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Mobile detailing service for vehicles based on an electronic application

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Dedication

We dedicate this work to our beloved parents, supervisors and friends.

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General introduction

General Introduction

In light of the current developments in the field of scientific and technical research, university entrepreneurship is considered an essential tool for transforming the outputs of scientific research into productive practical opportunities. This thesis falls within this framework, contributing effectively to the economic development of the country and also providing comfort to the Algerian citizen. In our pursuit of these goals, we found that vehicle owners face several problems, particularly the time required to wash their vehicles, which has become a significant concern for many vehicle owners in our contemporary society. The current pace of life, characterized by busy days and multiple responsibilities, leaves a little room for secondary tasks such as regular car maintenance. For example, the operating hours of traditional car washes do not always align with the client's free time, making it difficult to schedule this task. Even upon arriving at the car wash, vehicle owners often have to deal with waiting times. In this context, finding the time to go to a car wash and wait for the vehicle to be cleaned can seem like an insurmountable task. Based on these observations, it seems appropriate for us to pose the following problem: How can we facilitate the task of car washing for vehicle owners so they can maintain the cleanliness of their cars in a more practical way?

After careful thought and consideration, we came up with an idea to solve this problem: a mobile car washing service that relies on an electronic application through which vehicle owners can request this service from home or the workplace, a modern way to wash their vehicles.

Firstly, thanks to this application, vehicle owners can request the mobile car washing service at their doorstep with just a few taps on their phone. Once the request is received on the application, our team locates the car using GPS and promptly travels with all the necessary supplies to clean the vehicle. The application also helps identify the type of service the customer desires, as it offers several services such as polishing and regular washing, giving the customer the freedom to choose the service they want.

Secondly, vehicle cleanliness is a crucial element not only for personal aesthetics but also for the aesthetics of the environment in which the community operates. A clean car significantly contributes to the overall appearance of public and private spaces, thereby influencing individuals' perception of their daily environment. Regular and well-maintained vehicles reflect a positive image that benefits the entire community. This attention to vehicle cleanliness can have many beneficial effects, such as improving the civilized image, reducing visual pollution, and preserving the car's paint and value.

To address this topic, we will divide this scientific thesis into two sections. The first chapter will present the steps followed for washing and polishing the car inside and out, and the tools and materials used. At the end of this chapter, we will present our future outlook on car washing. On the other hand, the second chapter, titled "Mobile Application for Washing Service," will be dedicated to analyzing the needs and designs of the application, its development, and discussing the problems we encountered, concluding with the final thoughts.

Chapter one: Mobile washing and vehicle detailing and polishing

Introduction:

Car washing is a fundamental process for maintaining the cleanliness and appearance of a vehicle, as well as ensuring its protection from harmful environmental factors that can affect the paint and bodywork. With the increasing awareness of the importance of preventive maintenance and attention to detail, car washing has become an integral part of vehicle upkeep. The methods and tools for car washing vary based on the techniques used and the desired outcomes, whether for a quick clean or detailed care of the car.

In this chapter, we will delve into the steps of car washing in detail, starting from initial preparations to final procedures. We will review the tools and equipment used at each stage, focusing on how to choose the appropriate tools to ensure the best results. We will also discuss the latest techniques used in car washing and how they impact the quality and efficiency of the process.

The importance of this chapter lies in the need for a thorough understanding of the steps, machines and tools used in car washing, both for car owners and mobile car washing service providers. This understanding contributes to improving the quality of service provided, ensuring customer satisfaction and vehicle safety.

Section one: Mobile Washing and Vehicle detailing

I. Importance of Car Washing:

Car washing plays a vital role in the regular maintenance of vehicles, with significant importance manifesting in several aspects, including:

I.1. Maintaining Aesthetic Appearance:

Regular washing keeps the car clean and shiny, enhancing its exterior appearance and increasing its appeal. This not only improves personal appearance but also raises the car's resale value. [1]

I.2. Protecting Paint and Bodywork:

Dirt, dust, and environmental pollutants like acids and salts can damage the paint and corrode the car's metal body. Regular washing helps remove these pollutants, protecting the paint from early damage. [1]

I.3. Improving Visibility and Safety:

Accumulated dirt on windows, mirrors, and lights can affect visibility while driving. Regular car washing ensures these parts are clean, improving visibility and increasing safety on the roads. [1]

I.4. Extending Car Lifespan:

Regular cleaning and care reduce minor damages that may accumulate over time. This helps keep the car in good condition for a longer period, reducing maintenance and repair costs in the long run. [1]

I.5. Preventing Corrosion and Rust:

Removing dirt and chemical pollutants can prevent corrosion and rust, especially in areas exposed to moisture and rain or coastal areas where salts are more prevalent. [1]

I.6. Improving Car Efficiency:

Car washing also involves cleaning the engine and other mechanical parts, helping maintain the car's performance and efficiency. Accumulated dirt and oils on the engine can affect its performance and increase fuel consumption. [1]

The benefits of car washing are numerous, from maintaining the exterior appearance to protecting the paint, improving safety, and extending the car's lifespan. Regular car washing with the appropriate tools and techniques not only keeps the car clean but also enhances its performance and protects it from environmental damage. In the following sections of this chapter, we will detail the steps of car washing and the tools used to achieve the best results. [1]

II. Steps of Mobile Washing and vehicle detailing:

Mobile car washing has become a popular option for car owners seeking convenience and effectiveness in cleaning their vehicles without needing to visit a traditional car wash. This flexible service saves time and effort and delivers exceptional results at a time and place that suits the customer. The mobile car washing process relies on a set of well-thought-out steps and specialized tools to ensure comprehensive cleaning of the car, both inside and out. From the initial inspection of areas needing special attention to washing, drying, and final touches, each step is executed with care to protect the car's paint and interior surfaces. This process not only involves cleaning but also includes protecting the car components and maintaining their shine, enhancing its appeal and extending its lifespan. In this section, we will outline the essential steps of mobile car washing, which include:

II.1. Initial Inspection:

Before starting the car washing process, an initial inspection is conducted to assess the car's condition and determine its specific needs. This step includes several elements:

⇒ General Condition Assessment:

The mobile washing team inspects the car to determine the extent of dirt and grime accumulated on the paint, glass, bumpers, and wheels. [2]

⇒ Identifying Particularly Dirty Areas:

Based on the initial inspection, areas requiring special attention and intensive cleaning are identified. These areas are determined based on the extent of dirt and grime buildup and potential issues needing special care. Examples of areas that may need special attention include: [2]

◆ Undercarriage:

This area often experiences severe contamination from mud and soft dirt, requiring intensive cleaning to remove all dirt thoroughly. [2]

◆ Wheels and Tires:

Dust and mud particularly accumulate in this area, needing intensive cleaning using special brushes and cleaning agents to remove the accumulated dirt. [2]

◆ **Windows and Mirrors:**

It is essential to clean windows and mirrors well to ensure clear visibility while driving. This area may contain layers of dirt and stains needing intensive removal. [2]

◆ **Bumpers and Front Part of the Car:**

This part of the car encounters many smudges and stains from insects, mud, and airborne pollutants, needing intensive cleaning to restore its shine and cleanliness. [2]

◆ **Dirty Interior Areas:**

Some interior areas, such as floors, seats, and vents, may accumulate significant dirt requiring intensive cleaning to remove dirt and odors. [2]

⇒ **Consulting the Client and Identifying Needs:**

The team communicates with the client to discuss any specific issues or special requests for car washing. The client may request specific interior cleaning or the application of polishing materials on the paint, or any additional service. [2]

⇒ **Providing Recommendations and Additional Services:**

Based on the initial inspection, the mobile washing team can offer recommendations on additional services that might help enhance the car's appearance and condition, such as paint polishing or interior cleaning. [2]

These initial steps help in determining the requirements for the car washing process and securing the appropriate service according to the client's needs and the car's condition. With this information, the team can then proceed with the car washing process, which divides into two main parts.

II.2. Car washing process:

◇ **First part: Interior Cleaning**

Cleaning the interior of a car is essential for maintaining its aesthetic appeal and comfort. While many people focus on the exterior cleanliness and attractiveness of their vehicles, a clean interior significantly enhances the driving and riding experience. A tidy and organized environment not only improves the psychological comfort of the driver and passengers but also helps in maintaining the car's value over the long term [2].

Interior cleaning goes beyond removing visible dirt and dust; it includes attention to detail for elements such as seats, panels, windows, and plastic and metal surfaces. Regular interior cleaning not only improves the appearance but also helps eliminate unpleasant odors and accumulated bacteria, ensuring a healthy and safe environment inside the car. [2] With advancements in cleaning techniques and products, achieving remarkable results is now possible by using the right tools and materials. Below are the detailed steps for thoroughly cleaning a car's interior: [2]

1st. Step: Removing Trash and Debris:

The first and essential step in cleaning the car's interior is removing trash and debris. This step is crucial as it prepares the cabin for the subsequent detailed cleaning stages. Removing the trash makes it easier to access all parts of the cabin, facilitating a deep clean of the floors, seats, and various surfaces, thereby making the process more effective and efficient. [3]

2nd. Step: Using a Vacuum Cleaner:

Vacuuming is a critical step in the interior cleaning process, helping to effectively remove dirt and dust from floors, seats, and hard-to-reach areas. This step involves several stages: [3]

◆ Choosing the Right Nozzle:

Select appropriate vacuum attachments, using a wide nozzle for large areas like floors and seats, and smaller or elongated nozzles for tight corners and crevices. [3]

◆ Comprehensive Floor Cleaning:

After removing all floor mats, use the wide nozzle to make long, consecutive sweeps across the floor to ensure all dirt and dust are removed. [3]

◆ Seat Cleaning:

Use a dedicated upholstery nozzle to clean the seat surfaces and sides, employing circular or longitudinal movements to remove embedded dirt. [3]

