

**Proposed Automobile Centre for Globe Motors Holdings Nigeria
(Evaluation of Circulation in Automobile Sales and Maintenance Facilities)**

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Environmental Design and Management, Lead City University, Ibadan, Oyo State,
Nigeria**

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(MSc) in Architecture**

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Certification

This is to certify that **Oluwaseun Akinyemi AKINBOLA** with matriculation number **LG/PG/002135** carried out this research work titled “**Evaluation of Circulation in Automobile Sales and Maintenance Facilities**” in the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, for the award of Master Degree (MSc) and that this has not been previously submitted

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Date

Dedication

This research is dedicated to Almighty God for his grace and mercy upon my life especially during the process of carrying out the research. I also dedicate this to all people that contributed and supported me to make the research a successful one.

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Acknowledgement

I sincerely wish to express my gratitude to every institution where information and data was collected for the completion of the research work.

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Abstract

Automobile center simply refers to a shopping specially designed for cars and its buyers, planned as a unified whole to create an avenue for buyers or those who dream of owning a car to enjoy such friendly environment and provide space/facilities for vehicle repair and maintenance. Its friendly environment offers not only high standard of commercial activities, and extra amenities, but special natural landscape. The layout pattern of the auto center internal spaces and its relationship towards illuminating such spaces go a long way to improving the shopping experience of the users that aids profit of the developer. This project was aimed at designing an ultra-modern automobile center to provide the car owners a state of the heart workshop where vehicle can be repaired, be maintained and also provide showroom for potential buyer of brand-new car, spare parts in Ibadan (Oluyole Local Government Area) and environ. Circulation is very important as the concept that makes automobile center. The project focuses on circulation in automobile sales and maintenance facilities.

The result of designing this auto center and maximizing the solar energy by using the various sustainable principles and methods includes the creation of a conducive atmosphere. This atmosphere, in harmony with the natural environment, makes it possible in increasing working efficiency amongst staff, attracting more customers, improving sales, all as a result of using daylighting features and materials friendly to it.

Key Words: Automobile, Circulation, Sale, Maintenance

Word Count: 240

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Chapter One

Introduction

1.1 Background to the Study

The background to the existence of Automobile Mechanic workshop in Nigeria, Ibadan to be precise can be traced back on the basis of the need to render services to vehicles which when on the move can suddenly develop fault and requires an emergency repair. So, this makes it inevitable that some repairing workshops should be set up near the road side to render services to the vehicles when they go out of order or become inoperative, and be very helpful for the operation of vehicles. Within a short time, the number of vehicles increased enormously and many workshops were set up. Nowadays, many roads and high ways are built and hundreds and thousands of vehicles are found plying on those roads. In order to provide services to those vehicles to make them operative, a large number of mechanic workshops are located near the road side. (Technical report, Department of Mechanical Engineering, Federal University of Technology, Akure, Ondo State, Nigeria)

The job of an automobile mechanics over the 21st century has been increasingly specialized with rapid advancement in technology, they have broadened their knowledge from main mechanic work to including rewiring, electronic work due to the modern trend in production and manufacturing of modern vehicles whose part have been evolved with electronics. So, this creates basis for the mechanics to have broader knowledge in repair works than before. Although the land used for automobile mechanical works are mostly acquired through rent and lease so the managers have periods of years to locate their workshop there and at the end

of the period of practice, the workshop is later on the control of the previous worker who was a trainee and after the acquisition of knowledge, he becomes boss in his own level.

The automobile mechanic workshops in Nigeria are under the control of mostly illiterate or semi-literate individuals (Oguzie, 2001). The designs of vehicles nowadays have advanced to a very sophisticated level, and unlike the old mechanically operated vehicle systems, the modern vehicles are being operated and controlled by computerized electronic sensors. For example, latest vehicles' ignition systems are electrically controlled without employing the old use of manually reset contact breaker. Common to majority of the new trend cars is the brain box and other electronic gadgets that sense instant faults in the vehicle and immediately notifies the driver through the dashboard display. The modern trend of mechanical services therefore requires the use of more complex and highly technological and special diagnostic equipment to analyze vehicle faults for repair and service. To ensure this for efficiency, safety, comfort and style, competent professional hands are required (Auto Tips 2001; Dhillon 1980). Automobile repair and servicing is considered to be inelastic because it will always and forever be in demand. The need for people to purchase vehicles will continue to rise likewise the need to maintain, repair and service the vehicles no matter the level at which the economy struggles in a country.

Automobile repair works has tended to thrive higher in poor and better economy in as much as people demand to repair their old vehicles rather than spending huge amount on purchasing a new one and in as much as other people spend much amount in purchasing new vehicles and calls for demand in maintenance. The number of automobile technicians is

increasing and it is still in expectance to increase higher in future. The automobile technicians work may involve repair of a specific part or the replacement of one or more parts of assemblies.

Basically, automobile repair involves preventative maintenance on car body to avoid total breakdown of vehicle by replacing various car parts and vehicle maintenance which is when there is a sign of malfunction on car parts. Because of the complexity in the system of vehicles manufactured nowadays, the method of auto repair has advanced greatly and also widening, most auto technicians now use electrical equipment, diagnosing machine unlike the mechanical equipment use before.

Maintenance is defined as an activity applicable to all systems, natural and artificial, to cause such systems to remain unaltered or unimpaired. It is the repair activity carried out on vehicles or other machineries to keep them unaltered, and if altered, to restore them to their original state. (Okah-Avae 1995; Akinola and Ogedengbe 2005). Automobile Service workshop can be defined as the sales and leasing of vehicles, providing after sales services and sales of auto part.

The study of the distributional pattern of Automobile Mechanic workshop have not been paid much attention on until after the period of colonial era when the demand for vehicle ownership started increasing and also there occur increasing urge for mobility of goods, people compare to other service sector of the economy where there has been much attention. For example, Banking sector, Educational Sector e. t. c.

Mostly, the site of mechanic workshop where maintenance activities, repair of vehicle and sales of vehicle parts are carried out are of low capital base and either located on slippery terrains, under tree sheds, canopy made of banana or palm fronds, etc.

In Nigeria where land transport is largely in use compared to water transportation and other modes of transportation in other country, the use of automobile vehicles, either diesel or petrol driven is predominant. According to 'Akintola 1995', he stated that 'the vehicles cannot remain new forever, as the parts breakdown and wear out, and so, must be maintained'.

The National Automotive Design and Development Council's vision is to transform Nigeria into a modern industrialized nation and the mission is to design and implement policies, programmes and strategies for an effective, competitive and diversified private sector.

(National Automotive Design and Development Council – NADDC)

National Automotive design Development Council is made up of a Governing Board, its committees and the full secretariat membership of the Governing Board is drawn from relevant agencies and comprises of representatives of the government:

- Nigerian Automotive Manufacturers Association (NAMA)
- Automotive Local content Manufacturers Association of Nigeria (ALCMAN)
- Standards Organization of Nigeria (SON)
- Raw Materials Research and Development Council (RMRDC)
- Manufacturers Association of Nigeria (MAN)

- Nigerian Society of Engineers (NSE)
- Federal Ministry of Industry, trade and investment (FMITI)
- Automotive Local Content Manufacturers Association of Nigeria (ALCMAN)
- Motorcycles Manufacturers Associations of Nigeria (MOMAN) and
- Bicycle Manufacturers Association of Nigeria (BIMAN)

1.2. Statement of the Problem

According to Nigerian data, the sale of new automobiles decreased by 11% in 2018. In order to increase these sales, looking at the location (Ibadan), it involves people a place to repair their cars and have different ideas about industry and have choices of different brands of cars, and sometimes these cars could be affected by the heat of the sun or inter changing weathers, because it has been observed that dealers display most of the vehicle outside and it is also observed that there are lot of road side mechanics which cannot promote the architecture of automobile centre, so there is a need to design proper automobile centre to cater for optimal need and requirements.

The market's bleeding is owing to the country's underperforming economy, which is keeping potential buyers away from showrooms, mostly government and corporate Nigeria, and these issues can be witnessed today in numerous vehicle centers across the country. They include everything from construction processes to materials employed, as well as the design concept and proper functionality of interior areas. The majority of the designs are no longer in use. They lack the vitality and inventiveness that can be found in other parts of the world in their designs and arrangements. Some of these issues will be highlighted, and

architectural solutions will be proposed. Lighting in interior areas is a crucial issue in the construction of large motor showrooms. In Nigeria, there is a shortage of suitable lighting in the event of a power outage.

The architectural challenge here is to construct a functional vehicle center that addresses the harmonization of repair and maintenance activities as well as the separation of non-technical and administrative duties.

Poor accessibility, location, zoning, and proximity to the surrounding environment, as well as faulty design and the configuration of the facilities given, have all contributed to the failure of vehicle centers in Nigeria. As a result, it is necessary to identify the maintenance facilities that should be made available in automobile centers, as well as the extent to which these facilities are available in most automobile centers in Nigeria, the consequences of unavailability, and the recognized and approved approach for maintaining the facilities in automobile centers in Nigeria.

It also aims to determine the variables that must be considered when establishing an automobile center, particularly the architectural design. To put it another way, the project aims to determine the design of all new construction and remodeling projects for vehicle operations and maintenance facilities. It includes general criteria for establishing requirements, site evaluation and planning, and exterior and interior design, as well as policies and guidelines for determining building project requirements. For a better and improved system, construction planning and job management are taken into account.

Also, when establishing an Automobile center, the proximity of its users and the nearby environment should be carefully studied before deciding on a location. This includes things like access, correct zoning, the kind of commodities and merchandise sold, and the availability of public facilities that will work as a magnet to draw people in.

An automobile center should not be created solely for the aim of selling autos; it should also have other appealing amenities that will promote leisure, as well as the center's right location and accessibility. The architectural design of a display room, for example, and day lighting in car dealerships will boost and improve the rate of automobile sales in Nigeria. When these facilities are adequately maintained, repair and replacement costs are reduced, and unpleasant events are avoided.

1.3. Research Aim and Objectives

The aim of this study is to investigate the impacts of Architecture on Automobile sales and maintenance facilities. The objectives are to;

- i) to identify the components of an automobile and physical layout of an automobile workshop
- ii) to identify design approaches towards effective circulation in an automobile centre
- iii) to propose a design of an automobile centre using circulation approaches identified in the study
- iv) to identify the factors to be considered when selecting a site for automobile sales
- v) to identify the components of automobile service center and their design criteria.

- vi) to identify the importance of showroom and how it can influence the sales of automobile
- vii) Examine the design layout of an automobile showroom

1.4. Research Questions

To guide this study, the following research questions will be considered:

- i) What are the components of an automobile and physical layout of an automobile workshop?
- ii) What are design approaches towards effective circulation in an automobile centre?
- iii) What are circulation approaches identified in the study for the proposed design of an automobile centre?
- iv) What are the factors to be considered when selecting a site for automobile sales?
- v) How to identify the components of automobile service center and their design criteria?
- vi) What will influence the sales of automobile and identify the importance of showroom?
- vii) How to examine the design layout of an automobile showroom?

1.5. Significance of the Study

This project aims to give suitable service to Nigeria's growing population, which recognizes the need for a modernized set of automobile centers and services. The population data and understanding of the development needs of an ever-increasing Nigerian validates and attests

to the need for urgent research on existing auto mobile centers, which is why it seeks to critically examine the loopholes in Nigerian auto mobile centers and propose solutions to these loopholes.

This research would establish a foundation for the construction of automobile structures that would house not just man, but also the monster he has created in order to facilitate his activities on the planet, as well as raising awareness that architecture should adapt to diverse changes in function through time, providing solution to environmental problems in the society.

The benefit of the study will be able to identify approaches to effective circulation of an automobile center, the design can be a contribution to the location (New Garage, Akala Road, Oluyole Local Government Oyo State)

The Automobile Industries and Dealers, in particular, will benefit from this research by being able to manage their businesses more effectively and efficiently, hence increasing profits and improving overall performance.

The findings of the study will provide relevant information that will assist the government in planning, formulating, and implementing policies that will facilitate more profitable business in the motor vehicle industry. This will result in increased employment, improved infrastructure, and increased tax collection, as well as industry expansion.

In addition, the study will serve as a reference point for other researchers working in the same sector, making their work easier. The findings of this study will be valuable to

academics and researchers in setting the basis for future research on the subject, as well as giving a critical analysis of the discipline.

1.6. Scope of the Study

The scope of this study will be limited to the design of automobile centre for Globe Motors Holdings Nigeria (Mercedes, Toyota, Honda and Hyundai cars) in Ibadan, Oluyole Local Government Area Oyo State. The project is based on case studies, interviews, and journals, among other sources. The scope of work is determined by the demographic that will be served. Auto servicing and maintenance, battery charging and repair, panel beating, welding (arc/electric), spraying, electrical repair, and painting were among the operations offered by the workshops in the study area, which had been in business for 5 to 18 years. The automobile mechanics, who were discovered in at least one workshop, had the highest occupational designation among the study participants. This may be related to the quick expansion and dispersion of mechanic shops throughout the city as a result of the increased importation of Fairly Used Vehicles.

This research focuses on a portion of the Ibadan area in Oyo State. The research focuses on the link between the Architecture of Automobile Centre in Ibadan and the Evaluation of Circulation in Automobile Sales and Maintenance Facilities.

1.7. Operational Definition of Terms

Maintenance Facility

Means a public facility, supporting maintenance, repair, vehicular, or equipment servicing, material storage, and similar activities including street or sewer yards, equipment service

centers, and similar uses having characteristics of commercial services or contracting or industrial activities include car washes, parking garages, rental agencies, gasoline stations, automobile service and repair shops, public transportation and emergency response vehicle storage/ service areas, fleet storage/ service facilities, auto body shops, and parts suppliers.

General Workshop

This is a comprehensive service unit that features all general repair works done on cars.

Showroom

A showroom is a shop in which goods are displayed for sale, especially goods such as cars or electrical or gas appliances.

Automobile Service Centre

means a building or part of a building or a clearly defined space on a lot used for the retail sale of lubricating oils and gasoline and may include the sale of automobile accessories and the servicing and minor repairing essential to the actual operation of motor vehicles and may include an automobile car wash, an automobile body shop and/or repair shop.

Chapter Two

Literature Review

2.1. Conceptual Review

2.1.1 Historical Development of Automobile Sale's and Maintenance:1800 Invention:
The history of auto mechanics began in 1800s in Europe with the creation of the first cars. According to History.com, Europeans perfected the first modern automobile by 1901. These late-1800s makers of cars can be considered the first auto mechanics. They engineered, designed, and built the first successful automobiles, launching a trade for likeminded individuals in centuries to come.

Because the early European automobiles were advanced – compared to American automobiles – but not standardized, car owners faced the difficult task of finding people who could repair this just-invented machine. Mostly upper-classmen, lucky automobile owners could find a driver who also had specialized knowledge in maintaining cars.

These drivers/mechanics not only saved their employers from car-repair headaches; they also played an important role in merging the gap between the upper and lower class. According to the International Association of Mechanists and Aerospace Workers (IAM), upper-class car-owners recognized the specialized knowledge of their drivers, opening up a new level of pay and privilege for carriage drivers and footmen willing to learn the trade.

2.1.2 Standardization: Early 1900s

History.com credits American Henry Ford with perfecting efficient automobile-making. While Ford vehicles weren't as advanced as European cars, the standardized parts allowed them to be faster to make and cheaper to buy, introducing the automobile to a new market.

As more and more automobiles were produced and put into use, dealerships and private businesses began offering mechanic services. And with standardized parts, the auto mechanic trade became easier to learn.

International Association of Mechanists and Aerospace Workers (IAM), explains that competition grew quickly between mechanic businesses – and even individual mechanics – as most were paid by the hour. The most experienced mechanics worked faster, resulting in lower costs to the owner and more business for the mechanic or dealer.

2.1.3 Market Stagnation: 1930s to Mid-Century

As the Great Depression hit, auto sales declined, and the market – including auto maintenance and production – was pressed to continue making a profit despite its inability to evolve until demand increased.

During this time of still-early car maintenance, one of the most popular and noticed auto body tools, paint, was often handled by the owner. According to Eastwood.com, paint on early- to mid-1900s automobiles was far less durable than the paints available today. Therefore, cars needed frequent touch-ups for protection from the elements. Car owners

would paint their automobiles by hand with brushes. Runs and finish imperfections were common even on cars directly out of the assembly line, so owners had little reason to hire an individual auto body mechanic to conduct paint repairs.

2.1.4 The Split of Auto Mechanics and Auto Body: Mid-Century

To resist market stagnation and the do-it-yourself mindset around auto body repair, History.com notes that Alfred P. Sloan, Jr., is responsible for the focus on automobile style. With a plan to drive new-car demand, Sloan essentially created the cosmetic side of the auto body industry by creating the market's desire to have the latest, most fashionable model of an automobile. Those who couldn't afford the latest model, however, considered alternatives to achieving a higher level of automobile style, making way for the auto body repair industry. From this point forward, individuals in the auto industry could begin to focus on auto body or auto mechanics (or both), creating a lasting split in the industry.

2.1.5 Constant Advancement to the Present Day

With automobiles continuing to advance, and the industry continuing to grow in America, the changes in the auto mechanics and body repair industry are largely driven by technology. As the vehicles become more advanced, efficient, powerful, and long-living, auto mechanics working in the field are constantly learning.

The automotive repair industry has grown to include the following focus areas:

- Engine expertise

- Chassis work and repair tools
- Transmissions, axels, drive shafts, and torque converters
- Electrical circuits
- Fuel types and systems
- Diagnostics

Similarly, auto body repair continues to advance as styles and tools evolve. Auto body focuses on:

- Preparing a vehicle for repair
- Welding and glass
- Part alignment and laser equipment
- Plastic retexturing
- Primer, cleaning guns
- Paint mixing, application, and buffing

2.2. Empirical Review

2.2.1 Effect of Circulation and Design Strategies in Buildings

Internal circulation, both horizontal and vertical, should be logical, understandable, safe and easy for everyone to use.

Building users need to understand where they are, where they are going, and the route to take to get there. They then need to successfully move through the physical environment to

reach their destination. (<https://www.building.govt.nz/building-code-compliance/d-access/accessible-buildings/internal-circulation/>)

2.2.2 Orientation and Way-finding

The purpose of the building will undoubtedly determine how the internal space is to be arranged. Building users need to be able to enter the building, get to those spaces and move between them. The more complex the building, the more difficulty that new or less frequent building users will have, especially those who are blind or have low vision.

The layout of circulation space needs to be logical, with good sightlines. Some building users may not wish to enter areas where the ceiling heights are low, corridor widths are restricted or light levels limited. Curving corridors will lead to orientation problems and sharp corners present some with security concerns.

Simple, logical and consistent layouts enable people to memorize environments that they use regularly and predict and interpret environments they are encountering for the first time.

Visual links through windows to the outside environment can reduce stress and help with orientation. Grouping facilities such as co-locating lifts, ramps, stairs and escalators, or keeping all the sanitary facilities in the same place on all floors, results in a more predictable environment which is easier to understand.

The success of wayfinding will be affected by the number of decision points on a particular route and the quality of information available. That information could be environmental (for instance from the structure of the building, or from the color or texture of finishes) to

wayfinding-specific (such as floor plans, signage or room numbers on doors). The better the environmental information, the less wayfinding-specific information that will be required.

Consistency in design assists with wayfinding.

Signage should be located at decision points and perpendicular to the path of travel.

Some building users may not be able to navigate their way through the environment and need assistance. In this event, management procedures need to be in place to assist them in getting to, and returning from, their desired destination.

