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Lean manufacturing concept application for the Sub Station Door of Mercedes-Benz



I. Introduction

1. Background study and motivation

Mercedes-Benz Vietnam, established in 1995, has been strongly contributing and becoming a vital factor in developing the domestic automobile industry. Recently, the main products of MBV are Sedan (C200, C300, E180, E200) and Sport Utility Vehicle (GLC200, GLC300). With an area of 95000 m² and 100% foreign investment, the MBV capacity is estimated at 5000 cars, mainly served for the Asian markets and Europe markets.

In the industrialization and modernization era, fossil fuel energy resources have been at an alarming rate, requiring the demand for energy consumption to be gradually shifted from nonrenewable energy to renewable energy, and electricity is always one of the best alternatives for dealing with these problems. It is clear that gasoline machines like gasoline cars are much more tarnished than electrical products. Thus, in the last few years, Mercedes-Benz Vietnam has decided to use most of its production costs to develop electric vehicles instead of petrol cars. According to the "GO GREEN" project of Mercedes-Benz Vietnam, with the goal of sustainability business, by 2030, 50% of the vehicles produced at Mercedes-Benz Vietnam will be electric vehicles reducing emissions and hazardous waste in the environment as well as protecting natural resources, keeping up with the development speed of new trends in the automobile industry. Due to this reason, the cost of maintaining gasoline vehicle production in Vietnam must be reduced. This puts dramatic pressure on Mercedes-Benz Vietnam, especially the production department. This is also a challenging opportunity for Mercedes-Benz Vietnam to implement its promising new improvement projects.

From 2021, the project on lean manufacturing of the production department, especially the assembly department, is vigorously implemented to standardize the work steps of each station on the Assembly line and upgrade the layout of the Assembly line to reduce operation costs. The lean manufacturing project was carried out to check all the work steps at the assembly line to eliminate production waste and restructure the layout to reduce operating costs.

2. Research problem

With many years of operation in the automotive industry, the Mercedes-Benz Vietnam factory always holds the first position in the CKD countries in Southeast Asia. However, the factory production process still has much waste, especially for the assembly line.

Standardized Work Instruction: most of the procedures recorded in the CGIS are recorded by the Daimler group based on the modern production line of Mercedes-Benz Germany; therefore, it generally concludes that it is essential to have a new Standardized Work Instruction that is modified by orders, the priority of the process, processing time, ... in order to facilitate the management and supervise procedure of MBV. Without Standardized Work Instruction, the production situation of MBV has worsened, such as redundant workforce and machines, much significant queue time of the system, and so on.

Layout: the current layout of MBV is a challenging problem. Although redrawn many times, the assembly line layout cannot satisfy the requirement of operators and team leaders. Moreover, with the goal of producing more than 50% electric automobiles in 2030, the layout of gasoline automobiles should be improved in order to run three car models (C, E, GLC) in a unique layout instead of three layouts are necessary.



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3. Purpose and goal

In order to enhance the operation performance, the MBV factory must continuously improve and develop not only in the process but also in strategy. Moreover, with customers' increasing demands today, products with good color, design, quality, and price must always be focused on and appreciated by MBV. MBV requires continuous improvement and precision in each plant's operating procedures to achieve those expectations.

The main goal of the thesis is to improve the operational performance of the assembly line and facilitate the management process of MBV. Standardized Work Instruction will be the top priority to decrease production waste. Moreover, transparent data will assist the manager in scheduling and arranging daily tasks. Besides remaking SWIs, applying a standard layout will help reduce production costs and shorten the takt time for each car model.

The report also gives the reader an understanding of some fundamental concepts in Lean manufacturing and a particular method to analyze the problem, find the root cause, and plan to give a better solution for any problems. Moreover, the efficiency of the Lean concept in manufacturing will be demonstrated through the improvements in Mercedes-Benz.

4. Scope and Limitation:

This thesis covers only the problems in the assembly shop:

Assembly shop SWI only uses the problems in the Assembly shop and offers appropriate methodologies to clarify the problems and provide solutions for the Assembly shop. The problems in the Assembly shop are mainly to reduce the redundancy of labor, standardize the process, and provide reasonable solutions to help the operation in the Assembly shop be better.

Layout: the problem of Layout only focuses on solving the station Door because the station Door has raised almost all the problems that the Assembly layout has, such as the delivery process and the non-standard working process creating the unstandardized layout standard, the layout taking up a lot of space does not bring high efficiency.

