SUSTAINABLE LANDSCAPE DESIGN: EXTENT OF PROBLEMS FACED AND PRACTICES ADOPTED BY SELECTED DESIGN PROFESSIONALS.

APRIL 2023 **KURNISA KAMBOYA**

SUSTAINABLE LANDSCAPE DESIGN: EXTENT OF PROBLEMS FACED AND PRACTICES ADOPTED BY SELECTED DESIGN PROFESSIONALS.

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BY

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VADODARA

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Dedicated to,

Myself.

ACKNOWLEDGEMENT

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Kurnisa Kamboya

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CERTIFICATE

This is to certify that the thesis entitled **"SUSTAINABLE LANDSCAPE DESIGN: EXTENT OF PROBLEMS FACED AND PRACTICES ADOPTED BY SELECTED DESGIN PROFESSIONALS"** submitted for partial fulfilment of the requirement for the Degree of Masters in the Faculty of Family and Community Sciences (Family and Community Resource Management) to The Maharaja Sayajirao University of Baroda, carried out by Ms. Kurnisa Kamboya, is her original bonafide work.

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Ethical Compliance Certificate 2022-2023

This is to certify that **Ms. Kurnisa Kamboya's** study titled, **Sustainable Landscape Design: Extent of Problems Faced and Practices Adopted by Selected design Professionals** has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Science, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number **IECHR/FCSc/M.Sc./2022/12.**

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NAAC Accredited 'A' Grade

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INFORMED CONSENT FORM

The Department of Family and Community Resource Management, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda, Vadodara, supports the practice of protection of human participants in research. The following will provide you with the information about the research survey that will help you decide whether or not you wish to participate, please be aware that you are free to withdraw at any point throughout the duration of the research without any penalty. In this study, you will be asked about your background information (Name, Age,Educational Qualification, Ownership of the Firm, Work Experience (in years), Number of Projects Undertaken, and the Kinds of Projects Undertaken), Extent of problems faced and practices adopted by you as a design professional. Your participation will require approximately 15 minutes of your time. If you have any further questions concerning this research, please feel free to contact Ms. Kurnisa Kamboya through +91 92650 49507, or kurnisakamboya01@gmail.com.

Please indicate your signature on the space below that you understand what participation in the study involves and agree to participate. Your participation is strictly voluntary. All information will be kept confidential and your name will not be associated with any research findings.

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CHAPTER - I

INTRODUCTION

The planet Earth has a natural environment which consists of various elements like air, water, plants, and other living organisms which as a whole, is called as an ‘ecosystem’ (Karki, 2020). Any disruption in that environment can directly cause a major effect on the residents. Drastic escalation of activities in urbanization and industrialization with every changing day has taken a very serious toll on the human race as well as the habitat we are living in. The world has become one big concrete jungle with massive amount of exploitation of the natural resources to provide for the so called “luxuries”. This has also resulted in waste production without any account and depletion of the same has brought the humanity to where it is right now with end number of global crises; environmental issues being first one of the many. Adapting a lifestyle that does not only conserve the environment and its natural resources but also brings no or negligible harm to the planet has become the need of the hour and it is very necessary to introduce the concept of sustainability in it.

> “Sustainability can wear a lot of different hats. It could be a product that uses eco-friendly packaging, a business that develops a recycling program, or a home that uses energy-efficient plumbing systems to conserve water.” (Schill, 2019).

> “Sustainability is a vision for the world in which current and future humans are reasonably healthy; communities and nations are secure, peaceful and thriving; as well as there is economic opportunity for all; and the integrity of the life-supporting biosphere is restored and sustained at a level necessary to make these goals possible. All four dimensions of sustainability need to be addressed to achieve this vision” (Cortese and Rowe, 2003).

It becomes essential for individuals to conserve the natural resources. Landscapes that are “environmentally sustainable” have been famously talked about in the current advancements in the field of construction and development. According to “American Society of Landscape Architects” (ASLA, 2017);

> “Sustainable landscapes are responsive to the environment, re-generative, and can actively contribute to the development of healthy communities. Sustainable landscapes sequester carbon, clean the air and water, increase energy efficiency, restore habitats, and create value through significant economic, social and, environmental benefits.”
>
> “A sustainable landscape is one that conforms to the environment surrounding it, requiring only inputs (e.g., water, fertilizer) that are naturally available, with little or no additional support. It is self-sustaining over long periods of time.” (Horspool, 2022)

Goodland, 1995 stated that,

> “Environmental sustainability is defined as the maintenance of natural capital” and as a concept apart from, but connected to, both social sustainability and economic sustainability.”
>
> “Environmental sustainability could be defined as meeting the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them and more specifically, as a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity.” (Morelli, 2011)

The design professionals of today play a huge role in the implementation of a sustainable landscape design and helping the planet heal. The world has moved much forward towards advancement and hence Landscape Design is not limited to plants, trees, water, and soil only. It is now about designing a landscape which can sustain in low maintenance conditions and by cost effective methods which also requires substantially low input of resources that are harmful and that may produce waste.

Landscape sustainability could be achieved by adopting principles such as Water and Irrigation System, Vegetation and Planting, Built Environment and Materials, Shading, Wind Flow and Blocking Techniques, Optimizing the Use of Sunlight.

The principles of a sustainable landscape design include preventing global climate change, adapting to climatic conditions, preventing carbon emissions and pollutions resulting from the use of toxic pesticides and herbicides, as well as the use of renewable energy sources and native plants. Since water, plants, and constructed materials are frequently found in landscapes, the following principles and environmental sustainability standards are examined in landscape design. (Fadaie and Shemirani, 2021)

1. Water and Irrigation System

   In a sustainable landscape design, water is one of the most crucial elements of all. The growth and nurturing of any plant or a tree depend on its watering needs. Using straight and perpendicular water canals and placing the water streams under the trees' shades can reduce water evaporation. Water wastage can be avoided by irrigating through the canals and storing the water in the ponds and pools. Aligning the irrigation system with planting systems optimizes the water consumption without any of it running down the drain. Appropriate drainage can also benefit a landscape since it will prevent water accumulation in one place.

2. Vegetation and Planting

   A landscape is nothing without its plants. Making a landscape sustainable can mean planting native plants that require low water consumption, planting fruitful trees, not using pesticides and chemical fertilizers to falsely enhance the growth and development of the plant because the long-term results of using such toxins are neither in favour of the plant, nor for the consumer of that plant. Plantation of deciduous trees would provide shade in summer days and since the leaves wither off during winters, they let the sunlight flow through them. Also, planting evergreen trees can protect the space from the cold and unpleasant dusty winds.

3. Built Environment and Materials

   Sustainable landscaping includes indigenous and renewable materials, which means that they can grow and re-create themselves with low energy consumption and avoid using the materials and products that are harmful to the environment. Climatic objectives in landscape design have been one of the principles and features of environmental sustainability in landscape architecture. The design techniques that benefit the landscape in terms of sun preservation and reducing heat, natural ventilation and raising humidity, and finally, effectively regulates the dusty winds.

4. Shading

   In the gardens, trees and built elements such as walls and porticos can play an effective role in reducing the intensity of solar radiation on building surfaces and creating shade. Well placed shade trees in the West and the South sides of any building could reduce the energy costs, as well as atmospheric carbon. Dense evergreen trees and shrubs will provide continuous shading and block heavy winds. To effectively employ landscape shading, the location, size, and shape of the shadows cast by the trees and shrubs should be considered.

5. Wind Flow and Blocking Techniques

   Plants can control wind by obstruction, guidance, deflection, and filtration. This is achieved through the form, texture, and height of the plant itself or by its placement. Plants are used in conjunction with landforms and architectural structures guide the flow of air over the landscape.

6. Optimizing the use of Sunlight

   Plants absorb heat, provide shade, and create insulation. They absorb the sun's heat during the day and release it at night; they reduce the daytime temperature and increase the evening temperature. Each plant has its own texture, which determines the density of its shadow. With dense or open foliage, each plant form, whether deciduous or evergreen, has its benefit as a modifier.

Sustainable landscape design practices prioritize the use of environmentally friendly and socially responsible strategies. These practices include the use of native plants, water conservation techniques, energy-efficient shading, healthy soil practices, and waste reduction strategies. By implementing these practices, landscape designers can create beautiful and functional outdoor spaces that also support biodiversity, conserve resources, and promote healthy ecosystems. Sustainable landscape design practices are an essential component of building a more sustainable future. The above principles would help to create more cohesive designs that delight users of the landscape; and offer exceptional guidance to the Interior Designers, Landscape Designers as well as Architects.

Sustainable landscape design practices can contribute to sustainability by reducing carbon emissions and waste, maintaining local biodiversity, and increasing resilience to climate change and other environmental stresses. They can also have a positive impact on human health and wellbeing by lowering

stress levels, improving air quality, and encouraging physical activity. Overall, sustainable landscape design practices can contribute to the development of healthier, more resilient, and more sustainable communities. There are varied practices that can be adopted to accomplish a sustainable landscape design, which are:

1. Treating water as a valuable resource

   Installation of rain water barrels –tackles water runoff, gathers it into a sustainable water source. It is 100% soft water, does not have salts or chemicals which can harm the plant and it is natural as it contains all the nitrates crucial for the plant. Managing outdoor leaks which are much highly overlooked as compared to indoor leaks, helps in preventing unnecessary water wastage. A very important technique to help keep the roots of the plant cool and retain moisture in the soil is mulching a thick layer of shredded bark, wood chips, dried leaves or any other organic matter. Watering the soil, not the leaves is an essential method to water the right parts of the plant. Besides saving water, watering the soil just above the root zone helps keep it healthy and prevents sunscald and fungal disease on the leaves. Choosing the right kind of irrigation system also improves the sustainability factor of the landscape. Usage of reclaimed water helps to reduce the need to use potable water and well water for irrigation and watering. Over watering is to be avoided since it causes water wastage more than any other reason and the chances of a plant catching a root rot or any other disease surges.

Plate 1: Rainwater Barrel[26]

Plate 2: Watering Technique[27]

2. Composting

   Paying attention to what happens below the surface of a landscape means taking care of the soil, keeping in mind of it as an integral part of a sustainable landscape. Regular aeration is a must by punching small holes into the soil to allow water and the nutrients to reach the roots. This can be done twice a year. Composting is an environment friendly practice that keeps the soil nourished and keeps it moist. Since it makes use of food scraps, it serves as a cost-effective way to fertilize your plants while reducing waste. A successful maintenance of the soil considers mowing

high above the height of 3.5'' or 2/3rd of the grass length. This gives a sustainable lawn with strong grass roots and prevents nutrient loss.

Plate 3: Wet Waste Composting[28]

3. Preserving existing plants

   Removing all the existing plants from the landscape to start with a clean slate often ends up doing harm because it disrupts the natural processes occurring in the yard. A sustainable landscaping approach would be to assess the existing plant material and preserve native plants. Invasive, non-native plants should be removed and replaced with a more appropriate choice. Right plant, right place is a popular saying that should guide plant selection.

4. Conserving material resources

   The typical landscape produces high amounts of yard and construction waste. Additionally, many of the hardscape materials used are energy-intensive and transported hundreds, or even thousands of miles. A sustainable landscaping approach would be to reduce yard waste by selecting appropriately sized plants and reusing and recycling construction waste. Furthermore, building materials should be carefully selected, using locally sourced materials whenever possible.

5. Going native

This strategy will blend in with the natural/local biodiversity and will create a paradise for the local butterflies, birds, and other small garden creatures. Local and indigenous plants and trees will thrive even with fewer water requirements, and no/minimal fertilizers and will not catch any major diseases or pests. They are usually full of medicinal value and of therapeutic importance. The classification includes:

- Trees – Palash, Amaltash, Indian Coral Tree, Sita Ashoka, Indian Cork Tree, Neem, Peepal, Kadamba, Karanj.
- Shrubs – Kanchan, Shankasur, Raat Rani, Mehendi, Gulmehendi, Kunti, Parijatak.
- Climbers – Cleodendron, Jai, Juhi, Krishna Kamal, Green Champa.
- Seasonal Flowers – Utricularia, Balsam, Eriocaulon, Smithia, Vigna.

Plate 4: Parijatak (Native Flowering Shrub of India)[29]

Plate 5: Holy Basil (Tulsi - Medicinal Plant)[30]

Plate 6: Neem Tree Leaves (Medicinal Plant)[31]

6. Installing a sustainable irrigation system

Drip Irrigation is said to be so far the most sustainable irrigation system. It is a system of pumps and tubes which are either suspended above the soil or planted alongside the roots. A predetermined amount of water is then pumped and it is released through tiny holes poked into the tubes. To make environmentally smart choices, Solar Powered Drip Irrigation Systems are also available.

Plate 7: Drip Irrigation[32]

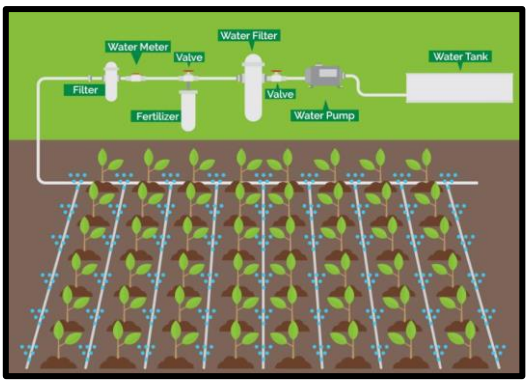

Plate 8: Drip Irrigation layout for a Sustainable Landscape[33]

7. Reduction of costs by shopping locally

   Shopping local reduces shipping and transportation charges. It also prevents the pollution of other various natural resources. Adopting sustainable procurement will ensure that raw materials, water, energy, fuel are used optimally, elongating the life cycle of precious resources. Such products not only incur reduced waste disposal costs by default, their material input efficiency further slashes the cost attached to end-of-life disposal expenditures**.**

8. Adopting organic alternatives

   Finding organic alternatives to toxic pesticides and herbicides may be mass planting, ground cover and shredded bark mulch to avoid and manage weeds between the main landscape. Enriching soils naturally with organic or homemade fertilizers could be one of the methods adopted.

Plate 9: Types of mulching materials for a Sustainable Landscape[34]

9. Reduce the need for power tools

   This can be accomplished by removing big grass areas since high power lawn mowers and the chemicals required to maintain vast weed-free lawns are not environmentally friendly. It's essential to utilize as little power equipment as possible while creating a sustainable landscape for a number of reasons. Electricity or fossil fuels are required to run power

tools, which has a negative impact on the environment by raising greenhouse gas emissions. Power tools may be noisy and upset both people and animals.

Following are various strategies through which the need of power tools can be avoid –

- Pick low-maintenance plants: By choosing plants that require little pruning or trimming, you may lessen your reliance on power equipment like chainsaws and hedge trimmers. Because they are suited to the environment and need less upkeep, native plants are frequently a wise choice.
- Use manual tools: Hand tools may frequently be used in place of power tools. Examples include pruning shears, loppers, and handsaws. They are not only more environmentally friendly, but they also permit more accurate cutting and may cause less harm to plants.
- Design for simple upkeep: You may use fewer power equipment if you plan your landscaping with maintenance in mind. For instance, layering plants can make it simpler to access plants in the front without using a ladder or power equipment. The taller plants should be placed in the rear.
- Alternatives to conventional landscaping include: Utilizing low-water use plants, or xeriscaping, is a sustainable landscaping technique that can lessen the need for irrigation and other care procedures. Likewise, replacing typical lawns with ground coverings or permeable pavers can cut down on the requirement for mowing and other power tool use.

10. Use of recycled and reclaimed materials

The use of recycled and reclaimed materials is an important aspect of sustainable design. There are several benefits to using these materials, including reducing waste, conserving natural resources, and reducing the carbon footprint of a project. Recycling involves taking waste materials and turning them into new products. This can include materials like plastic, metal, glass, and paper. By using recycled materials in

developing a landscape reduces the amount of waste that ends up in landfills and conserve natural resources. Reclaimed materials are materials that have been salvaged from buildings or other structures and reused in new projects. This can include things like reclaimed wood, bricks, or stone. Using reclaimed materials not only reduces waste but also adds character and history to a project.

Some examples of how recycled and reclaimed materials can be used in sustainable design include:
Using recycled plastic or composite lumber for decking and outdoor furniture.

- Using reclaimed wood for flooring, walls, or furniture.
- Using recycled glass for countertops or decorative features.
- Using reclaimed bricks or stone for landscaping features or building facades.
- Using recycled metal for roofing or architectural details.

By incorporating recycled and reclaimed materials into a design, we can reduce the environmental impact of a project and create a unique and sustainable space. It's important to note that the quality and durability of these materials should be considered, as well as their sourcing and transportation to the project site, to ensure they truly have a positive environmental impact.

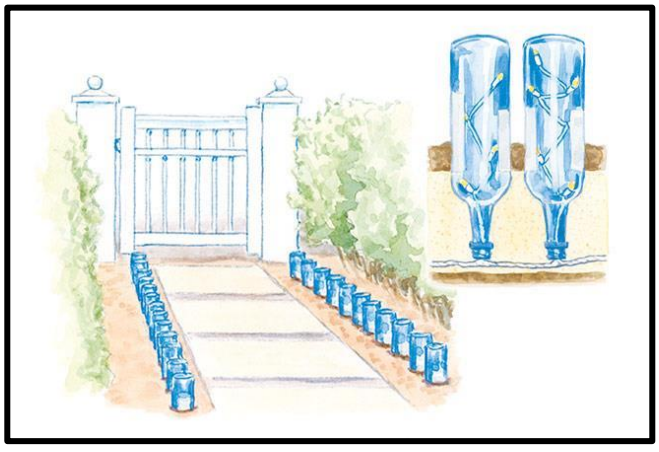

Plate 10: Pavement borders created using reclaimed glass bottle[35]

Plate 11: Decorative pavement created using coloured stones[36]

JUSTIFICATION

Landscaping goes past just enhancing the view; it has numerous benefits that a design professional can bring to life through their expertise and knowledge in the context of environmental sustainability. These professionals are in an exceptionally good place to instigate change, particularly with energy-efficient lighting, eco-friendly materials, materials with recycled content, sustainable wood, and low-energy and water-saving products. In today's times, proficient knowledge of principles in sustainability will influence a multitude of choices relating to eco-friendly materials, construction methods, energy choices, and smart water systems. However, in order to effectively decrease the impact, sustainability in Landscape Design should not be limited to merely adding plants and greenery to spaces. Rather, it should be a crucial consideration, integrated into the entire design process, from concept development to finishing specifications. It's encouraging therefore to know that this concept is now becoming more important in the eyes of the design professionals.

Adopting and endorsing a sustainable landscape design isn't only the responsibility of the government, but also the citizens of the country and the planet are equally responsible for the same. Ethical and sustainable business practices are integral to the quality of life on the planet which humans are experiencing now and will have significant ramifications for future generations who will live and interact with the environment going forward. The need of the hour today is becoming more and more aware of how the daily choices of an

Interior Designer or a Landscape Designer or an Architect affect the environment by opting for sustainable solutions like reduce, reuse, recycle. These solutions will not only reduce the negative impacts but also eliminate them over time.

Sustainable landscape design plays an essential role in achieving sustainability by promoting the efficient use of resources, reducing greenhouse gas emissions, enhancing human health and well-being, and promoting environmental educational awareness. Sustainable landscape design reduces water consumption, minimizes fertilizer and pesticide use, and preserves and enhances biodiversity, which helps conserve natural resources. Furthermore, by reducing energy use, promoting carbon sequestration, and reducing the use of fossil fuels, sustainable landscape design can help reduce greenhouse gas emissions. Sustainable landscape design can also enhance human health and well-being by providing opportunities for outdoor recreation and exercise, reducing stress, and improving air and water quality. Additionally, by incorporating features that demonstrate sustainable practices and encourage visitors to learn more about the environment, sustainable landscape design can promote awareness on environmental education. Overall, sustainable landscape design is an essential aspect of creating a sustainable future.

The Department of Family and Community Resource Management, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda, offers courses on “Landscape and Gardening” at Bachelor’s level as well as the Master’s level. Hence, the information gathered through the present research would widen the database and will help in strengthening the curriculum by making suitable modifications, from the point of view of sustainability. It is very crucial for the practicing as well as the upcoming Interior Designers and Architects to gain a better understanding of environmental sustainability and its immediate relatedness to landscape design as this can help them bring out a well functioned devised plan and design that can satisfy the owner and make an impact on the environment at the same time.

The data collected from the research would help to acquire knowledge about the current practices considering principles of sustainable landscape design adopted by these professionals. The findings of the study will also be beneficial to the users living within an aesthetically pleasing and environmentally sustainable landscapes which enhances the sense of wellbeing in the way of feeling of positivity and relaxation through the application of colours of the nature like green, yellow, brown, blue. This acts as an antidote to irritable moods and works as a stress buster amidst the hectic lifestyles. Landscaping and renewable technologies can help in the reduction of urban heat island, greenhouse effect, pollution, thermal stress, and other environmental hazards. It also conserves natural resources, reduces air pollution, and reduces the human-impact on the surrounding ecosystem.

Several studies were gone through the literature review which focused on elements, principles, parameters, problems, and practices of Sustainable Landscape Design. Studies related to edible Sustainable Landscape Design, hospital landscape sustainability, low-impact development, green landscape materials and nature-based solutions for Sustainable Landscape Design were also found.