2.2.3 Design Considerations

- Ensure the internal layout of a building takes account of the need for people to use circulation routes and provides as much wayfinding assistance as possible.
- Ensure circulation spaces are logical with good sightlines within an environment.
- On circulation routes provide visual links with the outside wherever possible.
- Avoid glare in the internal environment.
- To make the environment predictable and easy to understand, group provisions and facilities of the same type together.
- In open plan areas and where doors are omitted, ensure circulation routes are clearly defined.
- Ensure that assistance can be given to building users who find navigating the internal environment difficult.

2.2.4 Physical Movement

Travelling towards a destination within a building will consist of horizontal and vertical movement for the building user.

In the horizontal plane the limiting factors may be the distance to be travelled, the width of routes, the type of floor surface, and the presence of obstructions such as doors with door closers. In the vertical plane the limiting factors may be the gradient and rise of ramps, the number and pitch of stairs, the size or design of a lift or the absence of suitable alternatives.

2.2.5 Horizontal Circulation

People carrying objects, those with young children or users with mobility and strength limitations may find long distances a major barrier and take longer to reach their destination than others. Consequently, travel distances should be kept to a minimum. The incorporation of additional entrances with associated car parks can help reduce the length of walking required. Seating at regular intervals is also helpful.

Doors are a barrier not only because they need to be opened but also because they often restrict the width of a route. Wherever environmental, privacy and security requirements allow they should be omitted. As an example, configuring the layout of a toilet facility to restrict sightlines can remove the need for doors on the approach, saving money and improving access.

Doors can pose a problem when they are fitted with door closers. These can become increasingly heavy if they are not maintained.

Internal lobbies can cause problems as they often require effort to open the doors and require the negotiation of a small space. Where they are required, they should be made as easy to use as possible.

Open plan areas are beneficial as they reduce the need for internal doors or other divisions which often impede access. However, people who are blind or have low vision find crossing large areas without appropriate environmental and tactile guidance or cues difficult.

Non-vertical columns can cause confusion and create headroom issues and should not be placed near circulation routes.

2.2.6 Design Considerations

- Design circulation spaces to restrict travel distances.
- Consider the use of additional entrances and associated car parks to ensure facilities are all within easy walking distance.
- Where travel distances are long, provide seating and toilets at regular intervals.
- In airports or similar large buildings, travellers can be installed where long distances are unavoidable. Restrict the length of the travellers to ensure that facilities or destinations are not bypassed.
- Consider the provision of transport between areas separated by long distances.
- Wherever possible, omit doors from the design.
- Isolate quiet areas in buildings by a buffer zone to avoid the need for doors.

- Avoid the need for lobbies wherever possible. Where they are necessary, ensure they are large enough not to be restrictive.
- If non-vertical columns are essential to the design ensure that circulation routes keep away from them.

2.2.7 Vertical Circulation

Changes of level in buildings can be a problem for some building users. Not only are stairs, lifts and ramps costly, they also take up space which might be better utilized for another purpose.

For people who cannot or prefer not to use the stairs, a passenger lift is generally the most convenient method of travel between floors in a building. Passenger lifts have the advantage of being able to move a number of people quite quickly, although some people do not like entering a lift car. Sufficient lifts should be provided in convenient locations to suit the building use and expected occupant demands.

Where the installation of a lift is not immediately practical, the construction of a lift shaft with knock out floor panels and space for control equipment could save huge costs in the future. In the interim, the spaces on each floor could be used as cupboards.

Escalators can move large numbers of people quite quickly but some building users do not feel safe on them. When they fail (either through mechanical faults or perhaps a power outage during an evacuation) the result can be an extremely long staircase with high risers and sharp nosing.

Escalators do not provide a means of access for all and are unsuitable for wheelchair users, people pushing strollers and buggies, and some people with disabilities.

Stair lifts and chair lifts are slow, have high maintenance requirements and are generally only able to carry one passenger at a time. Limited weight capacity and size means they are unsuitable for regular use with larger power chairs. They can be effective in domestic environments but should not be installed in a public building.

Where the installation of a passenger lift in an existing building is not possible (such as in historic buildings) platform lifts could be considered.

Stairs are a standard way to link floors but their design can create problems for many building users.

A single isolated step is the most difficult change in level to perceive, presents a high trip and fall hazard for all users and should not be installed.

Ramps provide step-free access between levels but for people who are unable to incline the feet, or are using calipers, they present a barrier.

While portable ramps could appear to solve some immediate accessibility problems, they require a management input, present a trip hazard to others and are often too steep for independent use.

2.2.8 Design Considerations

- Herever possible, design sites and buildings to provide consistently level access thus avoiding the need for steps and ramps.
- Wherever possible, avoid changes in level within a storey.
- Provide lift access to all floors in multi-storey buildings where possible.
- Where lift access to every upper floor is not possible, provide all necessary facilities on accessible floors.
- If a lift is not provided, consider constructing a lift shaft so that a lift can be installed at a later date.
- Position stairs, lifts, ramps and escalators in the same location to allow building users to choose their preferred method of changing level.
- In existing buildings install passenger lifts in preference to other types.
- Use portable ramps only as a temporary measure in exceptional circumstances.
- Avoid the possibility that service ramps might be used as part of a circulation route.
- Single steps should not be installed or be available for use except in existing buildings where alterations are not possible.

2.2.9 Building Code Requirement

Building Code clause D1 Access routes:

D1.3.1 Access routes shall enable people to: (c) move into spaces within buildings by such means as corridors, doors, stairs, ramps and lifts.

D1.3.2 At least one access route shall have features to enable people with disabilities to: (b) have access to the internal space served by the principal access, (c) have access to and within those spaces where they may be expected to work or visit, or which contain facilities.

D1.3.3 Access routes shall: (a) have adequate activity space, (e) include stairs to allow access to upper floors irrespective of whether an escalator or lift has been provided, (i) not contain isolated steps.

D1.3.4 An accessible route, in addition to the requirement of Clause D1.3.3, shall:

(a) be easy to find, as required by Clause F8 Signs

(b) have adequate activity space to enable a person in a wheelchair to negotiate the route while permitting an ambulant person to pass

(c) include a lift complying with Clause D2 Mechanical installations for access to upper floors where:

(i) buildings are four or more storeys high

(ii) buildings are three storeys high and have a total design occupancy of 50 or more persons on the two upper floors

(iii) buildings are two storeys high and have a total design occupancy of 40 or more persons on the upper floor, or

(iv) an upper floor, irrespective of design occupancy, is to be used for the purposes of public reception areas of banks, central, regional and local government offices and facilities,

hospitals, medical and dental surgeries, and medical, paramedical and other primary health care centers.

(f) have doors and related hardware which are easily used.

(New Zealand Building Performance Code)

2.2.10 Corridors and Open Plan Areas

Wheelchairs, mobility scooters and double buggies vary considerably in their width and turning circle. It is important that circulation space, doors and their approaches are sized to accommodate a range of potential users travelling in both directions.

For people who have low vision, the opportunity to use their functional sight to recognize critical surfaces helps them to remain independent. Consequently, good contrasts between critical surfaces is very important.

Across open plan areas, visual and tactile guidance can be invaluable.

2.3 Design considerations

- Ensure circulation space is wide enough for anticipated traffic at peak times and is provided with sufficient headroom.
- Where circulation width cannot be wide enough for peak traffic, provide passing places in sight of each other.
- Ensure that there is good contrast between critical surfaces such as ceilings, wall, floors, and doors.

- Provide visual and tactile guidance across large open plan areas.
- Ensure that circulation space is kept free of permanent and temporary obstacles at all times.
- Recess items such as radiators and fire extinguishers to prevent them projecting into circulation routes.
- Ensure windows do not open into circulation routes.
- On long routes, provide seating at regular intervals.
- Where hazards cannot be physically protected or designed out provide visual, auditory and tactile cues for warning.
- Consider providing handrails to both sides of long corridors.
- Flooring surfaces should not be shiny or reflective as this can affect visibility and cause discomfort.

2.3.1 Building Code Requirement

Building Code clause D1 Access routes:

D1.3.1 Access routes shall enable people to: (c) move into spaces within buildings by such means as corridors, doors, stairs, ramps and lifts.

D1.3.2 At least one access route shall have features to enable people with disabilities to: (c) have access to and within those spaces where they may be expected to work or visit, or which contain facilities.

D1.3.3 Access routes shall: (a) have adequate activity space, (b) be free from dangerous obstructions and from any projections likely to cause an obstruction, (n) have any automatically controlled doors constructed to avoid the risk of people becoming caught or being struck by moving parts.

D1.3.4 An accessible route, in addition to the requirement of Clause D1.3.3, shall: (a) be easy to find, as required by Clause F8 Signs, (b) have adequate activity space to enable a person in a wheelchair to negotiate the route while permitting an ambulant person to pass, (f) have doors and related hardware which are easily used.

Building Code clause F8 Signs:

F8.2 Signs must be provided in and about buildings to identify: (d) accessible routes and facilities for people with disabilities.

Clause D1 Access routes can be viewed on the New Zealand Legislation website.

(New Zealand Building Performance Code)

2.3.2 Internal Doors

Where doors are provided, they should be easy to identify and operate, and wide enough for people to pass through comfortably.

Doors need to be:

- **Easy to identify.** Doors and their fittings that blend into their surroundings are difficult to identify especially for people with a vision impairment.
- **Surrounded by sufficient space.** Wheelchairs, especially powered versions, can be large and if turning from a corridor need appropriate space. For swing doors, wheelchair users may need to open the door towards them and maneuver around it. In addition, after operating any door control system it should not be necessary to move backwards to align with the entry path.
- **Simple to understand.** Building users who have not seen the door before need to be able to easily identify how it works. The appropriate installation of push plates and pull handles will help. When double doors are installed, it should be obvious which way they operate if one of the doors is bolted.
- **Easy to unlock and unlatch.** Door furniture should be easy to use and only require the use of one hand (either right or left). Door operation that requires the use of both hands, or requires a lifting action will be difficult for some building users.
 - Some building users may not be able to grip and turn, may be carrying something or be accompanied by an assistance dog. Lever handles that can be operated by a clenched fist or elbow are ideal. However, doors cannot be pulled towards a building user using only a clenched fist.
 - While raising up door fittings can put a handle out of reach for a child, it may also restrict its use by others.
 - Locks positioned below the handle are hidden from the view of a standing person and are more difficult to use.

- Full height handles are very useful as they allow users to select the height at which they wish to grasp. However, they can be an issue for wheelchair users as footrests can catch the handles on passing through, and restrict the clear opening width.
- **Easy to open.** Wheelchair users may use their footrests to open doors so kick plates should be large enough to protect the door and any glazing in it.
- **Easy to pass through.** Door openings need to be wide enough for all expected building users and the door should not close on anyone using it. Thresholds need to be level.
- **Safe.** The edges of doors that are open are a particular hazard especially for people with a vision impairment. Providing some method of closing doors can alleviate this problem. Users should also be able to easily establish what is on the other side of the door and if someone is approaching. Vision panels can help provide confidence and reassurance.

2.3.2 Design Considerations

- Ensure that doors are easy to identify and stand out from their surroundings. Doors that will not be accessed regularly (such as to service risers) should blend in with their surroundings to avoid being a distraction.
- Ensure that there is sufficient space on both sides of the door for its operation by all building users.

- Ensure that the operation of the door and any access equipment associated with it is easy to understand and use.
- Ensure door fittings are easy to see and operate with a clenched fist or an elbow.
- Place independent door locks above door handles so they are easy to see.
- Automate doors wherever possible.
- Make the direction of the opening of doors consistent through the building.
- Ensure the clear door opening is wide enough for all proposed uses of the space.
- Ensure the threshold is level.
- Where double doors are installed, ensure the principal leaf is easy to identify and has sufficient clear opening width if used on its own.
- When swing doors can remain open, ensure that the edge of the door is protected or easy to see.
- Install full height vision panels in doors wherever practical.

2.3.3 Building Code Requirement

Building Code clause D1 Access routes:

D1.3.1 Access routes shall enable people to: (c) move into spaces within buildings by such means as corridors, doors, stairs, ramps and lifts.

D1.3.2 At least one access route shall have features to enable people with disabilities to: (c) have access to and within those spaces where they may be expected to work or visit, or which contain facilities.

D1.3.3 Access routes shall: (a) have adequate activity space, (n) have any automatically controlled doors constructed to avoid the risk of people becoming caught or being struck by moving parts.

D1.3.4 An accessible route, in addition to the requirement of Clause D1.3.3, shall: (f) have doors and related hardware which are easily used.

(New Zealand Building Performance Code)

2.3.4 Door Closers

Where door closers are necessary, they should not adversely affect the ease of use of the door.

Door closers present major problems to building users and make movement about the building difficult. This is especially so where the force required to overcome them is too high, either through inappropriate specification or lack of maintenance.

On circulation routes, doors closing with a delayed action present a potential hazard to users following on behind.

2.3.5 Design Considerations

- Consider why a door closer is being installed. If one is required select an option that operates with the least force required. Avoid the use of a door closer if possible.
- When required for fire and smoke control purposes, consider the use of hold open devices linked to the fire alarm which can be overridden with a door closer linked to the fire alarm.
- Where doors return to the closed position after use, consider rising butt hinges rather than door closers.
- Ensure door closers have a controlled action allowing adjustment of closing pressure at different positions in the cycle.
- Avoid the use of fixed strength and spring door closers which cannot be adjusted.
- Consider the use of a modified striker plate with a gravity cam as this can significantly reduce the forces a door closer needs to exert to close the door.
- Consider the use of delayed action closers on doors to rooms, and avoid their use on circulation routes.
- Ensure that the operating arms of door closers do not strike the wall when the door is fully open.
- Ensure that door closers are maintained on a regular basis.

2.3.6 Building Code Reference

Building Code clause D1 Access routes:

D1.3.3 Access routes shall: (n) have any automatically controlled doors constructed to avoid the risk of people becoming caught or being struck by moving parts.

D1.3.4 An accessible route, in addition to the requirement of Clause D1.3.3, shall: (f) have doors and related hardware which are easily used

Building Code clause F8 Signs:

F8.2 Signs must be provided in and about buildings to identify: (d) accessible routes and facilities for people with disabilities.

(New Zealand Building Performance Code)

2.3.7 Access, Security and Intercom Systems

Access, security and intercom systems should be easy to locate, approach, understand and operate.

Systems that need to be operated prior to use of a door form a barrier for some building users and need to be easy to understand and operate.

Proximity card devices are useful as they require less dexterity to operate.

Intercom systems that rely on aural or oral communication are not suitable for people with hearing or speech impairment and create problems for everyone in noisy environments.

Combination locks can create problems for most people. They require good vision, memory and dexterity and it is often not clear how the handle operates. While they may have a place

as a security device for areas such as storage cupboards, they can be a major barrier to people using the building.

2.3.8 Design Considerations

- Consider the use of proximity card devices in preference to card-swipe devices as they require less dexterity.
- Where card-swipe devices are installed, ensure they are orientated vertically.
- Provide a suitable acoustic environment where intercom systems are installed.
- Ensure that intercoms systems have an integrated text display which is easy to read.
Consider the inclusion of an induction loop and coverage by CCTV.
- Avoid the use of combination locks on doors which form part of a circulation route.

2.3.9 Building Code Requirement

Building Code clause D1 Access routes:

D1.3.4 An accessible route, in addition to the requirement of Clause D1.3.3, shall: (f) have doors and related hardware which are easily used.

(New Zealand Building Performance Code)

2.4 Location and Identification

The staircase should be located in a logical position and be easily recognizable.

2.4.1 Location

Staircases should be designed to attract people to use them and be located in a prominent position.

Many ambulant disabled people find it easier to negotiate a suitable staircase than a ramp due to problems walking on a sloping surface.

People who are blind or have low vision may only be able to locate staircases by way of tactile warnings and visual cues. Strong visual contrast on the nosings (both leading edge and top of the riser) will provide visual cues.

By co-locating staircases with step-free routes, those who do not wish to, or cannot, use the staircase have an alternative option nearby.

2.4.2 Identification

Building users who miss the transition between level and stepped surfaces are at risk of serious injury. Often the position of a flight is first identified by seeing the handrail, but this only works if the handrail contrasts with the wall it is mounted on.

The next visual indication may be that the floor finish of the landing contrasts with the material used on the treads and risers. Then as the building user gets closer, contrasting nosing may be seen.

This process can only be successful if the building user is able to see these changes and is looking for them albeit sub-consciously.

Some building users with low vision may be able to see the landing or tread contrast or even be aware of a handrail if sufficient contrast and lighting is provided. However, other means of warning may be required for some users to detect the presence and proximity of the stairs. A change in color and texture can provide warning of the hazard and distance to the edge of the first step.

2.4.3 Design Considerations

- Locate staircases in a prominent position, and visible from the building entry and lift waiting areas
- Draw attention to a staircase by using higher levels of local lighting.
- Use different floor finishes to lead to the staircase.
- Introduce changes in the auditory environment to give notification of the presence of a staircase (e.g., carpet to hard flooring).
- Ensure handrails contrast with wall finishes.
- Ensure the start or end of a flight can be identified by contrasting the landing finishes with stair finishes and by the change in pitch of the handrails.
- Install contrasting nosings to treads. This should be applied to the leading edge of the treads as well as on the top edge of the risers.
- Consider the installation of tactile warnings such as a change of texture of the flooring material on the walking surface approaching the stairs.
- Orientate the staircase at right angles to or away from the direction of travel to reduce the possibility that someone will be unaware of the hazard.

2.4.4 Building Code requirement

Building Code clause D1 Access routes:

D1.3.1 Access routes shall enable people to: (c) move into spaces within buildings by such means as corridors, doors, stairs, ramps and lifts

D1.3.3 Access routes shall: (e) include stairs to allow access to upper floors irrespective of whether an escalator or lift has been provided, g) Have stair treads with a leading edge that can be easily seen.

Building Code clause F8 Signs:

F8.2 Signs must be provided in and about buildings to identify: (d) accessible routes and facilities for people with disabilities.

(New Zealand Building Performance Code)

2.4.5 Ease of use

Staircases need to be easy and safe to use. They need to have certain characteristics to make their use as easy as possible:

- **Consistent throughout the building.** This will provide consistency and familiarity to building users.
- **Wide enough.** Staircases need to be wide enough to facilitate the movement of people, and furniture or other bulky objects between floors.

- **Uniform.** Building users walking up and down stairs get into a rhythm that can be disrupted if the steps are not uniform. Step consistency is particularly important for people who are blind or have low vision.
- **Comfortable pitch.** Steep staircases with narrow treads and high risers will present significant difficulties to a range of building users.
- **Restricted length.** Landings are important on long staircases to provide areas to rest.
- **Closed risers.** Open risers can cause problems for people ascending stairs who risk catching the toe of their shoes beneath open treads or projecting nosings and tripping as a result.
- **Nosing.** Contrasting nosing on both the tread and the riser will assist everyone to identify changes in level.
- **Straight flights.** Spiral staircases cause problems for a variety of users. The centre handrail can be nearly vertical and combined with the restricted central tread length makes it impossible to be used by someone with a weakness on one side. In addition, it would be very difficult if not impossible to carry someone down a circular staircase in the event of an emergency.
- **Handrails.** Handrails are necessary on both sides of the stair as users who have a weakness on one side may only be able to use the handrail on their strong side. This can be a problem in cinemas and theatres where a second handrail would block access to seating. On narrow flights, two handrails can be used by some with locomotive issues to swing down stairs.