Limitation: đợi hoàn thành gần xong report sẽ bổ sung do hiện tại vẫn chưa chắc đc phần limitation sẽ là cái gì.

II. Analysis of current data and layout

1. History and Milestones

a. Mercedes-Benz Group

One of the most well-known trucks, buses, and automobile manufacturers worldwide, is Mercedes-Benz. The business is regarded as one of the oldest automotive manufacturers still in operation. Daimler-Benz initially had ownership of the business. It belongs to the parent firm, Daimler AG (formerly DaimlerChrysler AG).

The company's original roots are thought to have originated from two wholly distinct branches. "Benz & Co. Rheinische Gasmotorenfabrik Mannheim" was established in 1883 by Karl Benz (Rhein Mannheim Benz & Co. Gas Engine Factory). The business made available the first vehicles bearing the Benz Patent Motorwagen brand in 1886. The business has become one of the world's largest automotive manufacturers in just 15 years.

In 1890, Gottlieb Daimler and Wilhelm Maybach jointly founded "Daimler Motoren Gesellschaft" (DMG - Daimler Engine Company).

In 1901, the first cars under the Daimler-Mercedes brand were first sold by Daimler Motoren Gesellschaft.

On June 23, 1902, DMG decided to use the Mercedes name as a trademark for its automobile production and officially registered the trademark on June 26.

In 1907, Maybach departed the DMG. Daimler-Benz AG was formed in 1926 by merging two businesses, Benz & Co. Rheinische Gasmotorenfabrik Mannheim and Daimler Motoren Gesellschaft (Daimler-Benz Joint Stock Company). The new automaker is a merger of Mercedes-Benz and another well-known automaker.

From 1907 to today, Mercedes Benz has been trying to maintain its position in the automobile industry. With the quality and credit built over a century, the Mercedes Benz logo has been regarded as a symbol of luxury.

b. Mercedes-Benz Viet Nam:



Figure 1: Mercedes-Benz Viet Nam

A joint venture between the German company DAIMLER AG and the Saigon transportation mechanical conglomerate SAMCO, the business was founded in 1995. Mercedes Benz Vietnam is one of the first automakers to produce and supply commercial cars to the Vietnamese market.

Address: 693 Quang Trung street, Go Vap district, Ho Chi Minh city.

Area: 95 000 m² (included: one functional area, one production area, one product testing, and testing area, and one training center).

1995: Mercedes Benz received an investment license in Vietnam and started to build a factory in Ho Chi Minh city.

1996: CKD automobile assembly factory officially operated with the first product, E 200.

1997: Mercedes Benz opened the largest sales and maintenance center in Giang Vo, Ha Noi Capital.

2000: Mercedes Benz got ISO 9002 AND ISO 14001 certificates.

2002: Mercedes Benz opened a customer center on the factory premises in Ho Chi Minh City.

2012: Mercedes Benz Vietnam transformed from a joint venture to a diverse private sector and expanded its dealer network with 11 sales and after-sales service points nationwide.

2013: The factory invested in the Zircobond ED powder coating system and won the SEAward Best Service Award with the highest customer satisfaction index in the group's 8 Southeast Asian markets.

2015 - now: Mercedes Benz Vietnam has been a luxury passenger car brand with a dealer system spanning ³² Hanoi, Hai Phong, Da Nang, Nha Trang, Ho Chi Minh city.

2. General Background Information

a. The scale of operation

Number of employees: 850 employees

Number of offices: 15 offices

Number of factories: 1 factory (Mercedes Benz Viet Nam)

b. Direct Customer Mix

With 18 dealers in Vietnam, Mercedes Benz Vietnam's customers are mainly domestic customers and neighboring countries. It is estimated that 6000 Mercedes Benz is bought by Vietnamese every year.



