2 Total biomass:

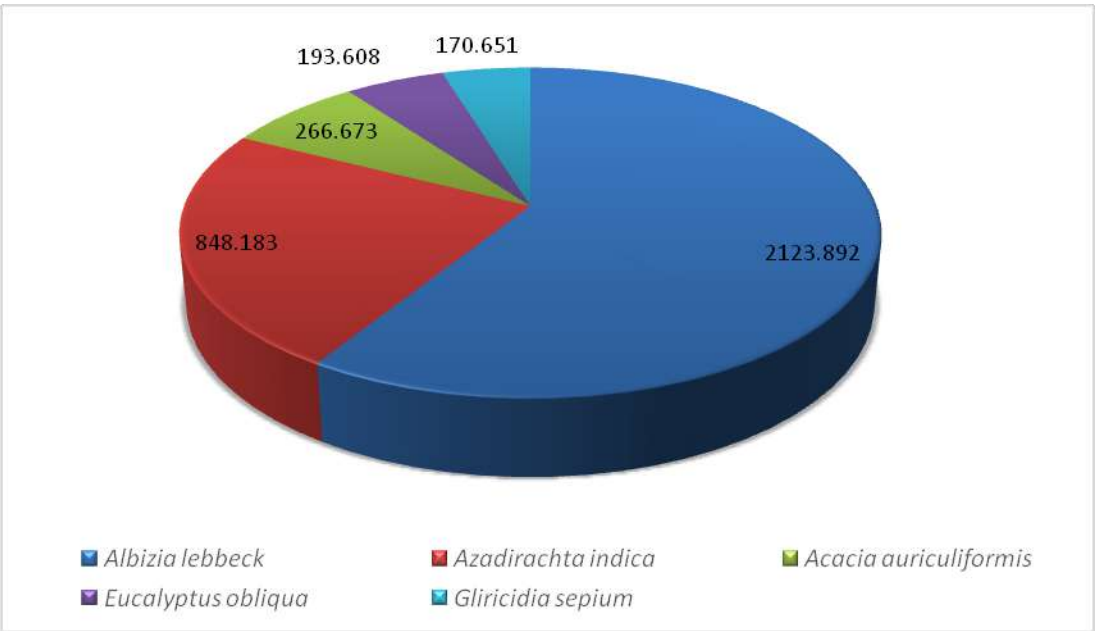
In ecology, the mass of living biological organism in a given area or ecosystem at a given time is called as biomass. Biomass can refer to species biomass and community biomass. The species biomass is the mass of one or more species. The community biomass, which is the mass of all species in the community. It includes microorganisms, plants or animals. The mass can be defined as the average mass per unit area, or as the total mass in the community.

4233.69 tons of total biomasses of woody vegetation have been recorded on the University campus during the current tree census. The total biomass on the campus is increased by 595.34 tons. *Albizia lebbeck* shows the highest biomass as it is with highest volume with more number of trees on the campus. Followed by *Azadirachta indica*, *Acacia auriculiformis* and *Eucalyptus oblique* are ranked at second and third place.

Table no. 7.2: Total biomass in tons of first five tree species (Tons)

Sr. No	Botanical Name	Common Name	Total Biomass (Tons)
1	*Albizia lebbeck*	Shirish	2123.90
2	*Azadirachta indica*	Neem	848.19
3	*Acacia auriculiformis*	Australian Babhul	266.67
4	*Eucalyptus oblique*	Nilgiri	193.61
5	*Gliricidiasepium*	Giripushap	170.65

Graph no.7. 2: Total biomass in tons of first five tree species



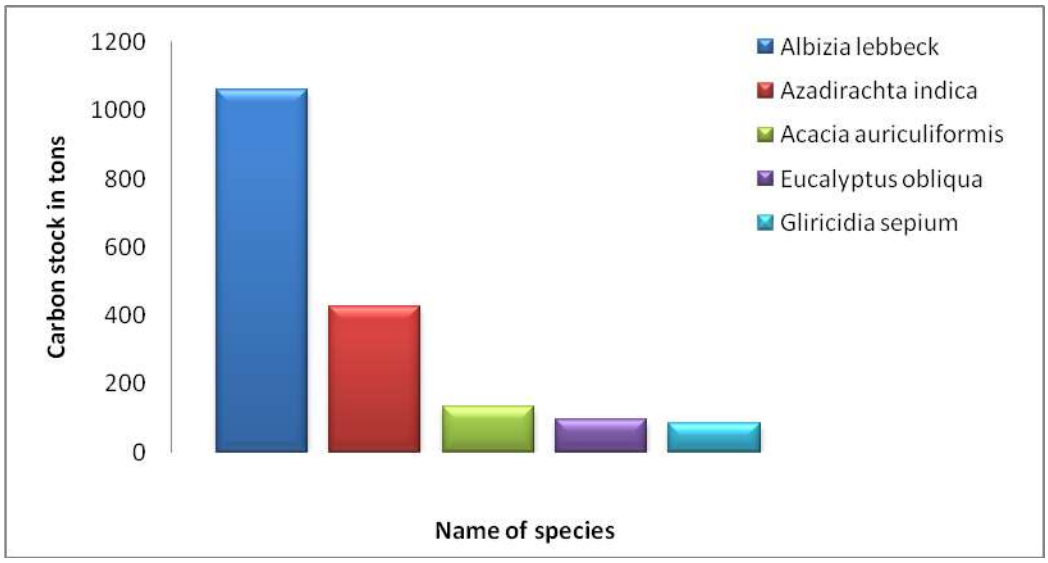
7.1.4.3 Carbon Stock:

The main carbon sink in tropical forest ecosystems includes the living biomass of trees, understory vegetation, dead mass of litter, woody debris and soil organic matter. The carbon stored in the Above Ground Biomass (AGB) of trees is the largest pool and is directly impacted by deforestation and degradation. Trees and forests act as natural carbon stores, but this carbon is released when the trees are felled and the area deforested. The amount of carbon stored within an area of land varies according to the type of vegetation cover 2116.85 tons of total carbon stock is present at the campus. The new 297.67 tons of carbon stock are added into the new record.

Table no.7. 3: Highest Carbon stock species in tons

Sr. No	Botanical Name	Common Name	Total Carbon Stock (Tons)
1	*Albizia lebbeck*	Shirish	1061.94
2	*Azadirachta indica*	Neem	424.09
3	*Acacia auriculiformis*	Australian Babhul	133.33
4	*Eucalyptus oblique*	Nilgiri	96.80
5	*Gliricidia sepium*	Giripushap	85.32

Graph no.7.3: Highest Carbon stock species in tons



7.1.5 Carbon Sequestration:

Carbon sequestration is long-term storage of carbon dioxide or other forms of carbon to avoid climate change. It has been considered as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels. Vegetation carbon pool having the potential of 560 Pg (Pg: Pentagram= billion ton) of carbon storage globally. In the current study the focus is given on the assessment of existing carbon stock stored in Shivaji University campus in the form of woody vegetation by enumerating every tree species. Overall 7768.82 tons of CO_2 has been captured and stored by the woody plants present on the University campus. A single tree consumes 0.0218 tons of CO_2 approximately annually consequently, as the campus possesses 13,473 mature woody plants 293.72 tons of CO_2 is consumed yearly by all woody vegetation on the campus.

As the university campus considered as carbon sink for CO_2 sequestration, the more 5.58 tons of CO_2 is sequestrated by the woody tree as referred to previous record of 2014.

7.1.6 Oxygen released

Woody vegetation in Shivaji University campus has released 20742.76 tons of oxygen in their lifetime till date. Released oxygen is directly proportional to CO_2 sequestrate in the ratio of

32/12. Thus, it is supposed to release 783.23 tons of oxygen annually. The oxygen released is increased by 16.94 tons as previous record of 2014.

A single tree supports oxygen demand of two people for their life. Thus, 13,473 woody trees on the Shivaji University campus are supporting 26,946 people on and around the campus.

7.1.7 Canopy cover

The vertical projection of plant foliage onto a horizontal surface is called as Canopy cover. In the other word, the canopy cover is the per cent forest area occupied by the vertical projection of tree crowns. Furthermore the measure of forest cover is useful to analyse the plant growth and survival. Hence, determining the nature of the vegetation and it is an important ecological parameter of forest ecosystem for its relationship with species richness, wildlife habitat and behavior. Forest canopy structure regulates radiation interception through the canopy, affects the canopy microclimate, and consequently influences the energy, water, and carbon fluxes between soil, vegetation and atmosphere through interactions with leaf photosynthesis. The total canopy area calculated around the campus is 403.11 acres. The total canopy cover area on the campus is 47.25 % and is more i. e. 33% forest cover decided for country or state.

7.1.8 Conclusion:

Forests and woody trees are the biggest carbon pool on Earth, act as a major sources and sinks of carbon in nature. The 853 acres campus of Shivaji University, Kolhapur possesses 13,473 woody tree populations. This woody vegetation is sequestrating 293.71 tons of CO_2 with the liberation of 783.23 tons of oxygen annually. Thus, the campus is working as a good carbon sink and a productive oxygen park.

- The total tree count on the campus recorded is 13,473. The reduction in population of *Gliricidia sepium* species is observed. *Gliricidia sepium i*s the exotic species on the campus and also doesn't have the ecological importance like nesting for birds, fruits for birds and at the same time the flowers have a smell which removes rat population on campus.

- The increase in the population of *Azadirachta indica* species which is having the medicinal value.