◆ Cleaning Gaps and Corners:

Use a small nozzle or brush to clean the gaps and corners between and under the seats, and around the dashboard. [3]

◆ Cleaning Carpets and Blankets:

Clean the carpets and blankets with sequential movements. For stubborn stains, use a carpet cleaner first, then vacuum to remove the dirt. [3]

◆ Final Check:

After vacuuming, inspect the cabin to ensure all dirt is removed. If necessary, re-clean areas requiring additional attention. [3]

3rd. Step: Cleaning Hard Surfaces:

Cleaning the hard surfaces inside the car, such as the dashboard, center console, doors, and control buttons, is a fundamental part of the interior cleaning process. These surfaces can accumulate dust, dirt, and food and drink residues, affecting the car's appearance and reducing its appeal. [4]

4th. Step: Cleaning the Seats:

Cleaning the car seats is crucial as they are frequently used and can accumulate dirt and stains over time. The cleaning methods vary depending on the seat material, whether fabric or leather: [2]

⇒ Cleaning Fabric Seats:

Spray a fabric seat cleaner on stains and leave it for a few minutes, then gently scrub with a soft brush or cloth. After treating the stains, spray the entire seat surface with a fabric seat cleaner and scrub in circular motions for deep cleaning. Finally, wipe the seats with a dry cloth to remove as much moisture as possible. [2]

⇒ Cleaning Leather Seats:

Start by wiping the seats with a soft, damp cloth to remove surface dirt. Then, spray a small amount of leather cleaner on a cloth and wipe the seats in circular motions to cover all areas. After cleaning, use a leather conditioner to maintain the softness and prevent cracking. [2]

5th. Step 5: Cleaning Carpets and Blankets:

Carpets and blankets are constantly exposed to dirt, dust, and food residues, making their cleaning necessary to prevent bad odors and bacteria buildup. Using a powerful vacuum can remove surface dirt and deep particles, while specialized carpet cleaners can tackle tough stains and high-traffic areas. Additionally, ensuring good ventilation after cleaning is essential to dry the carpets and blankets completely, preventing mold and mildew growth and maintaining a healthy car interior environment. [5]

6th. Step: Polishing Plastic and Vinyl Surfaces:

Polishing plastic and vinyl surfaces inside the car significantly enhances their appearance and extends their lifespan. These surfaces are exposed daily to dust, dirt, and fingerprints, so regular cleaning and polishing help maintain their attractiveness. Using specialized polish products for these materials can restore their original shine and add a protective layer against UV rays and wear. The result is clean, shiny surfaces that give the car's interior a fresh and appealing look, enhancing the comfort and cleanliness for the driver and passengers. [6]

7th. Step: Cleaning and Polishing Metal Parts:

Cleaning and polishing metal parts inside the car add a touch of luxury and elegance to its interior appearance. Metal parts, such as door handles, dashboard edges, and control elements, can accumulate dirt and fingerprints, losing their natural shine. Using metal-specific cleaners helps efficiently remove dirt and stains, while metal polish can restore shine and protect against corrosion and rust. Regular polishing not only enhances the interior's beauty but also keeps these parts in good condition for longer, adding value to the car and making the driving experience more enjoyable and comfortable. [2]

◇ **Second part: Exterior Washing**

1st. Step: Pre-Wash Stage:

After the initial inspection and before starting the actual washing process, a preliminary stage is conducted to prepare the car and facilitate the removal of dirt and stains. The car is completely sprayed with water to wet the dirt and reduce its adhesion to the car's surface.

By completing this preliminary stage well, the car is effectively prepared for the actual washing process, ensuring more efficient and effective cleaning of the surface and complete removal of dirt. [7]

2nd. Step: Basic Washing:

⇒ **Application of Cleaning Foam:**

After the initial rinse with clean water and basic surface cleaning, the application of cleaning foam follows to enhance dirt removal and provide a deep cleaning effect. The steps include: [7]

◆ **Using a Foam Gun:**

A special foam gun is used to spray the cleaning foam onto the car's surface. The gun is filled with an appropriate cleaning solution, which can be a mix of car soap and water. [7]

◆ **Covering the Surface with Foam:**

The foam is sprayed evenly across the car's surface, focusing on areas with heavy dirt accumulation. [7]

◆ **Waiting for the Foam to Take Effect:**

After spraying the foam, it is left to work on the car's surface for a certain period, which varies depending on the type of solution used and the degree of contamination.

Applying the cleaning foam helps in deep cleaning the surface and removing stubborn dirt and stains, providing an ideal effect for preparing the surface for final scrubbing and drying. [7]

⇒ **Manual Cleaning Using Special Gloves and Sponges:**

After applying the cleaning foam and allowing it to work on the car's surface, manual cleaning is done using special gloves and sponges to effectively remove the dirt. The steps include: [7]

◆ **Using Protective Gloves:**

Team members wear special gloves to protect themselves from cleaning materials and dirt, ensuring their safety and protecting the skin on their hands. [7]

◆ **Using a Soft Sponge:**

A soft sponge or special brush is used to gently clean the surface without causing scratches or damage to the paint. [7]

◆ **Scrubbing in Circular Motions:**

The team scrubs the surface in circular motions using the sponge or brush, which helps activate the cleaning agents and remove dirt effectively. [7]

◆ **Focusing on Difficult Areas:**

Special attention is given to hard-to-reach areas like openings, cracks, and window edges, using special tools to ensure thorough cleaning. [7]

⇒ **Final Rinse:**

After manual cleaning, it's essential to ensure all soap and dirt residues are completely removed to leave the car clean and shiny. The car is thoroughly rinsed using clean water and high-pressure hoses to remove all soap and accumulated dirt residues. A visual inspection is then conducted to ensure no soap or dirt residues remain on the surface. [7]

3rd. Step: Cleaning Tires and Wheels:

Tires and wheels are among the parts most exposed to dirt, dust, and oils that accumulate from continuous contact with the road. Keeping these parts clean not only enhances the car's overall appearance but also contributes to its performance and safety. [2]

Clean tires ensure good traction with the road, while clean wheels help prevent dirt accumulation that could affect the car's balance and efficiency. Regular cleaning of tires and wheels can also reveal any damage or unusual wear that might require immediate attention, helping to avoid major issues and extend the lifespan of the tires and wheels. [2]

This process requires using special tools and cleaners that efficiently remove dirt without damaging the materials the tires and wheels are made from. By following specific and systematic steps, the appearance and condition of the tires and wheels can be maintained, enhancing the car's aesthetics and ensuring safe and excellent performance on the road. [2]

4th. Step: Drying:

⇒ Manual Drying Using Microfiber Towels:

After the final rinse, it is recommended to manually dry the car using towels made from microfiber as they are soft on the surface and effectively absorb water without leaving any scratches on the vehicle's surface. The car is dried in circular motions with the towels to ensure the entire surface is covered and dried evenly, changing the towels regularly during the process to maintain their dryness and effectiveness, and paying attention to small details like cracks, openings, and joints to ensure they are well dried. [7]

⇒ Using Compressed Air to Reach Difficult Corners:

After manual drying with towels, it is advised to use compressed air to reach difficult corners and dry areas that might be hidden and hard to reach with towels. The steps include: [7]

◆ Controlling Air Pressure:

Adjust the air pressure to ensure it is not too strong to avoid damaging the paint or seals. [7]

◆ Using Compressed Air:

A compressed air device is used to blow air forcefully into difficult corners and areas that might contain water accumulations. [7]

◆ Focusing on Gaps and Cracks:

Focus on small gaps and cracks in the car like window edges, between the wheels, and under the bumpers to ensure any water residues are removed. [7]

◆ Final Inspection:

After using compressed air, a final inspection is conducted to ensure all water residues are removed and the difficult corners are completely dried. [7]

5th. Step: Final Touches:

Final touches are an integral part of the car washing process, adding the finishing touches that enhance the car's appearance and ensure its long-term protection. After completing the basic washing and drying, this stage adds shine and gloss and protects various surfaces from environmental damage. Final touches include a range of meticulous procedures like applying wax, cleaning and polishing windows, and treating tires and plastic parts. These steps not only improve aesthetics but also help maintain the car's value and safety, making it look its best and providing the driver with a comfortable and enjoyable driving experience. [2]

⇒ Cleaning and Polishing Glass:

Cleaning and polishing the car glass are essential steps to ensure clear and safe vision while driving. Clean glass not only enhances the car's aesthetics but also contributes to the safety of the driver and passengers. Over time, car glass is exposed to dirt, dust, fingerprints, and water spots, which can obstruct vision and affect the overall driving experience. Proper care of the glass requires using specialized products and tools to effectively clean it and remove all impurities and stains, in addition to polishing it to give it a clear, streak-free shine. By following precise and systematic steps in cleaning and polishing the glass, vision clarity can be maintained and the car's appearance significantly enhanced. The process includes the following steps: [2]

◆ **Choosing the Right Cleaner:**

Use a glass cleaner specifically designed for cars to effectively remove spots and dirt without leaving marks or streaks. [2]

◆ **Preparing the Glass for Cleaning:**

Ensure the glass is not too hot or exposed to direct sunlight when starting the cleaning to avoid rapid evaporation of the cleaner and leaving spots. [2]

◆ **Applying the Cleaner to the Glass:**

Spray the glass cleaner evenly on the surface. When working on the interior windows, spray the cleaner on a soft cloth instead of directly on the glass to avoid scattering the product on other interior surfaces. [2]

◆ **Cleaning the Glass:**

Use a clean, soft cloth, preferably made of microfiber, to rub the glass in circular motions or crosswise vertical and horizontal motions. This method helps avoid leaving streaks and marks on the glass. [2]

◆ **Cleaning Edges and Corners:**

Use the edge of the cloth to reach difficult edges and corners to ensure all dirt and dust are removed from those areas. [2]