- **Intermediate handrails.** The provision of additional handrails dividing a wide flight into separate channels allows everyone to be in easy reach of support. This is particularly important when lots of people are using the steps at the same time.
- **Horizontal handrail sections.** These give advance warning of the start or finish of a flight and provide support getting on or off the stairs. Without this warning, some building users may stumble and fall.
- A second and lower handrail may be appropriate in some buildings often used by small children.
- **Handrail detail.** Handrails need to be easy to grasp, give comfortable forearm support and have fixings and supports that do not interrupt use.

2.4.6 Design considerations

- Coordinate the design of different flights of stairs within the same building.
- Avoid the installation of spiral and helical staircases in public buildings.
- Ensure fixed ladders or paddle type stairs are not available for use in public buildings.
- Limit the number of steps in each flight and provide level landings of adequate size at the top and bottom of each flight.

Width and headroom

- Ensure the staircase is wide enough and with sufficient headroom for expected use.

Treads and risers

- Ensure that the dimension of risers and treads are uniform with a comfortable pitch.
- Ensure treads are long enough to take the placing of a full foot.
- Ensure that the risers are closed with no projecting nosings.
- Ensure nosings are uniform and easy to identify against treads, risers and landings.
- Ensure tread finishes are plain and contribute to the identification of nosings.

Handrails

- Ensure handrails are continuous and provided to each side of a stair throughout its length (including intermediate landings where this does not obstruct the use of adjoining access routes) with no sudden changes of height or position.
- Ensure handrails are easy to identify visually against their background.
- Position handrails at heights suitable for all users.
- Ensure handrails have horizontal extensions at the top and bottom of a flight protected by adjacent walls.
- Ensure handrails are easy to use and grip without the hand slipping.
- Ensure handrail design allows for continuous holding, unobstructed by handrail fixings.
- Ensure the ends of handrails terminate in a way that signifies that the top or bottom of a flight of stairs has been reached.
- Consider the installation of domed buttons on the surface of a handrail at the end of a flight to give tactile warning of the end of the handrail.

2.4.7 Building Code requirement

Building Code clause D1 Access routes:

D1.3.3 Access routes shall:

- (e) include stairs to allow access to upper floors irrespective of whether an escalator or lift has been provided,
- (f) have stair treads, and ladder treads or rungs which
 - (i) provide adequate footing
 - (ii) have uniform rise within each flight and for consecutive flights, (g) have stair treads with a leading edge that can be easily seen,
- (h) have stair treads which prevent children falling through or becoming held fast between treads, where open risers are used,
 - (i) not contain isolated steps,
 - (j) have smooth, reachable and graspable handrails to provide support and to assist with movement along a stair or ladder.

D1.3.3 Access routes shall:

- (j) shall not apply to isolated steps,
- (k) have handrails of adequate strength and rigidity as required by Clause B1 Structure,
- (l) have landings of appropriate dimensions and at appropriate intervals along a stair or ramp to prevent undue fatigue,

(m) have landings of appropriate dimensions where a door opens from or onto a stair, ramp or ladder so that the door does not create a hazard.

D1.3.4 An accessible route, in addition to the requirement of Clause D1.3.3, shall:

- (g) not include spiral stairs, or stairs having open risers,
- (h) have stair treads with leading edge which is rounded,
- (i) have handrails on both sides of the accessible route when the slope of the route exceeds 1 in 20. The handrails shall be continuous along both sides of the stair, ramp and landing except where the handrail is interrupted by a doorway.

2.4.8 Staircase safety

The design of the staircase should make its use as safe as possible.

User awareness: Being aware of the presence of a staircase is an essential part of reducing the risk of injury. A significant number of "air step" falls occur because the presence of a limited change in floor level is not perceived. This is a particular problem with single steps which are often not seen.

Contrasting the landing finish or texture with those of the tread and riser will give people advance warning of the start of a staircase.

Contrasting nosings on both the tread and the riser will assist building users to identify a staircase and determine where there are changes in floor level.

For people who are blind or have low vision, contrasting and tactile warnings assist with the detection of the presence and proximity of stairs.

Alignment and length. Building users who are distracted or who are blind or have low vision run an increased risk of falling up or down a staircase which is aligned in the direction of their travel. For longer flights the risk of injuries in a fall are greater when flights are continuous. Landings are important on long staircases to provide areas to rest and to help limit the distance down the stairs that someone might fall.

Predictable. The design of the staircase needs to be predictable and enable building users to stay on the staircase trafficable surfaces.

Width. The staircase needs to be wide enough for expected traffic. When medical emergencies occur, ambulance officers may have to use staircases to move patients on stretchers.

Underside of stairs. Building users who are distracted, have a vision impairment or are using a long cane run the risk of colliding with the underside of stairs and landings which are not physically protected.

Risers. A minor variation in riser height can cause someone to stumble. Excessively high risers can require too much strength for some people to climb and result in strain being placed on knee and hip joints when descending flights of stairs. Some people may feel insecure or dizzy when looking through open risers and assistance dogs might refuse to proceed. Open risers, and balustrades that have openings or can be climbed, increase the risk of children being injured.

Treads. Adequate tread depth is essential for stairway safety. Analysis of stairway related accidents shows that overstepping of treads is a common cause of accidents. The likelihood of an overstep decreases significantly with increasing tread depth. There is a risk of stumbling if frictional characteristics change too much (for instance, between treads and landings).

Handrails. Handrails need to be easy to identify, contribute to movement and within reach for all users. Handrails help building users keep their balance and provide leverage when ascending or descending stairs. They help people avoid or correct missteps and may reduce the extent of a fall. The ends of handrails that are not returned to the wall or floor present a potential hazard. This could increase the risk of clothing being caught or children being injured by running into them. The sudden termination without warning of a handrail being used for support could cause building users to stumble and fall.

Obstructions. Doors and windows which open onto staircases can pose a serious hazard when they are opened. Fixtures such as fire extinguishers are easy to walk into and should be located away from areas where people may walk.

Lighting. Good artificial and natural lighting is essential and assists safe use. Poor visibility of both risers and treads can lead to misreading the stair edge which can cause faulty foot placement and an accident.

2.4.9 Design Consideration

User awareness

- If the installation of tactile warnings at the top and bottom of stairs is being considered, ensure there is not a great difference in frictional resistance between the warning surface and the stair.
- Ensure any tactile hazard warning surfaces installed provide a visual contrast as well as tactile contrast. Tactile warning should be installed correctly for accurate interpretation or the user could be at risk of falling.
- Consider a change in the floor finish approaching a staircase to give advance warning of nearby stairs (e.g., from carpet to a level hard surface).
- Single steps should not be installed. In existing buildings where changes cannot be made ensure maximum warning is given.

Alignment and length

- Ensure stairways are placed perpendicular or at the side of the path of travel to limit the risk that someone will accidentally fall down them.
- Ensure the number of risers in each flight is limited.
- On longer flights, staircases should incorporate changes of direction at landings.

Predictable

- Ensure treads and risers are uniform and the number of risers in each flight the same.

Width

- Ensure that stairs are wide enough to be usable by expected traffic and ambulance staff carrying someone on a stretcher.

Underside of stairs

- Ensure the area beneath a flight of stairs is enclosed.

Risers

- Ensure riser heights are limited. While this will increase the footprint of the staircase, it will allow and encourage more people to use it.
- Avoid open risers in new buildings. For existing staircases, ensure the risers are divided to restrict their opening size.
- Ensure the slip resistance of the landings, treads and nosings is uniform.
- Ensure nosings are visually evident across the whole width of the stair.
- Avoid nosings comprising two parallel strips of different colors.

Treads

- Specify tread depth to be as long as practicable. Whilst this will increase the footprint of the staircase, it will reduce the accident rate.
- Ensure the surface of treads is level, with nosings set in to the tread and not planted on it.
- Avoid the use of patterned carpets (including those with lines parallel to the nosing) and patterned surfaces which will make the identification of nosings very difficult.

Handrails

- Ensure handrails and stairs are protected by adjacent walls or upstands and do not project into circulation space.
- Ensure the ends of handrails are returned back on themselves or are returned to the walls.
- Divide wide flights with central handrails (subject to means of escape requirements).
- Match handrail heights with the range of arm movements.
- Where floor level changes require the use of two steps, treat these as a staircase and provide handrails to each side.
- Ensure handrails are continuously graspable along their entire length without obstruction.
- Ensure handrails are easy and comfortable to grip without sharp edges, and able to provide adequate resistance to hand slippage.
- Ensure handrails are strong enough to support users and fixed to the structure in a way that supports the required loading.
- Provide balustrades for protection.

Obstructions

- Ensure stairs and landings are designed to be free of permanent and temporary obstacles.
- Position doors and windows such that they do not pose a hazard to those using the staircase.

Lighting

- Ensure artificial lighting is provided with switches which are easy to identify and reach at the top and bottom of each flight.
- Ensure artificial lighting is even and bright enough to distinguish treads and risers with no glare from wall lights, spotlights, floodlights or low-level light sources.
- If time-delay or sensor-operated lights are used in stairwells ensure that the timings accommodate the needs of all users.
- Locate the staircase away from areas where natural lighting could cause glare problems from low sun etc.

2.4.10 Building Code requirement

Building Code clause D1 Access routes:

D1.3.3 Access routes shall:

- a) Be free from dangerous obstructions and from any projections likely to cause an obstruction,
- b) Have adequate slip-resistant walking surfaces under all conditions of normal use,
- c) include stairs to allow access to upper floors irrespective of whether an escalator or lift has been provided,
- d) have stair treads, and ladder treads or rungs which
- e) provide adequate footing

- f) have uniform rise within each flight and for consecutive flights,
- g) have stair treads with a leading edge that can be easily seen,
- h) have stair treads which prevent children falling through or becoming held fast between treads, where open risers are used,
- i) not contain isolated steps,
- j) have smooth, reachable and graspable handrails to provide support and to assist with movement along a stair or ladder.

D1.3.3 Access routes shall:

- (j) shall not apply to isolated steps.
- (k) have handrails of adequate strength and rigidity as required by Clause B1 Structure,
- (l) have landings of appropriate dimensions and at appropriate intervals along a stair or ramp to prevent undue fatigue,
- (m) have landings of appropriate dimensions where a door opens from or onto a stair, ramp or ladder so that the door does not create a hazard,

D1.3.4 An accessible route, in addition to the requirement of Clause D1.3.3, shall:

- (g) not include spiral stairs, or stairs having open risers,
- (h) have stair treads with leading edge which is rounded.
- (i) have handrails on both sides of the accessible route when the slope of the route exceeds 1 in

Chapter 3

Methodology

3.1 Case Study One: Showroom Utrecht, The Netherlands

Address : Proostwetering 51 3543 AC, Utrecht, Utrecht, Netherlands

Architects: ONL, ONL [Oosterhuis_Lénárd]

Year: 2007

3.1.1 Case Studies Analysis

Structure in General

Building type: low-rise building

Building status: existing [completed]

Facade material: glass

Facade system: curtain wall

Facade color : gray

Architectural style: structural expressionism

Main Usage

Sale's Shop & Vehicle Service

FACT: The building is a mirror image of Mega Occasion Centrum Utrecht.

Technical Data

Floors (above ground): 2

Floors (below ground): 1

Construction end: 2007
Size: 100,000 sqft - 300,000 sqft
Type: Commercial › Showroom

3.1.2 Description of the Building

ONL builds 2 mirror-copied buildings for BMW dealer Ekris.

The 2 volumes together form a coherent image which refers to the 2 BMW grilles with slightly tilted bars. The double curved glass facade literally rounds the corner as the headlights of the new BMW 1 series and 5 series do. the design for the Ekris BMW showroom is in all styling aspects a shaped volume like the modern carbody itself. The construction of the 2 headlight buildings closely follows the architectural styling. As a consequence, not a single constructive element is the same, the Ekris headlight building is another example of Non-Standard Architecture. According to the principles of Mass-Customization and the unique F2F production processes as developed by ONL guarantee that the quality, precision and the costs are close to standard.

3.1.3 Appraisal of the building

Merits

1. The auto center is comprehensively designed to accommodate activities for repairs, services and Sales of cars.
2. The showroom has double glass facade literally round the corners as the headlights to showcase the indoor cars displayed.
3. Provision of adequate Sales of auto spare parts shop were available.
4. Provision of adequate maintenance and service workshop were available

5. Provision of adequate parking space were provided in the basement.
6. Administrative units and canteen were centrally located in the building.
7. The workshop bays are double loaded platforms that allow adequate activities in auto center.
8. The circulation core is well centered to allow easy flow of movement in the building.

Demerits

1. The toilets provided in the building are not well positioned to be environmentally efficient.

Plate 1 – 3 below shown the facades of the Utrecht Showroom



Plate 1: Utrecht Façade

Source: ArchDaily App, 2022



Plate 2: Utrecht Façade

Source: ArchDaily App, 2022



Plate 3: Utrecht Façade

Source: ArchDaily App, 2022

3.2 Case Study Two: Tesla Showroom, Dubai, United Arab Emirates

Address: 146 Sheikh Zayed Rd - Al Wasl - Dubai - United Arab Emirates

3.2.1 Case Studies Analysis

Designed By: Joe Sassine Finianos

Year: 2017

Dasyatis Pastinaca is a sustainable designed building for Tesla Headquarters and showroom located in Dubai, U.A.E. The project was originally designed to deal with the main problems faced by the ecosystem of Dubai, and to minimize the consumption of energy with the use of sustainable approaches.

3.2.2 Description of the Building

The project was initially inspired by the stingray living in water, since water is a core concept in sustainability and is important for a healthy ecosystem. Similar to how the stingray's mouth and nostrils are hidden below its skin the main concept of the building was to conceal it below a skin that avoids solar gain. The skin of the building was inspired by the fluidity of the stingray.

3.2.3 Appraisal of the building

Merits

1. The building was built on a well landscaped site, which gives it adequate external circulation space for various activities.
2. The Auto showroom were planned to give adequate view and clearance for automobile Sale's and human activities.

3. Administrative spaces are well positioned to maximize flow of auto administration in the building.

4. The workshop space is well articulated for efficient services and maintenance of automobile repairs work.

5. The workshop space creates balance for dispatch through the availability of adjacent customer's waiting lounge.

Demerits

1. The auto center toilets that are provided in the workshop and showroom were not in the right position to be efficient for odour control and in flow of ventilation and daylights.

2. The workshop lacks capacity to balance a space for diagnosis for vehicle awaiting repair in the workshop

3. The adopted tilted walls in the auto workshop and showroom doesn't allow spaces to be maximally effective for uses.

4. Two elevators provided in the showroom are much for the space and the occupants

Plate 4– 6 below shown the facades of the Tesla Showroom



Plate 4: Tesla Façade

Source: ArchDaily App, 2022



Plate 5: Tesla Façade

Source: ArchDaily App, 2022

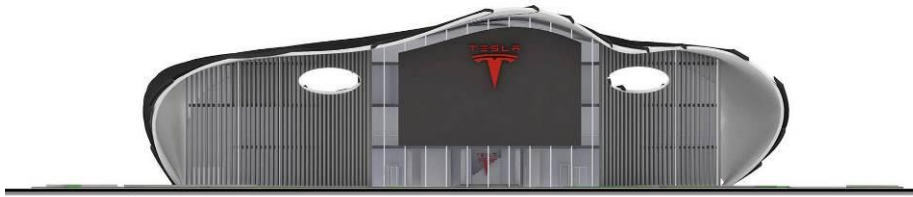


Plate 6: Tesla Façade

Source: ArchDaily App, 2022.

3.3 Case Study Three: Automotive Showroom in Herning / Krads Herning, Denmark

Address: Silkeborgvej 110, 7400 Herning, Denmark

3.3.1 Case Studies Analysis

Automotive Showroom in Herning / Krads

Herning, Denmark

Designed By: Krads

Area: 4000 m²

Client: Mercedes-Benz Gelecek Automotive

Project Completion Date: 2013

Materials & formal aspects:

The faceted building tapers at both ends reaching towards and engaging its immediate surroundings. Its two halves, triangular in shape, are set in contrasting materials. The half containing the service center is characterized by the heavy appearance of fair faced precast concrete elements. Housing the exhibition area, the northern triangle is defined by its light

stretch metal facade punctured by two large display windows. The perforated character of the stretch metal creates an interesting play of changing translucency over the course of a day. During daylight, selected cars in the display windows are the focus of attention. In the after hours, when internal light starts to permeate the metal facade, the whole exhibition space becomes perceptible.

Context and internal organization

The diagonal cut between the showroom and the service center creates a visual connection between a large shopping center north-west of the building and the green areas to the south-east. The showroom allows for a continuous spiraling flow of guests between its various levels, from the sub-street levels on the south-east end up to the ceiling on the north-west end. The main internal ramp is expressed in the tilting north-facade which simultaneously follows the sloping of the surrounding terrain. The showroom opens up to the south lying green areas which allow for outdoor exhibitions, creating an overlap between inside and outside, between the city and it's surrounding nature.

Sustainability:

Various measures towards sustainability have been taken. The stretch metal facade acts as a sun screen reducing mechanical ventilation of the exhibition area. Solar panels on the roof provide a supplement of renewable energy. Particular emphasis was placed on waste management.

3.3.2 Description of the Building

The automotive showroom is situated by the main gateway to the city Herning in Jutland, Denmark. The municipality of Herning and the client both wished for a showroom diverging

from the stereotypical and one that simultaneously would stand out as an architectural icon. The solution became a rhombic volume divided into two halves by a diagonal cut, creating a dynamic and lucid showroom facing the main road, contrasted by the stable mass of a service center behind. Placed at the edge of town it is a building where interior and exterior collaborate around the meeting between city and nature, and between function and space. The showroom deliberately downplays quantity, unlike the more common “aquariums” flooded with cars, in favor of carefully chosen views of selected automobiles. It is a showroom that stirs the curiosity of its visitors as well as those driving by this new portal to the city of Herning.

3.3.3 Appraisal of the building

Merits

1. The building interior has adequate circulation space for various activities.
2. The Auto showroom were planned to give adequate view and clearance for automobile Sale's and human activities.
3. Administrative spaces are well positioned to maximize flow of auto administration in the building.
4. The workshop space is well articulated for efficient services and maintenance of automobile repairs work.
5. The workshop space creates balance for dispatch through the availability of adjacent customer's waiting lounge.

Demerits

1. The auto center toilets that are provided in the workshop and showroom were not in the right position to be efficient for odour control and in flow of ventilation and daylight.
2. The workshop lacks capacity to balance a space for diagnosis for vehicle awaiting repair in the workshop

Plate 7 – 9 below shown the facades of the Automotive Showroom in Herning / Krads



Plate 7: Automotive Showroom in Herning / Krads Façade

Source: ArchDaily App, 2022.



Plate 8: Automotive Showroom in Herning / Krads Façade

Source: ArchDaily App, 2022.



Plate 9: Automotive Showroom in Herning / Krads Façade

Source: ArchDaily App, 2022.

3.4 Case Study Four: Audi Centre Singapore

Msakicho, Ibaraki, Osaka 567-0024, Japan

Architects: ONG&ONG Pte Ltd

Area: 7642 m²

Project Completion Date: 2012

3.4.1 Case Studies Analysis

The eight-stories high, Audi Singapore's newly unveiled flagship store is the first ever high-rise Audi Terminal, and at 1,350 square meters per floor, is also the largest Audi showroom in Southeast Asia.

This one-stop terminal offers a variety of services in a single location, housing showrooms, workshops, offices and even a café and waiting lounge for visitors. As many as 35 of Audi's latest models are displayed in the showrooms on the 2nd and 4th floors.