- The new 297.67 tons of carbon stock added on the campus as compared to previous report. As the university campus considered as carbon sink for CO_2 sequestration, the more 5.58 tons of CO_2 is sequestrated by the woody tree population as referred to previous record.
- The amount of oxygen released is increased by 16.94 tons as previous. The total canopy cover area on the campus is 47.25 % which is 403.11acres.

7.1.9 Precautionary measures:

To maintain green cover and carbon sequestration potential of University following precautionary measures have to be taken by every stake holder of University.

- Plantation of endemic species like *Acasia catechu, Alstonia scolaris, Butea monosperma, Azadirachta indica* etc. will be helpful for conservation of native biodiversity.
- The plantation of tree species like *Acacia nilotica subsp. indica, Albizia lebbeck, Azadirachta indica, Citrus aurantium* works as green belt which can maintain the ecological balance in the environment as well as act as sink for the harmful gases and improve air quality.
- Plantation activity should be taken yearly to increase the green cover on the University campus.
- Avoid plantation of exotic species like *Gliricidia sepium* which is fast growing species with less ecological values.
- There is need of fire lines or control measures should be taken in some sectors of the campus to overcome loss of trees due to fires during the summer season.

List of Species on Shivaji University Campus

Sr.No	Botanical Name	Common Name
1	*Araucaria columnaris*	Chrismtas tree
2	*Acacia mangium*	Australian teak
3	*Acacia nilotica subsp. Indica*	Babul
4	*Acacia auriculiformis*	Australian Babhul
5	*Acasia catechu*	Khair
6	*Adina cordifolia*	Kadamb
7	*Aegle marmelos*	Bel
8	*Albizia lebbeck*	Shiras
9	*Albizia saman*	Rain tree
10	*Alstonia scolaris*	Satvin
11	*Anacardium occidentale*	Kaju
12	*Annona reticulate*	Ramfal
13	*Annona squamosa*	Sitafal
14	*Anogeissus latifolia*	Dhavda
15	*Areca catechu*	Supari
16	*Artocarpus heterophyllus*	Fanas
17	*Artocarpus incise*	Nirphanas
18	*Azadirachta indica*	Neem
19	*Bambuseae*	Bamboo
20	*Bauhinia racemosa*	Apata
21	*Bombax ceiba*	Katesavar
22	*Bombax ceiba*	Shalmali
23	*Bougainvillea spectabilis*	Bogan vel
24	*Butea monosperma*	Palas
25	*Caesalpinia pulcherrima*	Shankasur
26	*Callistmon*	Bottle brush
27	*Carica papaya*	Papai
28	*Cascabela thevetia /Thevetia peruviana*	Bitti
29	*Casia fistula*	Bahava
30	*Cassia siamia*	Kassod tree
31	*Casuarina equisetifolia*	Suru
32	*Ceiba pentandra*	Cottan
33	*Celtis bungeana*	Hackberry
34	*Cinnamomum camphora*	Camphor tree
35	*Citrus aurantium Linn*	Limbu
36	*Cocos nucifera L.*	Coconut
37	*Couroupita guianensis*	Kailaspathi
38	*Cycas revolute*	Cycus

39	*Dalbergia latifolia*	Shisav
40	*Dalbergia sissoo*	Sisao
41	*Delonix regia*	Gulmohar
42	*Dillenia indica*	Karambel or Elephant apple
43	*Dypsis lutescens*	Bamboo palm
44	*Elaeis guineensis*	Oil palm
45	*Eucalyptus oblique*	Nilgiri
46	*Ficus benghalensis*	Vad
47	*Ficus elastic*	Rubber
48	*Ficus racemosa*	Umber
49	*Ficus religiosa*	Pimpal
50	*Gliricidia sepium*	Undirmari
51	*Gmelina arborea*	Shivan
52	*Grevillea robusta*	Silver oak
53	*Grewia tiliifolia*	Dhaman
54	*Hibiscus rosa-sinensis*	Jaswand
55	*Hyophorbe lagenicaulis*	Bottle palm
56	*Juglanas nigra*	American walnet
57	*khaya senegalensis*	African Mahogani
58	*Lagerstroemia speciosa*	Jarul
59	*Leucaena leucocephala*	Subabhul
60	*Mangifera indica*	Mango
61	*Mangolia pumila*	Laal chafa
62	*Manilkara zapota*	Chikku
63	*Millingtonia hortensis*	Buchache Zad
64	*Mimusops elengi*	Bakul
65	*Mogali eranda*	Erandmungli
66	*Moringa oleifera*	Shevaga
67	*Morus alba*	Tuti
68	*Muntingia calabura*	Cherry
69	*Murraya koenigii*	Kadipatta
70	*Musa acuminate*	Banana
71	*Nyctanthes arbor-tristis*	Parijatak
72	*Parkia biglandulosa*	Chenduful
73	*Peltophorum pterocarpum*	Peltophorum
74	*Phoenix dactylifera*	Date or khajur
75	*Phyllanthus emblica*	Aawla
76	*Pithecellobium dulce*	Vilayati Chinch
77	*Pittiosporum undulatum*	Australien cheesewood
78	*Plumeria alba*	Chafa
79	*Polyalthia longifolia*	Ashok