◆ **Final Drying:**

Use a dry, clean cloth to dry the glass after cleaning. Wipe the glass in circular motions to ensure no cleaner or water residues are left. [2]

⇒ **Applying Tire Protection Materials:**

Applying tire protection materials is an important part of car maintenance, enhancing both its appearance and overall performance. Using special protection materials for tires helps prevent cracking and drying caused by exposure to environmental factors like UV rays and ozone. These materials create a protective layer on the tire surface, maintaining its flexibility and preventing early damage. Additionally, these materials give the tires a deep shine, making them look new and clean for longer. Regularly applying protection materials can improve tire durability and keep them looking their best, enhancing the car's overall appearance and extending the lifespan of the tires. [8]

⇒ **Applying Air Freshener in the Car:**

Applying an air freshener in the car is a simple and effective step to improve the air quality inside the car and make the driving experience more pleasant and refreshing. Air fresheners help eliminate bad odors and provide a long-lasting refreshing scent, making the car ride a comfortable experience for both the driver and passengers. [8]

III. Machines and Tools Used on mobile washing and vehicle detailing:

Mobile car washing is an advanced service that offers convenience and efficiency to car owners by providing comprehensive vehicle cleaning at the location chosen by the client, whether at home, work, or elsewhere. The quality and effectiveness of this service depend significantly on the tools

and materials used in the washing process. These tools and materials are carefully selected to ensure the best results without causing any damage to the vehicle. Together, they provide a high-quality mobile washing service that ensures customer satisfaction and keeps cars in the best possible condition. The combination of modern technology and advanced materials helps deliver a thorough and efficient cleaning service that meets the needs of today, providing convenience and time saving for car owners. [2]

III.1. Utility Vehicle for Mobile Car Washing:

A utility vehicle for mobile car washing is essential for efficiently and effectively providing mobile car wash services. This vehicle is fully equipped with all the necessary tools and materials to perform washing operations at any location chosen by the client. It enables the provision of a comprehensive and convenient service without the need for fixed infrastructure, offering ample storage space for all tools and materials, including high-pressure equipment, buckets, car cleaners, and hand tools. As indicated in figure 1

III.2. Water Tank:

The size of the water tank depends on the vehicle's size and the frequency of washing operations, typically ranging from 100 to 500 liters. A large tank ensures a sufficient amount of water is available for several washes before needing a refill. Water tanks are usually made from durable and lightweight materials such as fiberglass-reinforced plastic or aluminum to prevent corrosion and ensure a long service life. The tank should be designed to ensure even water distribution and prevent vibration during movement, with gauges for easy water level measurement. [10]



Figure 1 Water tank [11]

III.3. High-Pressure Water Pump:

The high-pressure water pump is a crucial tool in car cleaning, providing a strong and continuous water flow to effectively remove dirt and grime. With its ability to generate high water pressure,

this pump quickly and efficiently cleans the car's exterior, wheels, and tires, easily removing mud, oils, and stubborn stains that might be challenging with traditional methods. The high-pressure water pump is water-efficient, using less water compared to hand washing, making it an eco-friendly option. It saves time and effort by quickly and accurately cleaning large areas. This pump can also be adjusted for low-pressure cleaning of delicate interior parts, ensuring thorough and safe cleaning of every part of the car. Thanks to these benefits, the high-pressure water pump is an indispensable tool in mobile and professional car washing centers, guaranteeing high-quality service and satisfying results for clients. [12]



Figure 2 High pressure water pump [61]



Figure 3 Pressure washer with gun [13]

III.4. Electric Generator:

An electric generator is a vital component in a mobile car wash vehicle, providing the necessary power to operate all washing equipment and tools. The generator enables service delivery at any location regardless of external electricity availability, enhancing service efficiency and flexibility. The generator's key specifications include sufficient electrical capacity to run high-pressure pumps, vacuum cleaners, sanitizing devices, and lighting. Preferably, the generator should run on diesel or gasoline, considering durability, reliability, and quiet operation to avoid disturbances in residential areas. It should also be compact, easy to transport and store inside the vehicle, with an automatic control system for easy operation and fuel savings. With these specifications, the electric generator ensures reliable and sustainable performance to meet the needs of efficient mobile car wash services. [10]



Figure 4 Electric generator [14]

III.5. Steamer:

A steamer for car detailing is an invaluable tool for achieving a thorough and efficient clean. Utilizing high-temperature steam, this device effectively loosens dirt, grime, and stains from both the interior and exterior surfaces of a vehicle. Unlike traditional cleaning methods that rely heavily on chemicals, a steamer offers a more environmentally friendly approach, using only water to generate steam. The intense heat not only cleans but also sanitizes surfaces, killing bacteria and allergens, which is particularly beneficial for maintaining a healthy car interior. [2]



Figure 5 Steamer [62]

Additionally, steamers can reach into crevices and tight spots that are otherwise difficult to clean, ensuring a comprehensive detailing job. Whether tackling upholstery, carpets, dashboards, or even engine bays, a steamer provides a versatile and powerful solution for car enthusiasts and professional detailers alike. [2]

III.6. Air Compressor:

An air compressor is a vital piece of equipment in car washing services, playing a crucial role in improving the quality and efficiency of the washing process. The air compressor generates a strong stream of compressed air that can be used for various applications. In exterior washing, compressed air removes dirt and dust from hard-to-reach corners and crevices, such as ventilation grilles, window edges, and wheels, ensuring thorough and precise cleaning. In interior cleaning, it is used to blow out air forcefully to clean and dry different parts of the cabin, including seats, carpets, and tight spaces between interior panels, effectively removing dust and small debris. [15] Additionally, the air compressor is used in drying the car after washing, helping to remove water quickly from surfaces to avoid water spots and preparing the car for final polishing and finishing. With these versatile applications, the air compressor enhances the efficiency of the car washing process, ensuring high-quality and effective service for customers. [15].



Figure 6 Air compressor [16]

III.7. Vacuum Cleaner:

The vacuum cleaner is an essential tool in the car cleaning process, providing an effective means of removing dirt, dust, and debris from the interior of the car. Vacuum cleaners used in car washing are characterized by their power and flexibility, making them capable of handling various types of dirt, from small crumbs to dirt embedded in deep fabrics. Thanks to powerful motors and advanced filters, vacuum cleaners have a high capacity for suction, saving time and effort compared to traditional manual cleaning. They also come with a variety of attachments, such as narrow nozzles and soft brushes, which make it easier to clean different surfaces and hard-to-reach areas, whether it be leather seats, fabric upholstery, or even the dashboard. Vacuum cleaners equipped with HEPA filters help capture fine particles and allergens, improving the air quality inside the car and making it a healthier and cleaner environment. [10].



Figure 7 Vacuum cleaner [64]

With these benefits, vacuum cleaners help maintain the car's interior appearance, extending the life of fabrics and upholstery, and making the car look new for a longer period. Thus, they play a vital role in providing high-quality car washing services.

III.8. Retractable Water and Air Hoses:

Retractable water and air hoses are essential equipment that enhances the efficiency and effectiveness of the mobile car washing process. These hoses can be automatically retracted and returned to their place, making storage easy and preventing tangling and damage that can occur with traditional hoses. For water use, retractable hoses help deliver pressurized water conveniently and effectively to different parts of the car, whether cleaning the exterior, tires, or removing stubborn dirt from hard-to-reach corners. For air use, retractable hoses direct compressed air accurately for cleaning and drying both the car's interior and exterior parts or inflating tires. [15].

These hoses save time and effort during the washing process, allowing workers to easily extend the hoses to the required length and use them comfortably without dealing with tangling or clutter. After use, the hoses are quickly and easily returned to their original position, keeping the work area organized and tidy. With these features, retractable water and air hoses are a valuable addition to any mobile car washing service, enhancing efficiency and effectiveness and providing excellent service to customers. [15].



Figure 8 Retractable water hose [65]



Figure 9 Retractable vacuuming hose with attachments [17]

III.9. Foam and Water Gun with Foam cannon:

The foam and water gun, equipped with a foam cannon, is an important and innovative tool in the car washing process, combining efficiency and ease of use to provide comprehensive and effective cleaning. The foam gun mixes water with cleaning agents to produce thick foam that is directly applied to the car's surface. This gun evenly distributes the foam, ensuring complete coverage of the target surface and facilitating the removal of dirt and grease. [15].

The foam bottle is an integral part of this system, filled with cleaning agents and attached to the gun to ensure a continuous flow of foam during the washing process. This design improves the efficiency of cleaning agent use and reduces waste. [15]

This tool achieves impressive cleaning results quickly and easily, reducing the time and effort involved in traditional washing. The thick foam also protects the car's paint from scratches caused by excessive scrubbing, maintaining the car's appearance and shine. [15]



Figure 10 Foam cannon [66]

III.10. Sponges, Brushes, and Microfiber Towels:

Sponges, brushes, and microfiber towels are essential tools in the car washing process, providing effective and safe means to clean all parts of the car with precision and care.

◇ Sponges:

Sponges are used to evenly distribute water and soap over the car's surface, helping to remove dirt and grime without damaging the paint. High-quality, highly absorbent sponges are ideal for use with various cleaning agents to ensure thorough and gentle cleaning of surfaces. [15].