The cars are arranged in a "power curve", making the formation seem as if they are zooming by on a race track. A specially designed lift carries cars to the servicing workshop that spans from the 5th to the 7th floor, while the offices take up the building's top level. Within the three basement floors are an Audi Cafe, quattro shop, customer waiting lounge, reception areas as well as a carpark.

3.4.2 Description of the Building

The design concept was to localize the international Audi Terminal template to suit the site and local conditions, whilst ensuring a consistent corporate branding. Hence, although space

constraints resulted in the building's uncharacteristic semi-circular shape, Audi's signature look is evident in elements such as the building's curved walls.

The façade is clad in aluminum with hexagonal cut-outs forming a honeycomb pattern, while full-height glass windows for the lower floors make the building appear to float off the ground. Located at the junction of Leng Kee Road and Alexandra Road, the Audi Terminal also had to contend with its close proximity to the MRT train track. As the Audi Terminal's foundations are mere centimeters away from those of the train track columns, the columns were monitored during construction through the use of lasers.

Given the site's close proximity to an MRT train track and the limited site area, the Audi Terminal's design is a feat of creativity that stays true to the Audi brand whilst successfully cementing its place as a landmark in the local landscape.

3.4.3 Appraisal of the building

Merits

1. The auto center is comprehensively designed to accommodate activities for repairs, services and Sales of cars.
2. The showroom has multi-stories indoor cars display, which give it an edge for advertisement awareness for automobile sale and maintenance facility.
3. Provision of adequate Sales of auto spare parts shop were available.
4. Provision of adequate maintenance and service workshop were available
5. Administrative units and canteen were centrally located in the building.
6. The workshop bays are double loaded platforms that allow adequate activities in auto center.

7. The circulation core is well positioned to allow easy flow of movement in the building.

Demerits

1. The toilets provided in the building are not well positioned to be environmentally efficient.

2. Adequate space were not provided around the building

Plate 10 –12 below shown the facades of Audi Centre Singapore



Plate 10: Façade of Audi Centre Singapore

Source: ArchDaily App, 2022.



Plate 11: Façade of Audi Centre Singapore
Source: ArchDaily App, 2022.

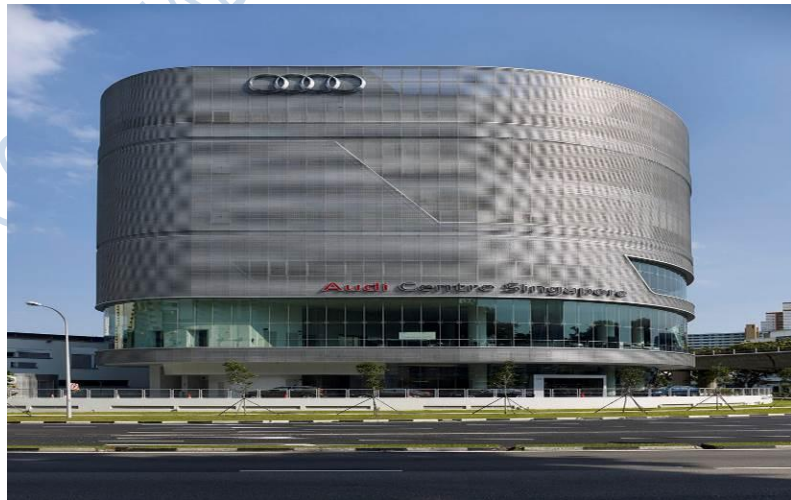


Plate 12: Façade of Audi Centre Singapore
Source: ArchDaily App, 2022.

3.5 Case Study Five: Mercedes-Benz Vadi Park Showroom

Mercedes-Benz Vadi Park Showroom

Istanbul Turkey

Designed By: Boytorun Architects

Client: Mercedes-Benz Gelecek Automotive

Project Completion Date: 04/04/2018

3.5.1 Case Studies Analysis

The Mercedes-Benz showroom is located in Kağıthane, one of the currently developing regions in İstanbul. The showroom and the service building have been designed to provide the “Perfect Customer Experience” using cutting edge technology.

Within the showroom, there are digital screens, tablets and virtual reality stands that have been integrated to the design in order to provide full experience of the cars for the customers without being beside the car. Configurators have been placed around the showroom so that the customers can design their own vehicles according to their choices in a co-design platform. Thus, the visitors are able to decide on the configuration of the car, and they can obtain the technical details and cost information within seconds.

3.5.2 Description of the Building

The showroom has a unique layout and design due to the 65 meters spiral ramp that has been used as a car display area. Using the 10.5 meters ceiling height, the ramp allows the customers to observe the sequence of display cars while they are following the path from the

ground floor level towards the first-floor level. The ramp provides an uninterrupted display area for the showroom as well as creating a distinctive design feature.

Due to the deep eaves suspended in front of the façade, a space has been created for vehicles to be stored without exposure to weather conditions before they are handed over to the customers. Also, the eaves block direct sun rays in order to protect the display cars, while it allows the sunlight to reach the interior in a controlled way with reflections. The showroom ceiling has voids to allow the light to penetrate evenly throughout the showroom, making sure natural lighting is utilized to maximum extent. For artificial lighting, led lamps have been preferred for the interior lighting elements in order to minimize energy usage.

A reading corner, accessories stand and boutique area has been placed adjacent to the customer lounge to provide better service for the visitors. A series of simulation devices have been placed in a recreational ground for the kids. Due to these additional functions that been placed within the showroom, the vehicle purchasing experience became more pleasant for the customers.

3.5.3 Appraisal of the building

Merits

1. The auto center is comprehensively designed to accommodate activities for repairs, services and Sales of cars.
2. The showroom has multiple-floor indoor cars display, which give it an elevated look from the exterior part of the building
3. Provision of adequate Sales of auto spare parts shop were available.

4. Provision of adequate maintenance and service workshop were available
5. It has excellent administrative unit for auto sales and maintenance facilities
6. The workshop bays are double loaded platforms that allow adequate activities in auto center.
7. The indoor showroom has a celebrated ramp display platform that allow easy assessment and business.

Demerits

1. The toilets provided in the building are not well positioned to be environmentally efficient.
2. Adequate space were not provided around the building

Plate 13 –15 below shown the celebrated ramp display platform and facades of Mercedes-Benz Vadi Park Showroom



Plate 13: Façade of Mercedes-Benz Vadi Park Showroom
Source: ArchDaily App, 2022.



Plate 14: Façade of Mercedes-Benz Vadi Park Showroom
Source: ArchDaily App, 2022.



Plate 15: Celebrated Ramp Display Platform of Mercedes-Benz Vadi Park Showroom
Source: ArchDaily App, 2022.

3.6 Case Study Six: Toyota Corolla Shinosaka Meishin Ibaraki Showroom

Misakicho, Ibaraki, Osaka 567-0024, Japan

3.6.1 Case Studies Analysis

Designed By: Takenaka Corporation

Area: 1979 m²

Project Completion Date: 2018

“A new geometry for a new era of Mobility”

3.6.2 Description of the Building

This building is located along the national highway in the northern area of Osaka. It is a car showroom that mainly sells and maintains cars.

Here, we have created a new architectural space and shape that incorporates the movement, scale, and speed of the car for a new era of Mobility. In addition, by using traffic graphics and road materials, we have realized new architecture that is continuous with the city.

3.6.3 Appraisal of the building

Merits

1. The auto center is comprehensively designed to accommodate activities for repairs, services and Sales of cars.
2. Provision of outdoor elevated display were provided to harness the philosophy of the building “A new geometry for a new era of Mobility”
3. Provision of adequate Sales of auto spare parts shop were available.

4. Provision of adequate maintenance and service workshop were available
5. It has excellent administrative unit for auto sales and maintenance facilities

Demerits

1. Much of concrete form were used for the construction which is not sustainable enough for tropical climate

Plate 16 –17 below shown the elevated outdoor ramp display platform and facades of Toyota Corolla Shinosaka Meishin Ibaraki Showroom



Plate 16: Façade of Toyota Corolla Shinosaka Meishin Ibaraki Showroom

Source: ArchDaily App, 2022.



Plate 17: Façade of the elevated outdoor display ramp platform of Toyota Corolla Shinosaka Meishin Ibaraki Showroom

Source: ArchDaily App, 2022.

3.7 Case Study Seven: Mitsubishi Showroom

1090 Adeola Odeku

Victoria Island, Lagos, Nigeria.

3.7.1 Case Studies Analysis

Designed By: Chronos Studio

Project Completion Date: 2020

3.7.2 Description of the Building

Project Brief

You can't but have a second look during a night drive. The Mitsubishi Motors Showroom is located in Victoria Island, Lagos, Nigeria. Our team was contracted to provide facade design

services for this strategically located building that houses Mitsubishi's major showcase location in Nigeria.

With support from Mitsubishi's brand theme, Chronos design team conceptualized a befitting outlook for the brand. Further upgrades for the interior parts of the showroom were completed to aid Mitsubishi's drive for dominance in Nigeria's automobile industry

3.7.3 Appraisal of the building

Merits

1. The auto center is adequately designed to accommodate activities for repairs, services and Sales of cars.
3. Provision of adequate Sales of auto spare parts shop were available.
4. Provision of adequate maintenance and service workshop were available
5. It has excellent administrative unit for auto sales and maintenance facilities It has excellent administrative unit for auto sales and maintenance facilities.

Demerits

1. It has no spectacular display platform aside indoor showroom

Plate 18 –20 below shown the facades of MITSUBISHI SHOWROOM



Plate 18: Façade of the façade of MITSUBISHI SHOWROOM

Source: ArchDaily App, 2022.



Plate 19: Façade of the façade of MITSUBISHI SHOWROOM

Source: ArchDaily App, 2022.



Plate 20: Façade of the façade of MITSUBISHI SHOWROOM

Source: ArchDaily App, 2022.

3.8 Case Study Eight: CFAO Suzuki Showroom

13A Akin Adesola, Victoria Island- Lagos, Nigeria.

3.8.1 Case Studies Analysis

Designed By: CHRONOS STUDIO

Project Completion Date: 2021

3.8.2 Description of the Building

Project Brief

The Chronos Studios Team was once again pushed to deliver high-quality design and construction services. Located in the prestigious Victoria Island, the Suzuki automobile showroom is one to behold.

Having brought our 'A Game' to our previous automobile showroom projects, we had to make sure we stepped it up for this new project. This was approached from a research phase with the clients' design manual, which provides a generic and consistent color scheme that informs how their facilities look, in all their showrooms. We adopted design features from the brand manual provided by the client and created optimized customer user experiences with new design features.

On the exterior, the existing building facade was improved to give a more dominant but simplistic look while on the interior, hanging lights gave the vehicles beautiful highlights and the backdrop upon entry is a sight to behold.

3.8.3 Appraisal of the building

Merits

1. The auto center is adequately designed to accommodate activities for repairs, services and Sales of cars.
3. Provision of adequate Sales of auto spare parts shop were available.
4. Provision of adequate maintenance and service workshop were available
5. It has excellent administrative unit for auto sales and maintenance facilities It has excellent administrative unit for auto sales and maintenance facilities

Demerits

1. It has no spectacular display platform aside indoor showroom.

2. No Adequate space for indoor showroom.

Plate 21 –23 below shown the facades of CFAO Suzuki Showroom



Plate 21: Façade of the façade of CFAO Suzuki Showroom

Source: ArchDaily App, 2022.



Plate 22: Façade of the façade of CFAO Suzuki Showroom

Source: ArchDaily App, 2022.



Plate 23: Façade of the façade of CFAO Suzuki Showroom

Source: Arch Daily App, 2022.

3.9 Case Study Nine: COSHARIS MOTORS

KM 32 Lekki - Epe Expway, Awoyaya 105101, Lekki.

3.9.1 Case Studies Analysis

Project Completion Date: 2014

3.9.2 Description of the Building

Cosharis Motors at awoyaya is the main depot of this automobile marketing and distribution giant in Nigeria of exotic range of automobiles, which includes BMWs, FORDs, ROLLROYS, RANGE ROVERS and lots more.

3.9.3 Appraisal of the building

Merits

1. The auto center is adequately designed to accommodate activities for repairs, services and Sales of cars.
3. Provision of adequate Sales of auto spare parts shop were available.
4. Provision of adequate maintenance and service workshop were available
5. It has excellent administrative unit for auto sales and maintenance facilities It has excellent administrative unit for auto sales and maintenance facilities

Demerits

1. No spectacular landscape element externally.

Plate 24 –26 below shown the images for Cosharis Motor Lekki Epe Express Way



Plate 24: Façade of Cosharis Motor Lekki Epe Express Way
Source: Google Image, 2022.



Plate 25: Workshop of Cosharis Motor Lekki Epe Express Way
Source: Google Image, 2022.



Plate 25: Showroom of Cosharis Motor Lekki Epe Express Way
Source: Google Image, 2022.

Chapter 4

Site Analysis and Design Synthesis

4.1. Design Considerations.

The concept of Architecture of Automobile Sales and Maintenance Facilities Vehicles Maintenance Workshops Layout and its Management. Automobiles occasionally require maintenance. Similar to how humans must maintain their personal hygiene, motors also need to be kept clean. Automobiles must operate in a filthy atmosphere and on dirty roads. They are subjected to loads that harm them since they run on uneven roads with potholes and other obstacles. As a result, there is a need for regular maintenance and servicing of vehicles, which is normally done in auto workshops or auto service locations. A car maintenance manual is included with every new car. As it contains car maintenance advice at some time while driving, the owner of the car is expected to read and use this manual. As it contains car maintenance advice at some time while driving, the owner of the car is expected to read and use this manual. After purchasing an auto or vehicle, it has been noticed that the owners tend to care less about routine auto or vehicle maintenance. Even if the owners frequently transport their car, the car protection advice provided in the car maintenance guide will significantly boost the car's durability or lifespan. When a car travels a certain number of miles on a regular basis or when it no longer performs as it should, vehicle maintenance and repair are performed. It is advised that car owners perform routine and periodic inspections on their vehicles, some of which are listed here.

The process of maintaining and repairing vehicles involves an automobile workshop and associated equipment. Workshops were created with this goal in mind, and as technology

has advanced over time, so too have they changed to keep up with the most recent advancements in automobile technology. Due to the advancement of technology, a better equipment-integrated architecture is crucial for allowing unrestricted movement of vehicles and equipment throughout the workshop. The private garages in our homes serve as the smallest component of the workshop. Smaller roadside mechanics, whose range of work is restricted by on-the-job experience, follow this closely. Since they were created specifically for this purpose, modern motor vehicle maintenance shops, whether small and large, are practically capable of fixing the majority of vehicle issues.

Layout refers to how a plant's equipment and departments are arranged to create goods as quickly as possible. A new facility plan could occasionally be required when a firm decides to purchase new machinery or to develop a new product, even though it should always be given top attention when starting a business or moving to a new location. A poorly planned layout could lead to bottlenecks, longer unit production times, and more expensive transportation.

The layout of an automobile workshop can be described as the positioning of tools like a crane, pit, etc. to permit free movement of people, tools, and vehicles inside the facility. It can be characterized as a method of placing equipment, procedures, and plant services within the workshop to produce the desired output in the proper amount and quality at the lowest possible production cost. It entails the thoughtful positioning of production facilities for efficient workflow. The arrangement of physical facilities within a manufacturing building, such as machinery, equipment, and furniture, in order to have the fastest flow of

materials at the lowest cost and with the least amount of handling in processing the product is referred to as plant layout.

The rationality of equipment layout optimization directly influences the fields of production capacity, work efficiency, and production cost. It is a fundamental question of floor improvement activities. 20 to 50 percent of the overall manufacturing costs are attributable to the operation of inefficient equipment layouts, while 10 to 30 percent of the costs can be saved by using improved equipment layout; Superior equipment layout can also increase the speed of materials handling, decrease the time that process items remain in place, decrease the capacity of the work piece buffer, decrease the amount of space that the production system is filled with, and lower the cost of manufacture.

The overall goal of layout is to create a physical arrangement that most efficiently produces the quantity and quality of output that is necessary. Layout makes the most efficient use of the building, encourages efficient use of manpower, and provides employees with convenience, safety, and comfort at work, as well as the greatest possible exposure to natural light and ventilation. It also streamlines the production process, reduces material handling, time, and cost. This is particularly significant since it has an impact on how materials and processes move, how effectively workers are managed, how much space is used, and whether or not there is room for expansion.

Today, initial facility layout planning necessitates large financial outlays. Long-term planning is required to determine the kinds of goods to be produced, the number of departments, the limitations of the company's size, and the potential for future expansion.

The choices that are made during the planning stage could have a significant effect on the operations. A facility architecture that has been improved increases production efficiency while also making the workplace safer for the employees. Forklifts could travel less, for instance, and there might be fewer accidents if the distance between departments were shorter. Additionally, a better structure might make it easier for the business to adhere to evolving legal and environmental laws. For instance, realigning the manufacturing streamlining could decrease the requirement for production transfers among departments, save CO2 emissions, and also result in distinct layouts for various productions. Layouts come in a variety of forms, including process layout, product layout, and fixed position layout. Each of these designs has benefits and drawbacks.

An automobile is a road vehicle that normally has four wheels, is propelled by an internal combustion engine or an electric motor, and can accommodate a limited number of passengers. A modern auto shop must have adequate floor space, ventilation, cutting-edge technology, adequate lighting, etc. It is now necessary to build a more integrated plan for efficient service delivery because the car workshop under consideration lacks adequate equipment arrangement, roof leaks, a pit that is too deep and has water pouring out of it, poor flow in and out of vehicles, etc. To meet current technology standards with enhanced car equipment and enhance the service provided to clients, an improved equipment integrated layout for effective automobile service delivery has been developed. Effective machine or department configurations and suitable transportation path structures are of utmost importance in order to achieve a competitive level of productivity in a manufacturing system. The layout creates a production system's fundamental structure and material flows,

which in turn affect how well it will operate over time. By integrating machine arrangement and transportation paths into plant layout structures, a more detailed layout planning is made possible. This approach also supports the detailed mapping of atypical but fixed machine shapes.

The stability of a Virtual Layout (VL) in comparison to an existing functional layout (FL) of an industry and a Classical Layout (CL), if considered for implementation, is studied by Laura, Lorenzo, Henri, and Emilio. A genetic algorithm (GA) based on cellular structure and intracellular formation. A real-world example from an IC packaging manufacturer serves as an illustration of the proposed methodology. Techniques for order preference by similarity to ideal solution (TOPSIS) and fuzzy TOPSIS are suggested as two approaches to tackling the case study problem. Experimental findings demonstrated that the suggested strategies are workable solutions to a layout design problem. For the case study issue, TOPSIS is a workable solution and is appropriate for accurate value performance ratings. The suggested approach will give the decision-maker of a manufacturing firm the ability to examine a layout from three different angles and base their decisions on those findings in order to increase efficiency. The amount and type of work to be done in the repairs workshop determines whether the layout should be Single-Speed Bay, Flow Line, Single-Speed Bay Service Layout, or Flow Line Service Layout. As with any other layout, the workshop area entirely depends on the work anticipated and, in the case of an exciting service station, the work already being done.

The format of any workshop will depend upon the Plan predicted. Smaller workshops normally have a bench at the closed edge of a workshop with one pit to enable work to be finished below a car. In this modern workshop, it demands highly equipped gadget to each rapidly diagnose faults as a means of exceptional manipulation following repair. firstly, to make certain a worthwhile workshop, floor area has to be used to the maximum, therefore all spaces workplaces, bays and different device should be such that at no time must they because of the design hinder the motion of materials, cars and workforce, so that time is completely applied. The need to hold cars moving as repairs and servicing is finished is obvious. Aside from this, customers generally call for a car as quick as possible as a car off the street means loss earning to them.