80	*Pongamia pinnata*	Karanj
81	*Prunus serotina*	Black cherry
82	*Psidium guajava*	Peru
83	*Pyrus*	Peru Nashpati pear
84	*Roystonea regia*	Royal palm
85	*Santalum album*	Chandan
86	*Saraca asoca*	Sitecha Ashoka
87	*Senegalia catechu*	Kat
88	*Senna auriculata*	Tarwad
89	*Sesbania bispinosa*	Shevri
90	*Simarouba glauca*	Lakshmi Taru
91	*Spathodea campanulata*	Pichkari
92	*Swietenia macrophylla*	Mohagani
93	*Syzygium cumini*	Jambhul
94	*Tamarindus indica*	Chinch
95	*Tectona grandis*	Sagwan
96	*Terminalia arjuna*	Arjun
97	*Terminalia catappa*	Badam
98	*Vitex negundo*	Nigadi
99	*Ziziphus mauritiana*	Bor

7.2 Carbon footprints

In today's world one of the biggest issues faced by all of us is global warming. Global warming refers to an increase in average global temperature of mother Earth. The main cause of global warming is increase in the concentration of greenhouse gases (GHGs) in the atmosphere due to anthropogenic activities and their level is determined with the help of global warming potential (GWP) and expressed as Carbon Footprint (CF). Carbon Footprint is another phenomenon used for GHGs or carbon dioxide emission in terms of CO_2 equivalents. There are various definitions of carbon footprint are in literature. But the most recognized definition given by Wiedmann "the Carbon footprint is the measure of carbon dioxide emissions directly or indirectly caused by an activity or accumulated over the life stages of a product." In other words, "A carbon footprint is the total greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event or product."

As the Shivaji University considered as institutional organization, the various energy resources like electricity, fuels, Liquefied petroleum gas (LPG) are used. It is necessary to calculate the carbon footprint of the University to upgrading the Clean Developmental Mechanism (CDM) in various processes. All the data from the various sources were collected from all the sectors where energy resources are used. The collected data is calculated by using standard emission factors.

7.2.1 Electricity carbon footprint:

In the university, electricity is used for various purposes like residential, office use and in the laboratories. The total electricity used in the University is 34,480.251 MW/annum which (approximately) liberates 2, 93, 08,213.35 kg of CO_2 per year. The laboratory equipments consume highest electricity which emits the large amount of carbon footprint i.e. 25, 79,750 kg of CO_2 per year approximately.

The solar panels are installed on the roof of Administrative building produces 14.58 MW electricity per year. The electricity produced from solar panels saves 12, 393 kg of CO_2 per year.

7.2.2 Liquefied petroleum gas (LPG) footprint:

The Liquefied petroleum gas (LPGs) is used in the Science laboratories, Hostels, Guest house and staff quarters on the campus. The total LPGs consumed is 3,324.2 kg/annum is responsible for the liberation of 9,916.09 kg of CO_2. The total 1,249 equipments used in Science laboratories consume 1192.8 kg LPGs per year emits 3,558.1224 kg of CO_2 per year approximately.

7.2.3 Vehicle footprint:

The vehicles are the source of CO_2 and other greenhouse gases. The number of vehicles passed through the campus daily, which emits the CO_2 in the atmosphere which add tons of CO_2 as vehicle footprint. The vehicle footprint of University is 37,325.23 kg of CO_2 per year approximately.

First Saturday of every month is followed as 'No Vehicle Day', the vehicles are not allowed in the campus to reduce the emission of CO_2. On this No Vehicle Day university campus reduce the 72.20 kg of CO_2 per year of four wheelers and 34.27 kg of CO_2 per year of two wheeler footprint. The total 106.47 kg of CO_2 per year footprint reduced during No Vehicle Days.

7.2.4 Paper footprint:

The papers are used in the institution for various purposes like exam answer sheets, circulars, notices, office work etc. The papers are responsible for the emission of CO_2. The University used total used 1,765.17 reams of papers which emits the 3.67 tons of CO_2. In the University campus various departments follows paperless methods of communication to reduce the footprint by use of papers. The various sections on the campus save 13, 48,914 papers per years i.e. 2,697 reams. The paperless work reduces approximately 5.61 tons of CO_2 approximately. The total 2.80 tons of biomass is saved by paperless communication i.e. green computing.