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Figure 2: Dealers of Mercedes Benz Viet Nam

3. Organizational chart



Figure 3: Organizational Chart

Company value chain:

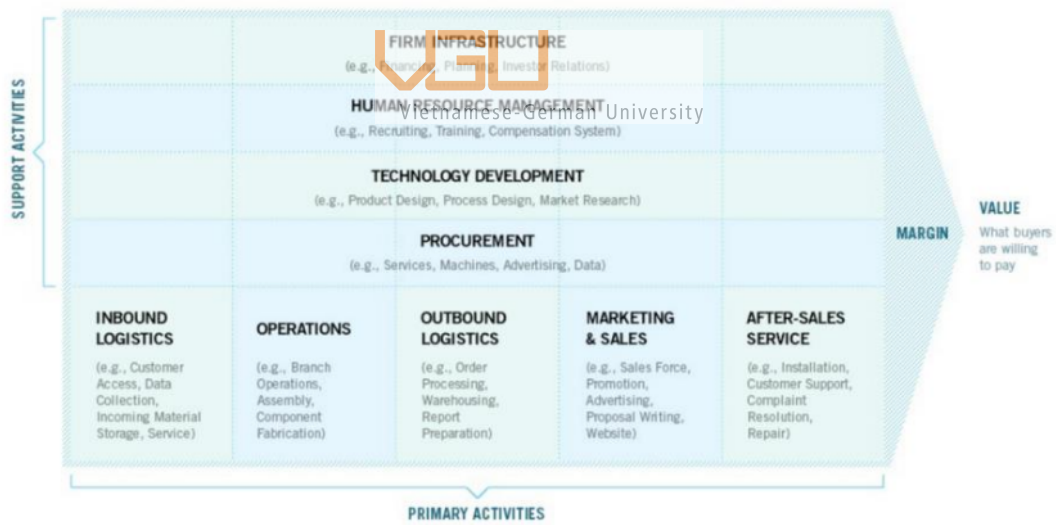


Figure 4: Companies value chain

Primary activities:

Inbound Logistics: Mercedes-Benz engages in inbound logistics to receive, store, and distribute product inputs. Through architecture, material management, and product storage, receiving and storing client information for a digital media corporation. Mercedes-Benz presently outsources the majority of its inbound logistical activities.

Operation: Activities that aid in the conversion of raw materials into final goods. Almost materials are imported from Germany and Russia, so Mercedes Benz is in charge of making the body, painting, assembling, and finishing a complete car.

Outbound Logistics: Mercedes Benz is responsible for delivering finished items to channel partners and customers. Outbound logistics duties include processing, scheduling, order fulfillment for wholesalers and retailers, distribution networks, and warehousing.

Marketing and Sales: Mercedes-Benz engages in marketing and sales activities to give avenues for customers to purchase the company's goods. Marketing, pricing, channel selection, sales force management, advertising and promotion, and so on are all part of it.

Services: For the product to be effectively used, Mercedes-Benz must provide maintenance and after-sales assistance. Mercedes-service Benz's options include after-sales maintenance, software product forward and backend alignment, component supply, installation services, and training.

Support activities:

Firm Infrastructure: The infrastructure support functions of Mercedes-Benz include finance and accounting, general management, quality management, planning, and legal services. Although the scope varies since Mercedes Benz is a diverse organization even within the industry, Mercedes Benz's athletic infrastructure activities serve the whole value chain. At Mercedes-Benz, for example, quality control, accounting, and legal issues are handled at the business unit level, while finance and strategy are handled at the corporate level.

Human Resources Management (HRM): Human Resources Management support tasks include recruitment, hiring, skill evaluation, people planning, training & development, selection, and pay at corporate and business unit levels. Human resource management has an influence on every company's competitive edge, but it is more important in certain sectors. Human resources, for example, are a crucial source of competitive advantage in consulting organizations.

Component design, technology selection, field testing, feature design, and process engineering are all examples of technology development activities.

Mercedes-value Benz's chain makes use of inputs obtained as part of ⁷ the company's procurement processes. It does not include the actual purchasing inputs. Purchased inputs include raw materials, supplies, machinery, lab equipment, office equipment, and construction.


Procurement: Mercedes-value Benz's chain relies on inputs obtained as part of ⁷ the company's procurement processes. It does not include the actual purchasing inputs. Purchased inputs include raw materials, supplies, machinery, lab equipment, office equipment, and construction.

II.

Methodology:

Lean manufacturing theory:

Lean manufacturing is a technique that seeks to improve production efficiency without increasing costs. The term "waste" is used to describe anything that consumers do not view as valuable and therefore are not willing to pay for. ²⁰ Shorter lead times, lower operating costs, and higher product quality are just a few of the benefits of lean manufacturing.