A modern workshop, vicinity with painted traces on a slope of 60o makes it simpler to run in and return out. Bench with steel tops and bench vices represent the primary system for restore work. Repair jobs requiring use of a existence will flow into the work area where lifts are part of standard gadget within the repair bays. At this factor it must be stated that wheel loose lifts are to be preferred and pits are to be averted. The reason is that many severe injuries have happened with the pits whilst fumes have gathered and brought on extreme poisoning. different twist of fate has come about when petrol has spilled into the pits and feature gone disregarded till a bare flame ultimately ignited the vapor with horrible outcomes for mechanics operating beneath automobiles. This leads to the factor of why the body restore store and spraying must be excluded from the principle of workshop. The operations concerned with frame repair i.e. panel beating, filling, grinding, and washing raises dust that may be dangerous to fellow mechanics have to it's done in an enclosed space

just like the workshop; besides this, there's also the chance of sparks welding operation igniting fuel vapor. because of this, it is beneficial that these operations be carried out in the courtyard with a provision of roofing to guard the people from harsh climate situations. The major activities and sections in an automobile workshop and its maintenance are analyzed below;

Repair Bays

Repair bay ought to be so situated or arranged within the workshop such that the job it is meant for is performed without difficulties to the mechanics and also to ease supervision by way of the foreman. The workshop must be broadly divided into the mechanical and electric sections for easy supervision and repair. This ought to be so, such that cars for every of these problems may be effortlessly directed to the bay for work. The engine room should be near the restore bay in order that engines may be effortlessly eliminated and taken there to work on. then again, the battery charging room should be near the electric repair bay.

Every other important thing of the workshop is the fast provider bay, in which ordinary servicing can be completed. This needs to be located at the court docket of the store and best automobile with most important maintenance must be allowed into the interior of the store. The repair bay required the provision of strength plugs with 13Amp and 15Amp fuse, an airline connection, an inter-communications connection of the bench directly to the shops for spare elements. This later object permits a mechanic to order elements and feature them without transferring from the auto. This hastens a repair job and store the mechanic valuable time. Low powered 24 sockets also are required for pressurized protection inspection lamps.

Also, a naked head wire machine with movable leads can be used as an inspection lighting fixtures approach. The bench is of metal with correct size drawer able to conserving equipment belonging to a mechanic. It ought to even have a 2nd underneath space to maintain devices even as repairs are occurring; for instance, gearbox housing or cylinder blocks. This allows in stopping accidents from tools and devices that are left lying about. All standard gear and device this is important for all repair bays must be saved in a centralized location so that a mechanic can use them and rep

lace them immediately after use. these include portable cranes, hydraulic stands, wheel braces, unique extractors, stock, amongst others. ultimately, a great workshop should have true lighting, air flow, drainage device, clean get admission to special gear, plug factors, inspection lamp factor, intercommunication device to stores, airline factor, sufficient working area, a cloak room for employees to alternate their cloths earlier than and after paintings and specially, sufficient safety devices should be provided and kept without problems of locations.



Figure1: An auto-restore bay lekki-epe parkway Lakowe Ibeju Lagos

Source: Google Image, 2022.

- **Diagnostic Center:** is a center wherein faults are recognized and extensively utilized to check work done on a vehicle as a method of satisfactory manage within the workshop; this latter component is often called Pre-delivery Inspection (PDI). analysis is made by way of appearing inspection to find out what components of a car will require adjustment or restore. this is vital in acquiring client's goodwill. the use of diagnosis gadget serves as a method of best manage, such that any repairs carried out are examined to ensure that the finished process is fulfill and operation is inside sure limits.



Figure 2: An auto-mechanic diagnosing a car

Source: Google Image, 2022.

- **Equipment selection:** The gadget for any type of workshop (massive or small) relies upon at the capita to hand, workshop length and the amount of labor expected. No workshop can be efficiently controlled without appropriate equipment and equipment.

Among the several system available, the following are very crucial, which are; Lifting jacks of numerous sizes, portable cranes for lifting engines, Engine stands for suspension of engine, Oxygen, acetylene and metallic welding system, fuel soldering iron with bits, Soldering iron electric repairs, Air compressor, Tyre stress gauge, Tyre servicing and repair gadget, Brake servicing device, Bench vices, portable grinding machines, electrical testing equipment for starter, dynamo, local lamps, circuits and ignition timing, Wheel alignment gauges, Hand drilling machines, Bench drilling machines, shock absorber extractor machines, Battery charging machine, Hydraulic puller, electrical computation system unit (Diagnostic device) and fire extinguishers for numerous grades (classes) of fire.

- **Vehicle Recovery System:** One manner of producing earnings for the workshop is by supplying a vehicle breakdown recovery equipment to help in extending offerings to a consumer with a hassle on the motorway. that is vital as cars do often breakdown on the road and should be moved as fast as possible in order that obstructions on the road is decreased to a minimal either by towing or by set off interest on the spot. Therefore, mechanics going out for a recovery of vehicle should be absolutely skilled and be capable of use all the restoration device, and be prepared to drag a automobile of ditches, tow wrecked automobiles and entire a number of upkeep to get the vehicles back to the workshop.

A recovery needs to be equipped with the following Winch, Crane, Slings, Shackles, towing bar, fire extinguishers, Sledge hammer, Ropes, Jack (of correct ability), locking clamps for guidance wheel (whilst a automobile is towed backwards), a spare holder for attaching to the breakdown automobile for rear illumination and regular mechanic tool kit.

- **Common Activities in the Workshop**

According to Class IX. Automobile service technician, 2019, the following are the common activities in the workshop:

- (i) Job card and its filling procedure
- (ii) Washing of vehicle and Washing Procedure
- (iii) Engine minor tune up
- (iv) Oil replacement
- (v) Checking of battery — electrolyte level and top-up
- (vi) Clutch and brake-free play and their adjustment
- (vii) Lighting system, its various parts and their checking
- (viii) Identification of greasing points of wheelers and procedure of greasing
- (ix) Checking of tyre inflation and procedure of inflation.

- **Job Card and Its Filling Procedure:** When a car proprietor enters the carrier center, he or she is attended by means of the supervising engineer. The consumer informs about the automobile defect. After getting comments from the automobile proprietor or driver related to defects of the vehicle, the supervising engineer in a provider station or workshop inspects it. The defects pointed out or listed are stated down in a general format, which is known as the job card or work order. In order to point out his pleasure with the prognosis

made with the aid of the supervising engineer, the client of the automobile symptoms the job card earlier than the repairs on the car are started. Work is then assigned to the worried individual to lift out repairs and the supervisor signs and symptoms the job card too. Motor motors want to be frequently maintained and repaired when essential in order to make certain vehicular health, toughness as properly as human and car safety. Globally thousands and thousands of motors are produced annually. The motor automobile enterprise in South Africa consequently contributes about 7.6% to the GNP of the USA. The gadget of preservation and restore works randomly, with overload or below load, violating techniques - selection rules. A specific challenge in making choices is due to the reality that in the passenger park there are extra than a hundred automobiles of more than a few capacities. The most complicated graph of buses consists of many components of units, the carrier nomenclature of which exceeds dozens of operations. In turn, the upkeep and restore complex, the most complicated queuing system, consists of a multitude of subsystems, fashions of regulatory, informational, organizational, technological and monetary support. Therefore, these days it is tough to think about the method of administration and decision-making besides the availability of records applied sciences for digitizing the manifestation of random events, for developing regulatory technologies, accounting and manipulate systems, and technological know-how to motivate employees to make bigger productiveness and satisfactory of work in the upkeep and restore system. Research and enhancement of methods, strategies of administration and making sure a excessive degree of reliability, durability, safety, and affectivity of MTE and motor motors (MV), which include the use of records technologies, are carried out through scientists from more than a

few fields of transport, data applied sciences and different areas. However, the introduction of such administration schemes and software program merchandise aimed at the renovation (prevention) device of the automobiles is instead restrained and as a result, in some enterprises, the report glide is fashioned solely in paper form, which complicates data evaluation tactics. The answer for growing overall performance of preservation workshops of cars is represented through developing a correct workshop diagram like that in determine 1 below.

The design format of the facility now proceeds specifying the place of automobile hoists, requires oil reticulation, compressed air supply, water provide and waste oil services. All unique measurements will be mentioned in relation to places of equipment, such as automobile hoists, to allow the correct documentation of electricity and different operational provider needs.

- **Daily Inspection (DI):** It is the accountability of a driver or proprietor of an automobile to lift out the following inspection and exams daily, before beginning the engine, to keep away from any kind of breakdown on the road.
 - (i) Check tire stress in all the tires visually or with the aid of hitting the tire wall with the assist of a stone and decide the sound
 - (ii) Check the radiators coolant degree
 - (iii) Check the fan belts for looseness
 - (iv) Check the degree of engine oil

(v) Check the windscreen, rear-view reflect and rear-window glass for their cleanliness¹.

- **Maintenance Check-up:** When one plans a lengthy distance travel, it is imperative to elevate out a hobbies check-up. One needs to examine the automobile renovation guide for clarity. Some necessary check-ups are accomplished for higher maintenance.

(i) Topping of oil level;

(ii) Proper tension of belt;

(iii) Battery for cleanliness and level of electrolyte (add only distilled water for topping of electrolyte water);

(iv) Brakes;

(v) Topping up of coolant, if required, in the coolant reservoir; (vi) Checking the serviceability of cooling system hoses;

(vii) Proper tyre inflation pressure; and

(viii) Air conditioning.

The significance of an automobile can be realized by observing the spaces that have been and are being conceptualized, designed and constructed exclusively for automobiles. Car showrooms in today's world are much more than a place to portray the cars of the concerned manufacturer. It is as an important link that connects the car manufacturers to their potential customers.

Factors of Automobile Sales

- **Car Showroom:** A car showroom is a place that brings the cars of various makes, designs and models before the consumer and provides with a real opportunity to know about them. Be it the features, the specifications, the design, color and the accessories, one gets to know all of this and more about the cars in a car showroom.

A car showroom serves an important purpose by imparting to the potential owner, a feel of the car, irrespective of all the advertisements and publicity. A car showroom serves an important purpose by imparting the potential consumer a feel of the car. Irrespective of all the advertisements and publicity, the car sales can happen and increase only when the consumer gets to see the car on his/her own. A showroom is opened to provide an amiable and pleasant ambiance to the potential customer. In addition, all the queries and information s/he can have with the sales associates at the car showroom. Further, the test ride opportunity is also available at most of the leading car showrooms. Best car showrooms take care of each and every need of the visitor viz-a-vis car purchase

- **Components of a showroom:** A modern day showroom serves more than just imparting the potential consumer a feel of the car. It a complete automobile business center. Sales, licensing, insuring discussions negotiations etc. all come under the shelter of a modern-day showroom. In addition to purchase related activities, some manufacturers have also gone to extents of making showrooms an assembly line, where one can customize the vehicle to suit his/her tastes. A showroom in turkey also has a track on its uppermost deck for test driving the

vehicles. Innovative thinking towards better marketing would give numerous additions to a showroom. However, the basic needs and areas involved in a present-day showroom can be listed.

- **The display area:** This is the most important part of the showroom where the potential customer actually sees/experiences his car. The display area can cover up to 50% of the showrooms space in some cases. This also is the area into which the visitor enters at first. Ensuring maximum visibility of the display area from the exteriors adds to the success of the showroom. This area is generally maintained barrier free so that the visitors can move about freely in the space, and is more comfortable in analyzing the vehicle. This space would be closely associated with other spaces which is of concern to the visitors.
- **The visitors' lounge:** This is a space provided in a showroom which allows to seat visitors before being attended to. This space can have in itself facilities like that of a television etc. A small coffee shop can be associated with this space. Some manufacturers also include a kids play area near this space. It helps in generating a better impression and makes the customers feel more taken care of. Business related negotiations are carried out on various discussion tables that are provided, generally within the display area. The seating for these tables could vary between 2 to 4.
- **The office space:** The office space is the area where the officials of the showroom are housed. Documents, records, finances, HR, meeting spaces, managers, and other

related spaces come within this zone. These spaces are generally kept out of bounds for the visiting customers. However, there are some portions of the office are opened to the visitors, as these spaces allow the visitors to take decisions and negotiate. The office space could also house meeting and conference rooms which could be used by the staff for official gatherings.

- **The accessories store:** This is a space associated with both the display as well as the office space. Here is where the manufacturer showcases additional fittings that can be put on the automobile, and hence help customizing the vehicle to suite his taste. Showrooms like that of Audi also sell Audi merchandize like clothing, bags etc. within the showroom. This is a very important space in a showroom as this space helps in completing the purchase of the vehicle. A vehicle without its accessories is incomplete.
- **The service area:** This space is one of equal significant as the display area. This area is associated with the after sales service of the vehicles. It also covers a large area of the showroom. This area sees a lot of technical detailing, and special attention to safety has to be paid to this area during design.

Special care is to be taken in ensuring proper ventilation and lighting. The service area also has a separate and defined entry. This space would also have with it a small waiting area for the customers. The service area could also function independent of the showroom.

Methods of displaying Automobiles for sale

- **Cars displayed on the floor level of the display:** This is the most common manner in which to display the cars in a showroom, as it requires the lesser amount of space and the maneuverability of the vehicles in and out of the showroom is convenient too. It also allows versatility, as cars can be moved around to fill in gaps when not all the cars are displayed in the showroom. There is however a drawback in this kind of display, which is the difficulty in creating spaces that are exciting; also, one has to heavily rely on lighting to enhance the appeal of the vehicle.
- **Cars displayed in elevated platforms and turn-tables:** Cars when displayed on elevated platforms or turntables are, literally „on display“. These cars become focal points and help grab attention. These kinds of display provide the cars displayed with a unique space for itself. Such spaces are generally put up for product launches and similar events, where the display object is the prime subject of the event. Cars displayed on turntables occupy a lot of space, as each car requires a circular space, the diameter of which is much more than the length of the vehicle on display. The turntables rotate slowly to allow observer to see the car from all angles, this feature lends an element of dynamism to the display object.
- **Cars displayed on ramps:** Cars are usually displayed on ramps when the exhibit area has a large height and has mezzanine areas to display the vehicles; provided there is adequate space on the ramps leading to the mezzanines; doing so helps make even the circulation spaces interesting. In many cases, ramps simply

leading to platforms on higher levels are used as display spaces to maintain a sense of continuity and to generate interesting dimensions in the showroom.

- **Cars displayed on different levels:** This mode of display is a very easy method which helps convert a potentially boring and flat display space into a one that is more dynamic and interesting, displaying cars on different levels and at different angles allow viewers a wider range of viewing options, many of which would be unconventional and unique.

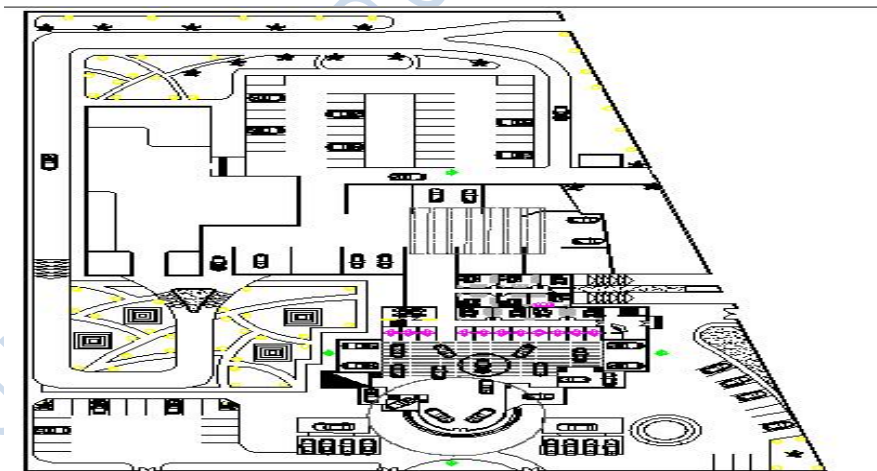


Figure3: BMW car showroom Architecture layout plan
Source: Google Image, 2022.

Lighting:

Lighting in a showroom is one of the most important aspects of a showroom that has to be given due attention during the design stage. Lighting can completely transform a space and help produce remarkable results. Providing the space with Dramatic lighting helps make the product in the showroom or up on the stage stand out. It draws the customer's eye to it. When selling a car in a showroom, lighting the car brightly, and lowering the lights around it helps make the car sparkle and reflect the light, thus making it stand out. The car shouldn't be too bright, but just warmly lit. The darkness around the edges of the car will serve to highlight it. Having a solid, dark colored backdrop behind the car helps contain the light that has been projected. This technique allows in bringing about dramatic effects not just to the vehicles but other products in the showroom as well. Day light utilization must be taken into consideration, as there is generally a vast glass façade that allows in large amounts of natural light.

Colour

The color used in the showroom should not dominate the presence of the car, rather, they should contribute to it and compliment the appearance of the vehicle. Colour can be effectively is to create moods, and to enliven the spaces. Where warm colour create a friendly cheerier atmosphere, cool collar imparts a calm and serene atmosphere. The colours for the flooring can act as a backdrop for the cars especially when the showroom has a mezzanine floor, as the cars could be viewed from the top, hence special care must be taken in this aspect too.

Challenges Facing Automobile Industries in Nigeria

Since the output rate in the six existing automobile sectors has fallen short of expectations over the past 20 years, the drop in Nigeria's automobile industry production is becoming worrying. As a result, eighty percent of the previously existing automobile industries have collapsed; the only one still operating is (PAN) Peugeot Automobile Nigeria Limited, which was founded in the 1970s and 1980s and had a production statistic of 264 cars per day in the 1980s but has since decreased to 22 cars per day as of 2010. Below are some of the issues that Nigeria's automotive industry is facing:

(a) **Poor Policy Implementation:**

Policy is the foundation for the development of the automotive sector in Nigeria. Government at all levels and their agencies are required to source all of their vehicles domestically, unless such automobiles are not readily available locally, according to a law passed by the federal government in 1994 to protect and support the nation's existing automobile industries. This law was published in the gazette under the number 28 of 1994. The government itself has disregarded this rule, which was put in place by the federal government to support and safeguard local auto businesses. Instead of buying cars built in Nigeria, the government imports foreign-made vehicles.

(b) **Poor Leadership**

The development of technology skills among Nigeria's citizens has not piqued the government's interest in the last 20 years. Every government holds this view regarding the nation's natural resource, crude oil. Since the nation is not expected to experience an

economic crisis, many previous government officials have mismanaged the country's funds by diverting funds abroad to build homes and businesses there rather than investing them in local industries that will boost production and provide jobs for her citizens. Dr. Oscar Odiboh, a consultant in the auto business, claimed that a country's developed economies completely relied on a thriving auto industryⁱⁱ.

(c) High Tariff

The cost of buying a new car in Nigeria is very high, so the average Nigerian cannot afford to buy the car of his choice. The interest rate applied to the purchase of a brand-new car in the country today is on the higher side. This comes down to the high cost of production facing the automotive industry. Countries like India and Russia are attempting to lower interest rates on car loans by as much as 5% (percent) in an effort to support local businesses by obliquely lowering taxes for a portion of the automotive sector.

(d) A Poor Economy

Owning a car is still a huge deal in Nigeria despite the country's weak economy which has increased the cost and maintenance of automobiles. The majority of people being able to buy a car indicates that poverty has been vanquished. In the traditional African household, the advent of a car is frequently hailed with the same joy as the birth of a male kid. The cars being discussed here aren't even completely new; rather, they are imported, somewhat used cars known as "Tokunbo." A man is believed to have arrived when he purchases a brand-new vehicle. Parties are held, neighbors are contacted, and even adversaries are politely teased as having lost the fight. All of them are results of the country's weak economy.