However, a dearth of research was found in investigating the Problems Faced and Practices Adopted by Design Professionals with regards to Sustainable Landscape Design. Therefore, the present research was undertaken.

STATEMENT OF THE PROBLEM

The present study aims to find out the problems faced and the practices adopted by selected design professionals with regards to sustainable landscape design.

OBJECTIVES

1. To assess the extent of problems faced by the Design Professionals with regards to sustainable landscape design.

2. To determine the frequency of practices followed by the respondents with regards to sustainable landscape design.
3. To develop an educational package (booklet) for creating awareness on Sustainable Landscape Design.

DELIMITATIONS

1. The study was limited to the Interior Designers, Landscape Designers and Architects who have been practicing since last 5 years only from the time of data collection.
2. The study was limited to selected respondents from 4 major cities of Gujarat namely Valsad, Surat, Vadodara, and Ahmedabad.
3. The sample for the present study was limited to those 120 practicing Interior Designers, Landscape Designers and Architects who have incorporated minimum 3 aspects (Landscape Sustainability in terms of Water and Irrigation System, Vegetation and Planting, Built Environment and Materials, Shading, Wind Control, and Modification of Sunlight) in their respective projects.

HYPOTHESES OF THE STUDY

1. There exists a relationship between the selected personal and situational variables of the respondents and extent of problems faced while practicing Sustainable Landscape Design.
2. There exists a relationship between the selected personal and situational variables of the respondents with frequency of following Sustainable Landscape Design Practices.
3. There exists a relationship between Extent of Problems Faced by the Design Professionals with regards to Sustainable Landscape Design and Extent of Practices adopted by the Design Professionals with regards to Sustainable Landscape Design.

CHAPTER II

REVIEW OF LITERATURE

Any scientific investigation starts with a review of literature. The main aim of the present research is to find out the extent of problems faced and frequency of practices adopted by selected design professionals with regards to Sustainable Landscape Design. The major area of research of related literature, articles, survey, journals, books, and other sources relevant to the issues, area of research, or theory, providing description, summary and critical evaluation of each work are presented here. In order to make the review clear and understandable, the present chapter has been divided in to the following sections.

2.1. Theoretical Orientation

2.1.1. Landscape Design

2.1.2. Sustainable Landscape Design

2.1.3. Need for Sustainable Landscape Design

2.1.4. Sustainability and the role of a design professional

2.1.5. Principles of Sustainable Landscape Design

2.1.6. Values of a Sustainable Landscape Design

2.1.7. Benefits of Sustainable Landscape Design

2.1.8. Factors influencing Sustainable Landscape Design

2.1.9. Barriers faced while practicing Sustainable Landscape Design

2.2. Empirical Researches

2.2.1. Researches conducted outside India

2.2.2. Researches conducted within India

Conclusion

2.1.1. Landscape Design

According to (Hussain et al., 2014),

> "Landscape design is an art and science of organizing and enriching the outdoor space through the placement of plants and structures in agreeable and useful relationships with the natural environment"

(Williams and Tilt, 2006) also defined Landscape Design as,

> "Landscape Design is the art of developing property for its greatest use and satisfaction."

Design is the creative process of responding to conditions and concentrating meaning; and landscape design is the creation of responsive, evocative, meaningful, sustainable, and regenerative landscapes (Motloch, 2000).

> "Landscape Design is an essential part of the environment. Landscape, which includes topography, vegetation and associated plants and soil, water bodies, and their spatial configuration, is one of the most visual needs of people." (Zheng B et al., 2011)

(VanDerZanden and Rodie, 2008) stated that,

> "Landscape Design blends arts with environmental, physical, and biological of science which mainly focus on outdoor space. A well-defined landscape space can enhance the quality of living areas which meet people's preferences. Besides that, landscape design is not only limited to plant material only. It also focuses on the hardscape that complements the plants in order to create a successful design. A well-defined landscape space can create a quality of an

environment and provide a conducive living space in residential."

2.1.2 Sustainable Landscape Design

The Association of Professional Landscape Designers (APLD) presents a very simple, concise, and profound definition for Sustainable Landscape Design,

"Living today without degrading tomorrow"

One of the major aspects of adopting Sustainable Landscape Design is thinking local and using techniques that are not only sustainable, but also regenerative and environmentally responsible.

According to (Murray, 2017),

> "Sustainable landscaping is the practice of incorporating environmental priorities and practices into landscaping design. Sustainable landscaping affects every phase of the landscaping process including design, construction, landscaping coordination, implementation, and management. Sustainable landscaping design aims to integrate and balance the goals of creating a beautiful outdoor environment while also creating a landscape that fits with its natural setting and protects the surrounding ecosystem."[1]

Sustainable landscape design is a simple and affordable technique to enhance a building's energy efficiency, enhance the beauty and value of a property, offer screening for seclusion, act as a barrier, and many other things. Such landscape designs may help to avoid significant building heat gain rather than just enhancing the surrounding area by creating a natural and healthy ambiance. For instance, certain plant species may be placed with deliberately to shield a structure from the sun's rays and heat, reducing glare and temperature and providing comfort both inside and outside the building. Thus, the need for additional cooling devices like air conditioners can be reduced. In many instances, the landscape

design is frequently neglected until after a structure is finished. (Hussain et al., 2014)

2.1.3 Need for Sustainable Landscape Design

Sustainability is a concept that can be traced back to the 1960s, when increasing concerns about the impact of human activities on the planet started to arise around issues such as the pollution of natural ecosystems and the depletion of critical resources. (Carson et al., 1962)

> "Sustainability and landscape are concepts that are interlinked as landscaping involves nature and nature has been self-sustained from the beginning of time. Sustainability is the need of the hour in the present context of climatic crises and through landscape architecture, these issues could be addressed and resolved. The need for sustainability in landscape design has brought about its evolution from static and manicured lawns to adaptable and energy-efficient designs. Habitat restoration, energy efficiency, and conservation of flora and fauna are all important attributes of sustainable landscape design." (Spandana, 2022)

Also, according to (Architectural Landscape Design, 2022),

> "As environmentalism becomes more important to our everyday lives, sustainability is gaining more popularity everywhere, including in the landscaping market. Constantly maintaining the yard can be tiring, and sustainability can play a vital role in lessening that pain while giving back to the planet. Finding unique ways to be nature-friendly and happy with a given space is the key to creating a sustainable landscape design. Sustainability will be attained when a bunch of small changes build up into larger ones, and together they create an eco-friendly space."

The pursuit of continuous economic growth has major impact on our environment and society is not in question. Globally, there is an increased awareness of the need for sustainable development and the principles of sustainable development are finding their way into national and international policy. As the human population continues to expand and seeks to improve the circumstances, creating significant additional demand for resources, it is more essential and necessary than ever that sustainability becomes a key focus of all designs. (Owen, 2021)

2.1.4 Sustainability and the role of a design professional

Designers have the ability to analyze, think, visualize and develop solutions to critical problems in innovative ways. Solutions that are buildable, operable, maintainable, safe and usable. This ability of the designers and engineers make them the key players in shaping the future. However, the contribution of designers is rarely focused when policies are made towards a sustainable future.

Good design not only makes the construction easier, quicker, cheaper and safer but also contributes towards decisions on the procurement of materials and equipment. The materials and equipment, often are key factors affecting our environment. It is estimated that around 80 percent of all the decisions related to environmental impacts are determined during the design phases of the project. So, designers have a big role to play in moulding a sustainable future.

It is important that the developers, regulators, and investors consider sustainability as a necessity. This will help in building an environment where design consultants and contractors will be able to motivate and embrace their designers to develop solutions that are sustainable; solutions that will create a better environment for the future generations. (Saikia, 2020)[2]

(Ramani et al., 2010) explained that, designers traditionally focus on the form and function of products. Eco-Designers / Sustainable Designers are different because they do not only focus on how products look like but also on how they are produced, distributed and dismissed.

Sustainable Landscape Design places a major focus on reducing the life cycle impact of products.

Most designers do not know what strategy is and how sustainability relates to it from an organizational perspective. Strategy is a core function of an organization that binds together all the other ones and as such, sustainability can only be achieved if strategy demands it. (Tulder et al., 2013) By training, designers have a technical background and are therefore able to change the way products are developed to reduce their impact on the environment on a larger scale.

2.1.5 Principles of Sustainable Landscape Design

Sustainable landscape design is a strategy that responds to environmental issues. Principles of sustainability in landscape design include adapting to climatic conditions, preventing carbon emissions, preventing global climate change and pollutions resulted from the use of toxic pesticides, as well as the use of renewable energy sources and native plants. Since the elements of landscapes often include water, plants and built materials, the principles and criteria of environmental sustainability in landscape design is analyzed in these three elements as follow:

1. Water and Irrigation

   Irrigation methods should prevent the reduction of water by evaporation. In sustainable landscape architecture, the goal is to use water properly and prevent its loss. Designing slopes and surfaces to reduce flooding and adequate drainage are other appropriate methods of water efficiency. (Klett and Cummins, 2014)

2. Vegetation and Planting

   Sustainable planting is a method of selecting or planting plants in horticulture that conforms to Sustainable landscape. It is a part of sustainable architecture that focuses on the planning and design of the building's external environment and includes various activities in response to the environment. These activities are conducted at every stage of

landscaping, including the design, construction, execution, and management of residential and commercial landscapes (Loehrlein, 2009). The sustainable landscape creates an attractive environment that balances with the local climate and requires using minimal resources such as fertilizers, pesticides and water. It reduces water consumption and prevents air, water and soil pollutions. Also, in this design method, the selection of suitable plant species and their appropriate planting are considered. Sustainable landscape design can be considered as an appropriate design with efficient sustainable principles. This method includes planting

vegetation while considering such issues as planting native plant species, not using chemical fertilizers and pesticides, not doing heavy irrigation and using methods to eliminate or reduce water consumption while irrigating at the site.

3. Built Environment and Materials

   The best way to achieve efficiency of resources and materials in design is to consider the site as a functional system with inputs and outputs from internal resources and cycles. In general, sustainable landscaping includes indigenous and renewable materials, which means that they can grow and re-create themselves with low energy consumption and avoid using the materials and products that are harmful to the environment. Moreover, as mentioned, compliance to climatic objectives in landscape design has been one of the principles and features of environmental sustainability in landscape architecture. Also, studies have shown the garden orientation was from northwest to southeast, which made the garden to have the most shade during the day. (Ghaem, 2001)

4. Shading

   In the gardens, trees and built elements such as walls and porticos can play an effective role in reducing the intensity of solar radiation on building surfaces and creating shade.

5. Wind Control

   Plants can control wind by obstruction, guidance, deflection, and filtration. This is achieved through the form, texture and height of the plant itself or by its placement. Plants are used in conjunction with landforms and architectural structures guide the flow of air over the landscape.

6. Modification of Sunlight

   Plants absorb heat, provide shade, and create insulation. They absorb the sun's heat during the day and release it at night; they reduce the daytime temperature and increase the evening temperature. Each plant has its own texture, which determines the density of its shadow. With dense or open foliage, each plant form, whether deciduous or evergreen, has its benefit as a modifier. (Fadaie and Shemirani, 2022)[3]

2.1.6 Values of a Sustainable Landscape Design

The values of sustainable landscape design encompass a range of principles and ideals that promote environmentally responsible and socially equitable practices in the design, construction, and management of landscapes. These values are rooted in the recognition that human well-being is intricately linked to the health of the natural environment, and that the design and management of landscapes can have a significant impact on both. Some key values of sustainable landscape design include promoting biodiversity, conserving natural resources, enhancing ecosystem services, promoting social equity, and fostering community engagement. By upholding these values, sustainable landscape design can help create healthy, vibrant, and resilient landscapes that benefit both people and the planet. There are four ways in which a landscape can be valuable: Aesthetically, Economically, Functionally and Environmentally.

1. Aesthetic Value

   An attractive landscape is aesthetically valued because it adds beauty or is pleasing to our senses. The visual beauty of our home and property can be enhanced through creative landscaping while undesirable features can be downplayed. The sounds of birds or of water splashing in a fountain, enhance the aesthetic qualities of one's home environment. The aroma of flowers or the smell of a freshly mowed lawn and even the taste of fruit from plants in the landscape are soothing. The sense of touch can also be an aesthetically valuable feature of the landscape.

2. Economic Value

   The well-done landscape adds economic value to the home and property. The value of any house can be increased as much as 6-15% as a result of a good landscape. The function of any landscape is to enhance the beauty and therefore economic value of a house. Thoughtful landscaping can also reduce energy bills by buffering seasonal temperatures. In addition, trees and shrubs can be used to reduce wind speed, making the outdoor area more comfortable.

3. Functional Value

   Landscape design offers a special functional value too. Well-placed trees, shrubs, turf, and construction features increase the use of property. A little shade in the right place, appropriate sunlight wherever needed, a place for kids to play, a private patio, pool, or a deck and various other such features all add to the enjoyment of being outside.

4. Environmental Value

   The landscape does not only possess functional worth, but it can enhance and benefit the environment too. Through careful sustainable practices and landscaping methods, temperatures can be buffered in the summer and winter. Glare and wind can be reduced, and water can be used more efficiently. In addition, plants in the landscape help clean the air of dust and some

other pollutants. Landscape design also provides a habitat for all kinds of wildlife. (Helfand et al., 2006; Williams and Tilt, 2006)

2.1.7 Benefits of Sustainable Landscape Design

Sustainable Landscape Design being a practice of using multiples eco-friendly strategies to create an environmentally sustainable and climate appropriate space has some major goals and benefits which include water conservation, improving soil health, reducing maintenance and organic waste generation, carbon sequestration, and creating habitat through appropriate plant selection.

Sustainable Landscaping is an umbrella term that encompasses several landscape design, construction, implementation, and management practices utilized for both residential and commercial landscapes. Essentially, it is a strategy for making full use of the environment to provide natural key elements that a healthy landscape requires. As part of sustainable development, it preserves limited resources, reducing waste and preventing air, wait and soil pollution.

Growing the right kind of plants, utilizing compost and mulch, employing natural fertilization, weed and pest management, and implementing effective moisture control are all component of sustainable landscaping. Sustainable practices help protect the environment by reducing pollution, energy use, erosion, and storm water runoff while creating wildlife habitat and strengthening the health of local ecosystems. The benefits are economical as well as ecological – sustainable landscaping increases property values, reduces the costs for irrigation, fertilizer and pesticides and provides a unique aesthetic appeal.

Major environmental benefits of sustainable landscaping include,

Less maintenance - A sustainable landscape ideally contains primarily native plants that thrive under local conditions so the property needs minimal human assistance, reducing the use of polluting power equipment and toxic materials.

Longer life - A sustainable landscape centres around a balanced ecosystem – native plants attract native insects, pollinators and creatures,

all of which play a role in stabilizing and supporting a healthy ecosystem, contributing to the greater environmental good over a longer period of time.

Reduced water usage - A sustainable landscape starts with healthy soil featuring the proper balance of nutrients, materials, and organic content so that it absorbs and retains moisture better, minimizing runoff and puddles that can attract disease-carrying insects such as mosquitoes.

Minimal use of fertilizers and pesticides - Healthy soil contains the micro and macro-organisms that feed off dead and decaying biomatter, feeding itself with natural ingredients rather than toxic, synthetic fertilizers. A balanced ecosystem helps sustain a proper predator/prey environment, reducing the need for pesticides.

Use of green waste - Compost created from dead flowers, stems, and leaves provide a natural fertilizer while mulch made from ground-up woody material provides an attractive, natural barrier to weeds and helps the soil retain moisture and protect root systems.

Conservation of energy and resources - A sustainable landscape requires less watering, less tilling, and generally less maintenance. Lower consumption of all goods has a ripple effect up the supply chain, reducing the need for long distance transportation and other polluting resources. (Lipson – Rubin, 2021)

The Benefits of Sustainable Landscaping for Your Business.

Sustainable landscaping saves water

One of the major features of a sustainable landscape is that it cuts down on the amount of water it needs to grow and thrive, which is great for the business's bottom line. Landscaping for water conservation, considers choosing native plants for foundation plantings and borders. These plants are adapted to the area's typical weather conditions, so they will not need much extra care or irrigation. Another way to conserve water in a landscaping is to eliminate large swaths of lawn. Though green grass is often the default way to cover large areas, maintaining a lawn takes a great deal of water and fertilizer, which can run off into local waterways

and harm wildlife. Eliminating the lawn in favour of xeriscaping and native plants both protects waterways and conserves water for other uses.

Shade trees cut utility costs

Another way to make a business's landscaping more eco-friendly is to add shade trees to your property. Deciduous trees like maples and oaks planted on the southern and western sides of your building will block the sun's rays during the hottest parts of the day in the summer, which in turn will reduce the amount of energy you burn to keep the air conditioner running. In the winter, the trees will lose their leaves and allow the afternoon sun to warm your building, reducing your heating bills as well. The judicious planting of shade trees cuts your carbon footprint by cutting your energy needs, and trees also directly absorb CO2 from the atmosphere and replace it with oxygen, which helps cut down on harmful greenhouse gases and pollution. Healthy trees also beautify your property, but they do require some specialized care. Bald spots, discoloration, and peeling are all signs of disease that should be checked by a professional to maintain the health of your business's sustainable landscape.

Sustainable landscaping supports local ecosystems

Addition of trees, shrubs and other native plants to the property, invites birds and other animals to shelter there. This can support native species by planting favorite food sources. For example, many birds seek berries and seed pods, while hummingbirds look for nectar sources. Monarch butterflies famously need milkweed to survive, and you can consult with a local expert to find out how to attract these colorful creatures to your landscape with the right plantings.

A landscape is also home to millions of tiny organisms that you can't see, but that are crucial for the health of the soil and act as the foundation for your ecosystem. Soil microbes help break down organic compounds and create natural fertilizers for plants. They also aerate the soil and keep it healthy. Protect these important microorganisms by minimizing the use of

pesticides and chemical fertilizers and using organic compost to build healthy soil instead. (Wild, 2016)[5].

2.1.8 Factors influencing Sustainable Landscape Design

Budget

Setting the budget before ordering a single paver or buying new plants is the simplest way to avoid a budget blow-out and stay on top of your costs. Prioritize money spending. Instead of looking at the project as a whole, break it down by its elements: pergola, paving, plants and trees, landscape lighting, decking, etc. This will help to determine how much each portion will require monetarily. If the pergola is important but a small garden isn't, allocate the money accordingly.

Usage

A primary influence on the sustainable landscape design should be its intended use. This means designing a landscape that meets the needs and

helps elevate outdoor living.

Plants

More than an aesthetic choice, the plants chosen can complement one's lifestyle. Keep in mind, the climate, the orientation of garden, and skill level as a designer to determine the type of plants used in your garden. Whether a more formal garden is created over a natural-looking garden will be determined by the look one is going for and the amount of time spent tending the plants.

Maintenance

Some of the most common maintenance tasks to consider including:

- Routine cleaning and paver sealing
- Pulling out weeds and plants (as needed)
- Trimming hedges and low-hanging branches
- Regular mowing, aerating, and fertilizing of the grass
- Sealing of wooden landscape features (as needed)

Some landscape designs will require more care than others. Choose hardy plants that take care of themselves. Opt for a design made of low

maintenance features such as steel or aluminium fencing, or installing paved entertaining spaces instead of a yard full of plants and turf that needs attention.

Connectivity

Connecting each space in a sustainable landscape is critical. This step is tricky for landscape design beginners, but connected spaces help give the yard a cohesive look and feel that makes time spent outdoors more appealing. Paths that lead people from an alfresco dining area to outdoor seating in the garden. Connectivity comes down to blending the hardscape (non-growing structures) and landscape. No matter how well planned a garden is, if it doesn't create movement between each space, it will stand alone and be separate from your home.

Form

In a sustainable landscape design, form refers to the shape of a plant or hardscape feature. The choice of form will influence your design and play a major role in how the outdoor space looks. Plants are available in many forms including round, upright, groundcover, and freeform. The choice of landscape structures can also influence yard's form with various heights and shapes whether to opt for garden paths, retaining walls, fences, or pergolas. Typically, a more formal landscape design will embrace structured forms like hedges and trimmed shrubs. In contrast, an informal design might use more flowing or climbing plants to execute its landscape.

Lay of the land

The natural undulation of your land will have a drastic effect on the design of your landscape. [8]

2.1.9 Barriers faced while practicing Sustainable Landscape Design

Lack of Technical Knowledge, Higher Capital Cost, Time Consuming Certification Process, Lack of Availability of Funds and Materials, Lack of Interest on Part of the Clients, Selection of Materials and Justifying the Decisions Made, and Other General Problems that Come in the Way While Practicing Sustainable Landscape Design are just a few of the problems encountered while designing a sustainable landscape.

“Overcoming The Barriers to Sustainable Building Design”, (Wan, 2019) explains that, “All facets of the construction industry support sustainable design and initially all new building projects embrace sustainability as one of their key attributes. Yet more often than not, the finished project has compromised sustainability. In many cases, the sustainability considerations have been discarded outright. Much has been written about the design of sustainable buildings. Many designers, including architects, planners and engineers, have access to this knowledge and yet the majority of designs still do not embrace sustainability fully, preferring to follow their customary ‘business as usual’ practices. External barriers generally relate to context and may include statutory laws, regulations and codes, site constraints, environmental constraints, financial constraints, and so on. This list is not exhaustive but highlights the idea that sustainable design does not exist in a vacuum. It works within a given context. The three most common internal barriers are mind-set barriers, design barriers and management barriers, which do not stand independently of each other.