Businesses in a wide variety of sectors can benefit from lean manufacturing, which also goes by the names lean production and lean. Numerous well-known brands, including Toyota, Intel, John Deere, and Nike, have adopted lean practices. ⁴ Many companies, Toyota included, use this method because it is based on the Toyota Production System.  Vietnamese-German University

Principles like Kaizen and constant refinement form the backbone of lean manufacturing.

²⁵ The five principles of lean production are:

1. Identify value from the customer's perspective: Assess worth from the buyer's point of view. Producers generate value, but consumers assign it. Business owners need to learn how much a customer values a product or service in order to establish an appropriate price. ⁵ The company should strive to eliminate waste and expenses from its business processes in order to achieve the optimal price for the customer and maximize profits.

2. Map the value stream: ²⁷ According to this theory, inefficiencies and areas for growth can be uncovered by tracking and analyzing the flow of data or resources needed to manufacture a given good or service. The entire product lifecycle, from raw materials to disposal, is taken into account when mapping the value stream.

Checking for waste at each stage is essential. Everything of no use must be disposed of. The lean mindset recommends including supply chain alignment in this effort.

3. Create flow: Find ways to shorten the lead time and remove any practical obstacles. This guarantees that the order-taking and fulfillment phases run smoothly. Waste management relies on a steady stream of traffic. Lean manufacturing is predicated on eliminating wasteful processes and facilitating a streamlined workflow by eliminating bottlenecks.

4. Establish a pull system: This means that no extra work is done unless absolutely necessary. Lean production relies on a pull system rather than a push system.

Manufacturing resource planning (MRP) systems rely on push technology. In a push system, production is timed to meet expected demand rather than the other way around. However, forecasts are often off, which can lead to fluctuations in stock levels, delays in delivery times, and subpar customer service.

In contrast to MRP, lean production relies on a "pull" system in which no goods are acquired or manufactured unless there is an actual need for them. Pull requires pliability and interaction.

5. Pursue perfection with continual process improvement, or Kaizen: Lean manufacturing is based on the principle of continuous improvement through the elimination of waste across the value stream and the identification and removal of the causes of quality problems.

Lean manufacturing eliminates eight common inefficiencies:

The Toyota Production System identified seven wastes, or activities and materials that reduce value for the customer. Here are the seven categories of trash:

- Defects
- Waiting time
- Extra motion
- Excess inventory
- Overproduction
- Extra processing
- Unnecessary transportation
- Unutilized talents

Lean manufacturing is based on seven ideas and tools, including:

In lean production, all non-value-added activities, or "waste," must be eliminated without fail. Therefore, the lean manufacturing principle of continuous improvement is crucial.

Other crucial lean ideas and practices are:

Heijunka: By releasing work to the plant at the necessary rate and avoiding interruptions, Heijunka, a method for leveling or smoothing production, aims to produce a continuous flow of production.

Heijunka is a Lean technique for balancing a production process and minimizing the possibility of overload. Heijunka is the Japanese word for "leveling" It can enhance capacity utilization and fluctuating demand response times.

In response to fluctuating demand, Heijunka enables businesses to switch from batch production to order fulfillment. If demand decreases, you will not need to maintain as much inventory, allowing you to save money.

When demand is high, your team and process will not be overwhelmed because you will produce value at your takt time, or average sell rate.

Toyota is the most well-known company employing Heijunka in the world. Utilizing a flexible assembly line, the Japanese automaker no longer manufactures vehicles in batches but rather on demand.

Leveling by volume:

Avoid batch processing when establishing a steady work flow to produce only what was ordered and reduce inventory costs.

In its purest form, Lean recommends waiting for an order before beginning new work. This may not be a viable alternative for businesses that receive a steady stream of new orders and need only to adjust their workflow to meet demand.

Utilizing Heijunka, production can be sustained regardless of demand fluctuations.

Leveling by type:

Heijunka can be used to achieve type-based parity when managing a portfolio of products. You can organize your efforts and increase production to meet the average demand for each product in the portfolio.

Produce adequate quantities of each product to meet the portfolio's average demand.