However, because the country's economy has a direct impact on the way its citizens live, fewer people now purchase brand-new automobiles, which has a positive impact for the country's automobile businesses.

(e) Lack of Fund

In Nigeria, business owners are solely responsible for covering all operating expenses. The Nigerian government never considers a way to support and encourage the existing businesses by guaranteeing or creating an environment that is favorable for them to operate, instead choosing to find a way to share in the profits by raising the company tax each year as a means of supporting their presence in the nation. According to Odiboh, the managing director of newsletter Nigeria Limited, "A developed country has an automobile industry that is operating; because the government of the country has failed to support the automobile industry in the country, lack of funding is impacting most automobile industries.

(f) Inadequate Power Supply

Electricity is the lifeblood of any industry, and its absence in well-established sectors causes a company's growth and development to stall. Based on the constant usage of electricity in the operation of their machinery, the majority of developed nations in the western world are able to exist. Only when there is a steady flow of electricity can the automobile industry survive. The price of fuel to run power plants during manufacturing and the cost of maintenance are on the high side, which has an impact on the financial health of the majority of the Nigerian automobile sector and leads to low production.

(g). Government Policies

These are the regulations the government imposes on the motor industry. Numerous initiatives have been launched in numerous nations. A study on effective policies and obstacles to the expansion of the car industry was created in Australia by the Federal Chamber of Commerce. Government policies that support the growth of automotive production and sales are necessary to foster a robust national automotive sector at both the macroeconomic and microeconomic levels.

In the majority of nations, local or regional auto sales and automobile production are tightly tied. Additionally, there is a direct correlation between the number of automotive sales and production and other macroeconomic policy-influenced variables such as consumer confidence, interest rates, and the availability of financing. Continuous and predictable economic growth is crucial since production in particular frequently has lengthy lead times. As a result, the level of automotive sales and manufacturing is typically greatly influenced by national macroeconomic and monetary policies that generate stability and consistency in Gross Domestic Product and per capita growth.

The macroeconomic elements that were discovered to promote car manufacturing and sales are listed below. Investor confidence drives stable national economic growth; consumers and businesses also require confidence to plan and anticipate future purchases. There should be little room for doubt. Consequently, it is advisable to minimize dramatic fluctuations in economic activity. National economic and regulatory policies must be consistent. Investment and consumer behavior depend heavily on uniform national policy. Inconsistent

rules may discourage purchases and investment while also causing potentially significant changes in economic performance. To invest and make purchases, respectively, investors and customers need stable economic policies and an effective regulatory environment. Economic and regulatory policies that are open: If policies are to be considered as fair, they must not only be fair, but also be perceived as fair. Therefore, maximizing transparency should receive a lot of attention. Policies and regulations should be made as simple as possible. For the car industry to prosper, the government's commitment to it is crucial.

Large sums of money must be invested in the automotive industry over an extended period of time. Investors want to reduce associated risks, so the government must demonstrate its unwavering commitment to the sector. Otherwise, investors may decide to scale back or divest from the industry. When it comes to the cost of capital, availability, and affordability of vehicles, monetary policies that support low interest rates are essential for fostering a strong demand for automobiles. In an effort to regulate the economy through interest rate mechanisms, governments that depend too heavily on monetary policy rather than fiscal policy may cause a significant decline in vehicle sales and production. Considering that the industry is international, it should be subject to the vagaries of exchange rate fluctuations.

As a result, drastically fluctuating exchange rates have the ability to quickly affect an industry's viability. The price of imported competition rises with devaluation. This danger to viability has the power to swiftly destroy long-established productive capacity and jobs. Infrastructure development for vehicles (roads, parking lots and complementary public transportation. Investments in public transportation and vehicular infrastructure should be balanced appropriately. To ensure that as many people as possible can profit from driving, a

good infrastructure is necessary. Chronic traffic issues could develop if this is done at the expense of deteriorating public transportation infrastructure.

(h) Price

One of the four Ps in the marketing mix is thought to be pricingⁱⁱⁱ. Consequently, it is the manual or automatic process of applying prices to purchase and sales orders based on a variety of variables, including a fixed amount, quantity break, promotion or sales campaign, a specific vendor quote, the price in effect at the time of entry, the date of shipment or invoice, the combination of multiple orders or lines, and many others. Therefore, automated solutions require more setup and upkeep, but this is likely to stop pricing mistakes. Cost-plus pricing is the method of pricing most retailers utilize. This entails raising the retailer's cost by a certain amount (or percentage). Simply charging the amount recommended by the manufacturer and typically displayed on the merchandise is what this entails.

The financial objectives of the business, such as profitability, must be able to be met with a well-chosen pricing. Additionally, it should be appropriate for the market while supporting a product's positioning and being consistent with the other elements of the marketing mix.

The quality of the goods, the sort of promotions employed, and the distribution channel type all have a significant impact on price. Therefore, if costs are considerable, distribution will undoubtedly be exclusive, and the product is supported by significant advertising and promotional efforts, the price should be rather high. Therefore, a low price might serve as a good substitute for a high-quality product, successful marketing campaigns, or a determined retail sales effort.

The costlier promotions, advertising efforts, large retail margins, elegant packaging, exclusive store locations, high quality products, and brand names aside, all contribute to the higher pricing of luxury goods. In order to make their products instantly identifiable and familiar, businesses proceed to invest significantly in these components. If they are not priced high, the luxury goods are at risk of losing their traits of uniqueness and exclusivity.

(i) Brand Loyalty

Brand loyalty is a sign of a customer's preference to buy a specific brand because they think it has the appealing qualities, images, or standard of quality at the best price. This customer's faith and belief serves as the foundation for new purchasing practices. Customers will initially buy a particular brand to try it out; if they are happy, they will continue to buy that brand's products. 43 Brand loyalty is a method that encourages a brand and leads to repeated purchases of the brand over time. Brand loyalty is the act of regularly and purposefully purchasing the same product.

Brand Loyalty measures the proportion of loyal customers to happy, product-loving customers. On the other hand, if people stick with the brand despite competitors offering better features, prices, and conveniences, then the brand, as well as maybe its logo and tagline, has significant value.

(j) Perceived Quality

Because all of our approaches now focus emphasis on the business rather than the consumer outside of the business, perceived quality is in the imagination of the believer and is a poor progeny. Therefore, one of the most crucial marketing components is perceived product

quality. For instance, researchers and practitioners have recently shown a great deal of interest in perceived quality, particularly in the context of services marketing.

Less attention has been paid to research that considers the function of perceived product quality in relation to other marketing factors like product participation, consumer pleasure, and buy intentions. The foundation of any business is the idea that high perceived quality encourages repeat purchasing. It follows that achieving perceptions of quality is crucial, but doing so necessitates the validity of the quality claim. Additionally, it indicates that in order for a company to produce high-quality goods and services, it is critical to develop an awareness of what quality means to different consumer segments, as well as a supportive culture and a quality improvement process. Additionally, producing a high-quality good or service is only a partial success; perceptions must also be shaped.

For a number of reasons, perceived and real quality can diverge. First, a previous perception of poor quality may have an undue influence on buyers. As a result, people could be hesitant to believe such statements or unwilling to make the effort to confirm them. Therefore, it is essential to prevent a brand from developing a reputation for poor quality from which it is difficult and occasionally impossible to recover. Second, a company can be obtaining quality in a way that consumers do not value. For instance, when Citibank automated its processing activities, it significantly increased back-office efficiency. The anticipated effect on customer evaluations was dissatisfactory. It turns out that customers either weren't aware of the modifications or didn't see any advantages. It's important to make sure that excellent investments are made where customers will see them.

Third, consumers may not have the time or motivation to process information even if they do have it. Consumers will very rarely have all the information necessary to make an objective and rational judgment on quality. Such customers ultimately rely on one or two indications that they connect with quality; the key to affecting perceived quality is simply comprehending and effectively managing these cues. It is crucial to comprehend the minor details that buyers use to determine the quality of a product. Perceived quality is influenced by a variety of factors, much like brand awareness. Specific categories for perceived quality include product quality and service quality.

There are seven factors that influence how consumers perceive a product's quality: fit and finish, performance, features, compliance to specifications, reliability, durability, and serviceability. On the other hand, the equivalent tangibles of dependability, competence, responsiveness, and empathy are used to assess service quality. Consumers are prone to forming stereotypical notions about the goods from particular nations. Customers may therefore have a preference for goods created in one nation over another.

4.2. Study Area

This chapter focuses on the site location of the proposed automobile center, to ensure that certain environmental factors are put into consideration for site selection, which also include site selection criteria.

The chapter also capture the project analysis and design synthesis base on brief analysis of automobile centre, developmental brief, design criteria, conceptual development, functional

relationship, space allocation/schedule, construction methods and materials and building service to ensure that the propose design is practically achievable in the built environment.

4.2.1 Site Location

The location for the proposed automobile centre is located along Akala New Garage – Apata Road beside Jofes Gas station, Oluyole Local Government Area of Oyo State, the site can be located in three different routes in the city of Ibadan; Route from Apata-Oluyole Estate Axis, Route from Dugbe-Challenge Axis, Route from Iwo Rd-Lagos-Ibadan Express.

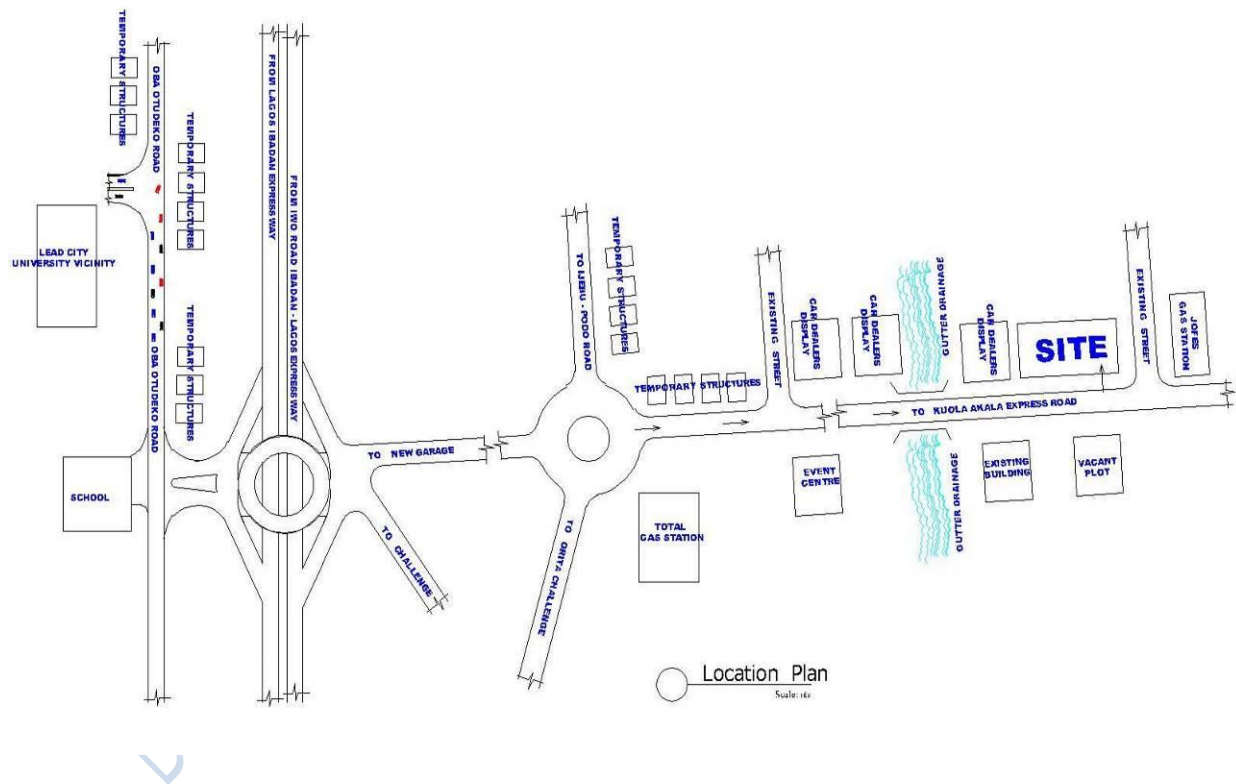


Figure 4: Location Plan of the site
Source: Researcher’s Fieldwork, 2022.

It is not just about visiting the site and conducting an inspection, it is also about taking cognizance of all the peculiar features of the site that will ensure to have enough idea about how to commence the building design and construction. Factors include the following:**Site Suitability:** The site proximity to Lagos with good road networks to Ibadan metropolis and business culture of the environment are what makes it suitable for the proposed design site, and these will foster the building performance and help the business of sales and easy access to maintenance facilities for car users.

Location and Accessibility: The site can be easily located on google map due to the existing landmarks near the site, and accessibility around the site area, the site has advantage of royal approach to the major road, which makes it acceptable for the automobile centre as these will aid or improve the business and give easy access to the end users.**Competitors Awareness:** Looking at the locality of the site, it is observed that the environment is majorly occupied with car dealers in automobile business, the competition between the brand-new seller and foreign used seller will be comparable as this will affect dealers' orientation and in the long run bring sanity to the industry, this will also change the perspective of potential buyer to have access to their choice cars. In most case mortgage can be allowed for the buyers to purchase brand new against foreign used cars; as this will change focus of buyers from second hand brand of cars.

- **Study the Building / Land Surrounding the Site:** The surrounding land and/or building can adversely affect planning if proper care is not taken. The site is a bit elevated by 1.2m height from the level of the major road, given it advantage for

drainage system to be adopted and advert advantages. Looking at perspective of buildings around the site, it is observed that adjacent buildings around the site will allow adequate daylighting and ventilation for the auto centre to be built on the site, because of low rise buildings around the site.

- **Soil Type/Landscape, size, shape, and topography:** Knowing the size and shape of the site helps to effectively get a plan that fits perfectly. The size of the site also give room for ancillary facilities and the shape of the site devoid of any sharp corners. The topographical surface is a plain terrain which helps for proper natural ground level of the building and foundation details to be adopted. The soil of the selected site is not loose as this will help the structural stability of building for the site.
- **Security and the nature of the neighborhood:** The protection of lives and properties is very crucial in automobile centre Therefore; this factor must not be taken with levity hand. Knowing the crime rate within the locality has allowed to make informed decisions and take precautionary measures in protecting property and lives of end users to hazard. The nature of the neighborhood is also very crucial. The site's neighbors are friendly as this has eliminated the environment filled with toxic elements the site itself is not suffering from any type of contamination that could be hazardous to human health.
- **Weather Condition:** The site weather condition is favorable, because it is free from any natural disasters like earthquakes, hurricanes, or volcanic eruptions, the site north direction helps to identify the climatic elements of the site, as this has helped

the orientation of the auto centre in relation to ventilation, daylighting, adoption of building envelope and construction details that mitigate the hazard effect any arising disasters.

4.3. Project Analysis and Design Synthesis

The design process is to generate a possible way the project work. This is a concept design, In the design process a number of concepts has been identified and then the best concept is chosen for further development.

These two stages are intertwined with iterations moving back and forth until a satisfactory design is achieved.

Analysis: Given project studies to analyze and show its requirements.

Synthesis: Given a set of technical requirements, synthesis will generate the system that performs as required. The verification of its performance will be made via project studies analysis or better yet via testing.

Analysis is once the concept is designed properly to understand the performance of the project studies that was designed as per the architectural requirements. This could be for building configuration, building sustainability and its ten strategies;

- Passive Sustainable Design
- Active Sustainable Design
- Renewable Energy Systems
- Green Building Materials
- Maximized Indoor Air Quality

- Waste Management, Stormwater
- Management, Rainwater Harvesting
- Recycled Water, Indigenous Landscaping.

1. Passive Sustainable Design

Passive strategies involve taking advantage of natural environmental factors like the orientation of the sun and climatic conditions when siting a building and deciding where windows will be placed. This enables designers to literally manage day-lighting and natural ventilation to their own advantage, and in this way reduce the energy requirements for the house.

In some climates, thermal-mass techniques may be incorporated into passive sustainable design and used to harness energy from the sun. For example, thick walls are designed with materials including brick, stone, and concrete, that will absorb the sun's heat during the day and release it into the house when temperatures drop at night.

2. Active Sustainable Design

Active design strategies involve various engineers who design and implement highly efficient HVAC, electrical, plumbing, and other systems. Energy-efficiency also relies on creating a well-designed building envelope with superior insulation that can block, hold, and release energy, allowing nature to help make the design work.

Renewable energy systems take active sustainable design a step further.

3. Renewable Energy Systems

Frequently used in conjunction with various passive design strategies, renewable energy systems include those that harness solar and wind energy.

It does take some investment, but generating electricity onsite with photovoltaic panels can make a huge financial impact, cutting costs as you would never have imagined possible.

Other popular technologies include solar thermal panels, ground- and air-source heat pumps, as well as biomass boilers.

On a smaller scale, the energy efficiency of any home can be improved by using energy-efficient appliances and lighting. This should be part of the overall sustainable energy strategy.

4. Green Building Materials

While some building materials are more sustainable than others, the basic strategy here is to use materials that don't plunder natural resources and are manufactured using responsible manufacturing techniques. It is also important to avoid materials that contain pollutants. When it comes to paint and sealants, its best to choose those that do not contain volatile organic compounds (VOCs). Board products that contain formaldehyde should also be avoided, and certified flooring should be the first choice.

The strategy also includes using recycled materials.

5. Maximized Indoor Air Quality

Part of active sustainable design, indoor air quality impacts on both the health and comfort of those who will live or work in buildings. It is vital for architectural design to be sustainable.

Important design elements include well-designed ventilation that will keep the indoor air clean and fresh, adequate air exchanges, and moisture control to avoid the development of mold.

6. Waste Management

Reducing, reusing, and recycling materials used for construction cuts costs. If the building is designed for durability, and to make efficient use of materials, future waste should also be minimized.

Additionally, there should be a waste management plan that simplifies the task of recycling waste once the house is occupied. The system might involve different containers for different types of waste, glass, plastic, metal, and so on.

7. Stormwater Management

Whether the building being constructed is a small rural cottage, a house in the suburbs, a skyscraper in the city, or a public building in the country, stormwater management is essential. Plumbing engineers design storm drains that channel water away from buildings. Traditionally, downspouts from gutters were connected to storm drains, but in the interests

of sustainability, it is advisable to allow rainwater to be absorbed into the garden, or, better still, for rainwater to be collected in one or more rain barrels.

Other measures that can assist with sustainable stormwater management include green roofs that are planted to enable infiltration of rainwater and permeable surfaces for driveways and parking areas. Retention ponds also help to reduce runoff, particularly in urban environments.

8. Rainwater Harvesting

Harvesting rainwater is not a new concept, but it is one of the top 10 strategies for sustainability. Instead of relying on water from a local authority, or sinking a borehole to access more groundwater, rainwater harvesting is a simple operation that involves collecting rainwater by channeling it from the roof gutters or downspouts into barrels for later use. It is excellent for irrigation, toilet flushing, washing clothes, and cleaning cars. But it isn't potable unless it is filtered and treated.

A reliable water harvesting system can be incorporated into the initial design of any building very easily.