Figure 11 Sponge [67]

◇ Brushes:

Brushes come in various shapes and sizes to fit all parts of the car, both exterior and interior. Soft-bristled brushes are used to clean paint and sensitive surfaces without scratching them, while stiff-bristled brushes remove stubborn dirt from wheels, tires, and hard-to-reach areas. With their diverse designs, brushes allow access to narrow spaces and corners that might be difficult to clean with just a sponge. [15]



Figure 12 Full brushes kit [18]

◇ **Microfiber Towels:**

Microfiber towels are essential for drying the car after washing. These towels are highly absorbent and quick-drying, helping to prevent water spots and maintaining the paint's shine. Additionally, their soft fibers are gentle on surfaces, making them perfect for polishing glass, mirrors, and interior decorations without leaving scratches or marks. [15]



Figure 13 Microfiber towel [68]

By using sponges, brushes, and microfiber towels together, comprehensive and precise car cleaning can be achieved, enhancing quality and maintaining the car's shiny and attractive appearance. These tools improve the washing experience, making it more efficient and comfortable, ensuring customer satisfaction and enhancing the reputation of car wash services. [15]

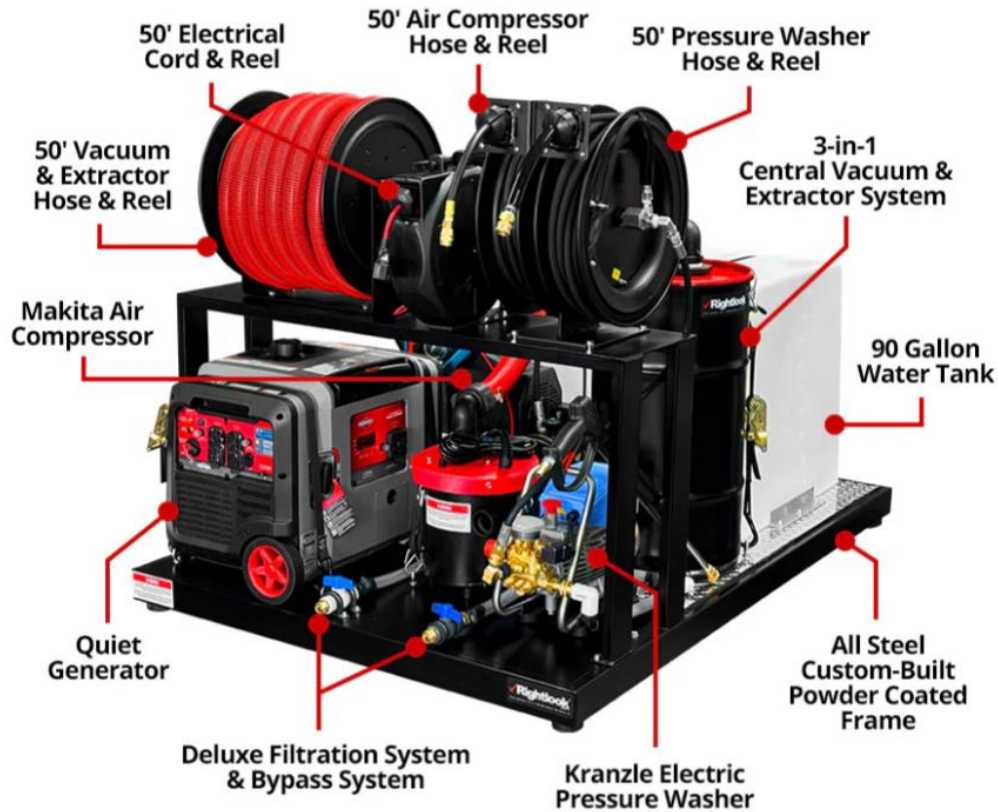


Figure 14 Full mobile washing and vehicle detailing unit [19]

IV. Materials Used on mobile washing and vehicle detailing:

IV.1. Exterior Cleaning Shampoo:

Exterior cleaning shampoo is a fundamental product in car washing, designed specifically to effectively remove dirt, grease, and stains that accumulate on the car's surface without causing damage to the paint. This shampoo features a special formula that generates a thick foam, lifting dirt and impurities gently, making rinsing easier without the need for intense scrubbing that could cause scratches. It contains mild ingredients that preserve the shine of the paint and provide a temporary protective layer against harmful environmental factors such as dust, acid rain, and UV rays. [20]



Figure 15 Cleaning shampoo [69]

Additionally, using exterior cleaning shampoo ensures uniform and comprehensive cleaning of all parts of the car, including the body, windows, and mirrors, enhancing the car's aesthetic appearance. Due to its effective properties, exterior cleaning shampoo is an integral part of professional washing tools, helping to keep the car in top condition and ensuring customer satisfaction with the washing services provided. [20]

IV.2. Engine Cleaner:

Engine cleaner is an essential tool in car maintenance and cleaning, used to remove grease and dirt accumulated on various engine parts. It helps maintain the engine's performance by removing deposits that could impede its function and reduce its lifespan. The engine cleaner contains an effective chemical formula that breaks down oils, greases, and other contaminants without harming the engine's sensitive components. Regular use of this cleaner improves ventilation and cooling of the engine, reducing the risk of overheating. [20] Additionally, cleaning the engine makes it easier to detect any leaks or mechanical problems that might be hidden under layers of dirt. Thanks to these benefits, the engine cleaner enhances the car's performance and prolongs its lifespan, while also giving the engine compartment a clean and attractive appearance, increasing the car's value and ensuring customer satisfaction with the quality of washing and maintenance services provided. [20]

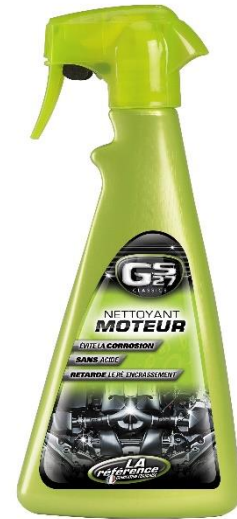


Figure 16 Engine cleaner [70]

IV.3. Interior and Exterior Plastic and Tire Restorer:

The plastic and tire restorer is an important product in car washing, playing a vital role in restoring the original appearance of plastic surfaces and tires. It is used to rejuvenate plastic parts damaged by environmental factors like UV rays, dust, and moisture, helping to remove fading and cracking. When used on interior parts like the dashboard, console, and doors, the restorer adds shine and a protective layer that keeps surfaces clean and glossy for a longer period. [20] On exterior parts such as bumpers and side trims, it restores the original color and gives them a new appearance. The tire restorer is essential for improving tire appearance, adding a deep shine, and preventing cracking and drying from continuous exposure to weather conditions. With these features, the plastic and tire restorer improves the overall appearance of the car and enhances its aesthetic value, making it look new and well-maintained, ensuring customer satisfaction with the quality of washing services provided. [20]



Figure 17 Plastic restorer [71]

IV.4. Headlight Cleaner and Restorer:

The headlight cleaner and restorer is an important product in car washing and maintenance, used to restore the clarity and shine of the car's headlights. Car headlights are exposed to various environmental factors like dust, rain, and UV rays, causing yellowing and degradation over time. The headlight cleaner and restorer helps remove dirt, oxidation, and yellowing from the headlight surface, restoring its original transparency and enhancing its lighting efficiency. [20] The product contains components that polish and protect the headlights from future degradation, extending their lifespan and maintaining driving safety, especially at night or in adverse weather conditions. Regular use of the headlight cleaner and restorer ensures the headlights perform at their best, enhancing the car's aesthetic appearance and increasing driver and passenger safety. With these benefits, the headlight cleaner and restorer is an indispensable part of car washing and maintenance services, providing effective and satisfactory results that improve the overall driving experience. [20]

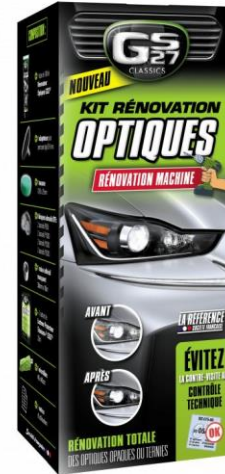


Figure 18 Headlight Cleaner and Restorer [72]

IV.5. Dashboard Cleaner:

Dashboard cleaner is an important product in car cleaning and maintenance, used to keep the interior of the car clean and beautiful. This cleaner features a special formula that removes dirt, dust, and fingerprints from the dashboard and surrounding plastic surfaces without causing damage. It also contains UV protection components that prevent the plastic from fading and cracking due to direct sunlight exposure. [20] The dashboard cleaner adds a natural shine and leaves a protective layer that helps reduce future dust accumulation, making maintenance easier and more effective. Its fragrant properties also improve the car's interior smell, enhancing the overall driving experience. Regular use of the dashboard cleaner maintains the car's interior appearance and prolongs the lifespan of plastic materials, increasing the car's value and ensuring customer satisfaction with the quality of cleaning services provided. [20]



Figure 19 Dashboard Cleaner [73]

IV.6. Leather Cleaner and Restorer:

Leather cleaner and restorer is a vital product in car cleaning and maintenance, used to keep the leather seats and other interior surfaces in excellent condition. This product features a specialized formula that removes dirt, stains, and oils without damaging the leather, helping to restore its natural and beautiful appearance. Besides cleaning, the restorer contains moisturizing components that nourish the leather, preventing cracking and drying, extending its lifespan, and maintaining its soft texture. [20]Regular use of the leather cleaner and restorer enhances the car's interior look, giving it a touch of luxury and elegance. It also provides protection from damage caused by continuous exposure to sunlight and other environmental factors. With these benefits, the leather cleaner and restorer is an indispensable tool in car washing services, ensuring the beauty and durability of leather surfaces and enhancing customer satisfaction with the quality of cleaning and care provided. [20]

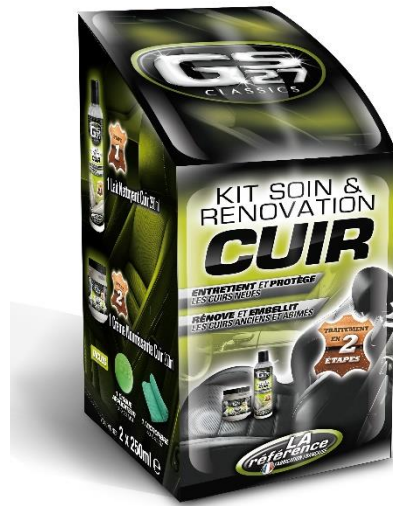


Figure 20 Leather cleaner and restorer [74]