7.2.5 Total footprint of the University:

The total footprint is the addition of all the footprints and it is expressed as tons of CO_2 per year. The total footprint of Shivaji University is 29,359.12 tons of CO_2 per year approximately.

As the university is following the Clean Developmental Mechanism to reduce the emission of CO_2 and greenhouse emission by using solar panels for electricity generation, paperless work and No Vehicle Day the university reduces of 18.10 tons of CO_2 per year approximately.

7.2.6 Conclusion:

India's CO_2 emission is increased by an estimated 4.6 % in 2017, despite a turbulent year for its economy. The carbon footprint of nation is measured per person; India's emissions are still very low – at only 1.8 tons of CO_2 per capita which is much lower than the world average of 4.2 tons. But those emissions have been increasing steadily, with an average growth rate over the past decade of 6 %. The universities are the organizations which are having large areas which consume the high quantities of electricity and LPGs for many purposes. The Shivaji University Campus emits 30,355 tons of CO_2 per year approximately. The present Clean Development Mechanism (CDM) or practices reduces the 18.10 tons CO_2 per year approximately.

The University campus covers total 853 acres area which is having the green cover of 13,473 mature woody trees which capture 293.72 tons of CO_2 per year. The total 2.80 tons of biomass is saved by paperless method capture 7.47 tons of CO_2 per year.

7.2.7 Reducing the Carbon Footprints:

- Installation of solar panels or solar energy generation devices should be enhanced to reduce the electricity footprint of the campus. Terrace of each building can be utilized to produce electricity from tiltable solar modules.
- The food waste generated from university hostel mess, guest house, canteens and staff quarters should be converted into the biogas which can be further utilized for hostel kitchens.
- The solar battery operated vehicles should be used on the campus to overcome the vehicle footprint.
- The Green computing or E- work is helping the organization to reduce footprint very effectively.
- The solar energy based street lamps on campus will reduce carbon footprint.

- The awareness should be made among the faculty, students and other employees regarding Clean Development Mechanism (CDM) to reduce the consumption of electricity and natural resources.

Chapter VIII

Green Initiatives

Shivaji University, Kolhapur is situated at South-West of Maharashtra on the outermost boundary of Kolhapur city. It is one of the important wilderness areas of Kolhapur city with its precious biodiversity. It covers an area of about 853 acres The major portion is covered with vegetation. The university aims to protect and conserve its biodiversity, fresh and clean ambience through many initiatives.

The university has taken following green initiatives to protect and conserve the nature as well as.

1. Shiv Jalashay:

The Shiv Jalashay Yojana is a watershed management of Shivaji University on campus which helps to conserve and store water. Nearly 2,80,000 Kiloliter water conserved and stored under Shivjal Yojana in two lakes in the campus. University is self sufficient in water and stopped taking water from Kolhapur Municipal Corporation.

The rain water harvesting strengthens the water supply to the campus lakes as well as enhance water level of wells in the campus through ground water recharging process. Even the recharging of bore wells and dug wells in the surrounding has also happend.

2. Shivjal Yojana (RO plant):

The University has installed an advanced reverse osmosis (RO) based water purification plant i.e. Shivjal Yojana. Under this scheme every person in the university department, Guest house, Hostels, etc. get benefitted by the pure drinking water. This has reduced waterborne diseases on the campus.

During the flood disaster in Kolhapur district in August 2019, this scheme has played very important role in providing safe drinking water to many people from the city. Many citizens availed this facility of pure drinking water during water scarcity condition in the city.

3. Wastewater (Sewage) Treatment Plant (STP):

The University has its own Wastewater Treatment Plant (STP) near Girls hostel which treats some amount of wastewater generated in Girl's Hostel. The Phytorid plant at Department of Technology treats wastewater coming out from Technology Hostel after Primary Treatment.

4. Carbon Sequestration on the University Campus:

Shivaji University has 13473 trees on the campus and therefore, university campus is considered as a carbon sink for carbon sequestration. This woody vegetation is sequestrating 293.71 tons of CO_2 with the liberation of 783.23 tons of oxygen annually. Thus, the campus is working as a good carbon sink and a productive oxygen park.

5. Plantation and Nurturing Programme

Many plantation drives are taken by the University on its campus and affiliated colleges. Every year on 5th June i.e. World Environment Day, the University takes Plantation activity. Under 33 Crore tree plantation scheme of Govt. of Maharashtra, university has taken many plantation drives. The garden department looks after tree plantation activities. The Department of Environmental Science has a plantation near Music Lake. The trees are watered by students of Environmental Science Department. They nurture these trees throughout the year. Students of various departments and NSS students make the plantation and nurturing programmes successful.

The Botany Department has a well established nursery. This nursery provides tree saplings from Western Ghat area to university plantation as well as to those require. Garden section also has nursery. These saplings are used on campus for plantation as well as sold to people at nominal cost.