Mind-set Barriers

Disregarding environmental impact gives rise to the mind-set barrier that sustainable building design is too costly, even more so when environmentally sustainable features are designed as “bolt-on” features to a building. A landscape development company cannot sustain its existence if it is not profitable, at least to the minimum extent to cover its development cost. Likewise, the social characteristics of the landscape must also be sustainable, meaning that the landscape must work for the designed purpose. A design that cannot be used successfully for its intended purpose will fail both socially and economically.

Design Barriers

Design barriers come in many forms. Generally, the first of these is a lack of knowledge of sustainable design. Although sustainability is common in most university design curricula nowadays, this is a recent development, and so today there are still many designers who are practicing without

adequate knowledge of sustainability. Time and continuing professional development programmes will improve matters.

Another design barrier is the perception that sustainable design is a separate discipline to other more traditional construction design team specialties such as architecture, structural, mechanical and electrical engineering, and so on. If sustainable design continues to be identified as an independent discipline, it implies that the other disciplines do not consider sustainability in their core thinking. This is one of the design challenges that needs to be addressed. Currently, in most multi-disciplinary teams, sustainability consultants are identified as a separate discipline. They bridge the gap between sustainable design and traditional disciplines, and will continue to do so until such a time when sustainable thinking is naturally merged into all disciplines.

It is often the case that if the integration is done poorly, or not at all, it can easily go unnoticed. It may even be regarded as business as usual. As a result, poorly integrated design solutions in buildings are often the norm. The end-user may suffer as a result in terms of operational costs, user experience, or both. Furthermore, this suffering is often passed on as the responsibility of facilities management. When the sustainability requirements are added to the design, the game changes. The reason for this is that no disciplines escape the effects of sustainability and no disciplines can achieve sustainability independently of the other disciplines. Therefore, the only way around this dilemma is to embrace integrated design solutions.

Management Barriers

Management barriers to sustainable design are usually present when mind-set barriers and design barriers exist within the project team. However, even if the latter are overcome, the management barriers can still persist through the lack of understanding between the relationship of time, cost, scope and quality to achieve sustainable design.

Effective management for the realization of a sustainable landscape comes from an overall understanding of the role of design and its relationship to mind-set. Design barriers and mind-set barriers are often perceived as conflicting. For example, the cost of energy efficient design

is too expensive. The relationship between these two potentially conflicting barriers requires careful management to overcome their associated challenges. The role of management is to transform the conflict around these barriers into collaboration, that is, from a lose-lose scenario to a win-win scenario.

Successful sustainable landscape design that has overcome the above barriers often gives rise to the natural emergence of a collaborative design approach. If more professionals adopt this approach, then maybe one-day "sustainable design" will simply be "design."

2.2 Related Researches

2.2.1 Researches Conducted Outside India

Masnavi (2007) conceptualized "Measuring Urban Sustainability: Developing a Conceptual Framework for Bridging the Gap Between theoretical Levels and the Operational Levels" where the issue of sustainable development was widely acknowledged and spread rapidly after United Nations conference on environment and development in Rio in 1992. Considerable attention is given to urban settlement areas. Thus, role of urban development is seen as a challenging issue under circumstances. Outcomes of the current patterns of world population growth and industrial development are agreed and reported as major causes of un-sustainability in long term. While at the turn of the century, over half of the world's population would have resided in urban areas, it is predicted that by 2030, this number would increase to 8.1 billion, or 60.5% of the global population. This is twofold; on the one hand cities are the places of the excessive use of energy and resources, of production of waste and pollution, of crimes and deprivations and socio-cultural un-stability, and so forth. However, some question will arise: is there a simple and universal model of sustainable urban form? How would decision makers be able to assess the rightness of their programs and actions in terms of sustainability of urban forms? And to what extent the concept of urban sustainability can be translated to some measurable elements? This paper therefore, aims to develop a conceptual framework within which the notion of urban sustainability-as a broad

conceptual term - can be translated into some quantities which can be measured and evaluated with more assertion. Through this model, characteristics of sustainable urban form, systematically are defined and translated into some indicators. It is hoped that this model can provide easement and clarification for researchers and decision-makers in their assessment of cities' form and function towards achieving sustainability.

Nijhuis and Bobbink (2012) conducted a study on "Design-related research in landscape architecture". This article introduces a research strategy for landscape architectonic design. It describes a systematic approach where design research and research-by-design are combined. Design research is considered to be an indispensable step in research-bydesign. Together they constitute a heuristic approach for knowledge-based and creative design, and include plan analysis, comparative analysis, experimental design study and design study. Taken together these modes of research are termed design-related research. The development of design-related research in landscape architecture is regarded as crucial for understanding the formative elements of landscapes and for the development of planning methods and design strategies. In this respect landscape architectonic design actually can be seen as a form of research. The presented research strategy is applicable in related spatial design disciplines such as urban design and architecture, and therefore a contribution to the field of design-related research.

Macedo et al., (2012) conducted research on "Edible Sustainable Landscaping at Clark University". Edible sustainable landscaping is an important step toward sustainability in an urban environment. Replacing a traditional grass lawn with this type of landscaping would reduce water and maintenance requirements of an area of campus and would create habitat for animals as well as providing food for local wildlife, pollinators, and members of the community. The project sought to design a plot of edible landscaping on campus of Clark University and understanding faculty and staff attitudes and opinions toward the project. The methods used in this project included the exploration of secondary data on edible

landscaping, field trip to UMass Amherst, interviews with six stakeholders, soil test analysis, plot and plants selection. The results indicated most stakeholders agreed that edible, sustainable landscaping at Clark would increase the institution's approach to sustainability, foster students' learning and encourage behavioural change through education, and collaborative partnership. Annual herbs, fruit-bearing shrubs, nutrient accumulating ground cover plants, and some trees are ideal for this type of landscaping. The soil test illustrated that the soil quality at the selected plot is low in important nutrients but lead levels are below hazardous limits so growing edible plants will not be a problem with the addition of compost. With the support of staff and faculty,one plot in Downing Street that is dominated by grass and difficult to mow was selected for this edible landscaping pilot project.

Fadaie and Shemirani (2013) conducted research on "A Comparative Study on Gardens of Isfahan and Shiraz From Sustainability View (Case Studies: Gardens of Hashtbehesht and Jahannama)" where the research was based on comparative study between two Persian gardens in different micro climates in arid regions. Sustainability could be observed in many aspects and elements of traditional Iranian architecture and landscape architecture, and this method of design has used to solve many problems for many centuries. Gardens of Iran have had special role to moderate hot and arid climate since many years ago and their design method is an appropriate strategy to create sustainable landscape in our today cities. In this research, the selected case studies are Hasht-Behesht garden in Isfahan, and Jahannama garden in Shiraz, located in two different areas in arid regions of central plateau of Iran. The research method adopted in this paper consisted of descriptive-analytic and deductive analyses. By the analysis of sustainable and climatic features and characteristics of these cases, the main goal was to identify the parameters of creating green space for present and future sustainable landscaping with similar climates. Results confirm that the similarities and differences between these two gardens are because of the different microclimatic regions they are located in.

Polat and Akay (2015) conceptualized the “Relationship between the visual preferences of urban recreation area users and various landscape design elements” where the objective was to evaluate the relationship between the visual quality of urban recreational areas and structural vegetation landscape elements of these areas with regards to the preferences of the visitors and users. One of the major concerns has been to satisfy demands of people living in the cities who seek comfort inside as well as outside of their homes. Creating locations with aesthetic and functional qualities can fulfill the needs of such city dwellers. In this study, one-on-one interviews were conducted using photo questionnaires with 409 individuals. According to the data collected, nearly half of the 409 participants were women. Efforts were made to determine the preferences of female users. Additionally, younger individuals between the ages of 16 to 30 constituted of 58% of individuals who answered the questionnaire. Based on the findings, it was observed that the water surface area, the widths of pedestrian walkways, the function of recreational areas, plant composition, plant colour composition, and plant species diversity positively affect the visual quality of a landscape area. Furthermore, it was determined that a lack of bush-type plants within the plant composition could have a negative impact on the visual quality.

Hayles (2015) conducted a study on “Environmentally Sustainable Interior Design: A Snapshot Of Current Supply Of And Demand For Green, Sustainable Or Fair Trade Products For Interior Design Practice”. This study aimed to develop a comprehensive understanding of what constitutes a sustainable material choice and subsequently undertake a study of the current supply of and demand for Green, Sustainable and Fair Trade (GSFT) products for interior design practice. Although environmentally sustainable interior design (ESID) has become a major issue in interior design practice, according to the literature the frequency with which interior designers make sustainable choices in real practice is still limited, particularly where materials selection is concerned. The results demonstrate the wide range of Green, Sustainable and Fair Trade

(GSFT) products that are currently in the marketplace (including fabrics, window treatments, surface materials, flooring, walls and ceilings) and indeed many of these materials and products could be sourced from the retail outlets surveyed during the research. However, it was not easy to readily identify GSFT products and frequently the researcher had to look through volumes of materials, relying on personal knowledge and manufacturers' literature to determine the provenance of the materials marketed. Sourcing products in this way is inefficient and time consuming and has been highlighted as a barrier to engaging in ESID in the literature. Only a small number of the retailers interviewed have actively encouraged their customers to purchase GSFT. This reluctance to promote GSFT may reflect a lack of information on the provenance of materials to hand but also their belief that people are not aware of the benefits of either sustainable or green materials and therefore not engaged in ESID. The research has confirmed how difficult it is to find information on the provenance of materials to encourage the practice of ESID. Better access to basic knowledge of sustainability as well as more up-to-date information about sustainable materials would play a critical role in promoting sustainable practice.

Akagwu et al., (2017) conducted research on "Evaluation Of Environmental Aesthetics Of Residential Plots, through Low Impact Development Strategies, In Satellite Town, Lagos, Nigeria". The research aims at assessing landscaping and management issues in open spaces within approved setbacks of residential buildings in Satellite town, Lagos Nigeria using Low Impact development approach, with a view of improving the environmental aesthetics and sustenance of the residential plot. The manifestations of the signs of ineffectiveness of most residential plots in terms of environmental aesthetics are due to the problems of design, planning, regulatory and administrative frame work within which physical development takes place. The research focused on the effect of non-structural low impact development infiltration strategy on accommodated residential building site plans in Satellite town, Lagos, Nigeria, using questionnaires distributed to elicit information on their socio-economic

status, residential site status, and low impact development status. Analysis at three levels were carried out using Statistical Package for Social Science (SPSS) Version 21 and TUBIT statistical software. The study reveals that the environmental aesthetics of a residential site is largely dependent on setback distance and the state of setback ground. The study concludes that through Government's implementation of a percentage of the residential site set aside for un-paving during approval and monitoring, will improve the chances of achieving environmental aesthetics within residential plots through low impact development practices.

Darkhani et al., (2018) conducted a study on "Sustainable Urban Landscape Management: An Insight into Urban Green Space Management Practices in Three Different Countries" with an objective to examine the urban landscape management systems of three different countries selected randomly. The countries were, England, Malaysia and Singapore. The findings revealed that appropriate urban planning, programs, activities and guidelines can lead to proper management of urban landscapes; which ultimately ensures sustainability in the landscapes of a country with suitable management systems. All of the three countries have adopted their own measures and initiatives to ensure successful landscape sustainability. This research offers best practices and lessons for developing countries. It also includes best proven principles that can be used as an effective management tool to ensure and maintain urban landscape sustainability. Hence, the authors propose the implementation of management principles described in the "Preliminary framework for sustainable landscape management" to achieve landscape sustainability.

Herman et al., (2018) conducted a study on "Creating Green Space Sustainability through Low-Budget and Upcycling Strategies" where the authors aimed to come up with low-budget strategies as a deliberate means of creating valuable, attractive, well-used, sociable public spaces as recognized by some influential designers using the "Light, cheap,

quick” method. Unused spaces, just like objects and waste, can be creatively changed, reinvented with little resource input through a circular solution of upcycling. Case study methodology was predominantly used in the inquiry with three new parks, built after the year 2004, in Faro, Portugal. The study examined how the success rate and the current state of these public green areas correlates with the amount of financial resources invested in each of the projects. The case studies show key aspects in the building of the three spaces including: urban context, management and community participation. The success rate of a place is established based on user activity observations, user counts and questionnaires—conveyed amongst both experts and local residents. Results illustrate how low-budget strategies and limited use of funds and resources can be translated into a successful project of a public greenery. Comparative studies from Warsaw and Berlin further extend the discussion to the concept of upcycling as a sustainable solution for landscape architecture.

Khawaja et al., (2021) conducted “A Relative Study of Contemporary Residential Landscape Architecture: From the Local to the Global Aspect”. This study aimed to discuss the planning strategies of residential landscapes from a socio-technical perspective. A diverse approach was implemented for collecting data due to the uncertain situation around the world because of COVID-19 including personal archival data, LDA authority, building regulations, research articles and interviews. The study suggests that the dynamics of space and practices can normalize the unsustainable arrangements rooted in social organizations. The increased consumption of electrical appliances and specification of spaces has changed the culture into and unsuitable indoor layout planning and has neglected the use of outdoor areas in contemporary societies. It was concluded that landscape designers have become increasingly interested in the improvement of residential projects since surroundings have an impact on the human beings. Thus, landscapers must create plans that cater to people’s physical and mental needs. Various concepts and classifications were put forth by the authors. Additionally, a

comparative analysis was drawn between the local and international planning and designing concepts of landscaping.

Fadaie and Shemirani (2021) conducted a research on “An Introduction to the Impact of Sustainable Landscape Parameters on the Archetype of the Design of Persian Garden: Royal Pasargadae Garden”. Studies have shown that sustainability is one of the most important factors, which contribute to the Persian Garden design. This paper aims to synopsize the sustainable characteristics of Pasargadae Garden as the oldest recognized type of Persian Garden, based on its architectural layout, identified by the archaeologists’ excavations and historical documents. To achieve this purpose, the research employs the interpretive-historical method to recognize the parameters and constituent elements of Pasargadae Garden, existing in the subsequent Persian gardens, and data are gathered from the relevant documents. By the study and analysis of sustainable characteristics of royal garden of Pasargadae, some information was obtained which had an effective role in gaining the design principles of the subsequent gardens. Results show that the architecture of archetype of Persian garden corresponds to the parameters of environmental sustainability.

Niedek (2022) conducted a research on “Ecophilosophical and Ecopsychological Aspects of Sustainable Consumption and Lifestyle” which aimed to outline the philosophical and psychological dimensions of a sustainable lifestyle based on responsible consumption. In the author’s opinion, moderate consumption and an ecologically balanced way of living should, for their durability, have a broader mental and worldview background. The article presents and compares the concepts of the ecophilosophy of Henryk Skolimowski and the ecopsychology of Theodore Roszak in terms of cognitive, ideological, and axiological propositions of these concepts that can form the motivating basis for responsible living on Earth. Apart from the economic dimension, the adoption of ecological ethics and of ecological sensitivity is crucial for the permanent rooting of sustainable consumption patterns in people's

attitudes. Ecophilosophical and ecopsychological concepts can significantly help in this, contributing to human sensitivity to environmental issues related to the contemporary ecological crisis. The ecophilosophical and ecopsychological approach, need each other because they use complementary perspectives and methods of building ecological awareness. In the process of environmental education and shaping sustainable life attitudes, they are equally necessary for the effectiveness of achieving the goals of education for sustainable development and promoting an environmentally responsible lifestyle in society.

Simonic (2003) explored the idea of “Considering Public Preferences In Design Of Urban Landscapes As Restorative Environments”. A visual landscape preference research was conducted among the groups in Slovenia. In this study, questionnaire was used for the selection of urban landscapes. These represented different types of naturalistic and natural landscapes. Possibilities of applying findings about public visual preference for landscape scenes and preferences for selected uses of those landscapes to the landscape design process were discussed. A particular attention was given to restorative and experiential quality of landscapes. Findings clearly suggested that the particular character, spatial organization, and the character present natural elements in the landscape influence preference for certain uses and selection of landscape scenes as restorative environments.

Heeter (2005) investigated “Human Response to Colour of Plant Materials in the Landsape”. The research examined preference for, emotional appraisals of, and activities associated with warm colours versus cool colours. A pilot study tested whether pairs of landscape scene differed in tone. The study confirmed that the images did vary as desired. Those images were then used in a second study that had 101 people evaluate the pairs in colour tone for preference, conveyed emotion, functions of the scene. Warm colours were preferred, but only in two of the three landscape types. Warmer scenes were also deemed more active. Examined by scene context, warm materials were preferred most in urban

scenes where are cooler colours were preferred (only slightly more) in the rural scenes. A third ‘on site’ study was conducted to obtain on-site rating. The study asked people to answer a set of appraisals based on two garden scenes. It was also found that people responded more favorably to a warm collared landscape rather than a cool one. The findings of this study have the potential to become a valuable tool in the landscape architect’s arsenal. Knowing how colour affects the responses and behaviours in landscapes can help create settings that better accommodate the intended users and enhance their experience.

1.2.2. Researches conducted within India

Gupta (2001) conducted a study on “Pattern of Space Utilization, Values, Opinion And Problems Of Homemakers Regarding Residential Landscape Gardening” with the objective of collecting information regarding the space available around their house and the pattern of space utilization by respondents, the values and opinions of homemakers towards landscape gardening, and to identify the problems faced by the respondents for landscape gardening around the house. Descriptive research design with survey method was selected as an appropriate means to meet the objectives of the study. Purposive cum random sampling technique was adopted to select the respondents for the study. The findings revealed that most of the respondents carried out the activities to a great extent in the front yard and to some extent in side yards and back yard. Most of the respondents had lawns, seasonal flower beds, trees, potted plants and pathways in front side. They had water tank, pathways and potter plants on the side yards, and utility area on the back side of the house. Majority of the respondents had Asoka trees, roses, night queen and Gulmohar flower plants and other common plants were cactus, money plant and tulsi. Most of them had rose, cactus, tulsi and rubber potted plants. But it was observed that vegetable garden was not so common in their landscape gardening. Regarding the values that were held by the respondents, it was found that the respondents gave importance to

environmental friendliness, quality of life, family centrism, health and comfort for landscape gardening. Most of the respondents considered aspects such as; space available around the house, soil type, landscape of neighbour's house, colour scheme in planning the landscape garden which they valued the most. Most of the respondents has good opinion towards landscape gardening. Further testing of the hypothesis showed that the opinion of the homemakers, regarding landscape gardening was correlated with problems faced by the respondents in maintaining landscape garden, value of economy and value of utility space. It could be concluded that age was correlated with family centrism and comfort.

Chonkar (2013) conducted a study on "Designing Terrace Garden For Commercial Building In Vadodara City" with an aim to develop a design of terrace garden for commercial building in Vadodara city. It was thought to be beneficial to obtain feedback from those who are using the terrace garden at commercial building in Vadodara city. Thus, case study method was selected to make an in-depth analysis of selected terrace gardens. The analysis of data gathered through the designed tools enabled the researcher to understand the problems faced by the respondents. Further, the extent of satisfaction experienced by the users varied from case to case 38 for different features of the terrace garden such as raised beds or planters to hold soil and plants, a variety of vegetation such as flowers, herbs, vegetables, and shrubs, irrigation systems to conserve water, seating areas for relaxation, lighting to create a welcoming and relaxing atmosphere, and privacy screens for increased privacy. With these features, a terrace garden could be a beautiful, functional, and sustainable space that allows people to connect with nature and enjoy the benefits of gardening even in urban environments. Based on the reviewed literature and feedback received from the respondents, the investigator proposed a design for terrace garden with feature namely, the lawn, sitting areas, lighting, pathways, trees, shrubs, rock garden, fountain and flowering and no flowering plants along with the cost estimation.

Roy et al., (2015) conducted research on “Lagerstroemia for Urban Landscapes in India” to find the impact of Lagerstroemia plants on the Urban Landscapes of India. Landscapes and urban green space play a critical role for keeping our cities attractive and healthy. Lagerstroemias are among the best flowering trees for urban landscapes due to interesting growth, long blooming period and attractive flowers during summer. They grow well in different agro-climatic condition and drought tolerant. These plant species are selected for plantation in central verge, along the road, traffic island and urban green space because they have a capacity to tolerate dust, automobile fumes and have moderate efficiency to absorb air pollution. The plants which are used for landscaping have a good growth habit, flowering and striking flower colour. Lagerstroemia species have all these characters and create attraction while moving through the roads, parks, avenue plantation.

Rao and Ranganathan (2016) conducted a study on “Landscape Planning and Design –Case Tumkur City Karnataka” Today the fundamental capacity of the urban system to support the quality of urban life has reached a critical threshold due to rapid impairment of biophysical elements. Particularly shrinking green spaces affect the urban environment quality, air, water, and microclimate; which in turn affects the human health. Numerous researchers exemplifying that trees functions such as carbon sequestration, ground water recharging and regulating local temperature, etc. improves city’s environmental quality. Thus, green urban infrastructure emerges as an indispensable component of sustainable urban planning in developed countries. So, no matter parks, how large and how well designed would provide the citizens with the beneficial influence of nature. For the study Tumkur city is taken as case study but like any other city, Tumkur city is continuously losing most of its green areas due to unplanned rampant development where conservation of natural resources are not at all considered. A study on Tumkur’s land cover change indicates that non

vegetative surface has increased, as a result, the city's environmental problems have up surged many folds. This paper addresses the issues related to status of landscape elements like green space and water which is the essential part of biodiversity. To achieve the sustainable habitat for developing cities, sustainable landscape design should be part of the planning processes. This paper also discusses about the processes for the green cover network development to be adapted to develop green infrastructure in the city and also environmental management plan, policies to improve the condition of the landscape elements of the city to upgrade the quality of life of the city.