IV.7. Fabric Cleaner and Restorer:

Fabric cleaner and restorer is an essential product in car cleaning and maintenance, used to care for fabric seats, interior upholstery, and other fabric surfaces inside the car. This product features a specialized formula that penetrates deep into fabric fibers, effectively removing dirt, stains, and impurities without damaging or discoloring the fabrics. Besides cleaning, the restorer contains components that help restore the freshness and softness of the fabrics, enhancing their overall appearance and prolonging their lifespan. [20] Regular use of the fabric cleaner and restorer helps maintain the cleanliness and beauty of the car's interior, also contributing to the removal of unpleasant odors and providing a fresh scent to the car. With these benefits, the fabric cleaner and restorer is an indispensable tool in car washing services, ensuring excellent and satisfactory cleaning results for customers, and keeping fabrics in their best condition for the longest time possible. [20]



Figure 21 Fabric cleaner and restorer [75]

IV.8. Glass Cleaner:

Glass cleaner is a fundamental tool in car washing, playing a significant role in maintaining the cleanliness and clarity of the windshield, windows, and mirrors. This cleaner features an effective formula that removes dirt, stains, fingerprints, and dust easily without leaving any unwanted streaks or marks. Additionally, the glass cleaner contains anti-fogging components that help maintain the clarity of the glass even in humid weather conditions. Using glass cleaner enhances visibility while driving, increasing safety on the road. It also adds shine and sparkle to the windows and mirrors, improving the car's aesthetic appearance. With these properties, the glass cleaner is an indispensable tool in car washing services, ensuring excellent and satisfactory cleaning results for customers, and keeping the glass in its best condition for the longest time possible. [20]



Figure 22 Glass cleaner [76]

V. Future prospects of car washing:

V.1. Water recycling system:

Water recycling system is an innovative solution for mobile car detailing, addressing both environmental and operational challenges. This system captures and treats the water used during the detailing process, removing contaminants through filtration, sedimentation, and chemical treatments. The cleaned water is then reused for subsequent detailing tasks, drastically reducing the need for fresh water. Implementing a water recycling system allows mobile car detailing businesses to operate more sustainably by conserving water resources, lowering operational costs, and minimizing environmental impact. This approach not only supports eco-friendly practices but also enhances the business's reputation by demonstrating a commitment to sustainability. [21]



Figure 24 Water containment mat [22]



Figure 23 Mobile water reclamation system [77]



Figure 25 Folded water containment mat [23]

V.2. Steam generator:

A steam generator is a valuable tool in mobile car detailing, offering an eco-friendly and efficient method for cleaning vehicles. Utilizing high-temperature steam, it effectively loosens and removes dirt, grime, and stains from various surfaces, including upholstery, carpets, and exterior paint. The steam not only cleans but also sanitizes, killing bacteria and eliminating odors without the need for harsh chemicals. This makes it ideal for a wide range of detailing tasks, from deep cleaning interiors to washing exteriors. The portability of steam generators enhances their practicality for mobile operations, allowing detailers to provide high-quality, water-efficient cleaning services on the go. This method not only improves the detailing process but also aligns with sustainable practices by reducing water usage and chemical runoff. [24]



Figure 26 Car cleaning with a steam generator [25]

Section two: Mobile polishing

I. Importance of car polishing:

Car polishing is essential for maintaining the appearance and longevity of a vehicle's exterior. It serves several crucial purposes:

I.1. Restoration of Shine:

Polishing removes surface imperfections such as swirl marks, minor scratches, and oxidation, restoring the paint's original gloss and enhancing the vehicle's overall aesthetic appeal. [26]

I.2. Protection:

By smoothing the paint surface, polishing helps to create a more uniform and reflective layer, which can then be sealed with wax or sealant to protect against environmental contaminants like UV rays, acid rain, and bird droppings. [26]

I.3. Value Retention:

Regular polishing can maintain or even increase a vehicle's resale value by keeping the exterior in top condition, which is often a key consideration for buyers. [26]

I.4. Surface Preparation:

Polishing prepares the paint surface for additional protective coatings, ensuring they bond properly and provide maximum durability and protection. [26]

I.5. Longevity:

By removing contaminants and reducing the risk of long-term damage to the paint, polishing helps extend the life of the vehicle's exterior, delaying the need for more costly repairs or repainting. [26]

II. Steps of mobile polishing:

After washing, scratch repair and car polishing are among the most crucial procedures to maintain the beauty and durability of a car's paint. The car's paint is exposed to numerous external factors that can cause scratches and erosion, such as dust, small stones, and UV rays. Although these scratches may seem minor, they can lead to bigger problems if not addressed promptly and efficiently. Polishing the car is a process aimed at restoring the paint's shine and removing surface imperfections, bringing back the car's original glossy appearance.

This process begins with a thorough cleaning of the car to ensure that all dirt and impurities that might affect the polishing results are removed. Then, specialized materials and polishing tools are used to remove the scratches and restore the paint's shine. Polishing requires precision and skill to ensure perfect results without causing further damage. Besides enhancing the car's aesthetic appearance, this process helps protect the paint from harmful environmental factors, extending its lifespan and maintaining the car's value.

Scratch repair and car polishing are not merely luxuries but necessities to keep the car in its best condition. Regular attention to these aspects allows car owners to ensure their vehicles remain attractive and well-preserved in the long term. This process involves several steps:

1st. Step 1: Surface Inspection

Inspect the car's paintwork under proper lighting to identify scratches, swirl marks, and other imperfections. Using inspection lights can help in spotting fine scratches and defects that are not visible under normal lighting conditions. [26]

2nd. Step 2: Clay Bar Treatment

A clay bar is used to remove bonded contaminants like tar, tree sap, and industrial fallout that washing alone cannot eliminate. Lubricate the surface with a clay lubricant and gently glide the clay bar over the paint to leave it smooth and free of contaminants. [27]

3rd. Step 3: Tape Off Sensitive Areas

Use painter's tape to mask off areas that should not be polished, such as plastic trim, rubber seals, and edges. This prevents accidental damage to these parts and ensures a focused polishing process on the paintwork. [28]

4th. Step 4: Choosing the Right Polishing Pad and Compound

Select the appropriate polishing pad and compound based on the severity of the scratches and imperfections. Heavier defects may require a more aggressive pad and compound, while lighter swirls can be addressed with a finer pad and finishing compound. [29]

5th. Step 5: Polishing Process

Attach the chosen pad to a dual-action or rotary polisher. Apply a small amount of polishing compound to the pad. Spread the compound on the surface with the polisher turned off, then turn it on at a low speed to spread the compound evenly. Gradually increase the speed and work in small sections using overlapping passes. The motion should be steady and consistent to avoid heat buildup and paint damage. This step levels the paint by removing a thin layer, thereby eliminating scratches and swirl marks. [30]

6th. Step 6: Removing Compound Residue

After polishing each section, use a clean microfiber towel to wipe off any remaining polishing compound. Inspect the surface to ensure the scratches have been removed. Repeat the polishing process if necessary to achieve the desired finish. [29]

7th. Step 7: Applying Scratch Remover

For deeper scratches that the polishing process does not completely eliminate, apply a scratch remover product. These products contain more abrasive compounds designed to level out deeper imperfections. Use the scratch remover according to the manufacturer's instructions, often involving application with a microfiber cloth or applicator pad and buffing until the scratch is no longer visible. [26]

8th. Step 8: Final Polishing

After addressing deeper scratches, perform a final polish using a finishing compound and a soft polishing pad. This step refines the paint further, enhancing the gloss and removing any minor imperfections left from the previous step [27]

9th. Step 9: Waxing and Sealing

Apply a high-quality car wax or paint sealant to protect the polished surface and enhance the shine. Waxing adds a protective layer that shields the paint from environmental elements and prolongs the life of the polished finish. Apply the wax in thin, even layers, allow it to haze, and then buff it off with a clean microfiber towel. [28]

10th. Step 10: Final Inspection

Conduct a thorough inspection of the entire vehicle under good lighting conditions. Ensure that all scratches, swirl marks, and polishing residues have been removed, and the surface is uniformly glossy and smooth. [30]



Figure 27 Car polishing [31]

III. Machines and Tools Used on mobile polishing:

III.1. Polishing Machine:

The polishing machine is an essential tool in the car polishing process and is necessary for achieving professional results. Polishing machines are available in two main types: Rotary Polisher and Dual Action Polisher. The rotary machine operates with a fixed circular motion and is effective in removing deep scratches and paint defects, but it requires skill and experience to avoid damaging the paint due to high heat concentration on a specific area. In contrast, the dual action polishing machine combines both circular and random movements, reducing the risk of paint damage and making it safer for use by both amateurs and professionals alike. [26] Polishing machines are characterized by their ergonomic design and ease of control, allowing for efficient application of polishing compounds and waxes. These machines help improve the paint's shine and remove surface defects, restoring the car to its original shiny appearance and preserving the paint's value and quality. By using the appropriate polishing machine, remarkable results can be achieved, highlighting the car's beauty and protecting it from harmful environmental factors. [27]



Figure 29 Rotary polisher [32]



Figure 28 Dual action polisher [78]

III.2. Polishing Pads:

Polishing pads are a vital element in the car polishing process, as they are used with the polishing machine to effectively apply polishing compounds and wax. Polishing pads come in different types, each designed for a specific purpose and different levels of abrasiveness. Foam pads are the most common and come in different colors indicating the levels of abrasiveness, from coarse to fine. [29] Coarse pads are used to remove deep scratches and major paint defects, while soft pads are used to apply final polishing compounds and wax, giving the paint a smooth shine. There are also wool pads used to remove deep defects, but they require more experience in use. Polishing pads are known for their ability to evenly distribute polishing compounds, ensuring efficient paint treatment and reducing the risk of damage. Choosing the right pad can make a big difference in the quality of the final polishing, enhancing the car's appearance and keeping its paint shiny and clean. [30]