8. Recycled Water

Another water-saving strategy involved recycling water used for sinks, bathtubs, showers, and clothes and dishwashing appliances and equipment. Frequently used for irrigation, recycled gray water should be treated on-site to minimize any risks. Ideally, this facility

would need to be included by the building designer. The NSF (originally founded as the National Sanitation Foundation), has developed a draft standard, *Onsite Residential and Commercial Reuse Treatment Systems*, that covers all types of wastewater treatment systems, including gray water. The Environmental Protection Agency (EPA) has guidelines for water reuse which summarizes state requirements and outlines the treatment and uses of recycled water.

9. Indigenous Landscaping

Indigenous landscaping, and even gardening on a very small scale, has gained popularity worldwide. Not only are native trees and plants easier to grow, but they also reduce irrigation needs. Landscaping can also be used as part of passive sustainable design. For instance, planting trees that will shade windows and even the roof of the house on hot days reduces solar heat gain inside the house. An architect would work with the landscaper to ensure that native trees and large shrubs are planted in the right places. Even though cost is often the primary consideration for sustainable architecture strategies, they all provide long-term savings and impact on our lives in a positive manner. One thing's for certain, sustainable architecture isn't something we need to strive to embrace in the future, it is all-important right now, in the present. (<https://www.caandesign.com/top-10-strategies-for-sustainable-architecture-design/>)

The project process is to achieve a sustainable design that fit in for best practices of human activities in automobile center through proper project studies and its requirements.

4.3.1. Brief Analysis



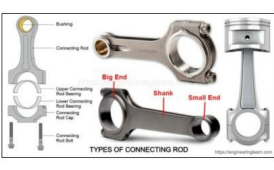
The holistic approach is to design a state of the heart automobile centre that cater for the need of auto sales and maintenance facilities; however, five major elements of green building design were introduced in the design brief namely: **Sustainable Site Design, Water Conservation and quality, Energy and Environment, Indoor Environmental Quality, Conservation of Material and Resources.**

All these will be achieved by having a functional and aesthetically appealing design through conceptual development, principle and through design philosophy of the proposed automobile centre.

4.3.2. Brief Development

Architecturally the concept and philosophy for the proposed design is achieved base on the principle of motion in a car engine (Piston) and integration of fictional five fingers that work. Conceptually piston road and structural ribs were merged together to form a building shape.

DESIGN PHILOSOPHY & CONCEPT

PHILOSOPHY	BUILDING TYPE	CONCEPT	DESCRIPTION
FORM FOLLOWS FUNCTION philosophy of motion is defined as the analysis of phenomena across social, aesthetic, scientific and ontological domains from the perspective of motion.	AUTOMOBILE CENTRE (COMMERCIAL) 	PISTON IS TO DERIVE MOTION OR TO IMPART MOTION 	ARCHITECTURE INSPIRED BY MOTION 

ARCHITECTURE INSPIRED BY MOTION

Figure 6: Design Philosophy and Concept Derivation
 Source: Researcher's Fieldwork, 2022.

4.3.3. Design Criteria

- **Daylighting and Ventilation**

Making good use of natural lighting in a building can improve the overall attitude, satisfaction and well-being of its occupants. This can be achieved by using low-e (low emissivity) glass windows. The glass is simply Emirate Glass LLC Smart lite; is a switchable glass turns from a clear to an opaque glass panel to create on-demand privacy, and allow for plenty of natural light when needed, it is also a wavy diffused glass panel that give diffuse indoor light from direct sunlight.

The coating appears invisible to the naked eye, allowing as much natural light into the house as possible. However, though transparent or plain, this coating also protects the building from unwanted Ultra violet n

Natural ventilation can be a cost-effective alternative to mechanical ventilation with air conditioning. In order to maximize the use of natural ventilation, passive cooling techniques will be incorporated. However, even the smallest wind will induce pressure distributions on the building envelope that will also act to drive the airflow. Proper ventilation is important to avoid cross contamination in automobile center is essential in the design.

- **Safety and Security**

Automobile Centre requirements requires basic precautions to protect the health and safety of the end user. The presence of fire alarms and first and first aid kits are a must and the security of the users inside the workshop, showroom and other areas as well as the display tower.

- **Comfort**

An automobile center safety has to be balanced with worker comfort. Comfort primarily is concerned with maintaining appropriate temperatures and air velocities. Ease of use of the auto centre equipment's is also a factor in worker comfort. workshop equipment's and layout must allow staff to perform necessary tasks with minimal additional effort. The more comfort a building provides, the more staying power it offers to the end users and better productivity it is translating into.

- **Sustainability**

Sustainability or sustainable architecture is a must when it comes to designing or planning a building. Not only it will benefit the users but also the one who owns the building and especially the environment. Sustainable architecture attempts to minimize the negative environmental impacts of a building by the use of energy efficient methods or techniques, the right materials, and sustainable energy.

- **Aesthetics**

Global Competitiveness intricate planning of spaces with the consideration of accessibility, circulation, flexibility, segregation, comfort and design of the building in consideration of aesthetics, daylighting and ventilation, sustainability and temperature or humidity.

- **Temperature or Humidity**

temperature or humidity needs to be controlled for storage of archaeological and anthropological or ethnographical collections.

- **Accessibility**

Accessibility in an automobile centre is a must, from the design of services and environment for persons with disabilities to workshop and other part of the building

- **Circulation**

The relationship of spaces and the way people move and interact from one place to another is an important factor for research and learning center. The process or how the work flow inside an anthropological and archaeological laboratory, the relationship of each corresponding archaeology and anthropology laboratories, the relationship of laboratories and classroom and or other spaces.

- **Flexibility**

Maximizing flexibility has always been a key consideration in designing of automobile centre. It gives the ability to expand easily, to readily accommodate reconfigurations and other changes and to permit a variety of uses. The flexibility in architectural design system fosters the supply and exhaust air, water, electricity, voice/data, vacuum systems that are extremely important to workshop area and showroom.

The handling of equipment found in workshop and support areas carries high risk of exposure to illness and injury. The segregation of workshop and non-maintenance activities is important.

(Design Criteria in Architecture Essay Sauce)

4.3.4. Conceptual Development

4.3.5 Conceptual development approaches to the proposed design focuses on:

- Functional
- Material
- Contextual
- Conceptual
- Formal
- Collaborative
- Philosophical

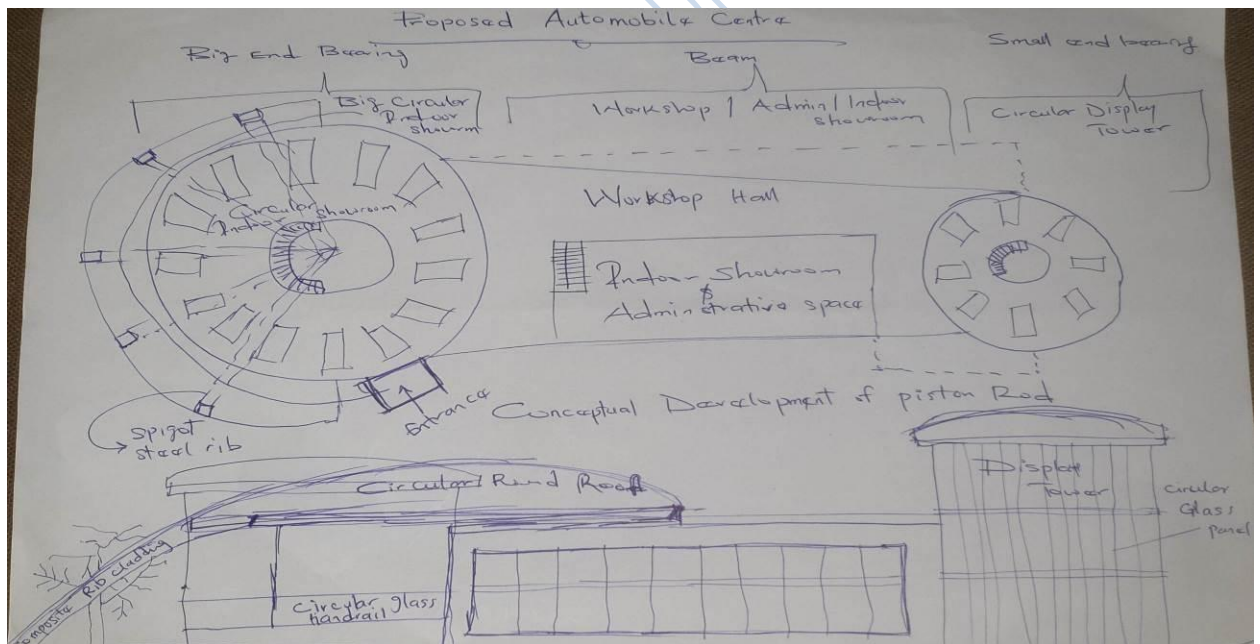


Figure 7: Conceptual Sketch Development
Source: Researchers Fieldwork, 2022.

4.3.6 Functional

The proposed design is approached with function at the forefront of the minds, to have more necessity for the functional elements rather than the aesthetic appearance of the building.

4.3.7 Material

The proposed design has an approach on materials for the structure as part of the early architectural concepts. By focusing on a specific material for the roof and building envelope, the structural forms of ribs that will be naturally led towards particular forms of construction, thus creating a type of appearance organically.

Perhaps material was selected base on approach to site context, which suggests a historical use of a particular material especially glass panel and roofing material selection, which are to be used in a more innovative way. By selecting such innovative materials, it will give the local visitors and foreign visitors a sense of comfort and familiarity, whilst also giving a nod to the natural surroundings and environmental benefits of sourcing locally.

4.3.8 Contextual

Contextual approach to the concept looks at the context of the site and surroundings, the historical features of the area, the people that occupy the area. Site analysis, exploring the data about the site, both physical and non-physical.

4.3.9 Conceptual

A conceptual approach to a design looks at the idea of conceptual architecture. The sole focus of the design is about the idea of integrating piston rod with five fingers that work, a combination of approaches and processes to conceptual architecture is sometimes never built, but rather designed as a form of thought provocation, exploration of ideas.

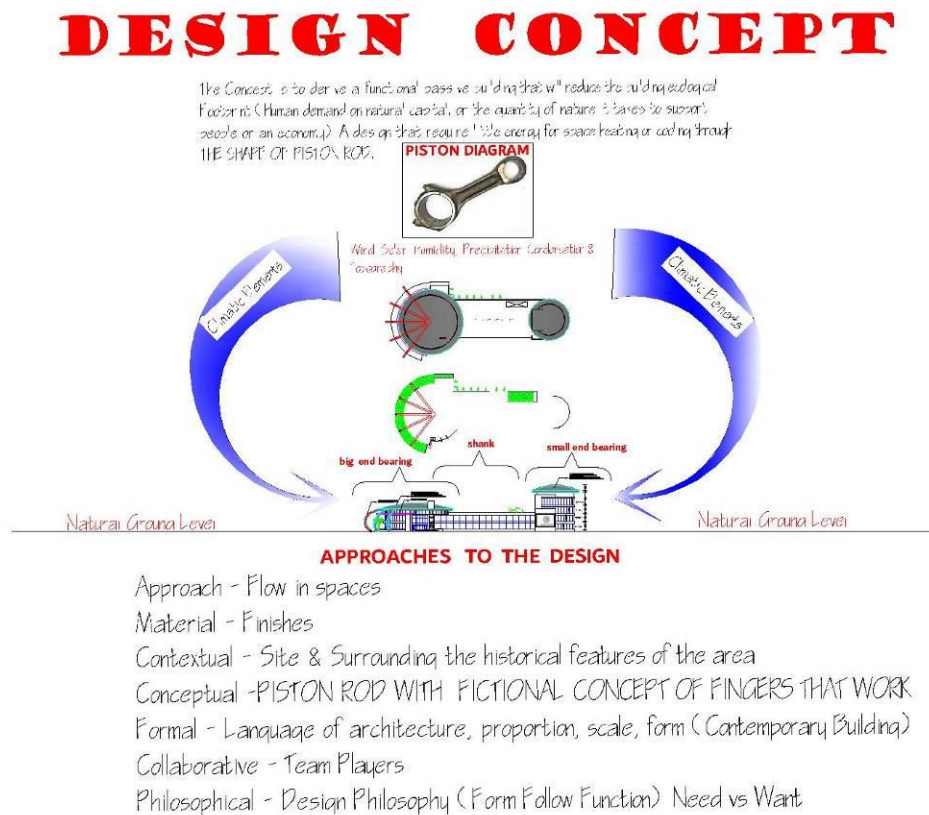


Figure 8: Concept Development
Source: Researcher's Fieldwork, 2022.

4.3.10 Formal

A formal approach to the design looks at drawing on the formal language of architecture to develop a concept of commercial building with perception contemporary look and high-tech.

4.3.11 Collaborative

Concept form collaboration from design processes among the team to the end for occupants.

4.3.12 Philosophical

This is a set of values used to inform the proposed design. The values base on the life values of the project studies and reflection of the design brief or context of the site, or indeed a combination of all three.

4.3.13 Functional Relationship

This is an architectural flow that identifies system function and their interactions, this implies the functions of spaces in the proposed automobile centre about how spaces operate together to perform the system mission for the end users and it include a minimum substantial and positive exchange of human interaction, goods, resources, department, services, jobs or workers between land uses or developments or within building configuration.

It is a complementary and interactive relationship among land uses or development, figure 9 and 10 below indicates functional relationship of spaces in the proposed automobile centre

ZONING FLOW DIAGRAM

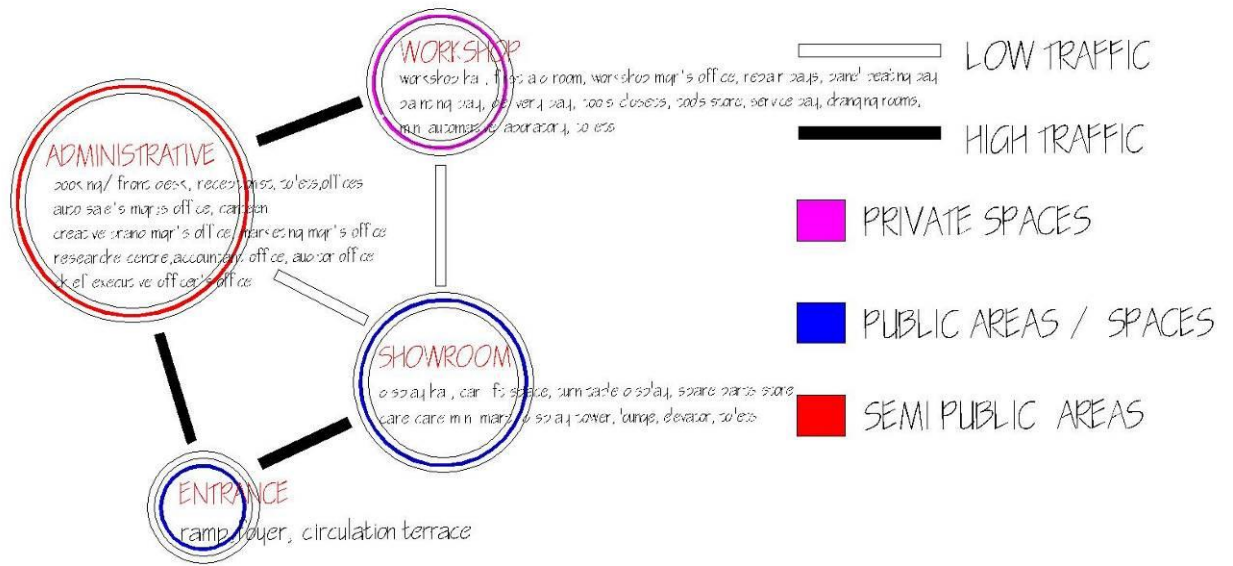


Figure 9: Zoning Flow Diagram

Source: Researcher's Fieldwork, 2022.

PROXIMITY/ ADJACENCY MATRIX DIAGRAM

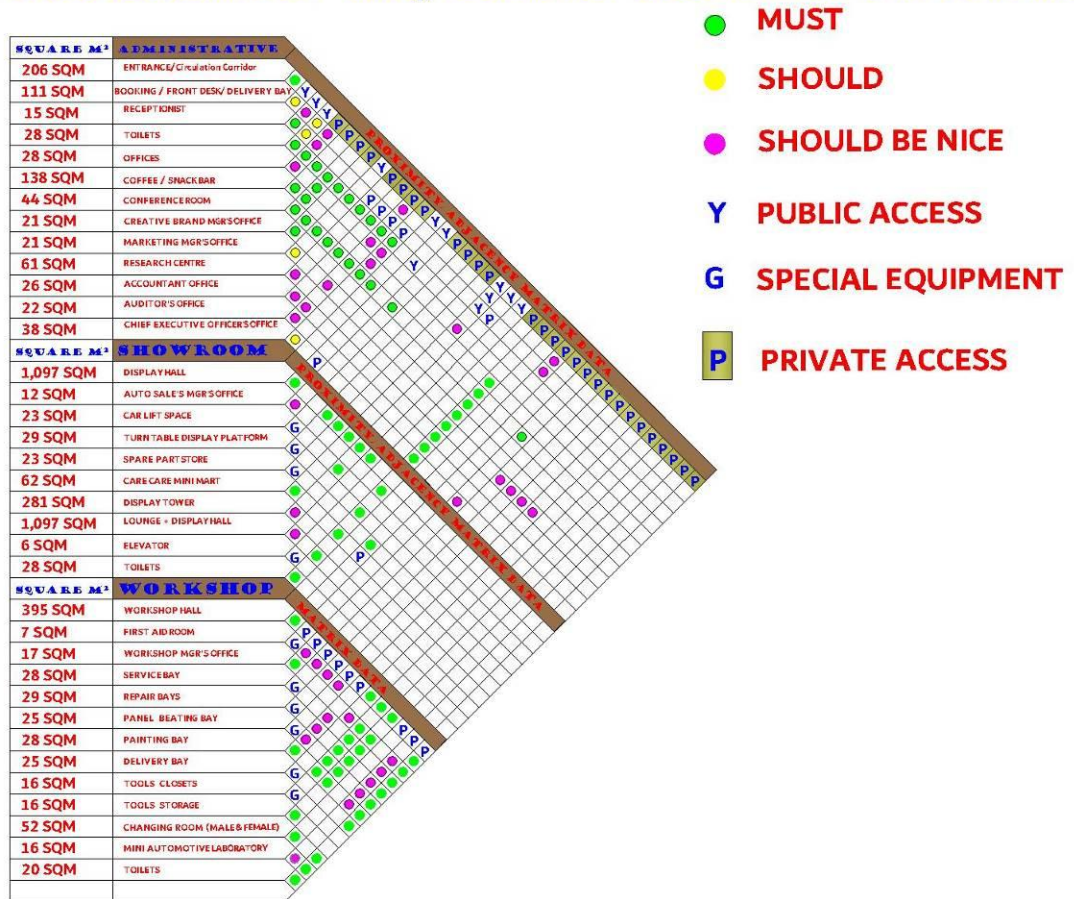


Figure 10: Proximity / Adjacency Matrix Diagram

Source: Researcher's Fieldwork, 2022.