6. Green computing practice:

Being an academic institution, papers are used for various purposes like exam answer sheets, circulars, notices, office work , for document printing and Xeroxing. Since the trees are cut for paper manufacturing, the sequestration of carbon is reduced increasing carbon foot print.

It was estimated that the university uses total 1,765.17 paper reams which is equal to emission of 3.67 tons of CO_2. To cut down the carbon footprint, the university administration and various departments follows paperless methods of communication by using emails. The examination department use SRPD system for paper distribution. The convocation process i.e. Shiv Dikshant system also involves online submission of form. Through such practices, it was estimated that overall 13, 48,914 papers per years i.e. 2,697 reams were saved during the routine work. The paperless work was helpful in reducing approximately 5.61 tons of CO_2. The total 2.80 tons of biomass is saved by this green computing practices.

7. Plastic free campus :

The University has banned use of plastic on the campus and campus of university is 'Plastic free campus'. In all functions, workshops and conferences, the plastic mineral water bottles, tea cups, straws, bouquets and gifts with plastic covering, decorations and unwanted plastic use is strictly avoided. Instead of mineral water bottles, the drinking water is made available through traditional water pots or steel water. The Department of Environmental Science has taken workshops related to awareness for plastic reduction in various colleges affiliated to University. The department also conducted a competition for students on 'Plastic alternatives' under Kirloskar Vasundhara Festival – 2019.

8. Solar Electricity Generation:

The University has installed solar panels system for electricity generation which produces 180 kilowatt of electricity and send to the grid of Maharashtra State Electricity Board (MSEB) which is helpful for electricity bill reduction. The University hostels are provided with solar water heaters which reduce use of electricity for geysers. Most of the buildings are constructed considering the need of Light and ventilation which reduces the use of electricity. The air conditioners are used only in essential conditions in the laboratories and offices to reduce electricity consumption.

9. Fuel Conservation :

The University follows 'No Vehicle Day' on first Saturday of every month which saves high amount of fuel. During this one day of 'No Vehicle Day' the use of four wheelers save 14.93 liters

of fuel and two wheeler save 31.45 liters of fuel. In total 46.38 liters of fuel is saved to be used for vehicles on the campus. This saves 110.85 kg/lit of carbon dioxide to be released in the environment which is a very good step taken up by university towards saving our environment.

The university has bought two electric vehicles which are used for internal transport of officers, faculty, staff, students and visitors coming to the university. It runs for around 30-40 km after 6 hrs of charging.

The university has composting at Vidyarthi Bhavan and in future going to install biogas plant on hostel, canteen and guest house waste.

10. Conferences and workshops on Environmental Sustainability:

Shivaji University also organized many Conferences and Workshops based on the theme of environmental sustainability. Department of Environmental Science has taken a workshop on Carbon sequestration potential and carbon credits for farmers in Kolhapur District. Department of Botany has also taken a National Level conference on Mangrove protection and Conservation. Geography department also has taken internation conference on 'Geoinformatics' and environmental sustainability. A popular lecture of Mr. Rajendra Sinh Rana, a Magasasey Awardee was organised by Department of Environmental Science, who spoke on saving rivers and water resources.


NILAMBARI AUDITORIUM

Chapter IX

Summary and Conclusion

Summary :

Green Audit is one of the important tool to check the balance of natural resources and its judicial use. Green auditing is the process of identifying and determining whether institutional practices are eco-friendly and sustainable. It is a process of regular identification, quantification, documenting, reporting and monitoring of environmentally important components in a specified area.

The Department of Environmental Science, Shivaji University, Kolhapur has conducted a "Green Audit" of Shivaji University, Kolhapur in the academic year 2018-19. The main objective to carry out green audit is to check the green practices followed by university and to conduct a well defined audit report to understand whether the university is on the track of sustainable development. The previous green audit of the university was conducted during the year 2013-14. This is the second time to conduct green audit of university campus.

After completing the audit procedure of university for green practices, there are following conclusions, recommendations and Environmental Management Plan (EMP) which can be followed by university in future for keeping campus environment friendly.

Conclusion:

From the green audit following are some of the conclusions which can be taken for improvement in the campus.

1. University takes efforts to dispose majority waste by proper methods. The Green computing i.e. Online payment system, online circulars and examination procedures (SRPD) are helpful for reducing the use of papers and ultimately reducing carbon footprint.
2. Reducing the use of one time use plastic bottles, cups, folders, pens, bouquets, decorative items will be useful to solve the problem of plastic pollution to some extent.
3. Biodegradable waste is used efficiently for composting and vermicomposting. There is a scope to utilize the organic matter for biogas generation or manure production.
4. Installation of solar panels provides ample amount of electricity. Such solar modules should be installed wherever possible in the campus.