Figure 30 Polishing pads [33]

III.3. Adhesive Tapes:

Adhesive tapes are essential tools in the car polishing process, used to protect parts that should not be exposed to chemical compounds or polishing, such as plastic and rubber edges, glass, and metal parts. Adhesive tapes help accurately define the areas to be polished, ensuring that polishing compounds do not reach sensitive areas or areas that could be damaged. [34] Thanks to their strong adhesive strength and easy removal without leaving residues, adhesive tapes provide effective and easy-to-apply protection. They also help reduce the time and effort spent on cleaning after polishing, preventing the spread of compounds to unwanted areas. Using adhesive tapes enhances the accuracy and efficiency of the polishing process, ensuring professional results and maintaining the final appearance of the car without damage. [35]



Figure 31 Adhesive tape [79]

III.4. Inspection Lights:

Inspection lights are an essential tool in the car detailing process, playing a crucial role in identifying imperfections that might be invisible under normal lighting conditions. These high-intensity lights illuminate the vehicle's surface, highlighting scratches, swirl marks, and other defects that need attention. [36] By providing a bright, focused beam, inspection lights allow detailers to perform a thorough examination and ensure that every flaw is addressed during the polishing and correction stages. They come in various forms, including handheld devices, portable stand-mounted lights, and headlamps, offering flexibility and convenience for different detailing tasks. Using inspection lights ensures that the final result is a flawless, high-gloss finish as every inch of the car's surface is carefully scrutinized and perfected. This attention to detail not only enhances the vehicle's aesthetic appeal but also maintains the integrity of the paintwork over time. [36]



Figure 32 Inspection light [80]

IV. Materials Used on mobile polishing:

IV.1. Clay Bar:

A clay bar is an essential tool in car detailing, designed to remove bonded contaminants from the surface of a vehicle's paintwork. These contaminants, which include tar, tree sap, industrial fallout, and brake dust, often cling to the paint and cannot be removed through regular washing alone. Using a clay bar is a straightforward process: the bar is lubricated with a clay lubricant to ensure smooth movement over the paint surface. [37] As the clay bar is gently rubbed across the vehicle, it picks up and traps the impurities, leaving the paint silky smooth and ready for polishing. This decontamination step is crucial for achieving a flawless finish, as it prevents these particles from causing scratches during the polishing process. Regular use of a clay bar helps maintain the paint's clarity and shine, ensuring that the vehicle's exterior remains in top condition. [38]



Figure 33 Clay bar [81]

IV.2. Paint cleaner:

Paint cleaners are specialized products designed to remove contaminants and impurities from a vehicle's surface, ensuring a pristine base before polishing or waxing. These cleaners effectively dissolve and lift stubborn residues such as tar, tree sap, bird droppings, and industrial fallout that regular washing might not eliminate. By penetrating the top layer of the paint, they help restore the car's natural shine and smoothness, making subsequent detailing steps more effective. Paint cleaners come in various formulations, including sprays, liquids, and gels, each tailored to different levels of cleaning intensity and types of contamination. [37] Their use is crucial for achieving a flawless finish, as they prepare the paint by removing embedded dirt and old wax layers, allowing polishes and waxes to bond better and last longer. Ultimately, paint cleaners enhance the overall appearance of the vehicle, ensuring it looks its best while providing a clean, smooth surface that protects against future damage. [39]



Figure 34 Paint cleaner [82]

IV.3. Scratch Remover:

Scratch remover is a specialized product used in car detailing to address and eliminate surface imperfections such as fine scratches, swirl marks, and scuffs from a vehicle's paintwork. Formulated with fine abrasives, scratch removers work by gently sanding down the edges of scratches and blending them into the surrounding paint, making them less visible or completely eliminating them. When used during the polishing process, scratch removers restore the smoothness and gloss of the paint, enhancing the overall appearance of the vehicle. These products can be applied by hand or with a polishing machine, depending on the severity and extent of the damage. By effectively removing surface defects. [40]

Scratch removers not only improve the car's aesthetic appeal but also prepare the paint for further protective treatments like waxing or sealing. Regular use of scratch removers can keep a car looking pristine, extending the life of the paint and maintaining its value. [41]



Figure 35 Scratch remover [83]

IV.4. Polishing Compounds:

Polishing compounds are critical products in car detailing, designed to refine and restore the vehicle's paintwork by removing imperfections. These compounds come in varying levels of abrasiveness, from heavy-cut for tackling deep scratches and oxidation to fine-cut for eliminating minor swirls and enhancing gloss. They work by using abrasive particles to level the paint surface, effectively removing a thin layer of clear coat or paint to smooth out defects. Polishing compounds are applied with either rotary or dual-action polishers, which enhance their effectiveness by ensuring even distribution and consistent pressure. [42]

Using the right polishing compound can transform a dull, scratched surface into a mirror-like finish, significantly improving the car's aesthetic appeal and value. Moreover, they prepare the paint for waxing or sealing by creating a smooth, flawless surface, ensuring that protective products adhere better and last longer. Proper use of polishing compounds not only rejuvenates the car's appearance but also extends the life of the paintwork by removing damaging contaminants and imperfections. [43]



Figure 36 Polishing compound [84]

IV.5. Titanium Wax:

Titanium wax is a premium car detailing product known for its exceptional durability and high-gloss finish. Infused with titanium particles, this advanced wax provides a robust protective layer on the vehicle's paintwork, shielding it from environmental elements such as UV rays, acid rain, and road grime. The unique formulation enhances the paint's depth and clarity, delivering a brilliant, mirror-like shine that can last for months. Titanium wax is particularly valued for its ability to resist harsh weather conditions and maintain its protective properties over an extended period, reducing the need for frequent reapplications. [44]



Figure 37 Titanium wax [85]

Its application is straightforward, often involving a simple spread and buff process, making it a favorite among both professional detailers and car enthusiasts. By using titanium wax, car owners can ensure long-lasting protection and an impeccable finish, keeping their vehicles looking new and well-maintained. [45]

V. Future prospect of car polishing:

The future prospects of car polishing are promising, driven by advancements in technology and an increasing demand for vehicle maintenance and aesthetics. Innovations in polishing materials and equipment, such as more effective and environmentally friendly compounds and high-tech polishing machines, are making the process more efficient and accessible. The rise of electric and autonomous vehicles, which often come with sophisticated paint finishes, is also boosting the need for specialized car polishing services to maintain their appearance and value. [46] Additionally, a growing awareness of the importance of regular car maintenance for extending vehicle longevity is encouraging more car owners to invest in professional polishing services. As consumers become more environmentally conscious, there is also a trend towards sustainable and eco-friendly polishing products and practices. Overall, the car polishing industry is poised for growth, with opportunities for businesses to innovate and meet the evolving needs of car owners. [47]

Conclusion:

In summary, this chapter provides a comprehensive guide to mobile washing, vehicle detailing, and polishing, divided into two main sections for clarity. The first section covers the steps of mobile washing and vehicle detailing, including preparation and inspection, pre-washing, detailed washing, thorough interior and exterior detailing, drying, and final inspection. It emphasizes the use of essential machines, tools, and materials such as pressure washers, foam cannons, detailing brushes, microfiber towels, and specialized cleaning agents. The second section focuses on the steps of mobile polishing, detailing the process of surface preparation, polishing to remove scratches and imperfections, and applying protective sealants or waxes. It highlights the necessity

Chapter I: Mobile washing and vehicle detailing and polishing

of quality tools like dual-action polishers, rotary buffers, and various polishing pads and compounds. By stressing the importance of proper techniques and high-quality materials, the chapter equips readers with the knowledge to achieve professional-grade cleaning, detailing, and polishing, ensuring vehicles are maintained to perfection.

The chapter provides a well-rounded understanding of both mobile washing and vehicle detailing, as well as the polishing process. By emphasizing the importance of preparation, the right techniques, and quality tools and materials, it equips readers with the knowledge needed to perform these tasks to a professional standard. Whether for personal use or as part of a mobile detailing business, these guidelines ensure vehicles are cleaned, detailed, and polished to perfection.

Chapter two: Prototype showcase

Introduction

Technology is used to simplify processes and improve efficiency, which increases the speed of operations and enhances communication between the seller and the customer. It also saves time and effort, leading to greater customer satisfaction. Additionally, it provides necessary information to the project owner. Therefore, technology plays a vital role in improving services across various sectors and continues to evolve to better meet the needs of society.

Using a mobile application for car wash services can offer many benefits, such as ease of booking, allowing customers to schedule a car wash service easily through the application without the need for a phone call or in-person visit. It saves time and offers service flexibility, enabling customers to choose the type of service that suits them and specify a convenient location for the car wash team. Customers can also track the washing process and know when it will be completed, a feature known as service tracking. Additionally, electronic payment is possible, and customers can view offers and discounts, which helps improve the quality of services provided. Overall, using a mobile application for mobile car wash services can provide the best service to customers and improve the efficiency of service delivery.

In this chapter, we will explain the stages involved in creating the electronic application and the tools and techniques used. We will also present several screenshots, clarify their purpose, and explain each one.