Singh (2017) conducted a study on "Urban Cultural Landscapes and Sacredscapes: The Indian Vision" where the concept of Indian Cultural Landscape refers to a complex cultural mosaic and network of spatiality of time, temporality of space, sacrality of nature and overall, the encompassing manifestation of transcendence of man who since time immemorial is trying to make a strong bridge between conscious mind and super-conscious divine. This way the interplay has been part of constant and continuous evolutionary drama between earthly Man and cosmic Nature, turning into various built-structures and traditions that maintained continuity maintenance-transformation and changes, of course always keeping the essence of the past that processed and get transferred from one generation to another. This makes the aliveness in the lifeways of the people and culture. Concept of cultural landscape has root in geographical thought and commonly accepted as one of the best strategies to understand and project the vividness and commonality of landscape and culture. This essay is an attempt on the line of critical appraisal of history of Indian Cultural Landscape, and its selected manifestive representations, e.g., cosmic rhythm and mandala, Bharat as Devi, the 'motherly' Ganga River and sacred sites, and intangible heritage.

Kapoor (2017) conducted a study on "Managing Ambient Air Quality Using Ornamental Plants-An Alternative Approach". Air quality management involves the determination of the relative contribution of

current or future source emissions at receptor sites to ground level pollutant concentrations coupled with implementation of effective management plan to reduce emission level. From the last few decades, urban air pollution has become an inevitable issue for its possible consequences on public health. In order to manage the ambient air quality, there are several methodologies with each having some specific advantages and constrains. Improvement of ambient air quality involves the basic approaches like emission reduction at source level, conversion of pollutants to a fewer damaging compounds and sequestration of pollutants. However, in order to manage the air quality, application of ornamental plants may be considered a well alternative approach. Although, it may not be imperative to consider plants as a sole alternative for urban ambient air quality management, but certainly it may useful to manage air quality for a small confined area, especially in case of indoor air. This paper reviews the possible application of ornamental plants, which may be trees, shrubs or herbs for its possible applications to regulate air quality. Some selective plant species has also been recommended based on its air pollution tolerance index.

Chatterjee (2018) conducted a study on “Living Cultural Landscape River Island of Majuli”. World Heritage as a concept generated from a competition has grown from focusing on distinctness to one that appreciates diversity and is now expanding to include living systems. This shift implies that more than a prediction-based assessment, monitoring of state of conservation and management has to respond to dynamic systems. Through the case of Majuli river island (located in India, in the northeastern state of Assam on the Brahmaputra River), it explores how this changed approach is a logical next step and will encourage state parties to propose inscription of living and continuing traditions.

Conclusion

The review of literature revealed that much effort has been made in the research area of “Landscape Design” abroad. An overview of the studies carried out reflected that much work has been done in relation to perceptions regarding sustainable outdoors, elements, principles and parameters of environmental sustainability in landscape, sustainable materials for landscaping as well as interiors, guidelines and strategies towards the achievement of Sustainable Landscape Design.

Very few researches were found in India which focused on Sustainable Landscape Design practices and problems. Therefore, the researcher was motivated to adopt the present study which finds out the extent of problems faced and frequency of landscape design practices adopted by the selected design professionals.

CHAPTER - III
METHODOLOGY

The present study was undertaken to discover answers to questions regarding Sustainable Landscape Design; extent of problems faced and practices adopted by the selected design professionals. In order to achieve the aim of the present study, a detailed plan of work and sequential procedure was followed which is presented in this chapter. The chapter deals with Research Design, Variables and Conceptual Framework under Study, Operational Definitions, Locale of the Study, Unity of Enquiry, Sample and Sampling Technique, Selection, Development and Description of the Tool, Data Collection and Data Analysis, which are explained in brief under the following headings:

3.1. Research Design

3.2. Variables and Conceptual Framework under the study

3.3. Operational Definitions

3.4. Locale of the study

3.5. Unit of Inquiry

3.6. Size and Sampling Technique

3.7. Selection, Development and Description of the Tool

3.8. Data Collection

3.9. Data Analysis

3.10. Development of Booklet

3.1 Research Design

The research design for the present study was descriptive in nature. The major purpose of Descriptive Research was describing the state of affairs as it exists. Descriptive Research Design was adopted for the present research because it gathers data on the Extent of Problems Faced and Frequency of Practices Adopted by selected design professionals with regards to Sustainable Landscape Design.

3.2 Variables and Conceptual Framework Under the Study

There were three sets of variables under the present research viz. Independent Variable, Intervening Variable and Dependent Variable. The selected Independent Variables classified for the study were – Personal Variables viz. Age (in years), Ownership of the Firm, Educational Qualification, Years of Work Experience, Number of Projects Undertaken, Kinds of Projects undertaken. The Intervening Variable for the present research was Extent of Problems Faced by the Design Professionals with regards to Sustainable Landscape Design. The dependent Variable was Frequency of Practices Adopted by the Design Professionals with regards to Sustainable Landscape Design.

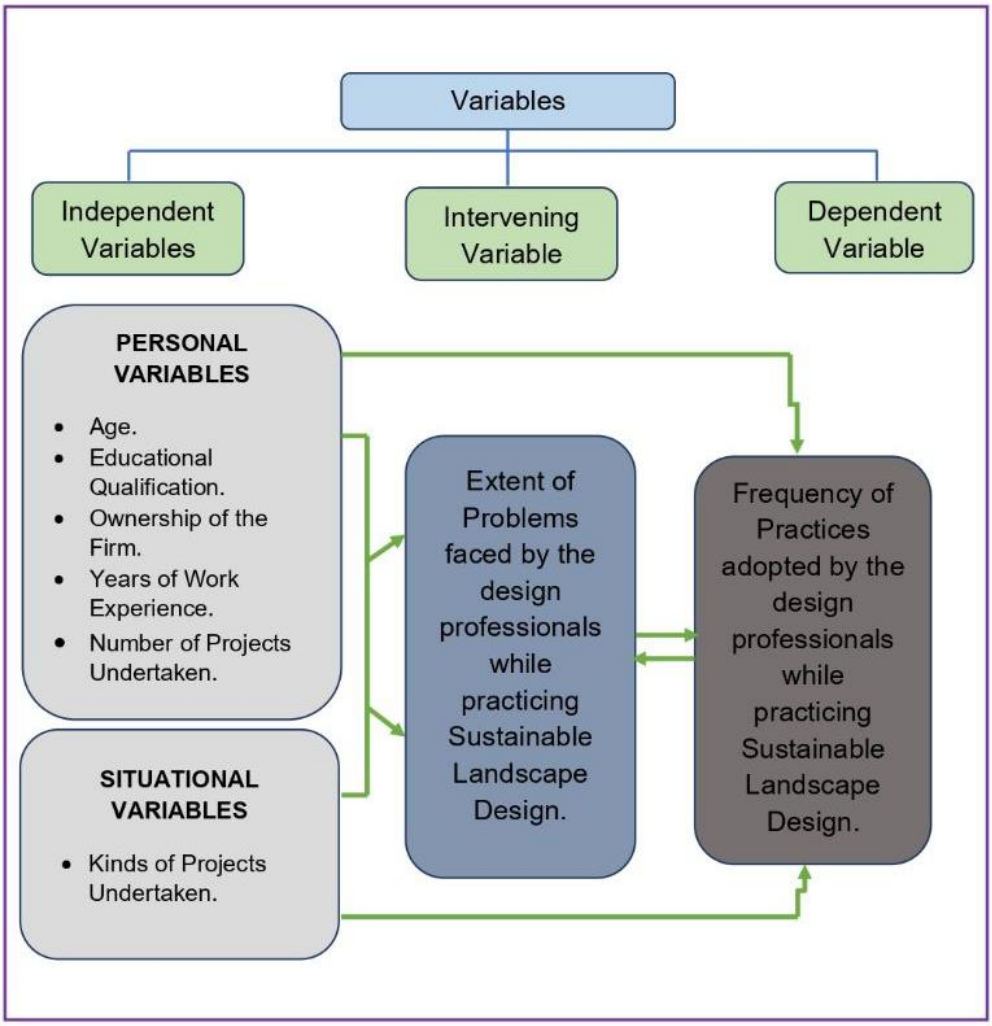

Figure 1: Conceptual framework of variables under study

3.2.1 Hypothetical Relationship Between Variables

A schematic diagram showing hypothetical relationship between selected variables with its explanation is presented here:

1. There exists a relationship between the selected Personal and Situational Variables with Extent of Problems Faced by the Design Professionals with regards to Sustainable Landscape Design.
2. There exists a relationship between the selected Personal and Situational Variables with Frequency of Practices Adopted by the Design Professionals with regards to Sustainable Landscape Design.

   There exists a relationship between Extent of Problems Faced by the Design Professionals with regards to Sustainable Landscape

Design and Frequency of Practices adopted by the Design Professionals with regards to Sustainable Landscape Design.

3.3 Operational Definitions

The operational definitions for the present research are given below.

3.3.1 Landscape Design

For the present study, Landscape design was operationally defined as the art of arranging the features of any area of land for aesthetic and/or functional purpose.

3.3.2 Sustainable Landscape Design

For the present study, Sustainable Landscape Design was operationally defined as a design of landscapes which sequester carbon, clean the air and water, increase energy efficiency, restores natural habitats, and create value through significant economic, social, and environmental benefits.

3.3.3 Design Professionals

For the present study, a Design Professional was operationally defined as a person who was qualified by education, experience and examination, who identifies, researches and creatively solves problems pertaining to the function and quality of the interior as well as exterior environments. The present research included Interior Designers, Landscape Designers and Architects who practiced Sustainable Landscape Design.

3.3.4 Extent of Problems Faced with Regards to Sustainable Landscape Design

For the present study, Extent of Problems was operationally defined as the obstacles that came in the way while practicing Sustainable Landscape Design such as; Lack of Technical Knowledge, Higher Capital Cost, Time Consuming Certification Process, Lack of Availability of Funds and Materials, Lack of Interest on Part of the Clients, Selection of Materials and Justifying the Decisions made and other general problems.

3.3.5 Frequency of Practices Adopted While Designing Sustainable Landscape Design

For the present study, Frequency of Practices Adopted was operationally defined as different methods used in a landscaping such as Water and Irrigation System, Vegetation and Planting Methods, Built Environment and Materials, Shading Practices, Wind Flow and Blocking Techniques and Optimizing the use of Sunlight to make it sustainable. The degree to which designers and practitioners incorporated sustainable principles, techniques, and materials into their sustainable landscape design projects. This included the use of environmentally friendly materials, the implementation of sustainable practices such as rainwater harvesting and composting, the selection of plant species that are native or adapted to the local climate and soil conditions, and the integration of ecological and social factors into the design process. The Frequency of Sustainable Practices adopted can vary widely depending on the specific goals, budget, and resources of each project, but overall, the aim is to create landscapes that are both aesthetically pleasing and environmentally responsible.

3.4 Locale of the study

The locale of the present study was 4 renowned cities of Gujarat, namely; Valsad, Surat, Vadodara, and Ahmedabad (30 design professionals from each city).

3.5 Unit of Inquiry

The selected design professionals who are practicing since last 5 years was the unit of inquiry for the present study.

3.6 Sample Size and Procedure:

Sample Size: The total sample size constituted of 120 Design Professionals who had practiced minimum 3 aspects of (Landscape

Sustainability in terms of Water and Irrigation System, Vegetation and Planting, Built Environment and Materials, Shading, Wind Flow and Blocking Techniques, and Optimizing the use of Sunlight) in their respective projects.

Sampling Technique: Purposive Random Sampling Technique was used to select the cities – Valsad, Surat, Vadodara, Ahmedabad. Snowball Technique was used by the investigator to select the sample (Design Professionals) who had practiced minimum three aspects of Sustainable Landscape Design in their respective projects.

3.6.1 Inclusion Criteria:

1. The selected Design Professionals who had been practicing Sustainable Landscape Design since last 5 years only from the time of data collection were included in the study.
2. The selected Design Professionals who had practiced / or were practicing minimum 3 aspects of Sustainable Landscape Design in their respective projects.

3.6.2 Exclusion Criteria

1. The Design Professionals who were not willing to participate in the present research will be excluded from this study.

3.7 Selection, Development and Description of the Tool

3.7.1 Selection of the Tool

In the light of the objectives framed for the present study, data collection tool was developed, namely, questionnaire. Questionnaire was developed to collect information regarding the Extent of Problems Faced and Frequency of Practices Adopted by the Design Professionals in the context of Sustainable Landscape Design.

3.7.2 Development of the Tool

Based on the objectives and variables selected for the study, information was collected through the review of literature, the questionnaire was prepared for the Landscape Designers. While preparing the tool, care was taken to include all such questions that would elicit the information needed

to attain the objectives of the study. The tool was prepared with guidance and interactive sessions with the experts.

It was selected because,

1. It is relatively inexpensive than other method as a researcher only need to distribute the questionnaire forms.
2. It is free from biasness as misreading of questions were reduced by explaining the questions.
3. It allows collection of wide range of information related to the problems faced and practices adopted by selected Design Professionals with regards to Sustainable Landscape Design.

3.7.3 Description of the Tool

The selection of the tool developed for the study are described in details as follow:

Section I - Background Information of the Respondents:

This section contained questions regarding the background information of the respondents viz. Name, Age (in years), Educational Qualification, Ownership of the Firm, Work Experience (in years), Number of Projects Undertaken, and the Kinds of Projects Undertaken.

Section II - Extent of Problems Faced by the selected design professionals: This section included questions regarding the obstacles faced by the design professionals while in practicing Sustainable Landscape Design such as; Lack of Technical Knowledge, Higher Capital Cost, Time Consuming Certification Process, Lack of Availability of Funds and Materials, Lack of Interest on Part of the Clients, Selection of Materials and Justifying the Decisions that come in the way while practicing Sustainable Landscape Design. A total of 38 statements reflecting different problems were prepared. The response structure on the scale was given a score of 3 to 1 for responses such as “Major Problem”, “Minor Problem”, “Not a Problem”. High extent of scores reflected high extent of problems and vice versa.

Section III - Frequency of Practices Adopted by the selected design professionals:

This section included of the items which elicited the information regarding the Frequency of Practices adopted on the basis of inclusion of the

practices of Sustainable Landscape Design, such as: Water and Irrigation System, Vegetation and Planting, Built Environment and Materials, Shading, Wind Control, Modification of Sunlight, and various other practices. A total of 36 statements reflecting various Sustainable Landscape Design practices were prepared. The response structure on the scale was given a score of 3 to 1 for responses such as “All of the Projects”, “Some of the Projects”, “None of the Projects”. High scores reflected higher frequency of practices and vice versa.

3.7.4 Establishment of Reliability

The reliability was established for selected scales prepared by the researcher.

Pretesting: A pilot study was conducted to find out the feasibility and clarity of the scales developed. Therefore, the developed scales were pretested on a sample of 30 design professionals (Architects/ Interior Designers/ Landscape Designers) who practiced Sustainable Landscape Design Practices in their projects.

Reliability of the scales: The reliability of the scale was established through internal consistency, based on the average inter-item correlation to establishing reliability. The Cronbach’s alpha test has been applied on 30 samples. The formula of Cronbach’s alpha is as below:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

Where, N is the number of items, c̄ = average covariance between item-pairs, v̄ =

average variance. In order to get overview of each of the scale used in present

study, the reliability coefficient was as given below (Table 1). The reliability values

were found to be high for all the scales as reported below.

Table 1: Overview of the scales with reliability values

Sr. No.	Scales	Reliability value
1.	Extent of Problems faced by the design professionals in adapting Sustainable Landscape Design.	**0.937**
2.	Extent of Practices adopted by the design professionals while practicing Sustainable Landscape Design.	**0.947**

For the present investigation, the researcher prepared 2 scales which were as follows: (i) Extent of Problems Faced by The Design Professionals While Practicing Sustainable Landscape Design, (ii) Extent of Practices Adopted by The Design Professionals While Practicing Sustainable Landscape Design.

3.8 Data collection

The data was gathered by the researcher between November 2022 to December 2022. The questionnaire was used as a tool for data collection. The purpose of the research was explained and rapport was built so as to gather true responses. The questionnaire was personally given by the researcher to the respondents. The data was collected only by the respondents who enthusiastically and willingly gave the needed information for the study.

3.9 Data Analysis

Data was analysed in four steps; Categorization, Coding, Tabulation and Statistical Analysis.

3.9.1 Categorization

The categorization of age (in years), educational qualification, duration of time working as a design professionals, kinds and number of Sustainable Landscape Design projects undertaken, sources of information, Extent of Problems faced by the respondents while practicing Sustainable Landscape Design and Frequency of Practices adopted by the

respondents while practicing Sustainable Landscape Design were formulated as follows:

Section 1: Background information of the homemakers

1. **Age of the respondents (in years):** It was measured in terms of number of years completed by the respondents at the time of data collection. The categories made were:
    a. 26 – 38 years
    b. 39 – 51 years
    c. 52 – 65 years
2. **Educational qualification of the respondents:** The educational qualification was categorized as follows:
    a. Diploma
    b. Bachelor's Degree
    c. Master's Degree
    d. Others
3. **Kinds and number of Sustainable Landscape Design projects undertaken:** The kinds and number of Sustainable Landscape Design projects undertaken by the respondents was categorized as follows:
    a. Residential Projects
        I. 1 – 10 projects
        II. 11 – 20 projects
        III. 20 projects
    b. Commercial Projects
        I. 1 – 10 projects
        II. 11 – 20 projects
        III. 20 projects
4. **Sources of information gathered by the respondents:** The sources of information gathered by the design professionals was categorized as follows:
    a. Print Media
    b. Audio/Visual Media

c. Word of Mouth
d. Formal Education/ Seminars

Section 2: Extent of Problems faced by the design professionals while practicing Sustainable Landscape Design.

This section included questions regarding the obstacles faced by the design professionals while in practicing Sustainable Landscape Design such as; Lack of Technical Knowledge, Higher Capital Cost, Time Consuming Certification Process, Lack of Availability of Funds and Materials, Lack of Interest on Part of the Clients, Selection of Materials and Justifying the Decisions that come in the way while practicing Sustainable Landscape Design. A total of 38 statements reflecting different problems were prepared. The response structure on the scale was given a score of 3 to 1 for responses such as “Major Problem”, “Minor Problem”, “Not a Problem”. High extent of scores reflected high extent of problems and vice versa**.**

Section 3: Frequency of Practices adopted by the design professionals while practicing Sustainable Landscape Design.

This section will include of the items which elicited the information regarding the frequency of practices adopted on the basis of inclusion of the practices of
Sustainable Landscape Design, such as: Water and Irrigation System, Vegetation and Planting, Built Environment and Materials, Shading, Wind Flow and Blocking Techniques, Optimizing the use of Sunlight, and various other practices. A total of 36 statements reflecting various Sustainable Landscape Design practices were prepared. The response structure on the scale was given a score of 3 to 1 for

responses such as “All of the Projects”, “Some of the Projects”, “None of the Projects”. High scores reflected higher frequency of practices and vice versa.

3.9.2 Item Intensity (Weighted Mean Scores)

The weighted mean is a type of mean that is calculated by multiplying the score (or probability) associated with a particular statement.

$$W = \frac{\sum_{i=1}^{n}(xi * wi)}{\sum_{i=1}^{n} wi}$$

Where, w= weighted mean n= number of terms to be averaged, wi = weights applied to x values and xi = data values to be averaged.

3.9.3 Coding

Score were given to each response and then the information from questionnaire were transferred on excel sheet.

3.9.4 Tabulation

The data were transferred from excel sheet into tabular form to give clear picture of findings.

3.9.5 Statistical Analysis

Descriptive Statistics: The data were presented in frequencies, percentage, mean, standard deviation and weighted mean.

Relational Statistics: Analysis of variance (ANOVA), t-test and coefficient of correlation (r-test) were computed to test the hypothesis formulated for the study.

3.10 Development of Booklet

A booklet was developed on “Every Professional’s Guide to – Sustainable Landscape Design”. It included the importance, need, benefits, principles and practices of Sustainable Landscape Design. A panel of experts from Family and Community Sciences validated the language clarity of the content of the booklet. The suggestions given by the judges were incorporated and changes were made accordingly.

CHAPTER IV

FINDINGS AND DISCUSSIONS

The aim of the present study is to find out the extent of problems faced and practices adopted by various design professionals, with regards to Sustainable Landscape Design. The findings are presented in the form of frequency, percentage, which are followed by statistical application for testing the hypotheses. The results are summarized as per the objective of the study and have been supported by relevant interpretations and discussions.

The chapter has been structured under the following sections:

Section I: Background information of the selected design professionals.

Section II: Extent of problems faced by the selected design professionals, with regards to Sustainable Landscape Design.

Section III: Frequency of practices adopted by the selected design professionals, with regards to Sustainable Landscape Design.

Section IV: Testing of Hypotheses.