5. Use of LED lamps and Tube Lights is minimum and is to be encouraged.
6. Shiv Jalashay in the campus proved to be one of the best watershed management program for making the university self reliant in water.
7. A continuous counter trench (CCT) has given good results on percolation of water and for filling up of lakes on campus. Roof top rain water harvesting has proved beneficial.
8. Toilets and bathrooms are consuming more water in the departments. The replacement of old taps can be beneficial for solving this issue
9. Shivjal Yojana of RO drinking water has solved the major problem of safe drinking water in all departments, Hostels, Guest house, Quarters, etc.
10. 'No Vehicle Day' proves to be one of the good practice to save the fuel and help for green and clean environment on the campus. The use of electrical cars are good initiatives to save fuel.
11. The overall ambient air quality on the campus is good while some air quality issues may arise due to developmental activities on the campus should be addressed.
12. The sound levels on the campus is good except due to some transportation and construction activities.
13. E-waste and biomedical waste segregation, handling and disposal are properly done as per rules.
14. Science departments are following the principles of Green Chemistry to reduce chemical wastes.

Recommendations:

Following are some of the key recommendation for improving campus environment:

1. An environmental policy document has to be prepared with all the recommendations and current practice carried by university.
2. A frequent visit should be conducted to ensure that the generated waste is measured, monitored and recorded regularly and information should be made available to administration.
3. The university should develop internal procedures to ensure its compliances with environmental legislation and responsibility should be fixed to carry out it in practice.

4. The solid waste should be reused or recycled at maximum possible places. The biodegradable waste is generated in more amounts in hostels which should be properly utilized for manure preparation or biogas generation.
5. Reuse of glass bottles for storage of chemicals should be encouraged or the bottles should be sent to again suppliers for reuse.
6. Electrification of street lights by solar power should be encouraged.
7. Installation of sensor based electrification items like fans, lights, etc. can save electricity.
8. Installation of solar panels and rain water harvesting system to every terrace of building will be useful in conserving the natural resources.
9. Regular checkups and maintenance of pipes, overhead tanks and plumbing system should be done by engineering section to reduce overflow, leakages and corrosions.
10. Science laboratories large amount of water goes waste during the process of making distilled water; the system should developed to reuse this water for other purposes. The solar distillation unit be installed at the earliest.

Chapter X

Environment Management Plan (EMP):

By understanding the dynamics of present situation of resource utilization and current practices of waste disposal, the Department of Environmental Science has prepared an 'Environment Management Plan' for the University. This plan will reveal the strengths and weaknesses and suggests remedies to develop green and clean campus. The EMP also gives suggestion for the priority of work to carry out.

Environment Management Plan 2018-19 to 2023-24

Solid Waste				
Sector	**Strengths**	**Weakness**	**Suggestions**	**Priority**
1. Paper	• Use of green computing practices • Pulping of major portion of papers i.e. answer sheets, bills and other administrative papers. • Use of one sided papers in main building and many departments. • The examination department use SRPD system for paper distribution. • The convocation process also involves online system. • The administration use emails and online payment.	• Multiple number of copies required for office work. • More number of departments and affiliated colleges where circulars to be sent.	• Towards paperless office: more use of e-mails, e-money transfer and advance IT technology for communication.	Medium

2. Plastic	• Total Plastic ban on campus. • Recycling and reuse of plastic at some departments. • In all functions the plastic mineral water bottles, tea cups, straws, bouquets and gifts with plastic covering, decorations, etc. unnecessary plastic use is avoided.	• Sometimes plastic items are thrown with general waste. • The plastic covering of dispatched laboratory equipment boxes and other items are unavoidable. • Sometimes plastic bottles and bags are required for water and soil sampling which is unavoidable as per the protocol. • Distribution of RO water through plastic cans.	• Segregation of waste at the source and sending plastic waste for recycling.	Medium
3. Biodegradable waste	• Composting of bio-degradable waste at canteen and at Vidyarthi Bhavan Mess	• Burning of dry bio-degradable waste at some places.	• Composting of all bio-degradable waste at various places by Garden section and using it for nursery, plantation and gardening. • The kitchen waste generated in hostel kitchens should	Medium

			be utilized for compost production or biogas generation**.**	
4. Glass waste	• Reuse of bottles at some departments for storage of chemicals.	• Throwing of glass waste with regular waste though it is recyclable. • Sometimes the glasses of windows and doors crack suddenly which produce glass waste.	• Maximum reuse of bottles. • Sending the broken glass for recycling.	High
5. Biomedical waste	• Biomedical waste sent to KMC incineration plant for disposal.	• No separate containers for storage of biomedical waste.	• Separate containers for glass, Liquid and body waste should be maintained	High