Section One: Tools and techniques used

I. The tools used



Figure 38 Tools and technologies used

I.1. Github

GitHub (/ˈɡɪtʰʌb/) is a developer platform that allows developers to create, store, manage and share their code. It uses Git software, providing the distributed version control of Git plus access control, bug tracking, software feature requests, task management, continuous

integration, and wikis for every project.^[6] Headquartered in California, it has been a subsidiary of Microsoft since 2018. [48]

I.2. Android Studio

Android Studio is an official integrated development environment (IDE) for Android app development, based on the JetBrains IntelliJ IDEA software. To support app development on the Android operating system, Android Studio uses a Gradle-based build system, emulators, code templates, and Github integration. Android Studio is Google's official integrated development environment (IDE) for the Android operating system, built on JetBrains IntelliJ IDEA software and designed specifically for Android development. The Android build system is a set of tools used to create, test, run and package your applications. [49]

Android Studio is also considerably faster than the eclipse, which, to be fair, must cover a wider range of development needs rather than just one, and can be performed on less powerful machines. The Gradles construction system uses the more specific Android functionalities provided by the Android Gradles plugin. [49]

Android developers rely on various plugins from Android Gradle and a custom construction logic to adapt the construction system to your applications. The Android Gradle 4.0.0 plugins include support for the build analyzer of Android Studio, which includes, using Java 8 language APIs (regardless of the minimum API level of your applications) and creating function-on-function dependencies between dynamic function modules. Android Studio isn't the only way to develop Android apps; other IDEs exist, like Eclipse and NetBeans, and it is even possible to develop a complete application using nothing more than the text editor and a command line. [49]

I.3. Flutter

Flutter is one software development kit (SDK) open-source user interface created by Google. It is used to develop applications for Android, iOS, Linux, Mac, Windows, Google Fuchsia and the web from a single code base. [50]

The main components of Flutter are :

- ◇ **The platform Dart**
- ◇ **The Flutter engine**
- ◇ **The Foundation library**
- ◇ **The design specific widgets**

I.4. Firebase

Store and sync data with our NoSQL cloud database. Data is synced across all clients in real time, and remains available when your app goes offline. [51]

The Firebase Real time Database lets you build rich, collaborative applications by allowing secure access to the database directly from client-side code. Data is persisted locally, and even while offline, real time events continue to fire, giving the end user a responsive experience. When the device regains connection, the Real time Database synchronizes the local data changes with the remote updates that occurred while the client was offline, merging any conflicts automatically. [51]

The Real time Database provides a flexible, expression-based rules language, called Firebase Real time Database Security Rules, to define how your data should be structured and when data can be read from or written to. When integrated with Firebase Authentication, developers can define who has access to what data, and how they can access it. [51]

The Real time Database is a NoSQL database and as such has different optimizations and capabilities compared to a relational database. The Real time Database API is designed to only allow operations that can be executed quickly. This lets you build a great real time experience that can serve millions of users without compromising on responsiveness. Because of this, it is important to think about how users need to access your data and then structure it accordingly. [51]

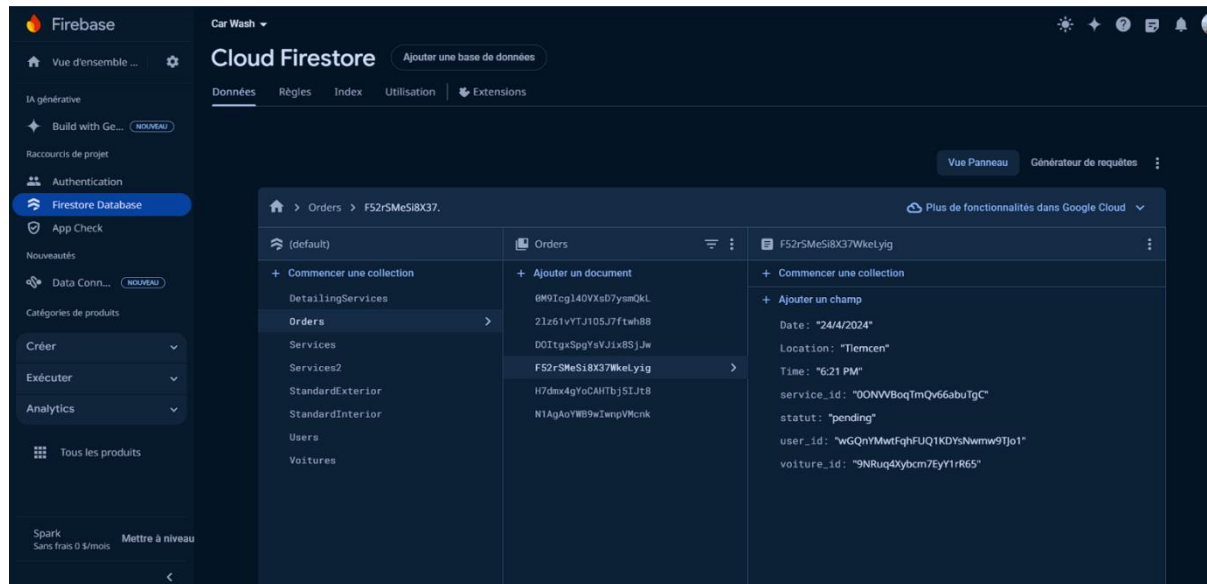


Figure 39 Programming stage in Firebase

II. Work Methodologies

We divided the work into several stages to accelerate the task completion process and organize it. We divided it as follows: Stage 1 Project Definition, Goal Setting and Needs Identification, Market Study, Stage 2 Super Admin Account Interface, Stage 3 Admin Account Interface, Stage 4 User Interface.

1st. Stage: Project Definition, Goal Setting, Needs Identification, Market Study

⇒ **From March 3rd to March 21st:**

This stage involved researching the project idea in neighboring countries to obtain the required information. We also researched potential competitors directly or indirectly within the country and counted the potential customers. Additionally, we prepared a list of materials and equipment necessary for the project. The graduation thesis was also one of our concerns during this stage, so we dedicated time to completing the business plan and writing the general introduction.

2nd. Stage: Super Admin Account

⇒ **From March 25th to April 8th:**

This stage focused on researching the permissions that can be granted to the super admin account, such as creating an admin account or knowing the number of cars each account owner has worked on individually. We also focused on developing the application and writing some parts of the graduation thesis.

3rd. Stage: Admin Account

⇒ **From April 14th to April 28th:**

In this stage, we researched the permissions that should be granted to the admin account, such as knowing the number of registered users, changing service prices, and seeing customer orders in detail. We developed the application from this perspective and wrote other parts of the graduation thesis.

4th. Stage: User Interface

⇒ **From April 30th to May 17th:**

In the fourth stage, we focused on researching what falls under the user interface domain, such as service offers, prices, and profiles. We programmed these aspects and continued writing the graduation thesis, starting with the business model canvas.

III. General architecture of the system

III.1. Overview

The general engineering of the customer's application was developed using the Flutter system, which is based on the MVVM (Model-View-ViewModel) system. It provides several models as a data presentation model, representing the ways of displaying the user interface. The user interface elements are the graphical components used to create the display methods.

This engineering helps to separate concerns and make the code more systematic and reusable. By leveraging efficient data management and communication with the backend through a REST API interface, the engineering consists of:

◇ **Models:**

Models are classified into a data source category and are listened to by specific display methods (UI). Whenever the model is modified, it notifies the followers to update the dependent displays. Models are responsible for managing data and its state.

◇ **Widgets:**

In Flutter, any graphical user interface element is represented by a widget. User interface elements can be predefined elements by Flutter, such as buttons, navigation bars, text groups, etc. They can also be custom user interface elements created to meet the specific needs of our mobile applications. [52]

◇ **Display Methods:**

Display methods represent the user interface that the user interacts with. Each screen in the application is a separate display. Display methods consist of a sequence of graphical components called user interface elements. [53]

◇ **Communication with the Backend (Firebase):**

This is a service provided by Google that stores data. It acts as a link between the user interface and the backend, providing several other services such as facilitating registration with Google, Facebook accounts, etc. It also stores data, files, images, and provides notification services. [54]

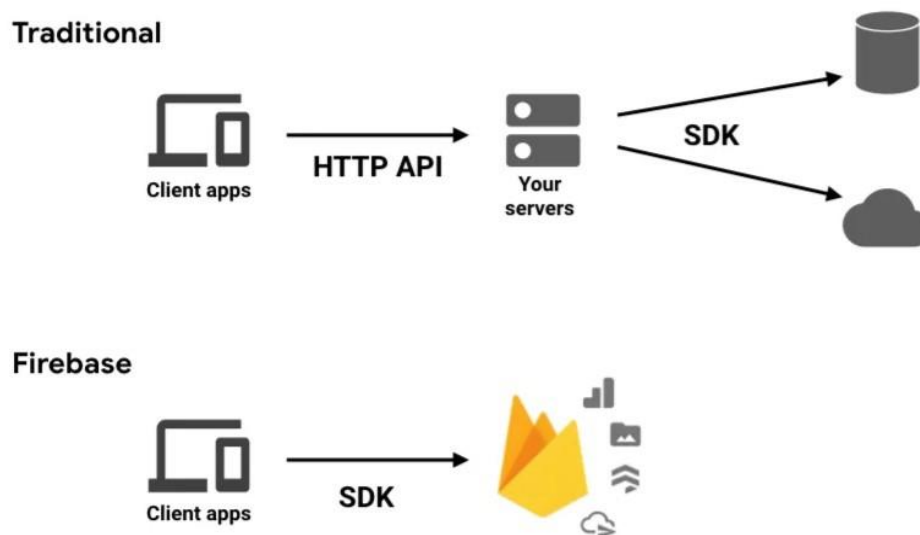


Figure 40 Firebase system [54]

III.2. Other technologies used

◇ Google Maps API

Google Maps API, now called Google Maps Platform, hosts about 17 different APIs, which are themed under the following categories: Maps, Places and Routes.