Section V: Development of an educational package (booklet).

SECTION I

4.1 Background information of the respondents.

This section deals with background information of the selected design professionals which consists of age, educational qualification, duration of time working as a design professional, number and kinds of projects undertaken in which aspects of Sustainable Landscape Design are incorporated and the sources through which they obtained information about Sustainable Landscape Design.

4.1.1 Age of the respondents

The findings revealed that slightly more than one-half (53.33%) of the respondents were in the age group of 26 to 38 years. It was also revealed that more than one-third (37.5%) of the respondents were in the age group of 39 to 51 years. Very few of the respondents i.e., 9.2 percent were in the age group of 52 to 65 years. The minimum age of the respondent was found to be 26 years and the maximum was 65 years. The mean age of the respondents was found to be 38.41 years. (Table 2)

Table 2: Frequency and percentage distribution of the respondents according to their age (in years).

Sr.No.	Age (in years)	Respondents (n=120)	
		f	%
1.	26 – 38	64	53.33
2.	39 – 51	45	37.5
3.	52 - 65	11	9.2
	Mean	**38.41**	
	Standard Deviation	**9.087**	
	Minimum	**26**	
	Maximum	**65**	

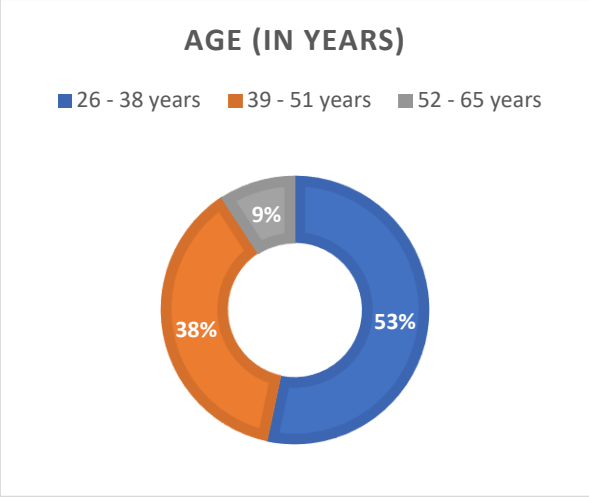

Figure 2: Percentage distribution of respondents according to their age (in years).

4.1.2 Education qualification of the respondents

The data pertaining to the educational qualification of the respondents as shown in Table 3, revealed that almost two-third of the respondents (66.6%) were holding a Bachelor's Degree, whereas very few (15.8%) had pursued a Master's Degree. Moreover, slightly more than 16.7 per cent of the respondents had pursued their Diploma and remaining (0.9%) were qualified from various other design fields (PhD in The Water Architecture of Arid India).

Table 3: Frequency and percentage distribution of the respondents according to their educational qualification.

Sr.No.	Educational Qualification	Respondents (n=120)	
		f	%
1.	Diploma	20	16.7
2.	Bachelor's Degree	80	66.6
3.	Master's Degree	19	15.8
4.	Other (PhD in Water Architecture of Arid India)	1	0.9
	Total	**120**	**100**

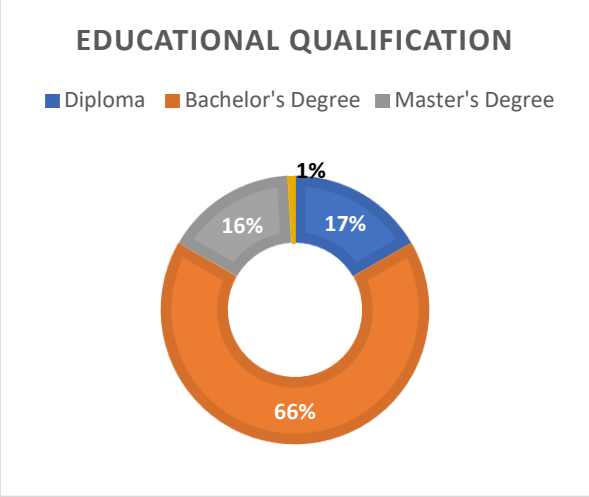

Figure 3: Percentage distribution of respondents according to their educational qualification

4.1.3 Duration of time working as a design professional

The findings in Table 4, revealed that majority of the respondents (53.3%) of the respondents had a work experience of more than 10 years and the remaining 46.7 per cent of the respondents had a work experience of less than or equal to 10 years.

Table 4: Frequency and percentage distribution of respondents according to their duration of time working as a design professional.

Sr.No.	Duration of time working as a Design Professional (in years)	Respondents (n=120)	
		f	%
1.	≤ 10 years	56	46.7
2.	> 10 years	64	53.3
	Total	**120**	**100**
	Minimum	**6**	
	Maximum	**42**	

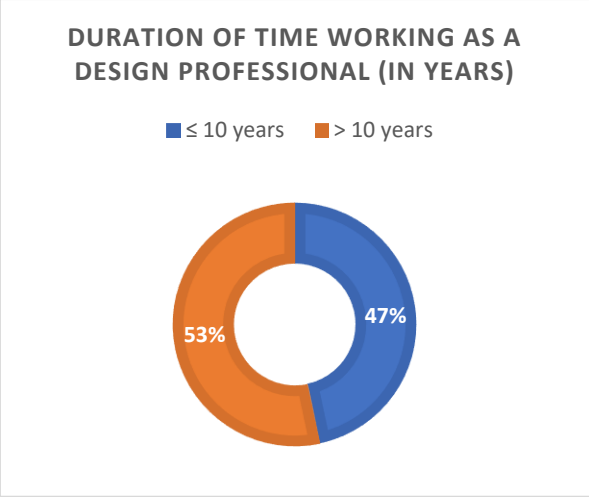

Figure 4: Percentage distribution of respondents according to their duration of work experience as a design professional

4.1.4 Kinds and number of Sustainable Landscape Design projects undertaken by the respondents

The findings showcased that 53.3% of the respondents had work experience of more than 10 years, which was reflected through a greater number of residential as well as commercial landscape design projects undertaken by them.

The findings in relation to the number and kinds of sustainable landscape design projects in residential areas revealed that 41.6 per cent of the respondents had undertaken 1 to 10 residential projects and the same proportion of respondents had also undertaken more than 20 residential projects. Furthermore, the data revealed that with regards to the number and kinds of sustainable landscape design projects in commercial areas indicated that one-half of the respondents (50.8%) had undertaken 1 to 10 commercial projects. It was also revealed that 25.9 per cent of the respondents had undertaken more than 20 commercial projects.

Table 5: Frequency and percentage distribution of respondents according to the number and kinds of Sustainable Landscape Design Projects undertaken.

Sr.No.	Kinds of Projects Undertaken	Respondents (n=120)	
		f	%
1.	**Residential Projects**		
	1 – 10 Projects	50	41.6
	11 – 20 Projects	20	16.8
	> 20 Projects	50	41.6
	Total	**120**	**100**
2.	**Commercial Projects**		
	1 – 10 Projects	61	50.8
	11 – 20 Projects	28	23.3
	> 20 Projects	31	25.9
	Total	**120**	**100**

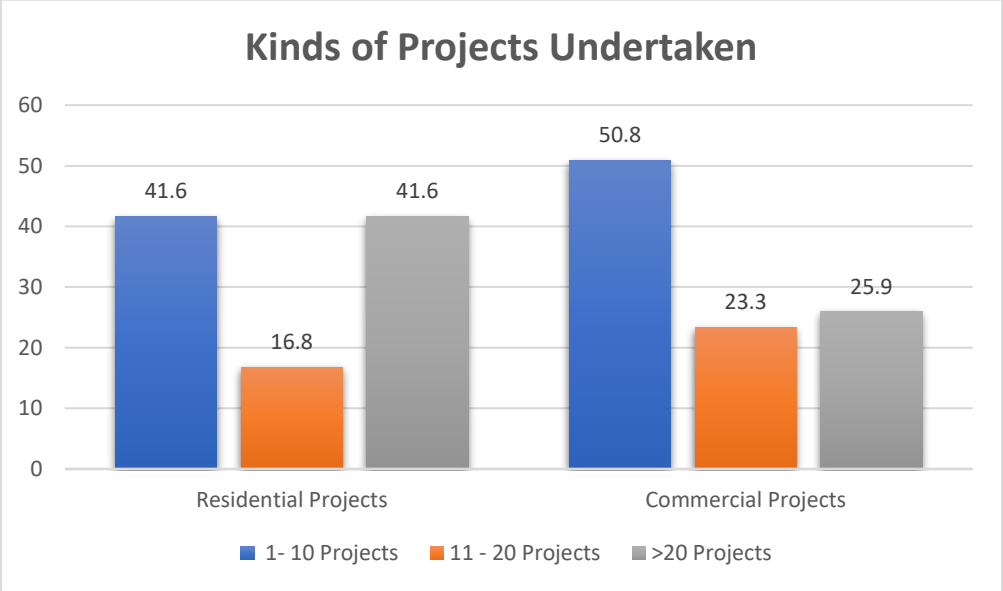

Figure 5: Percentage distribution of respondents according to the number of Sustainable Landscape Design projects undertaken.

4.1.5 Sources of Information obtained by the selected design professionals regarding Sustainable Landscape Design.

Generally, apart from their own experiences, the design professionals made use of various other sources of information to acquire knowledge about Sustainable Landscape Design. Different sources used were print media, audio/visual media, word of mouth and formal education or seminar.

Table 6: Frequency and percentage distribution of respondents according to various sources of information on sustainable landscape design practices.

Sr.No.	Sources of Information	Respondents (n=120)	
		f	%
1.	Print Media (Newspaper, Magazine)	16	13.3
2.	Audio/Visual Media (Television Programs)	11	9.2
3.	Word of Mouth (Clients, Professional Associates, Friends)	49	40.8
4.	Formal Education/Seminars (Educational Programs, Workshops, Conferences, Seminars, Personal Research)	44	36.7
	Total	**120**	**100**

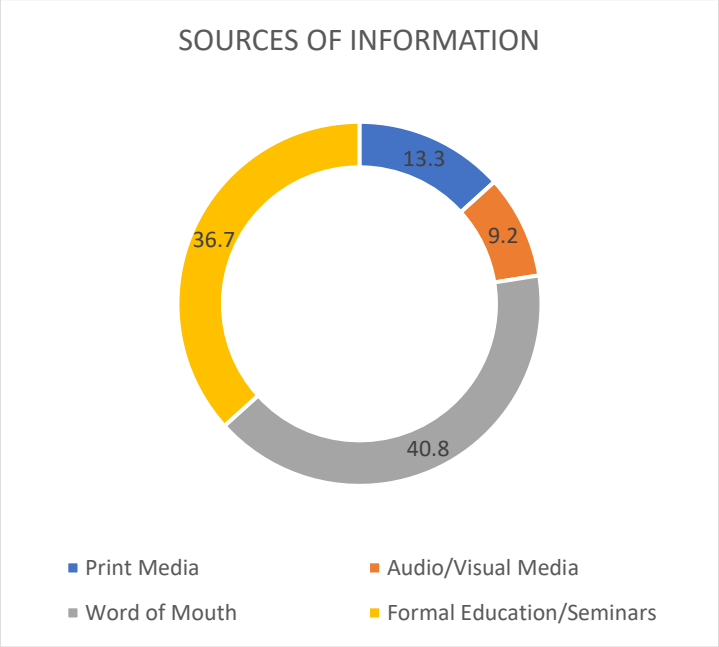

Figure 6: Percentage distribution of respondents according to the Sources of Information on Sustainable Landscape Design Practices

The data with regards to sources of information on Sustainable Landscape Design Practices of the respondents revealed that maximum awareness and information was sourced from audio/visual media (40.83%) by the selected design professionals. Whereas, more than

one-third (36.6%) of the respondents also gained information regarding Sustainable Landscape Design from print media such as newspapers and magazines. A very few respondents were informed about the same through word of mouth from the clients, professional associates, or friends (13.33%) and through formal education/seminars (9.16%) also.

SECTION II

4.2 Problems faced by the selected design professionals while practicing Sustainable Landscape Design.

This section covers information regarding the problems faced by the selected design professionals while practicing Sustainable Landscape Design. The problems considered were listed as ‘Lack of technical knowledge’, ‘Cost’, ‘Issues with the certification process’, ‘Resource constraints’, ‘Clients’ perception’, and ‘Other’ problems. The responses were sought in terms of ‘Major Problem’, ‘Minor Problem’, and ‘Not a Problem’. These were ascribed the scores of 3 through 1 respectively. The scores were interpreted in terms of ‘To High Extent’, ‘To Moderate Extent’, and ‘To Low Extent’. Higher scores revealed high extent of problems and vice versa.

4.2.1 Lack of technical knowledge

4.2.2 Cost

4.2.3 Issues with the certification problem

4.2.4 Resource constraints

4.2.5 Clients’ perception

4.2.6 Other problems

4.2.1 Lack of Technical Knowledge

Table 7: Frequency and percentage distribution of respondents according to Lack of Technical Knowledge as a problem while practicing Sustainable Landscape Design.

Sr. No.	Lack of technical knowledge as a problem while practicing Sustainable Landscape Design	Respondents (n=120)						Weighted Mean Scores (3-1)
		To High Extent		To Moderate Extent		To Low Extent		
		f	%	f	%	f	%	
1.	Lack of training/education about Sustainable Landscape Design.	43	35.8	49	40.8	28	23.3	**2.13**
2.	Lack of technical understanding.	24	20	53	44.2	43	35.8	**1.84**
3.	Lack of experience.	20	16.7	49	40.8	51	42.5	**1.74**
4.	Lack of education and knowledge about the concept among the clients.	35	29.2	47	39.2	38	31.7	**1.98**
5.	Preconceived notions/stigma amongst the professional as well as the client for the concept to be “tough” to implement.	22	18.3	60	50	38	31.7	**1.87**
6.	Unaware about several codes, materials and standard for Sustainable Landscapes.	29	24.2	67	55.8	24	20	**2.04**
7.	Unaware about concern and immediate importance for Sustainable Landscape Design.	36	30	44	36.7	40	33.3	**1.97**
	Total Weighted Mean							**1.90**

The data revealed that more than one-third of the respondents (35.8%) were facing problems due to lack of training/education about Sustainable Landscape

Design to a high extent, followed by more than one-half (55.8%) of the respondents who stated that not being aware about several codes, materials and standards for Sustainable Landscapes also moderately impeded the adoption of Sustainable Landscape Design.

4.2.2 Cost

Table 8: Frequency and percentage distribution of respondents according to Cost as a problem while practicing Sustainable Landscape Design.

Sr. No.	Cost as a problem while practicing Sustainable Landscape Design	Respondents (n=120)						Weighted Mean Scores (3-1)
		To High Extent		To Moderate Extent		To Low Extent		
		f	%	f	%	f	%	
1.	High initial cost for implementing Sustainable Landscape Design.	41	34.2	68	56.7	11	9.2	2.25
2.	High cost of sustainable landscape design materials.	31	25.8	62	51.7	27	22.5	2.03
3.	High cost associated for accreditation/certification.	33	27.5	63	52.5	24	20	2.08
4.	Uncertainty about the economic benefits in the longer run from Sustainable Landscape Design.	26	21.7	69	57.5	25	20.8	2.01
	Total Weighted Mean							**2.18**

The findings analysed in Table 8, revealed that slightly more than one-third (34.2%) of the respondents found that the high initial cost for implementing Sustainable Landscape Design projects hindered the adoption of Sustainable Landscape Design to a high extent. The data also showed that more than one-half (57.5%) of the respondents experienced uncertainty about the economic

benefits from Sustainable Landscapes as a problem which had a moderate effect on their Sustainable Landscape Design practices in the longer run.

4.2.3 Issues with the certification problem

Table 9: Frequency and percentage distribution of respondents according to Issues with the Certification Process as a problem while practicing Sustainable Landscape Design.

Sr. No.	Issues with the certification process as a problem while practicing Sustainable Landscape Design	Respondents (n=120)						Weighted Mean Scores (3 – 1)
		To High Extent		To Moderate Extent		To Low Extent		
		f	%	f	%	f	%	
1.	Unable to understand the process of certification.	31	25.8	67	55.8	22	18.3	**2.08**
2.	Expensive certification process.	23	19.2	56	46.7	41	34.2	**1.85**
3.	Lengthy certification process.	29	24.2	53	44.2	38	31.7	**1.93**
4.	Difficulty in obtaining the certification.	23	19.2	60	50.0	37	30.8	**1.88**
5.	Unaware of the various Certifications and Green Standards that can be acquired.	35	29.2	62	51.7	23	19.2	**2.10**
6.	Lack of active Government participation in endorsing certification.	54	45.0	54	45.0	12	10.0	**2.35**
	Total Weighted Mean							**1.92**

The data presented in Table 9, shows that, slightly less than one-half of the total number of respondents (45%) found lack of active government participation in endorsing getting certified as a major problem for them to practice Sustainable Landscape Design. Moreover, 55.8 per cent of the respondents found process of certification was not easy to understand to a moderate extent.

4.2.4 Resource Constraints

Table 10: Frequency and percentage distribution of respondents according to Resource Constraints as a problem while practicing Sustainable Landscape Design.

Sr. No.	Resource constraints as a problem while practicing Sustainable Landscape Design	Respondents (n=120)						Weighted Mean Scores (3-1)
		To High Extent		To Moderate Extent		To Low Extent		
		f	%	f	%	f	%	
1.	Lack of financial assistance from financial institution to practice Sustainable Landscape Design.	42	35	72	60	6	5	**2.30**
2.	Lack of availability of the required sustainable materials locally.	49	40.8	48	40	23	19.2	**2.22**
3.	Unaware about the available materials and various resources used for a Sustainable Landscape Design.	40	33.3	45	37.5	35	29.2	**2.04**
4.	Misleading information by manufacturers regarding company's materials and its effect on the environment.	40	33.3	56	46.7	24	20	**2.13**
5.	Relatively higher cost of required materials acting as a barrier for adopting Sustainable Landscape Design.	34	28.3	67	55.8	19	15.8	**2.13**
6.	Lack of availability of landscape space for implementation of sustainable landscape practices.	41	34.2	53	44.2	26	21.7	**2.13**
	Total Weighted Mean							**2.24**

The findings given in Table 10, it was indicated that lack of availability of the required sustainable materials locally, affected 40.8 per cent of the respondents to a high extent. Whereas, 60 per cent of the respondents were moderately affected due to same.

4.2.5 Clients' Perception

Table 11: Frequency and percentage distribution of respondents according to Clients' Perception as a problem while practicing Sustainable Landscape Design.

Sr. No.	Clients' perception as a problem while practicing Sustainable Landscape Design	Respondents (n=120)						Weighted Mean Scores (3-1)
		To High Extent		To Moderate Extent		To Low Extent		
		f	%	f	%	f	%	
1.	Unwillingness of the clients to pursue Sustainable Landscape Design.	81	67.5	32	26.7	7	5.8	**2.62**
2.	Unable to imbibe proper knowledge and awareness about Sustainable Landscape Design to the clients.	32	26.7	53	44.2	35	29.2	**1.98**
3.	Persistence of negative stereotypes among the clients about adopting Sustainable Landscape Design.	50	41.7	59	49.2	11	9.2	**2.33**
4.	Unaware about the positive environmental impact of Sustainable Landscape Design.	51	42.5	51	42.5	18	15	**2.28**
5.	Resistance to change one's mindset from traditional Landscape Designing practices to Sustainable Landscape Design practices.	71	59.2	39	32.5	10	8.3	**2.51**
6.	Lack of interest on the part of the client.	82	68.3	32	26.7	6	5	**2.63**
	Total Weighted Mean							**2.48**

The findings in the Table 11, revealed that more than two-third (68.3%) of the respondents faced problems to a high extent due to a lack of interest on the part of the client. Moreover, persistence of negative stereotypes among the clients about adopting Sustainable Landscape Design was also a problem experienced by almost one-half of the respondents (49.2%) to a moderate extent.

4.2.6 Other problems

Table 12: Frequency and percentage distribution of respondents according to Other Problems while practicing Sustainable Landscape Design practices.

Sr. No.	Other problems while practicing Sustainable Landscape Design	Respondents (n=120)						
		To High Extent		To Moderate Extent		To Low Extent		Weighted Mean Scores (3-1)
		f	%	f	%	f	%	
1.	Lack of legislative support to encourage the practices of Sustainable Landscape Design.	50	41.7	63	52.5	7	5.8	**2.36**
2.	Demotivation arises due to not getting the recognition for the projects on Sustainable Landscape Design.	42	35	56	46.7	22	18.3	**2.17**
3.	Difficult to practice Sustainable Landscape Design when deadlines of project completion are supposed to be met.	31	25.8	58	48.3	31	25.8	**2.00**
4.	Last minute changes by clients leads to errors in the design.	43	35.8	60	50	17	14.2	**2.22**
5.	Last minute changes by clients leads to waste of time.	44	36.7	58	48.3	18	15	**2.22**
6.	Lack of commitment to protect the environment through adoption of	50	41.7	55	45.8	15	12.5	**2.29**

	Sustainable Landscape Design practices.							
7.	Unsure about the methods of repurposing the not useful resources in the actual landscape design instead of discarding it.	18	15	63	52.5	39	32.5	**1.83**
8.	Unaware about the competitive advantage of practicing Sustainable Landscape Design as compared to Landscape Design.	37	30.8	50	41.7	33	27.5	**2.03**
9.	Inability to execute the planned Sustainable Landscape Design.	21	17.5	52	43.3	47	39.2	**1.78**
	Total Weighted Mean							**2.19**

The data in Table 12, revealed that 41.7 per cent of the respondents found lack of legislative support to encourage the practices of Sustainable Landscape Design and lack of commitment to protect the environment through adoption of Sustainable Landscape Design practices as a problem to a high extent. Moreover, 52.5 per cent of the respondents were affected due to a lack of legislative support to encourage the practices of Sustainable Landscape Design to a moderate extent.