Energy				
Sector	**Strengths**	**Weakness**	**Suggestions**	**Priority**
6. Electricity	• Installation of solar panels and production of 180 KW of electricity and fed to the grid. • Use of solar water heaters at Ladies and Boyz hostels. • Use of LED lamps in front of	• Insufficient use of solar energy for electricity generation. • Unnecessary use of lights, fans and computers at some places when no one is using.	• Electrification of street lights by solar power. • Installation of sensor based electrification for fans, lights, etc. • Use of solar pumps for water tanks.	Medium

	university main building. • Use of CFLs at some places • Most of the buildings are well constructed considering the need of illumination and ventilation which reduces the use of electricity. • The air conditioners are used only in essential conditions in the laboratories. • Energy Conservation programmes are conducted in some departments	• Sometimes ignorance by the staff and students wastes electricity in class rooms.	• Use of electricity efficient equipments for laboratory and office use. • Installation of solar panels on the top of every building can reduce the use of conventional energy. • General awareness about electricity saving among all the staff and students should be enhanced.	
7. Fuel	• 'No Vehicle Day' on first Saturday of every month which saves fuel. • Use of Electrical vehicles on university campus is use for internal transportation.	• Hostels using high quantity of LPG fuel for their kitchens.	• 'Cycle on rent' service for students will be beneficial. • The biogas generation plant can be helpful to the hostel kitchens. • General awareness about efficient use of fuel.	Medium

Water				
Sector	**Strengths**	**Weakness**	**Suggestions**	**Priority**
8. Water utilization	• WTP on campus to filter water. • Maximum water self-sufficiency by watershed management through Shiv Jalashay Yojana on the campus • Roof top rain water harvesting at some departments • Shivjal i.e. RO water system provides pure water to all university departments, administrative buildings, hostels, guest house, etc.	• Overflowing of tanks at some places • Excess use of water at bathrooms and toilets. • Fitting of old taps in bathrooms and toilets wastes water. • Leakages not repaired on time.	• Installation of water guards or sensors at overhead water tanks to avoid overflowing losses. • Proper and timely maintenance of plumbing. • Installation of rain water harvesting assembly at every department.	Medium
9. Wastewater	• Sewage Treatment Plant on campus • Phytorid installation at Department of Technology	• Laboratory effluent and other wastewater drain off untreated and it percolates into soil. • Wastage of large amount of good quality water by distilled water plants at various science departments.	• Installation of CETP to treat laboratory waste from all departments • Use of phytorid technology to be encouraged at every department. • Reuse of wastewater from the process of	High

			water distillation should be done. • Common distillation plant should be installed.	

Hazardous Waste				
Sector	**Strengths**	**Weakness**	**Suggestions**	**Priority**
10. Chemical waste	• The practical protocols are set to use minimum quantity of chemicals for the routine practicals. • Microbial waste thrown out after proper disinfection measures at every departments dealing with microorganisms.	• No proper disposal method for hazardous chemicals wastes.	• Hazardous chemical waste should be transferred to disposal facility centre.	High
11. E-waste	• Regular disposal of e-waste through certified e-waste collection agency.	• E-waste is thrown along with regular waste, some material in e-waste can be hazardous and most of it can be recycled.	• There must be segregation of e-waste from regular waste at source. • Precious metal recovery can be possible by university laboratories.	High

Air				
Sector	**Strengths**	**Weakness**	**Suggestions**	**Priority**
12. Air	• University has ample amount of green cover for maintaining fresh atmosphere.	• The construction activities and burning of waste on the University campus are adding contamination of ambient air quality.	• The precautions like water sprinkling or use of enclosures should be made to reduce the particulate matter in air during construction activity.	Low

Noise				
Sector	**Strengths**	**Weakness**	**Suggestions**	**Priority**
13. Noise	• University is located away from noisy area of city. • The tree cover absorbs the noise of highway traffic.	• The construction activities like excavation, digging, hammering, welding, transportation, loading and unloading operations. are responsible for ambient noise which disturbs the routine classes and research activities.	• Silent zone rules be followed. • The noise producing activities should be done during the holidays or after the office hours. • The contractor should be advised to use less noisy machines.	Low

Tree Census				
Sector	**Strengths**	**Weakness**	**Suggestions**	**Priority**
14. Tree Vegetation	• There is lots of space for plantation. • 99 tree species on campus. • 13,473 total full grown trees on campus. • Lead Botanical garden with endemic species of Western Ghats. • Plantation activity by university and all departments. • University tree authority to look after campus garden and plantation.	• Less plantation on campus. • Plantation on campus of some exotic plants. • More growth of trees like Gliricidia and subabhool.	• Avoid monoculture, variety of species should be planted in campus area. • Plantation only on slope areas of campus. • No permission to other organization for plantation. • Campus plantation plan be prepared. • Guidance of Botany department for plantation activity.	Medium