4.3.14. Space Allocation/Schedule of Accommodation

Figure 11 and figure 12, 13, 14 below indicates space allocation/planning and schedule of accommodation for the proposed automobile centre, to have architectural insights of spatial requirement / size of spaces provide, below are the spaces provided in the proposed building:

- Entrance Foyer

- In-door Showroom
- Turntable Display Platform
- Circulation Terrace
- Car Care Mart
- Display Tower Showroom
- Car Lift
- Elevator
- Spare Parts Storage
- Sales Manager's Office
- Changing Room (Male & Female)
- Toilets
- Workshop Hall
- Repair Bay
- Servicing Bay
- Tools Storage
- Booking/Front Desk
- Delivery Bay
- Panel Beating Bay
- Painting Bay
- Tools Closet
- Offices
- Lounge

- Canteen
- Kitchen
- Dry Store
- Wet store
- Servery
- Workshop Manger's Office
- Secretary to Workshop Mgr.'s Office
- Accountant Office
- Auditor Office
- Research Centre
- CEO Office
- First Aid Room
- Mini Automotive Laboratory
- Solar Panel Power Room
- Main Power Room
- Marketing Mgr.'s Office
- Marketing Offices
- Creative Brand Manager's Office
- Conference Room
- Auto Sales Mgr.'s Office
- Ramp

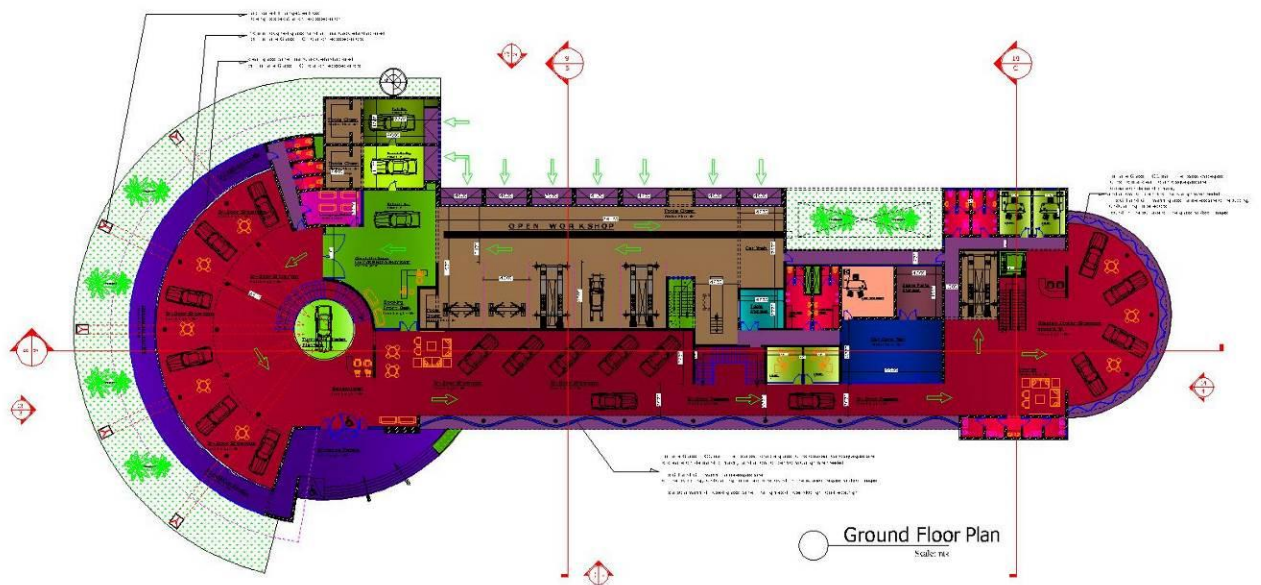


Figure 11: Ground Floor Plan Diagram

Source: Researcher's Fieldwork, 2022.



Figure 12: First Floor Plan Diagram

Source: Researcher's Fieldwork, 2022.

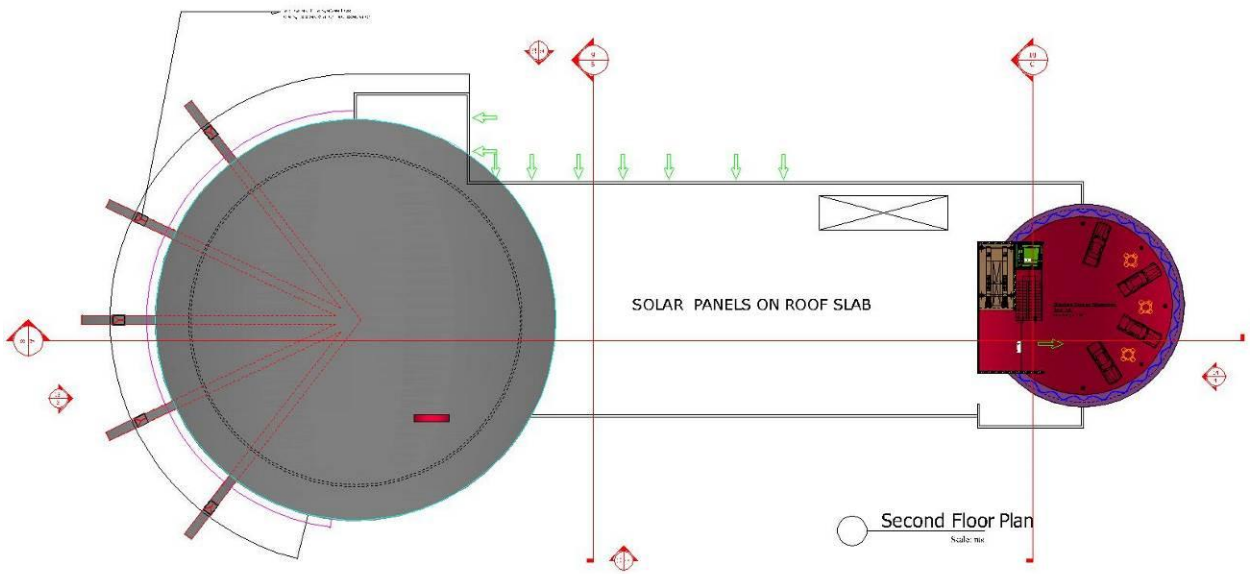


Figure 13: Second & Third Floor Plan Diagram

Source: Researcher's Fieldwork, 2022.

SPATIAL ANALYSIS / REQUIREMENT

















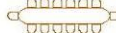














SQUARE M ² ADMINISTRATIVE				SQUARE M ² SHOW ROOM			
S/N	Size	Space	Furniture Template	S/N	Size	Space	Furniture Template
1.	206 SQM	ENTRANCE/Circulation Corridor		1.	1,097 SQM	DISPLAY HALL	 
2.	111 SQM	BOOKING / FRONT DESK/		2.	12 SQM	AUTO SALE'S MGR'S OFFICE	 
3.	15 SQM	RECEPTIONIST		3.	23 SQM	CAR LIFT SPACE	
4.	28 SQM	TOILETS	  	4.	29 SQM	TURN TABLE DISPLAY PLATFORM	
5.	28 SQM	OFFICES		5.	23 SQM	SPARE PART STORE	
6.	138 SQM	COFFEE / SNACK BAR		6.	62 SQM	CARE CARE MINI MART	
7.	44 SQM	CONFERENCE ROOM		7.	281 SQM	DISPLAY TOWER	 
8.	21 SQM	CREATIVE BRAND MGR'S OFFICE		8.	1,097 SQM	LOUNGE - DISPLAY HALL	 
9.	21 SQM	MARKETING MGR'S OFFICE		9.	6 SQM	ELEVATOR	
10.	61 SQM	RESEARCH CENTRE		10.	28 SQM	TOILETS	  
11.	26 SQM	ACCOUNTANT OFFICE					
12.	22 SQM	AUDITOR'S OFFICE					
13.	38 SQM	CHIEF EXECUTIVE OFFICER'S OFFICE					

Figure 14: Spatial Analysis / Requirement Diagram

Source: Researcher's Fieldwork, 2022.

SPATIAL ANALYSIS / REQUIREMENT

SQUARE M² WORKSHOP			
S/N	Size	Space	Furniture Template
1	395 SQM	WORKSHOP HALL	
2	7 SQM	FIRST AID ROOM	
3	17 SQM	WORKSHOP MGR'S OFFICE	
4	28 SQM	SERVICE BAY	
5	29 SQM	REPAIR BAYS	
6	25 SQM	PANEL BEATING BAY	
7	28 SQM	PAINTING BAY	
8	25 SQM	DELIVERY BAY	
9	16 SQM	TOOLS CLOSETS	
10	16 SQM	TOOLS STORAGE	
11	52 SQM	CHANGING ROOM (MALE & FEMALE)	
12	16 SQM	MINI AUTOMOTIVE LABORATORY	
13	20 SQM	TOILETS	

Figure 15: Spatial Analysis / Requirement Diagram

Source: Researcher's Fieldwork, 2022.

4.3.15. Construction Methods and Materials

Construction Methods for the automobile center will be developed with proper planning and design so that each process reduces the construction time, cost and maintain overall sustainability.

Flat Slab Construction are to be introduced this also construction through fabrication of supporting structural members.

4.3.16 Flat Slab Construction

The flat slabs are structural elements that are highly versatile in nature. This is this versatility that it is used widely in construction. The flat slab provides minimum depth and faster construction. The system also provides column grids that are flexible.

The flat slab construction is also a means of increasing the energy efficiency as this allows the exploitation of building thermal mass in the design of ventilation, heating and the cooling requirements. This allow Floor-to-floor height which are introduced at display tower of the auto centre.

Building materials can generally be divided into two categories: Natural building materials such as stone and wood, and Man-made building materials such as concrete and steel. Both categories usually require a certain level of preparation or treatment before the use in a structural application.

There are many types of building materials used for the proposed construction of the automobile centre are; Concrete, Steel, Glass and Brick/Masonry are to be adopted for the construction of the proposed automobile center, each material has different properties such as weight, strength, durability and cost which makes it suitable for project. The choice of materials for construction is based on cost and effectiveness to resisting the loads and stresses acting on the structure.

Material type Sample compressive strength as force (Newton) per unit area (mm²)

Steel 300 MPa*

Concrete 25 MPa*

Masonry 10 MPa*

Parallel to grain 5 MPa*

3.5 MPa*

*MPa: mega Pascal or N/mm²

Below is the list of materials to be adopted

Concrete

Concrete is a composite material made from mixing cement, aggregates such as sand and crushed stone and water. The properties of concrete depend on the ratios used in the mix design.

Concrete is very strong when exposed to compression stresses however, it's brittle and has limited tensile strength. Combined with steel rebar, reinforced concrete is stronger and more suitable for a wide range of structures such commercial residential project and other application.

Figure 16 below shown the typical concrete diagram

Concrete:

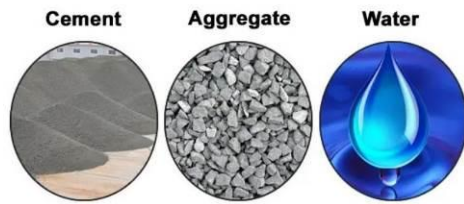


Figure 16: Concrete Diagram

Source: Google Image, 2022.

Steel

Steel is one of the strongest building materials available with excellent strength capacity in both tension and compression. Because of its high strength-to-weight ratio, it is ideal for structural framework of automobile center facilities. Structural steel is available in standard shapes such as angles, I beam and C-channels. These shapes can be welded together or connected using high-strength bolts to build structures capable of resisting large forces and deformations.

The installation of steel is less time consuming compared to concrete and can be installed in any type of environment. Figure 17 below shown typical example of steel diagram.



Figure 17: Steel Diagram

Source: Google Image, 2022.

Brick/Masonry

Masonry construction is using individual units to build structures that are usually uses mortar to bound the units together. Masonry is strong in resisting compression loads/stresses which makes it ideal to use for the construction of load bearing walls. Other masonry materials include brick, stone and glass block. Masonry is a highly durable and fire-resistant material. Figure below shown typical diagram of Brick/Masonry.



Source: Google Image, 2022.

Figure 18: Brick/Masonry Diagram

Glass

Glass is fascinating building material, aesthetically acceptable for automobile center to bring in a sort of advertisement for sales of automobile vehicle and accessories, glass has unique properties as a transparent glazing material in the construction industry. It has various architectural applications in doors, windows, partitions, etc; which is applicable to curtain wall, handrail, doors, partitioning, windows and stair in the automobile centre. Figure below shown typical diagram of glass



Figure 18: Glass Diagram

Source: Google Image, 2022.

4.3.17. Building Services

Building Services are the electrical, plumbing, and mechanical systems in the proposed auto center building. For this reason, they are also called MEP services, for Mechanical, Electrical, and Plumbing.

A comprehensive list of services that could be provided in the auto center building are follows:

Mechanical Services

1. Firefighting Systems
2. Elevators
3. HVAC Systems (heating, ventilation, and air-conditioning systems)
4. Gas Supply Systems (such as for heating and cooking in the kitchen for canteen, and workshop hall)
5. Compressed Air Systems used in industries

Electrical Services

1. Main Power Supply
2. Solar Power
3. Backup Power (such as diesel generators)
4. Emergency Power (such as battery-based uninterrupted power supply)

Plumbing Systems

1. Water Supply
2. Drainage of Wastes
3. Water Recycling Systems (these allow you to recover the water from your waste and re-use that water for low-grade applications such as flushing)
4. Rainwater Harvesting
5. Storm Water Drainage

Data based Systems or Low-Voltage Systems

1. Security Systems
2. Fire Alarm Systems
3. Building Management Systems
4. Public Address Systems
5. Cable TV Systems
6. Data Networks
7. Voice Networks

Chapter 5

Conclusion

5.1. Project Appraisal

5.1.1 Construction Method and Material

The location of the facility will influence the choice material as well as method of construction. Automobile Centre building being a facility that provides space for auto sales, spare parts sales and maintenance facilities and create space for human activities, it is expected that durable and modern type of building materials should be used. All structural works and configurations should be handled by a certified structural engineer registered by COREN as designs of columns, beams, and reinforcements and so on will be required. Several analyses will also be required to know the soil safe bearing capacity, effect of wind load among others on the facility. Reinforced concrete and steel shall be main structural elements in the design. The choice of finishes will take into cognizance the finishes for auto workshop and showroom design, the thermal insulation and other factors in finishes. The use of each interior space shall also determine the choice of finishes.

A. Pre-Construction Operations

The pre-construction operations are the operations that are carried out by the contractor and other concerned agencies. The operations are evaluation of health and safety aspects of the project, provision of on-site documentation, provision of facility access and security.

A preconstruction conference should be organized to allow all the parties involved to get clear understanding of the procedures involved in contractor submittals, sampling and

testing, construction surveys, inspections by outside agencies, payment requests, claims and disputes, unforeseen job conditions and change order requests.

B. Substructure

The substructure of the building comprises of mainly foundation. The soil within the site is firm, well compacted, with good load bearing capacity and has the presence of rock boulders running underneath the soil layer. Normal strip foundation would be employed in this case because of the favorable characteristics of the soil. The quality of the foundation materials will offer resistance to chemical and pose adequate compressive strength; this will aid in conveying the weight of the building without any form of differential settlement. The operations that are mainly involved in substructure stage are:

- i. Site clearing:** all obstruction on the space to be occupied by the buildings is to be removed to allow for other operations to follow. Trees and other plants that exist on the building site must be removed.
- ii. Site hoarding:** it is the erection of barrier around the perimeter of the site to improve security and protection of equipment and materials. The material to be used for the hoarding is corrugated galvanized zinc sheets nailed on timber frames
- iii. Removal of topsoil:** the removal of the topsoil over the space on the land covered by the buildings. The top soil on the other spaces should be retained to be used for landscape planting. The average depth for top soil removal is 150mm.
- iv. Setting out:** the transfer of dimensions on the building drawings to the site is called setting out. The buildings are to be set out in relation to the existing road that is the reference

point for the buildings. The setting out is to be done with the use of theodolite to achieved higher degree of accuracy compared to other methods.

v. Excavation to trenches: after the setting, out has been completed and certified by the consultants. The trenches are to be done by excavators to the specified depth by the structural engineer. The trenches are to be checked and signed off before the blinding will be put in place. **vi. Casting of blinding, foundation footing and column bases:** Concrete piles will be driven deep down into the water bed with all piles having pile caps. The foundation footing is to be laid to adjust to the slope of the site. The column bases are to be reinforced to structural engineer's specification and location.

vii. Laying of foundation block wall: The foundation block walls are to be 225mm sandcrete block wall laid in stretcher bond. The foundation block walls are to be filled to solid with concrete. The concrete will improve the strength of the foundation block wall.

viii. Hard-core filling: the hard-core should be 300mm thick weathered rock. It should be well compacted and levelled. **ix. Damp proofing:** the damp proofing material should be in 3 plies of bituminous felt laid over the area of the foundation. It is to disallow capillarity of water to the floor slab.

x. Casting of in-situ ground floor slab: the ground floor slab is to be constructed to a thickness specified by the structural engineer. The floor slab should be reinforced. It must be checked and signed off by the structural engineer before progress of work.

C. Superstructure

The building will be concrete framed structure. Reinforcement concrete will be used for columns, beams, and slabs. Sand Crete and non-flammable light partition for walls. The

ceiling and doors will be fire rated and the floors will be finished generally in non-slippery vitrified floor tiles of different materials and textured in different places especially the workshop hall. Fire resistant finishes will be used. Mechanized anti-fire equipment will however complement the anti-fire efforts. The superstructure comprises of five basic components namely; floors, walls, doors & windows, ceiling and roof.

- i. Floors:** The floor as a structural member should meet necessary requirements according to structural specification. It should be able to withstand imposed loads and prevent damp penetration. It should have the ability to absorb heat and sound, and fire resistance; ease of maintenance; allow for good appearance, comfort, safety, cleanliness etc. Reinforced concrete floor slab is used for the floors and they are finished with PVC tiles, marble tiles, vitrified tiles, ceramic tiles and cement screed
- ii. Walls:** Walls are elements that contribute majority to the image and the appearance of the building. It should be designed to protect against wind, dust, animals and to have good aesthetics. Strength and stability are most importance as well as resistance to dampness, thermal and sound insulation along with fire resistance. Both internal and external walls will be of 225mm sandcrete hollow blocks. Some of the walls for the conveniences will be of 150mm sandcrete hollow blocks. Stair walls should be made of extensive 170 concrete to act as defences against fire thereby facilitate the easy and safe evacuation of people from the building when there is a fire outbreak

- iii. Doors and Windows:** Both internal and external doors will be 2100mm in height with respective width at 900mm, 1800mm, revolving door of 3000mm diameter, and sliding shutter of 3970mm x 6450mm. Special wavy windows were introduced base on architect's detail.
- iv. Ceiling:** In contemporary times, new ceiling materials have been developed ranging from the dry to the wet ones. Suspended ceiling will be used in most spaces to help in housing major light fittings and for acoustic considerations; the ceiling materials used is 600x600mm cellulose ceiling boards. The boards are to be installed according to the pattern specified by the architect.
- v. Roof:** For a roof to be functional it must meet the following requirements; strength and stability, durability, fire resistance and occasionally, sound insulation, lighting, ventilation. The span and nature will determine the construction method used in the various unit. Flat concrete roof will also be used. The roof is a space frame structure, supported by steel and reinforced concrete columns.

5.2 Conclusion

Until now the subject of circulation in designing and building has not been given due attention in public discourse and legislation in Nigeria, due to inadequate collation of brief, understanding the approach to spatial requirements on spaces and its activity. It becomes imperative for the Nigerian government to lead the way in making circulation spaces of commercial buildings a priority and in enacting laws which mandate use of space and

promote excellent activities for user's experience. This should be seen as a way of making life more convenient for everyone.

5.3 Recommendation

Automobile center designs are expected to fulfill necessary design consideration so as to meet up with end users' requirements and demands. Sustainable approaches to the design are to give it a building that is energy efficient and conservative in nature through adequate provision of circulation spaces and use of materials.

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5.1.5 Appendixes

Appendix I Presentation Drawings

Appendix II Working Drawings

Appendix III Details