Table 13: Frequency and percentage distribution of respondents according to the extent of problems faced by them while practicing Sustainable Landscape Design practices.

Sr. No.	Problems while practicing Sustainable Landscape Design	Respondents (n=120)						
		To High Extent		To Moderate Extent		To Low Extent		Weighted Mean Scores (3-1)
		f	%	f	%	f	%	
1.	Lack of technical knowledge	7	5.8	94	78.3	19	15.8	**1.90**
2.	Cost	36	30	70	58.3	14	11.7	**2.18**
3.	Issues with the certification process	12	10	86	71.7	22	18.3	**1.92**
4.	Resource constraints	40	33.3	69	57.5	11	9.2	**2.24**
5.	Clients' perception	61	50.8	56	46.7	3	2.5	**2.48**
6.	Other problems	32	26.7	79	65.8	9	7.5	**2.19**
	Overall	**15**	**12.5**	**104**	**86.7**	**1**	**0.8**	**2.12**

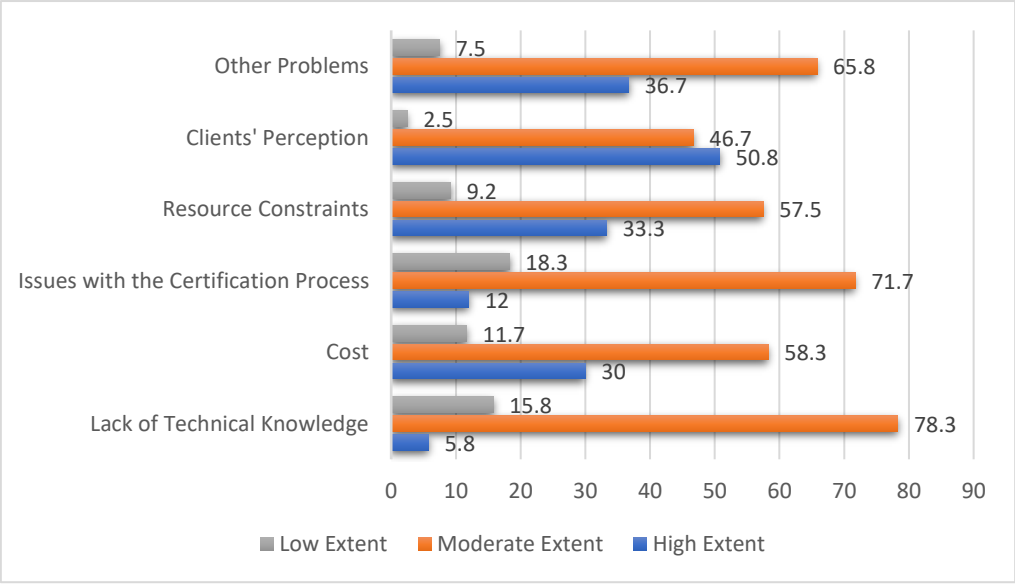

Figure 6: Percentage Distribution of respondents according to the Extent of Problems Faced while practicing Sustainable Landscape Design

In context of the extent of problems faced by the respondents while practicing Sustainable Landscape Design, clients' perception was found to be the major problem faced by a little more than one-half (50.8%) of the respondents to high extent. The findings also elicited that 71.7 per cent of the respondents faced issues with the certification process to a moderate extent.

The computed weighted mean scores for each problem faced while practicing sustainable landscape designing revealed that 'Clients' Perception' and 'Resource Constraints' were the aspects in which major problems were faced while practicing sustainable landscape design. The overall weighted means score of all problems faced was 2.12.

Table 14: Weighted Mean Scores for Extent of Problems Faced While Practicing Sustainable Landscape Design.

Sr.No.	Extent of Problems Faced While Practicing Sustainable Landscape Design	Total Weighted Mean Scores
1.	Lack of technical knowledge	1.90
2.	Cost	2.18
3.	Issues with the certification process	1.92
4.	Resource constraints	2.24
5.	Clients' perception	2.48
6.	Other problems	2.19
	Overall Weighted Mean	2.12

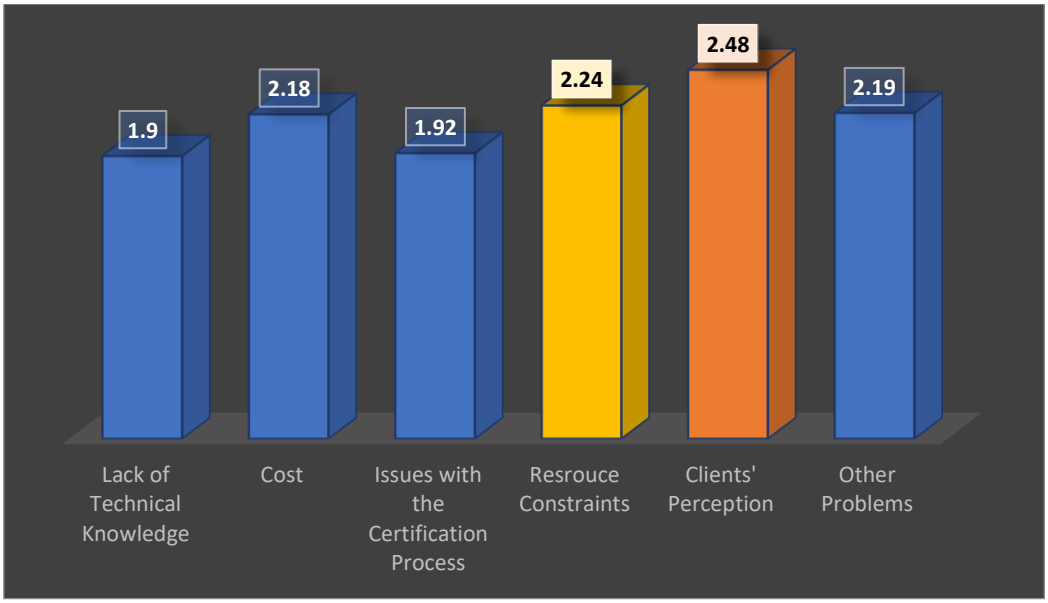

Figure 7: Weighted Mean Scores for the Extent of Problems Faced while practicing Sustainable Landscape Design

SECTION III

4.3 Frequency of Sustainable Landscape Design practices followed by the selected design professionals

This section deals with the Sustainable Landscape Design practices followed by the various design professionals. The respondents were asked about their practices which included ‘Water and Irrigation Practices’, ‘Vegetation and Planting Practices’, ‘Built Environment and Materials’, ‘Shading Practices’, ‘Wind Flow and Blocking Techniques’, and ‘Optimizing the use of Sunlight’. Higher scores on the scale revealed higher frequency of practices and vice versa. These responses were sought in terms of ‘All of the Projects’, ‘Some of the Projects’, and ‘Few of the Projects’; which were ascribed scores of 3 through 1 respectively. The scores were interpreted in terms of ‘Very Often’, ‘Sometimes’, and ‘Rarely’.

4.3.1 Water and Irrigation

4.3.2 Vegetation and Planting

4.3.3 Built Environment and Materials

4.3.4 Shading

4.3.5 Wind Flow and Blocking Techniques

4.3.6 Optimizing the use of Sunlight

4.3.1 Water and Irrigation

Table 15: Frequency and percentage distribution of respondents according to Water and Irrigation as a practice with regards Sustainable Landscape Design.

Sr. No.	Water and Irrigation as an aspect of Sustainable Landscape Design Practice	Respondents (n=120)						
		Frequency of following Sustainable Landscape Design practices						Weighted Mean Scores (1 – 3)
		Very often		Sometimes		Rarely		
		f	%	f	%	f	%	
1.	Installation of rain water barrels to tackle water run-off on the landscape.	17	14.2	78	65.0	25	20.8	**1.93**
2.	Considering water needs of plants grown in a landscape in context of weather conditions of the respective sustainable landscape site.	68	56.7	47	39.2	5	4.2	**2.53**
3.	Creating straight and perpendicular water canals that lead to a reservoir for collecting and conserving excess water on the landscape.	48	40.0	50	41.7	22	18.3	**2.22**
4.	Placing water streams under the shade of dense trees to decrease the amount of water evaporation.	54	45	49	40.8	17	14.2	**2.31**
5.	Creating big or small reservoirs on the landscape like ponds, pools or wells to collect water and avoid wastage of the same.	43	35.8	56	46.7	21	17.5	**2.18**

6.	Aligning the irrigation system with the plantations for optimizing water consumption without it running down the drain.	68	56.7	41	34.2	11	9.2	**2.48**
7.	Installation of landscape appropriate drainage system to accumulate water in one place.	77	64.2	37	30.8	6	5.0	**2.59**
	Total Weighted Mean							**2.51**

The data in Table 15, revealed that the majority (64.2%) of the respondents had practiced the installation of landscape-appropriate drainage systems to accumulate water in one place very often, followed by 56.7 per cent of the respondents who also aligned the irrigation system with the plantations for optimizing water consumption without it running down the drain and considering water needs of plants grown in a landscape in the context of weather conditions of the respective sustainable landscape site very often.

4.3.2 Vegetation and Planting

Table 16: Frequency and percentage distribution of respondents according to Vegetation and Planting as a practice with regards to Sustainable Landscape Design.

Sr.No.	Vegetation and Planting as an aspect while practicing Sustainable Landscape Design	Respondents (n=120)						
		Frequency of following Sustainable Landscape Design practices						Weighted Mean Scores (1 – 3)
		Very Often		Sometimes		Rarely		
		f	%	f	%	f	%	
1.	Planting regionally appropriate native plants.	89	74.2	25	20.8	6	5.0	**2.69**
2.	Cultivating plants and trees that have low water needs.	77	64.2	33	27.5	10	8.3	**2.56**

3.	Avoiding chemical pesticides and fertilizers to falsely enhance the growth of fruit and vegetable bearing plants.	72	60.0	38	31.7	10	8.3	**2.52**
4.	Plantation of deciduous trees which provide shade in summers and allow sunlight to pass through in winters when the leaves wither off.	70	58.3	41	34.2	9	7.5	**2.51**
5.	Planting evergreen trees to protect the space from cold and unpleasant dusty winds.	77	64.2	32	26.7	11	9.2	**2.55**
6.	Planting various medicinal plants that naturally prevent the insects and pests in a sustainable landscape.	60	50.0	48	40.0	12	10.0	**2.40**
	Total Weighted Mean							**2.63**

The findings in Table 16, revealed that the majority (74.2%) of the respondents were planting regionally appropriate native plants very often and less than one-half of the respondents (40%) of the respondents sometimes planted various medicinal plants that natural prevent the insects and pests in a sustainable landscape.

4.3.3 Built Environment and Materials

Table 17: Frequency and percentage distribution of respondents according to Built Environment and Materials as a practice with regards to Sustainable Landscape Design.

Sr.No.	Built Environment and Materials as an aspect while practicing Sustainable Landscape Design	Respondents (n=120)						
		Frequency of following Sustainable Landscape Design practices						Weighted Mean Scores (1 – 3)
		Very Often		Sometimes		Rarely		
		f	%	f	%	f	%	
1.	Using indigenous and renewable materials for hardscape components in a sustainable landscape.	71	59.2	43	35.8	6	5.0	2.54
2.	Using materials which uses minimal energy in its production.	66	55.0	42	35.0	12	10.0	2.45
3.	Considering the climatic objectives of any sustainable landscape site and designing it accordingly.	80	66.7	32	26.7	8	6.7	2.60
4.	Considering solar preservation in a sustainable landscape by installation of solar powered equipments and structures like lawn mowers, irrigation systems and solar paneled sheds.	38	31.7	63	52.5	19	15.8	2.16
5.	Placement of plants, trees and hardscape components in such a way which results in decreasing direct heat, increasing natural ventilation and humidity content, as well as controls dusty winds very efficiently.	75	62.5	39	32.5	6	5.0	2.58
	Total Weighted Mean							**2.03**

It was observed from the findings of Table 17, that more than one-half (66.7%) of the respondents very often considered climatic objectives of any landscape site and design while practicing Sustainable Landscape Design. Additionally, more than one-half of the respondents (52.5%) sometimes considered solar preservation in a sustainable landscape by installation of solar powered equipments and structures like lawn mowers, irrigation systems and solar panelled sheds.

4.3.4 Shading

Table 18: Frequency and percentage distribution of respondents according to Shading as a practice with regards Sustainable Landscape Design.

Sr.No.	Shading as an aspect while practicing Sustainable Landscape Design	Respondents (n=120)						
		Frequency of following Sustainable Landscape Design practices						Weighted Mean Scores (1 – 3)
		Very Often		Sometimes		Rarely		
		f	%	f	%	f	%	
1.	Installation of walls and porticos for reducing solar heat intensity.	26	21.7	80	66.7	14	11.7	**2.10**
2.	Installation of pergolas and sheds for shade in summertime, covered in foliage.	24	20.0	73	60.8	23	19.2	**2.01**
3.	Placement of tree in West and South directions to reduce energy costs.	66	55.0	42	35.0	12	10.0	**2.45**
4.	Taking into account the size, location, shape of the shadows cast by the trees.	79	65.8	36	30.0	5	4.2	**2.62**
5.	Placement of tress in West and South directions to reduce atmospheric carbon.	67	55.8	38	31.7	15	12.5	**2.43**

6.	Planting of dense evergreen trees and shrubs to provide continuous shading and heavy winds.	77	64.2	34	28.3	9	7.5	**2.57**
	Total Weighted Mean							**2.51**

The findings in Table 18, stated that 65.8 per cent of the respondents considered the size, location, shape of the shadows cast by the trees on a landscape while planting trees very often. The findings further elicited that two-third (66.7%) of the respondents installed walls and porticos for reducing solar heat intensity sometimes in their various Sustainable Landscape Design projects as a practice of Shading.

4.3.6 Wind Flow and Blocking Techniques

Table 19: Frequency and percentage distribution of respondents according to Wind Flow and Blocking techniques as a practice with regards to Sustainable Landscape Design.

Sr.No.	Wind Flow and Blocking Techniques as an aspect while practicing Sustainable Landscape Design	Respondents (n=120)						
		Frequency of following Sustainable Landscape Design practices						Weighted Mean Scores (1 – 3)
		Very Often		Sometimes		Rarely		
		f	%	f	%	f	%	
1.	Considering the form of the tree in placement.	80	66.7	33	27.5	7	5.8	**2.61**
2.	Considering the texture of the tree in placement.	75	62.5	37	30.8	8	6.7	**2.56**
3.	Considering the height of the tree in placement.	86	71.7	27	22.5	7	5.8	**2.66**
4.	Planting trees that can control wind by obstruction, guidance, deflection and filtration.	84	70	24	23.3	8	6.7	**2.63**

5.	Considering the various attributes of plants, trees and built structures, such as, size, shape, height, form and texture that guide the flow of air over the landscape.	86	71.7	28	23.3	6	5.0	**2.67**
6.	Regularly mulching a thick layer over the landscape to prevent soil erosion caused by heavy winds.	46	38.3	57	47.5	17	14.2	**2.24**
	Total Weighted Mean							**2.62**

From the findings of Table 19, it was found that more than two-third (71.7%) of the respondents considered the height of the tree for placement very often and the similar proportion of respondents (71.7%) also considered the various attributes of plants, trees and built structures, such as, size, shape, height, form and texture that guide the flow of air over the landscape very often. The findings also highlighted that 47.5 per cent of the respondents sometimes mulched a thick layer over the landscape to prevent soil erosion caused by heavy winds.

4.3.6 Optimizing the use of Sunlight

Table 19: Frequency and percentage distribution of respondents according to Optimizing the use of Sunlight as a practice with regards to Sustainable Landscape Design.

Sr.No.	Optimizing the Use of Sunlight as an aspect while practicing Sustainable Landscape Design	Respondents (n=120)						
		Frequency of following Sustainable Landscape Design practices						Weighted Mean Scores (1 – 3)
		Very Often		Sometimes		Rarely		
		f	%	f	%	f	%	
1.	Planting as much trees and plants as possible in major spots of direct sunlight to absorb maximum amount of heat.	73	60.8	43	35.8	4	3.3	**2.58**

2.	Planting dense and tall trees which provide shade during the day time and cool breeze during the night time.	73	60.8	40	33.3	7	5.8	**2.55**
3.	Growing trees with various different attributes such as size, shape, texture, height and form to add an extra dimension and create patterns with sunlight and shadow.	76	63.3	37	30.8	7	5.8	**2.58**
4.	Making optimum use of climatic and seasonal changes and its direct impact on sunlight intensity for Sustainable Landscape Design.	79	65.8	34	28.3	7	5.8	**2.60**
5.	Installing solar panels in a Sustainable Landscape to minimize the solar exposure on the plants and trees.	31	25.8	73	60.8	16	13.3	**2.13**
6.	Planning the placement of windows and doors considering the amount and availability of daylight for Sustainable Landscape Design.	63	52.5	46	38.3	11	9.1	**2.43**
	Total Weighted Mean							**2.65**

The findings analysed in Table 19, depicted that slightly less than two-third (65.8%) of the respondents made optimum use of climatic and seasonal changes and its direct impact on sunlight intensity for Sustainable Landscape Design very. Also, more than one-half (60.8%) of the respondents sometimes installed solar panels in a Sustainable Landscape to minimize the solar exposure on the plants and trees.

Table 20: Frequency and percentage distribution of respondents according to the Frequency of Sustainable Landscape Design Practices Adopted.

Sr.No.	Frequency of following Sustainable Landscape Design practices	Respondents (n=120)						
		Frequency of following Sustainable Landscape Design practices						Weighted Mean Scores (1 – 3)
		Very Often		Sometimes		Rarely		
		f	%	f	%	f	%	
1.	Water and Irrigation System	69	57.5	43	35.8	8	6.7	**2.51**
2.	Vegetation and Planting	77	64.2	42	35	1	0.8	**2.63**
3.	Built Environment and Materials	17	14.2	89	74.2	14	11.7	**2.03**
4.	Shading	65	54.2	51	42.5	4	3.3	**2.51**
5.	Wind Flow and Blocking Techniques	76	63.3	42	35	2	1.7	**2.62**
6.	Optimizing the Use of Sunlight	81	67.5	36	30	3	2.5	**2.65**
	Overall	**78**	**65**	**42**	**35**	**-**	**-**	**2.65**

The findings analysed in Table 20, highlights the overall data for the Frequency of Sustainable Landscape Design practices followed by the respondents. It was observed that 67.5 per cent of the respondents incorporated Optimizing the use of Sunlight as an aspect of Sustainable Landscape Design practice in their projects very often. The data further revealed that 74.2 per cent of the respondents had taken into consideration Built Environment and Materials as a practice of Sustainable Landscape Design.

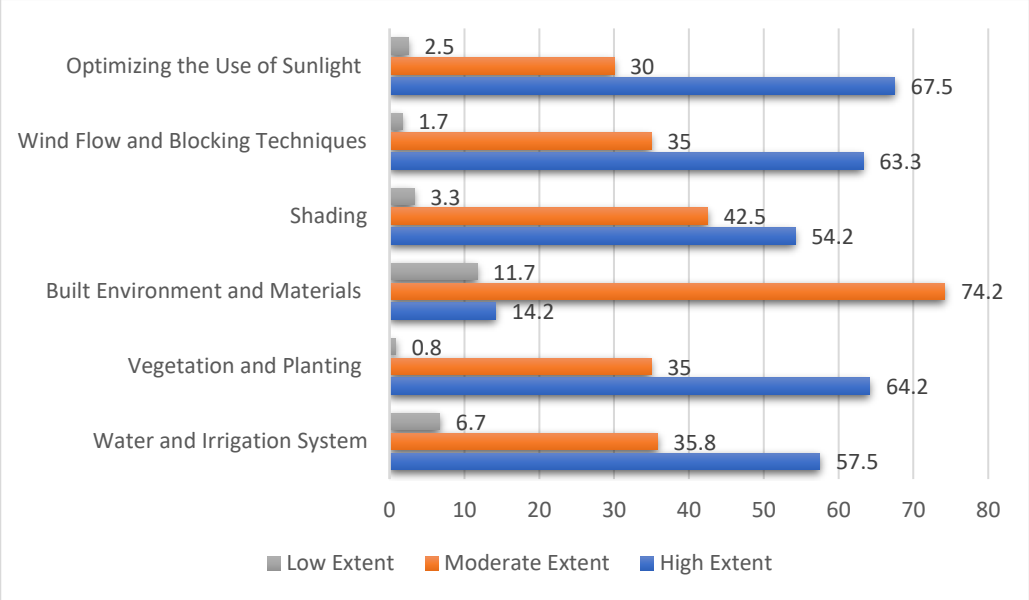

Figure 8: Percentage distribution of respondents according to frequency of following Sustainable Landscape Design Practices

Table 21: Weighted Mean Scores for frequency of following Sustainable Landscape Design Practices.