After the success of reverse-engineered mashups such as chicagocrime.org and housingmaps.com, Google launched the Google Maps API in June 2005 to allow developers to integrate Google Maps into their websites. It was a free service that did not require an API key until June 2018 (changes went into effect on July 16), when it was announced that an API key linked to a Google Cloud account with billing enabled would be required to access the API. The API currently does not contain ads, but Google states in their terms of use that they reserve the right to display ads in the future. [55]

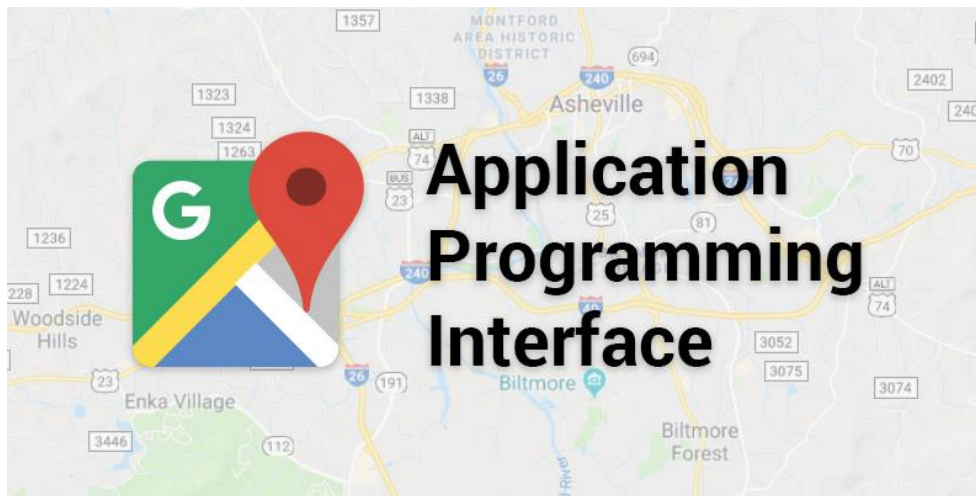


Figure 41 Google maps API [56]

◇ Electronic payment

Concept began to appear Electronic payment And his urgent need after the emergence of e-commerce. The electronic payment process that you know online payment An integrated financial process of systems and programs is provided to facilitate financial procedures over the Internet. Online payment is an electronic currency exchange for the purchase of goods or services.

This process operates according to laws that guarantee the confidentiality and privacy of buying and selling procedures. Speak electronically via the Internet, through the use of a secure payment system, encrypted information printed on your card and various confidential details. Companies and sites interested in this field differ according to their financial outlook. [57]



Figure 42 Electronic payment with EDAHABIA [86]

Class diagram

Sequence diagrams, commonly used by developers, model interactions between objects in a single use case. They illustrate how the different parts of a system interact with each other to perform a function, and the order in which interactions occur when a particular use case is executed.

We will present the different diagrams that we created in the following figure.

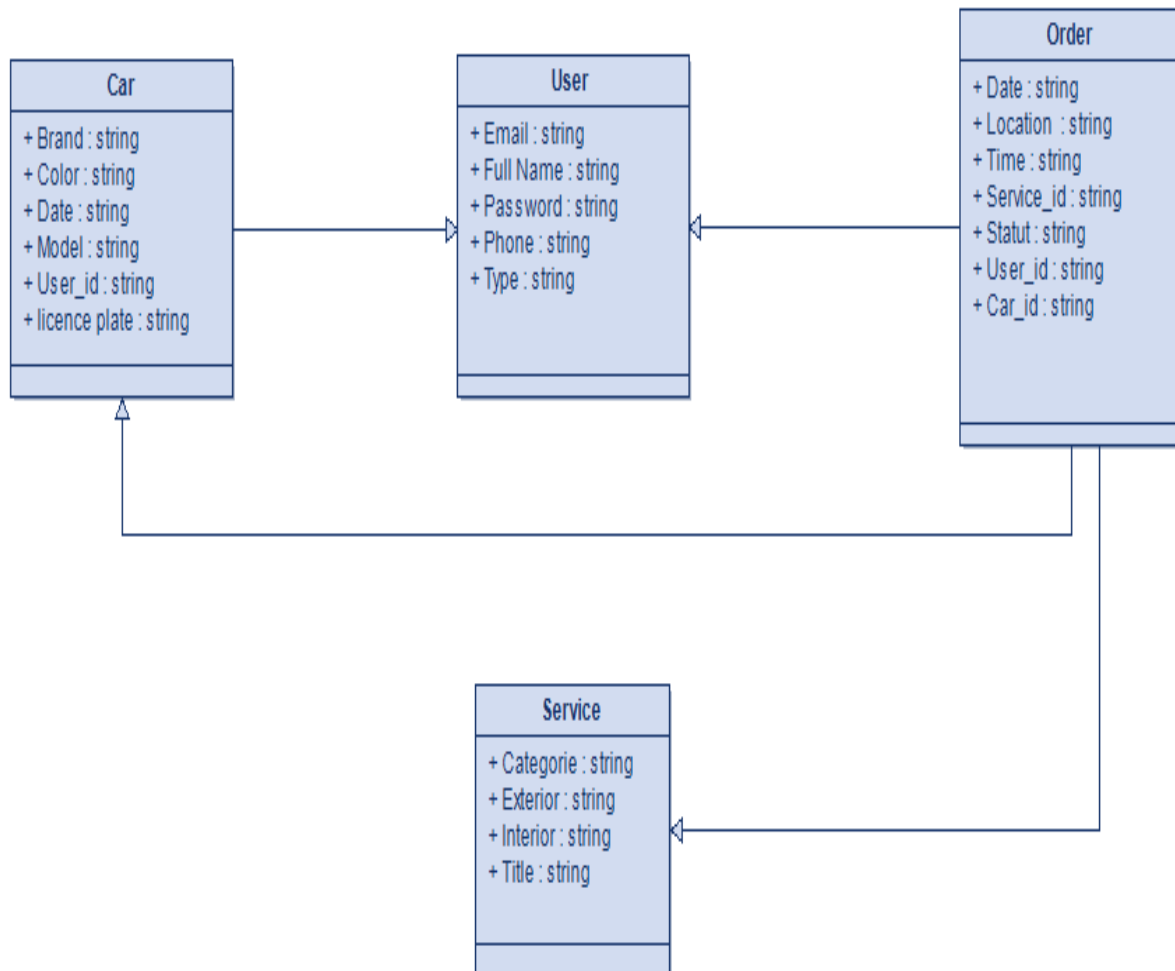


Figure 43 Class diagram

General Conclusion:

This thesis focused on designing and creating a solution for the problem of limited time faced by many workers and the discomfort women feel when going to traditional car wash shops. Our solution is a mobile car wash service that relies on an application to communicate with customers, aiming to provide convenience for Algerian citizens and develop the technology sector in Algeria.

To create this application, we prioritized research. After identifying all the work requirements needed to satisfy car owners, especially in our community, we started developing the user interface according to the general preferences of web application users. This approach makes the application easy to use, meaning car owners won't need any guidance to use the application.

To meet the customer's needs, we began by using UML (Unified Modeling Language) to design use cases, system sequences, and class diagrams. For the application itself, we used a framework called Flutter to develop it, allowing us to receive customer requests and access all the information we need from them.

In conclusion, this project has been extremely fruitful for us. We have gained some experience in the fields of programming and car washing. We are particularly satisfied with the results obtained, although there are still areas that need improvement. As for future plans, we will work on developing the application by integrating artificial intelligence and using more advanced car washing equipment, such as steam washing machines.

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Abstract

Today, cars are one of the essential elements in our lives, and their cleanliness should be one of our priorities as it reflects our personal cleanliness and plays a significant role in maintaining the cleanliness of our environment. However, car owners often do not have enough time to go to traditional car wash shops and wait for long periods. Therefore, Our goal was finding a solution to this problem: a mobile car wash service which is based on an electronic application to receive requests from car owners. To achieve this, we researched all the necessary equipment to provide a mobile car wash service. For the application, we used Firebase to link the application's front end with the back end, serving as the information center. We used Flutter because it is a suitable framework for creating applications with advanced technologies to facilitate the work.

Keywords: Mobile Car Wash, Car Owners, Electronic Application.

Résumé

Aujourd'hui, les voitures sont l'un des éléments essentiels de notre vie, et leur propreté devrait être l'une de nos priorités car elle reflète notre propreté personnelle et joue un rôle important dans le maintien de la propreté de notre environnement. Cependant, les propriétaires de voitures n'ont souvent pas assez de temps pour se rendre dans les ateliers de lavage traditionnelle et attendre longtemps. Par conséquent, Notre objectif est trouver une solution à ce problème : un service de lavage mobile de voitures qui se base sur une application électronique pour recevoir les demandes des propriétaires de voitures. Pour y parvenir, nous avons recherché tout l'équipement nécessaire pour fournir un service de lavage mobile de voitures. Pour l'application, nous avons utilisé Firebase pour relier l'interface de l'application avec l'arrière-plan, servant de centre d'information. Nous avons utilisé Flutter car c'est un cadre approprié pour créer des applications avec des technologies avancées pour faciliter le travail.

Mots-clés: Lavage Mobile de Voitures, Propriétaires de Voitures, Application Électronique.

ملخص

تعتبر اليوم السيارات أحد العناصر الأساسية في حياتنا و نظافتها يجب أن تكون أحد أولوياتنا فنظافتها من نظافتنا الشخصية ولها دور هام في نظافة محيطنا ولكن بالرغم من كل هذا لم يعد لأصحاب المركبات الوقت الكافي للذهاب إلى ورشات الغسيل التقليدية و الانتظار لفترات زمنية طويلة، لهذا هدفتنا من خلال هذا العمل إلى إيجاد حل لهذا المشكل وهو خدمة الغسيل المتنقلة للسيارات والتي تركز على تطبيق إلكتروني لتلقي طلبات أصحاب المركبات لإنجاز كل هذا قمنا بالبحث عن كل المعدات اللازمة لتقديم خدمة غسيل السيارات المتنقلة أما بالنسبة للتطبيق، استعملنا firebase للربط بين واجهة التطبيق والخلفية فهي مركز المعلومات، استخدمنا flutter لأنه إطار عمل مناسب لإنشاء التطبيقات فهو يحتوي على تقنيات متطورة لتسهيل العمل .

الكلمات المفتاحية : الغسيل المتنقل للسيارات، أصحاب المركبات، تطبيق إلكتروني.