Sr.No.	Frequency of Following Sustainable Landscape Design Practices.	Total Weighted Mean Scores
1.	Water and Irrigation System	2.51
2.	Vegetation and Planting	2.63
3.	Built environment and Materials	2.03
4.	Shading	2.51
5.	Wind Flow and Blocking Techniques	2.62
6.	Optimizing the Use of Sunlight	2.65
	Overall Weighted Mean	2.49

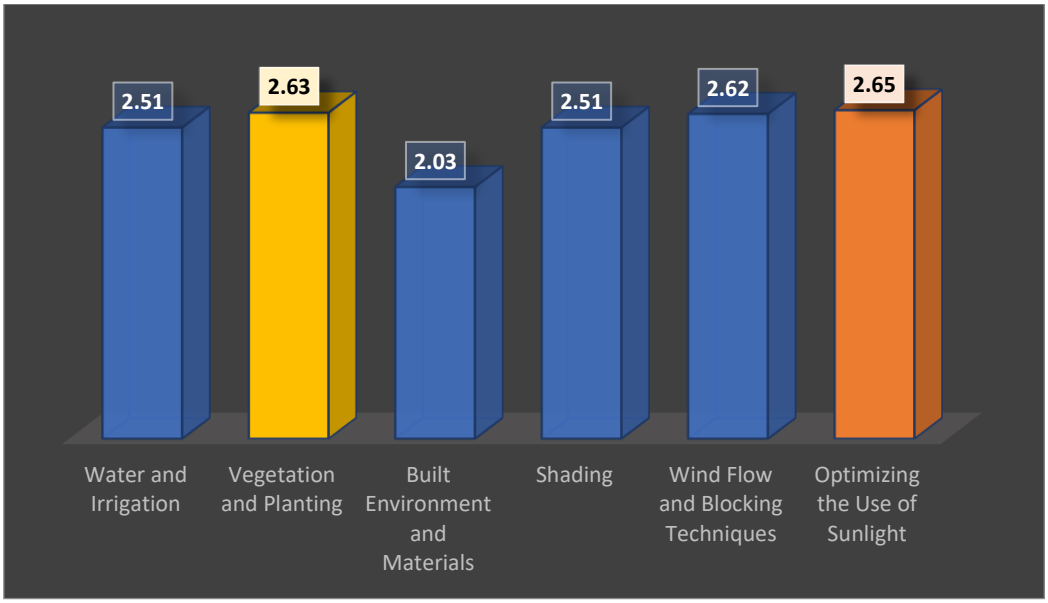

Figure 9: Weighted Mean Scores for Frequency of Sustainable Landscape Design Practices followed by the Selected Design Professionals.

The computed weighted mean scores for each aspect of Sustainable Landscape Design Practices revealed that 'Optimizing the use of Sunlight' and 'Vegetation and Planting were practiced very often by the design professionals. The overall weighted mean score for the entire scale was 2.49.

Section IV

4.4 Testing of Hypotheses

This section covers findings of the present research in detail which is derived from the statistical analysis computed for the hypotheses formulated. Three hypotheses, were formulated for the present research, and to test them statistically null hypotheses were formulated. In order to test the hypotheses formulated for the present research and as per the nature of the variables, coefficient of correlation, 'f' test and 't' test were computed to analyse the findings statistically. The details of the relational statistics computed are as follows:

For the purpose of statistical analysis, the hypotheses were formulated in null form. The results are presented in this section.

> **Ho_1: There exists no variation in the Extent of Problems faced by the respondents with their age, educational qualification, ownership of the firm and years of work experience.**

The broad hypothesis was further divided into several sub hypotheses.

To find out the difference between the Extent of Problems faced by the respondents with their age (in years) and educational qualification, ownership of the firm, and years of work experience. Analysis of Variance and t-test were computed.

> **$Ho_{1.1}$: There exists no variation between the Extent of Problems faced by the respondents with their personal variables age (in years) and educational qualification.**

Table 23: Analysis of Variance showing variation in the Extent of Problems faced by the respondents with their personal variables (age (in years) and educational qualification).

Sr.No.	Selected Variables	df	Sum of Squares	Mean Squares	f value	Level of Significance
1.	**Age (in years)**					
	Between Groups	**2**	**0.079**	**0.039**	**0.322**	**N.S.**
	Within Groups	**117**	**14.288**	**0.122**		
2.	**Educational Qualification**					
	Between Groups	**3**	**0.238**	**0.079**	**0.653**	**N.S.**
	Within Groups	**119**	**14.128**	**0.122**		

The results showed that the f- value was not found to be significant in the Extent of Problems faced by the respondents with their age (in years) and education qualification. Hence, the null hypothesis was accepted.

$Ho_{1.2}$: There exists no variation in the Extent of Problems faced by respondents with their selected personal variables (ownership of the firm and years of work experience).

Table 2: t-test showing the difference in the Extent of Problems faced by the selected design professionals with their ownership of the firm and years of work experience.

Sr.No.	Selected Variables	Mean Scores	t value	df	Level of Significance
1.	**Ownership of the firm**				
	Owned	**2.10**	**0.815**	**118**	**N.S.**
	Not Owned	**2.15**		**75.835**	
2.	**Years of Work Experience**				
	≤10 years	**81.59**	**2.581**	**118**	**0.01**
	>10 years	**75.44**		**116.485**	

t-test was computed for this hypothesis. The results of t-test indicated that t value was found to be significant in Extent of Problems faced by the respondents with their years of work experience at 0.01 level of significance. However, the computation of t-value exhibited no significant difference in the Extent of Problems faced by the respondents with the ownership of the firm. Thus, the null hypothesis was partially accepted.

Ho_2: There exists no variation in the Frequency of Practices adopted by the respondents with their age, educational qualification, ownership of the firm and years of work experience.

The broad hypothesis was further divided into several sub hypotheses.

To find out the difference between the Frequency of Practices adopted by the respondents with their age (in years) and educational qualification, ownership of the firm, and years of work experience. Analysis of Variance and t-test were computed.

Ho2.1: There exists no variation in the Frequency of Practices adopted by the respondents with their age (in years) and educational qualification.

Table 3: Analysis of Variance showing variation in the Frequency of Practices adopted by the respondents with their age (in years) and educational qualification.

Sr.No.	Selected Variables	df	Sum of Squares	Mean Squares	f value	Level of Significance
1.	**Age (in years)**					
	Between Groups	**2**	**0.079**	**0.039**	**0.322**	**N.S.**
	Within Groups	**117**	**14.288**	**0.122**		
2.	**Educational Qualification**					
	Between Groups	**3**	**0.238**	**0.079**	**0.653**	**N.S.**
	Within Groups	**119**	**14.128**	**0.122**		

The results showed that the f- value was not found to be significant in the Frequency of Practices adopted by the respondents with their age (in years) and education qualification. Hence, the null hypothesis was accepted.

Ho2.2: There exists no variation in the Frequency of Practices adopted by the respondents with their selected personal variables (ownership of the firm and years of work experience).

Table 4: t-test showing the difference in the Frequency of Problems adopted by the respondents and their selected personal variables (ownership of the firm and years of work experience).

Sr.No.	Selected Variables	Mean Scores	t value	df	Level of Significance
1.	**Ownership of the firm**				
	Owned	**2.67**	**0.604**	**118**	**N.S.**
	Not Owned	**2.62**		**95.538**	
2.	**Years of Work Experience**				
	≤10 years	**83.21**	**3.722**	**118**	**N.S.**
	>10 years	**92.53**		**111.259**	

t-test was computed for this hypothesis. The results of t-test indicated that the computation of t-value exhibited no significant difference in the Frequency of Practices adopted by the respondents with the ownership of the firm and years of work experience. Thus, the null hypothesis was accepted.

Ho3: There exists no relationship among the Extent of Problems faced and the Frequency of Practices adopted by the respondents with regards to Sustainable Landscape Design.

To find out the relationship between the Extent of Problems faced and the Frequency of Practices adopted by the respondents with regards to Sustainable Landscape Design, coefficient of correlation was computed.

Table 5: Coefficient of Correlation showing the relationship between the Extent of Problems faced and the Frequency of Practices adopted by the respondents with regards to Sustainable Landscape Design.

Sr.No.	Selected Variables	n	r - value	Level of Significance
1.	Extent of Problems Faced by the Respondents with regards to Sustainable Landscape Design.	**120**	**0.087**	**N.S.**
2.	Frequency of Practices adopted by the Respondents with regards to Sustainable Landscape Design.			

The results revealed that the co-efficient of correlation displayed no significant relationship between the Extent of Problems faced and the Frequency of Practices adopted by the respondents with regards to Sustainable Landscape Design. Hence, the null hypothesis was accepted.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Climate change is a pressing global issue, and sustainable landscape design can play a significant role in mitigating its impact. The depletion of natural resources, including water and soil, is a significant environmental concern. Sustainable landscape design practices, such as sustainable water and irrigation techniques, native vegetation and planting, conservation of built environment and materials, shading practices, wind flow and blocking techniques and optimizing the use of sunlight can help conserve resources. Biodiversity loss is another significant environmental challenge, and sustainable landscape design can help to preserve and promote biodiversity.

Urbanization and land-use change have a significant impact on the environment, and sustainable landscape design can help to reduce this impact. Practices such as the use of permeable surfaces and the incorporation of green spaces in urban areas can help to mitigate the negative effects of urbanization on the environment.

Design professionals, such as architects, landscape designers, and interior designers, have a critical role to play in promoting Sustainable Landscape Design and mitigating the effects of the global environmental crisis. They can advocate for sustainable landscape design principles and educate their clients about the importance of sustainability. Raising awareness about sustainable landscape design, encourages more people to adopt these practices and contribute to a better cause. Overall, sustainable landscape design practices can help to address several critical environmental issues and promote a more sustainable and resilient future.

The researcher had gone through many studies on Sustainable Landscape Design but has not found any research on this particular topic because with the rising adversities in the environment, the researcher was more intrigued about finding out the concerns and contribution of design professionals of today.

The Department of Family and Community Resource Management, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of

Baroda, offers courses on “Landscape and Gardening” at Bachelor’s level as well as the Master’s level. Hence, the information gathered through the present research would widen the database and will help in strengthening the curriculum by making suitable modifications, from the point of view of sustainability. It is very crucial for the practicing as well as the upcoming Interior Designers and Architects to gain a better understanding of environmental sustainability and its immediate relatedness to landscape design as this can help them bring out a well functioned devised plan and design that can satisfy the owner and make an impact on the environment at the same time.

The data collected from the research would help to acquire knowledge about the current practices considering principles of sustainable landscape design adopted by these professionals. The findings of the study will also be beneficial to the users living within an aesthetically pleasing and environmentally sustainable landscapes which enhances the sense of wellbeing in the way of feeling of positivity and relaxation through the application of colours of the nature like green, yellow, brown, blue. This acts as an antidote to irritable moods and works as a stress buster amidst the hectic lifestyles. Landscaping and renewable technologies can help in the reduction of urban heat island, greenhouse effect, pollution, thermal stress, and other environmental hazards. It also conserves natural resources, reduces air pollution, and reduces the human-impact on the surrounding ecosystem.

The present study was conducted with the aim to find out about the extent of problems faced and frequency of practices followed by the selected design professionals. A booklet was prepared to enhance the knowledge of the design professionals regarding the importance, need, benefits, principles, and practices regarding Sustainable Landscape Design. This booklet will be helpful directly to the design professionals as well as the students.

STATEMENT OF THE PROBLEM

The present study aims to find out the problems faced and the practices adopted by selected design professionals with regards to sustainable landscape design.

OBJECTIVES

1. To assess the extent of problems faced by the Design Professionals with regards to sustainable landscape design.
2. To determine the frequency of practices followed by the respondents with regards to sustainable landscape design.
3. To develop an educational package (booklet) for creating awareness on Sustainable Landscape Design.

DELIMITATIONS

1. The study was limited to the Interior Designers, Landscape Designers and Architects who have been practicing since last 5 years only from the time of data collection.
2. The study was limited to selected respondents from 4 major cities of Gujarat namely Valsad, Surat, Vadodara, and Ahmedabad.
3. The sample for the present study was limited to those 120 practicing Interior Designers, Landscape Designers and Architects who have incorporated minimum 3 aspects (Landscape Sustainability in terms of Water and Irrigation System, Vegetation and Planting, Built Environment and Materials, Shading, Wind Control, and Modification of Sunlight) in their respective projects.

HYPOTHESIS OF THE STUDY

The results of t-test indicated that t value was found to be significant in Extent of Problems faced by the respondents with their years of work experience at 0.01 level of significance.

METHODOLOGY

Since the present investigation dealt with the extent of problems faced and frequency of practices adopted by selected design professionals, with regards

to sustainable landscape design, descriptive research design was adopted. Locale for the study was four renowned cities of Gujarat namely; Valsad, Surat, Vadodara, and Ahmedabad. The sample size comprised of 120 design professionals who had a minimum work experience of 5 years in the fields of Architecture/ Interior Design/ Landscape Design and had practiced minimum 3 aspects of Sustainable Landscape Design in their respective projects. Snowball Sampling technique was used for selecting the cities and Purposive Random Sampling technique for selecting the respondents. The data was analyzed by utilizing Descriptive as well as Relational Statistics. For the present study, questionnaire methos was selected to get detailed data about the respondents.

The information gathered through a questionnaire method was divided into the following sections:

Section 1 covered the information regarding the background information of the respondents; namely, age (in years), educational qualification, ownership of the firm, duration of time working as a design professional, registration or certification under any professional association, details regarding the projects undertaken and the sources of information from where they had gathered knowledge regarding sustainable landscape design.

Section 2 included the scale regarding the extent of problems faced by the design professionals while practicing sustainable landscape design. The response structure on the scale was given a score of 3 to 1 for responses such as “Major Problem”, “Minor Problem”, “Not a Problem”. Higher scores reflected high extent of problems and vice versa.

Section 3 included the scale regarding the frequency of practices adopted by the design professionals with regards to sustainable landscape design. The response structure on the scale was given a score of 3 to 1 for responses such as “All of the Projects”, “Some of the Projects”, “None of the Projects”. High scores reflected higher frequency of practices adopted and vice versa.

MAJOR FINDINGS OF THE STUDY

Background Information

The mean age of the respondents was found to be 38.41 years. It was found that more than one-half of the respondents had pursued a bachelor's degree. The findings revealed that majority of the respondents (53.3%) of the respondents had a work experience of more than 10 years. The findings in relation to the number of Sustainable Landscape Design projects in residential and commercial areas revealed that 41.6 per cent of the respondents had undertaken 1 to 10 residential projects and one-half (50.8%) of the respondents had undertaken 1 to 10 commercial projects. It was indicated that maximum awareness (40.83%) and information was sourced from audio/visual media.

Extent of Problems faced while practicing Sustainable Landscape Design

The data revealed that more than one-third of the respondents (35.8%) were facing problems due to lack of training/education about Sustainable Landscape Design to a high extent. The findings analysed also revealed that slightly more than onethird (34.2%) of the respondents found that the high initial cost for implementing Sustainable Landscape Design projects hindered the adoption of Sustainable Landscape Design to a high extent. Slightly less than one-half of the total number of respondents (45%) found lack of active government participation in endorsing getting certified as a major problem for them to practice Sustainable Landscape Design. Further, it was indicated that lack of availability of the required sustainable materials locally, affected 40.8 per cent of the respondents to a high extent and that more than two-third (68.3%) of the respondents faced problems to a high extent due to a lack of interest on the part of the client. Moreover, the findings also elicited that 41.7 per cent of the respondents found lack of legislative support to encourage the practices of Sustainable Landscape Design and lack of commitment to protect the environment through adoption of Sustainable Landscape Design practices as a problem to a high extent.

Frequency of Practices adopted while practicing Sustainable Landscape Design

The data analysed, revealed that the majority (64.2%) of the respondents had practiced the installation of landscape-appropriate drainage systems to accumulate water in one place very often, and (74.2%) of the respondents were planting regionally appropriate native plants very often. It was also observed that more than one-half (66.7%) of the respondents very often considered climatic objectives of any landscape site and design while practicing Sustainable Landscape Design. Moreover, 65.8 per cent of the respondents considered the size, location, shape of the shadows cast by the trees on a landscape while planting trees very often and more than two-third (71.7%) of the respondents considered the height of the tree for placement very often. The findings also indicated that slightly less than two-third (65.8%) of the respondents made optimum use of climatic and seasonal changes and its direct impact on sunlight intensity for Sustainable Landscape Design very often.

TESTING OF HYPOTHESES

Several hypotheses were formulated to find out the relationship between variables of the present study. For the present investigation, as per nature of the variables, the Analysis of Variance (ANOVA) and ‘t’-test were computed. The results of t-test indicated that t value was found to be significant in Extent of Problems faced by the respondents with their years of work experience at 0.01 level of significance.

CONCLUSION

A study was conducted on the Extent of Problems faced and Frequency of Practices adopted by selected design professionals with regards to Sustainable Landscape Design. The mean age of the respondents was found to be 38.41 years. It was found that more than one-half of the respondents had pursued a bachelor’s degree. The findings revealed that majority of the respondents (53.3%) of the respondents had a work experience of more than 10 years. The findings in relation to the number of Sustainable Landscape Design projects in residential and commercial areas revealed that 41.6 per cent of the respondents had undertaken 1 to 10 residential projects and one-half (50.8%)

of the respondents had undertaken 1 to 10 commercial projects. It was indicated that maximum awareness (40.83%) and information was sourced from audio/visual media. The data analysed for the Extent of Problems faced while practicing Sustainable Landscape Design revealed that more than one-third of the respondents (35.8%) were facing problems due to lack of training/education about Sustainable Landscape Design to a high extent. The findings analysed also revealed that slightly more than one-third (34.2%) of the respondents found that the high initial cost for implementing Sustainable Landscape Design projects hindered the adoption of Sustainable Landscape Design to a high extent. Slightly less than one-half of the total number of respondents (45%) found lack of active government participation in endorsing getting certified as a major problem for them to practice Sustainable Landscape Design. Further, it was indicated that lack of availability of the required sustainable materials locally, affected 40.8 per cent of the respondents to a high extent and that more than two-third (68.3%) of the respondents faced problems to a high extent due to a lack of interest on the part of the client. Moreover, the findings also elicited that 41.7 per cent of the respondents found lack of legislative support to encourage the practices of Sustainable Landscape Design and lack of commitment to protect the environment through adoption of Sustainable Landscape Design practices as a problem to a high extent. The data analysed for Frequency of Practices adopted, revealed that the majority (64.2%) of the respondents had practiced the installation of landscape-appropriate drainage systems to accumulate water in one place very often, and (74.2%) of the respondents were planting regionally appropriate native plants very often. It was also observed that more than one-half (66.7%) of the respondents very often considered climatic objectives of any landscape site and design while practicing Sustainable Landscape Design. Moreover, 65.8 per cent of the respondents considered the size, location, shape of the shadows cast by the trees on a landscape while planting trees very often and more than two-third (71.7%) of the respondents considered the height of the tree for placement very often. The findings also indicated that slightly less than two-third (65.8%) of the respondents made optimum use of climatic and seasonal changes and its direct impact on sunlight intensity for Sustainable Landscape Design very often.

A booklet was developed on “Every Professional’s Guide to – Sustainable Landscape Design”. It included the need, importance, benefits, principles and practices of Sustainable Landscape Design.

IMPLICATIONS OF THE STUDY

The findings for the present study may prove to be beneficial to various people concerned with this field.

For Students: The Department of Family and Community Resource Management, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda, offers courses on “Landscape and Gardening” at Bachelor’s level as well as the Master’s level. Hence, the information gathered through the present research would widen the database and will help in strengthening the curriculum by making suitable modifications, from the point of view of sustainability.

For Design Professionals: It is very crucial for the practicing as well as the upcoming design professionals to gain a better understanding of environmental sustainability and its immediate relatedness to landscape design as this can help them bring out a well functioned devised plan and design that can satisfy the owner and make an impact on the environment at the same time. The data collected from the research would help to acquire knowledge about the current practices considering principles of sustainable landscape design adopted by these professionals.

For Users: The data collected from the research would help to acquire knowledge about the current practices considering principles of sustainable landscape design adopted by these professionals. The findings of the study will also be beneficial to the users living within an aesthetically pleasing and environmentally sustainable landscapes which enhances the sense of wellbeing in the way of feeling of positivity and relaxation through the application of colours of the nature like green, yellow, brown, blue. This acts as an antidote to irritable moods and works as a stress buster amidst the hectic lifestyles. Landscaping and renewable technologies can help in the reduction of urban heat island, greenhouse effect, pollution, thermal stress, and other

environmental hazards. It also conserves natural resources, reduces air pollution, and reduces the human-impact on the surrounding ecosystem.

RECOMMENDATIONS FOR FUTURE STUDY

1. A study on long-term monitoring of sustainable landscape projects can be conducted.
2. A study to assess the impact of sustainable landscape design on human health can be investigated.
3. An exploratory study can also be conducted on the potential of emerging technologies and their impact on sustainability can be conducted.
4. A comparative study on the performance of sustainable landscape design to conventional design could also be undertaken.
5. A study on public opinion and attitudes towards sustainable landscape design can also be investigated.
6. Similar study can also be conducted with a larger sample size.

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APPENDIX-I

सत्यं शिवं सुन्दरम्
Estd. 1949

Institutional Ethics Committee for Human Research (IECHR)

FACULTY OF FAMILY AND COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

Ethical Compliance Certificate 2022-2023

This is to certify that **Ms. Kurnisa Kamboya's** study titled, **Sustainable Landscape Design: Extent of Problems Faced and Practices Adopted by Selected design Professionals** has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Science, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number **IECHR/FCSc/M.Sc./2022/12.**

Prof Shagufa Kapadia
Chairperson
IECHR

Prof Mini Sheth
Member Secretary
IECHR

APPENDIX-II

QUESTIONNAIRE

SECTION I

Background Information

Personal profile

1. Name of the respondent:
2. Age (in years):
3. Educational Qualification:
    a) Diploma in Interior Design/ Architecture/ Landscape Design ☐
    b) Bachelor in Interior Design/ Architecture/ Landscape Design ☐
    c) Master in Interior Design/ Architecture/ Landscape Design ☐
4. If any other (degree), please specify:

    _____.
5. E-mail address:

    _____.

Please give information about your work profile

1. Do you own a firm?

    Yes ☐ No ☐

    If yes, then please mention the name of your firm

    _____.

2. Since how long are you in this profession? _____ years.

3. Are you a registered / certified Interior Designer/ Architect/ Landscape Designer under any professional association?

    Yes ☐ No ☐

If yes, then please mention the name of the association you are affiliated with -_____.

4. Details regarding the projects undertaken

Sr. No.	Kinds of projects undertaken	Number of Landscape Design projects undertaken	Number of Sustainable Landscape Design projects undertaken in which at least three aspects of Sustainable Landscape Design are incorporated
1.	Residential		
2.	Commercial		

5. From where have you collected information about Sustainable Landscape Design?

a) Print Media

i. Newspaper

ii. Magazine

b) Audio / Visual Media

iii. Television Programs

c) Word of Mouth

iv. Clients

v. Professional Associates

vi. Friends

d) Formal Education / Seminar

vii. Educational Programs / Workshops

viii. Conference / Seminars

ix. Professional Organization

x. Personal Research

e) Any other, please specify: _____.

SECTION II

Extent of Problems Faced while practicing Sustainable Landscape Design

Here are a few statements reflecting problems faced while practicing Sustainable Landscape Design Practices. Please go through the following statements and state whether the following statements are major problem, minor problems, or not a problem for you in adopting Sustainable Landscape Design.

Sr. No.	Problems faced while practicing Sustainable Landscape Design	Major Problem	Minor Problem	Not a Problem
A	**Lack of Technical Knowledge**			
1.	Lack of training/education about Sustainable Landscape Design on your part.			
2.	Lack of technical understanding.			
3.	Lack of experience.			
4.	Lack of education and knowledge about the concept among the clients.			
5.	Preconceived notions/stigma amongst the professional as well			

	as the client for the concept to be “tough” to implement.			
6.	Unaware about several codes, materials and standard for Sustainable Landscapes.			
7.	Unaware about concern and immediate importance for Sustainable Landscape Design.			
B	**Cost**			
1.	High initial cost for implementing Sustainable Landscape Design.			
2.	Cost of sustainable landscape materials is high.			
3.	Cost associated for accreditation/certification is very high.			
4.	Uncertainty about the economic benefits in the longer run from Sustainable Landscape Design.			
C	**Issues with the Certification Process**			
1.	The process of certification is not easy to understand.			

2.	The process of certification is expensive.			
3.	The process of getting certified is lengthy.			
4.	The process of getting the certification is difficult.			
5.	You are unaware about the various Certifications and Green Standards that can be acquired.			
6.	You are unaware about the benefits of credibility that one can achieve by being certified.			
7.	Lack of active Government participation in endorsing certification.			
D	**Resource Constraints**			
1.	Lack of financial assistance from financial institution to practice Sustainable Landscape Design.			
2.	Lack of availability of the required sustainable materials locally.			
3.	Unaware about the available materials and various resources used for a Sustainable Landscape Design.			

4.	Misleading information by manufacturers regarding company's materials and its effect on the environment.			
5.	Relatively higher cost of required materials acting as a barrier for adopting Sustainable Landscape Design.			
6.	Lack of availability of landscape space for implementation of sustainable landscape practices.			
E	**Clients' Perception**			
1.	Client's hesitation to pursue sustainable landscape strategies.			
2.	Lack on your part to imbibe proper knowledge and awareness about Sustainable Landscape Design to the clients.			
3.	Persistence of negative stereotypes among the clients about adopting Sustainable Landscape Design.			
4.	Unaware about the positive environmental			

	impact of Sustainable Landscape Design.			
5.	Resistance to change one's mindset from traditional Landscape Designing practices to Sustainable Landscape Design practices.			
6.	Lack of interest on the part of the client.			
F	**Others**			
1.	Lack of legislative support to encourage the practices of Sustainable Landscape Design.			
2.	Demotivation arises as sometimes they do not get the recognition for their projects on Sustainable Landscape Design.			
3.	You find it difficult to practice Sustainable Landscape Design when deadlines of project completion are supposed to be met.			
4.	Last minute changes by clients leads to errors in the design.			

5.	Last minute changes by clients leads to waste of time.			
6.	Lack of commitment to protect the environment through adoption of Sustainable Landscape Design practices.			
7.	Not sure about the methods of repurposing the not useful resources in the actual landscape design instead of discarding it. For example, dried leave, glass bottles, stones that are of no use anymore, car tires, kitchen waste.			
8.	Unaware about the competitive advantage of practicing Sustainable Landscape Design as compared to Landscape Design.			
9.	Inability on your part to execute the planned Sustainable Landscape Design.			

SECTION III

Extent of Practices adopted while practicing Sustainable Landscape Design

Here are few statements reflecting frequency of following Sustainable Landscape Design Practices. Please go through the following statements and put a tick in the appropriate column, which will reflect practices adopted in your projects with regards to Sustainable Landscape Design.

Sr. No.	Practices Adopted with regards to Sustainable Landscape Design	All of the Projects	Some of the Projects	None of the Projects
A	**Water and Irrigation System**			
1.	Installation of rain water barrels to tackle water run-off on the landscape.			
2.	Considering water needs of plants grown in a landscape in context of weather conditions of the respective sustainable landscape site.			
3.	Creating straight and perpendicular water canals that lead to a reservoir for collecting			

	and conserving excess water on the landscape.			
4.	Placing water streams under the shade of dense trees to decrease the amount of water evaporation.			
5.	Creating big or small reservoirs on the landscape like ponds, pools or wells to collect water and avoid wastage of the same.			
6.	Aligning the irrigation system with the plantations for optimizing water consumption without it running down the drain.			
7.	Installation of landscape appropriate drainage system to accumulate water in one place.			
B	**Vegetation and Planting**			
1.	Planting regionally appropriate native plants.			
2.	Cultivating plants and trees that have low water needs.			
3.	Avoiding chemical pesticides and fertilizers			

	to falsely enhance the growth of fruit and vegetable bearing plants.			
4.	Plantation of deciduous trees which provide shade in summers and allow sunlight to pass through in winters when the leaves wither off.			
5.	Planting evergreen trees to protect the space from cold and unpleasant dusty winds.			
6.	Planting various medicinal plants that naturally prevent the insects and pests in a sustainable landscape.			
C	**Built Environment and Materials**			
1.	Using indigenous and renewable materials for hardscape components in a sustainable landscape.			
2.	Using materials which uses minimal energy in its production.			
3.	Considering the climatic objectives of any sustainable landscape			

	site and designing it accordingly.			
4.	Considering solar preservation in a sustainable landscape by installation of solar powered equipments and structures like lawn movers, irrigation systems and solar paneled sheds.			
5.	Placement of plants, trees and hardscape components in such a way which results in decreasing direct heat, increasing natural ventilation and humidity content, as well as controls dusty winds very efficiently.			
D	**Shading**			
1.	Installation of walls and porticos for reducing solar heat intensity.			
2.	Installation of pergolas and sheds for shade in summertime, covered in foliage.			
3.	Trees specifically placed in West and South directions to reduce energy costs.			

4.	Taking into account the size, location, shape of the shadows cast by the trees.			
5.	Trees placed in West and South directions to reduce atmospheric carbon.			
6.	Dense evergreen trees and shrubs to provide continuous shading and heavy winds.			
E	**Wind Control**			
1.	Considering the form of the tree in placement.			
2.	Considering the texture of the tree in placement.			
3.	Considering the height of the tree in placement.			
4.	Planting trees that can control wind by obstruction, guidance, deflection and filtration.			
5.	Considering the various attributes of plants, trees and built structures, such as, size, shape, height, form and texture that guide the flow of air over the landscape.			
6.	Regularly mulching a thick layer over the landscape to prevent			

	soil erosion caused by heavy winds.			
F	**Modification of Sunlight**			
1.	Planting as much trees and plants as possible in major spots of direct sunlight to absorb maximum amount of heat.			
2.	Planting dense and tall trees which provide shade during the day time and cool breeze during the night time.			
3.	Growing trees with various different attributes such as size, shape, texture, height and form to add an extra dimension and create patterns with sunlight and shadow.			
4.	Making optimum use of climatic and seasonal changes and its direct impact on sunlight intensity for Sustainable Landscape Design.			
5.	Installing solar panels in a Sustainable Landscape to minimize			

	the solar exposure on the plants and trees.			
6.	Planning the placement of windows and doors considering the amount and availability of daylight for Sustainable Landscape Design.			

ABSTRACT

Drastic escalation of activities in urbanization and industrialization with every changing day has taken a very serious toll on the human race. Adapting a lifestyle that does not only conserve the environment and its natural resources but also brings no or negligible harm to the planet has become the need of the hour. It becomes essential for individuals to conserve the natural resources. Landscapes that are “environmentally sustainable” have been famously talked about in the current advancements in the field of construction and development. Landscaping goes past just enhancing the view; it actually has numerous benefits that a design professional can bring to life through their expertise and knowledge in the context of environmental sustainability. Sustainable landscapes sequester carbon, clean the air and water, increase energy efficiency, restore habitats, and create value through significant economic, social and, environmental benefits. These professionals are in an exceptionally good place to instigate change, particularly with energy-efficient lighting, eco-friendly materials, materials with recycled content, sustainable wood, and low-energy and water-saving products; but somehow various problems such as lack of technical knowledge, cost, issues with the certification process, resource constraints, clients’ perception and other general problems were faced by the design professionals while practicing Sustainable Landscape Design.

Hence, the present study was conducted with the objective to find out the extent of problems faced and the frequency of practices adopted by the Design Professionals with regards to Sustainable Landscape Design. Descriptive research design was adopted for the present study with the sample size of 120 design professionals. The data was collected through questionnaire method which consisted of a scale on Extent of Problems faced and Frequency of Practices adopted by selected design professionals with regards to Sustainable Landscape Design. The content validity and reliability of the scale was established. The major findings revealed that Clients’ Perception and Resource Constraints were the major problems faced by the respondents of the study; whereas, Optimizing the Use of Sunlight and Vegetation and Planting practices were very frequently practiced.

EVERY PROFESSIONAL'S GUIDE TO

SUSTAINABLE LANDSCAPE DESIGN

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INTRODUCTION

The term "ecosystem" is used to describe the natural environment on the planet Earth, which is made up of elements like air, water, plants, and other living things. The human species and the environment have suffered greatly due to the rapid acceleration of urbanization and industrialization activities. This has led to waste production without any account, and its depletion has brought humanity to where it is today with a number of global crises. Design professionals play a huge role in the implementation of a sustainable landscape design and helping the planet heal. Sustainable landscapes are responsive to the environment, re-generative, and can actively contribute to the development of healthy communities. They sequester carbon, clean the air and water, increase energy efficiency, restore habitats, and create value through significant economic, social and, environmental benefits.

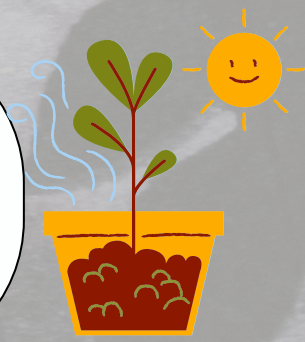
NEED

In today's world, the need for sustainable landscape design has been particularly pressing. Climate change, the global food crisis, and population growth are just a few of the challenges that make sustainable design critical to our future. Sustainable landscape design prioritizes natural resources, ecosystems, local cultures, and communities by developing ecologically resilient environments that produce clean energy, provide water protection, clean air, habitat protection, waste and resource management, and climate adaptation. Sustainable landscape designs also contribute to urban environments by increasing green space, providing recreational opportunities, providing habitat for native wildlife, enhancing public health, and conserving local green space. Not only does sustainable landscape design help to protect the environment and local communities, but it helps to make our cities more vibrant and livable.

BENEFITS OF SUSTAINABLE LANDSCAPE DESIGN

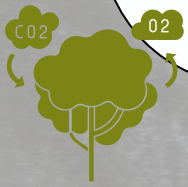
REDUCES WATER USAGE

Sustainable landscape design promotes the conservation of water by utilizing efficient irrigation systems, mulching, and native plants that require less water than traditional landscaping designs.



IMPROVES AIR QUALITY

Sustainable landscape design utilizes plants that help to filter pollutants in the air, creating a healthier environment.



PROMOTES BIODIVERSITY

Sustainable landscape design encourages the use of plants and materials that are native to the area, which helps to promote biodiversity and improve the local environment.

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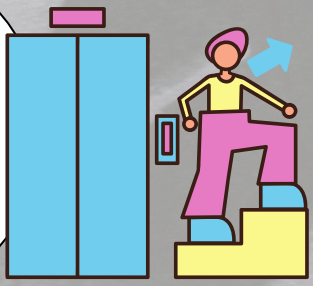
BENEFITS
OF
SUSTAINABLE LANDSCAPE DESIGN

ENHANCES ECOSYSTEMS

Sustainable landscape design enhances the local ecosystem, improving the local environment and creating a healthier area for plants, animals, and humans.

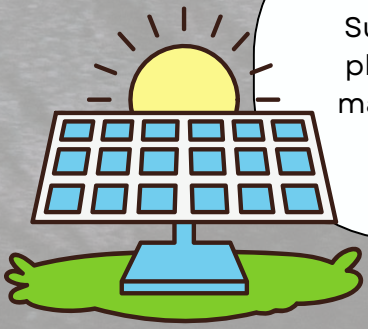
INCREASES PROPERTY VALUE

Sustainable landscape design can add value to your home or business. The green look is in, and buyers are willing to pay a premium for this type of design.



SAVES MONEY

Sustainable landscape design utilizes plants and materials that require less maintenance, saving you money in the long run.



SUSTAINABLE LANDSCAPE DESIGN PRINCIPLES

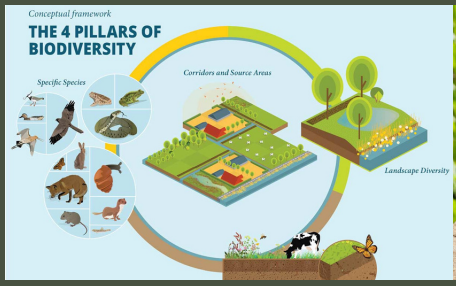
Sustainable landscape design principles are essential for creating resilient, healthy, and vibrant outdoor spaces that benefit the environment, the community, and the economy. They prioritize environmental conservation, social responsibility, economic benefits, climate change mitigation, and carbon sequestration. They can also improve the quality of life for community members, increase property values, and attract tenants or customers.

- **Utilize nature-based solutions**
- **Maximize environmental health benefits**
- **Minimize resource consumption**
- **Encourage community participation and engagement**
- **Promote accessibility and equity**
- **Create aesthetically pleasing areas**
- **Prioritize low-impact development**
- **Utilize smart and connected technologies**
- **Utilize sustainable and eco-friendly practices**

PRINCIPLES

Utilize Nature-Based Solutions

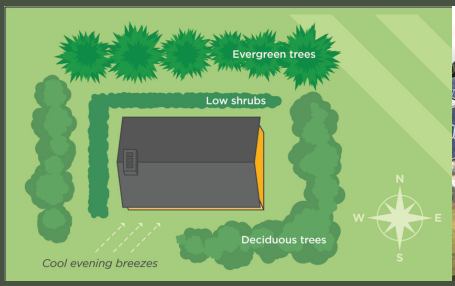
Utilize natural systems and implement nature-based solutions to reduce water and air pollution, reduce flooding, and manage stormwater runoff from residential and commercial developments.



Maximize Environmental Health Benefits

Design landscapes with native and non-invasive plants that provide essential food, habitat and nutrition sources for beneficial wildlife.

PRINCIPLES



Minimize Resource Consumption

Aim for resource efficiency throughout the design process. Utilize drought tolerant plants, capture and store rainwater, and design systems to reduce water use in irrigation and other outdoor uses.

Encourage Community Participation and Engagement

Incorporate elements like greenways, community gardens, and outdoor gathering places to promote social connection and increase access to nature.

PRINCIPLES

Promote Accessibility and Equity

Prioritize access to green spaces, regardless of an individual's mobility or socio-economic background.

Create Aesthetically Pleasing Areas

Ensure the landscape design is visually pleasing and caters to a variety of tastes and preferences with an emphasis on promoting green infrastructure.

PRINCIPLES

Prioritize Low Impact Development Practices

Where possible, use low-impact development practices and aesthetics that are consistent with the local environment.

Utilize smart and connected technologies

Utilize smart and connected technologies to monitor and manage the landscape in a responsible, sustainable manner.

PRINCIPLES

Utilize Sustainable and Eco-Friendly Practices

Utilize sustainable and eco-friendly practices throughout the design such as natural, low-impact construction materials, efficient irrigation systems, and bioengineered swales, filtration and detention systems.

SUSTAINABLE LANDSCAPE DESIGN PRACTICES

- **Water and Irrigation Techniques**
- **Vegetation and Plantation Techniques**
- **Built Environment and Materials**
- **Shading Techniques**
- **Wind Flow and Blocking Techniques**
- **Optimizing the Use of Sunlight**

WATER AND IRRIGATION

- **Installing rain barrels to deal with water runoff.**
- **Taking into account the weather at the specific sustainable landscape site when determining the water requirements of plants cultivated in a landscape.**
- **Constructing waterways that are straight and perpendicular that lead to a reservoir to collect and store any extra water on the terrain.**
- **Water streams can be placed under the shadow of large trees to reduce water evaporation.**
- **Constructing ponds, pools, or wells on the landscape in order to collect water and prevent its wastage.**
- **Coordinating the irrigation system with the plants to maximise water use and prevent water loss.**
- **Installing a drainage system that is suitable for the landscape can help collect water in one spot.**

PLANTING AND VEGETATION

- Constructing the hardscape elements of a sustainable landscape with locally sourced and renewable resources.
- Using materials whose manufacturing requires less energy.
- Each sustainable landscape site should be designed with its climatic goals in mind.
- Installing solar-powered tools and buildings like lawn mowers, irrigation systems, and solar-paneled shelters, one might consider solar preservation in a sustainable landscape.
- The strategic placement of plants, trees, and hardscape elements to reduce direct heat, increase natural ventilation and humidity levels, and effectively manage dusty breezes.

BUILT ENVIRONMENT AND MATERIALS

- **Planting natural plants that are suitable for the area.**
- **Cultivating trees and plants with minimal water requirements.**
- **Avoiding the use of artificial fertilisers and pesticides to boost the development of plants that produce fruit and vegetables.**
- **Plantation of deciduous trees that offer summer shade and winter solar penetration when the leaves fall off.**
- **Evergreen trees should be planted to shield the area from chilly and unpleasant dusty breezes.**
- **Planting a variety of medicinal plants that naturally repel insects and other pests will create a landscape that is sustainable.**

SHADING PRACTICES

- **Installation of walls and porticos to lessen the intensity of solar heat.**
- **Installation of green-covered shelters and pergolas for summertime shade.**
- **Trees that are deliberately positioned to save energy in the west and south.**
- **Considering the amount, placement, and form of the shadows the trees throw.**
- **Trees planted in the west and south to absorb carbon from the atmosphere.**
- **Dense evergreen bushes and trees to offer constant shade and strong winds.**

WIND FLOW AND BLOCKING TECHNIQUES

- **Considering the form of the tree in placement.**
- **Considering the texture of the tree in placement. Considering the height of the tree in placement.**
- **Planting trees that can control wind by obstruction, guidance, deflection and filtration.**
- **Considering the various attributes of plants, trees and built structures, such as, size, shape, height, form and texture that guide the flow of air over the landscape.**
- **Regularly mulching a thick layer over the landscape to prevent soil erosion caused by heavy winds.**

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- **Regularly mulching a thick layer over the landscape to prevent soil erosion caused by heavy winds.**

WIND FLOW AND BLOCKING TECHNIQUES

- placing as many trees and plants as you can in areas that receive a lot of direct sunshine to absorb the most heat.
- the planting of thick, towering trees that offer cool nighttime breezes as well as daytime shade.
- Growing trees with a range of characteristics–size, shape, texture, height, and form–will add another level and produce patterns with sunshine and shadow.
- Making the most use possible of meteorological and seasonal fluctuations and their direct influence on sunshine intensity.
- To reduce the sun exposure on the plants and trees in a sustainable landscape, solar panels are installed.
- Considering the amount and availability of sunshine while placing windows and doors for sustainable

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IMAGE REFERENCES

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