The 5S methodology is an approach to workplace organization that aims to boost productivity and efficiency while reducing hazards and the number of accidents on the job. 5S is a methodology that promotes order and cleanliness. The goal of the 5S program is to make workplaces generally cleaner and more organized. The 5S methodology is also known as arranging, shining, standardizing, and maintaining. Well-organized workplaces contribute to the standardization of processes, which is essential for their maintenance and implementation. Woolson and Husar illustrate employee engagement from a customer-centric perspective. Ask yourself, "What would a customer think if they walked into the plant and saw a filthy work area with unlabeled materials and employees not engaging in standardized procedures?" From this vantage point, employees can recognize the importance of office cleanliness. First impressions cannot be reversed.

- Sort: Sorting entails arranging items in a logical order and eliminating anything that does not belong.
- Set in order putting everything you need to do your job efficiently in a place where you can easily find it
- Shine: put on a show by keeping your workspace, tools, and equipment in impeccable condition.
- Standardize: Creating uniformity in office cleaning, sorting, and maintenance.
- Sustain: Self-disciplined effort sustains the developed process.



Figure: 5S method

Kanban is a signal used to create JIT delivery and streamline processes. Through a system, it is also possible to transmit physically-based signals, such as a tag or an empty bin, electronically.

The term "kanban," which originates from the Japanese for "visual board" or "sign," has been used as a noun meaning "system" or "method" since the 1950s. Toyota developed and first implemented this system to ensure timely manufacturing.

There are six pillars upon which the Kanban method of managing services and transitions is built:



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1. **Start with what you do now:** The first step in implementing Kanban, which is focused on continuous improvement, is to gain an appreciation for existing processes and workflows.
2. **Agree to pursue incremental, evolutionary change:** Instead of making massive changes all at once, Kanban encourages incremental, iterative ones over time.
3. **Encourage acts of leadership at all levels:** Kanban should be used to encourage leadership at all levels of an organization, not just among managers and team leaders. Anyone can take on a leadership role, and good ideas can come from anywhere.
4. **Focus on customer needs and expectations** Focus on satisfying the needs and anticipating the expectations of your customers. The purpose of Kanban is to

improve the worth and quality of services provided by catering more closely to customers' wants and needs.

5. **Manage the work, not the workers:** Kanban promotes self-organization within teams according to the tasks at hand, rather than top-down management.
6. **Regularly review the network of services:** Kanban promotes teamwork by regularly reviewing the entire network of services and inviting input from staff on how to enhance the quality of their work.

Jidoka is a technique that lays out a plan for when something goes awry so that you can stop what you're doing, fix the problem, and then figure out what went wrong. Jidoka is a widely used Lean technique in production and new product development. Known by its technical name, **autonomation** safeguards businesses against delivering defective or subpar products to customers on time.

Andon: A flashing light or other visual signal to inform employees of an issue.

Poka-yoke: A safeguard against human error, such as an alarm that sounds if a necessary step is skipped, a sign that shows when a bolt has been tightened the right number of times, or a program that won't let you move on until you've finished everything in the previous section.

Poka-Yoke is useful in any situation where errors or inefficient procedures are possible. It can be incorporated into any manufacturing or service procedure for effective error prevention:

- **Processing error:** An important part of the procedure was skipped or not done in accordance with standard operating procedure.
- **Setup error:** A setup error occurs when the wrong tools are used or when the machine is not properly adjusted.
- **Missing part:** Not every component goes through welding, assembly, etc.
- **Improper part/item:** Mislabeled or otherwise defective manufacturing components.

- **Operations error:** Performing an operation incorrectly or relying on an out-of-date specification constitutes an operational error.
- **Measurement error:** Measurement error can be caused by a number of factors, including human error during testing, inaccurate machine calibration, or incorrect part dimensions from the manufacturer.

Cycle time: A component's or a process's cycle time is the total amount of time it takes to go from beginning to end.

III. The Standardization project:

With the continuous improvement and development mindset, Mercedes Benz Viet Nam has been making an effort in all production activities, especially for the assembly shop. The standardization project was first launched at the assembly shop applying the lean manufacturing concept to eliminate waste and increase the capacity of the assembly line.

1. Lean manufacturing concept:

Lean Manufacturing, also known as Lean Production, is a system of tools and methods to continuously eliminate all waste in the production process, originating mainly from the Toyota Production System (TPS). The main benefit of lean Manufacturing is to reduce production costs, increase output and shorten production time. In other words, Lean Manufacturing aims to create more value for customers with fewer resources by eliminating seven types of waste: overproduction, inventory, motion, defect, over-processing, waiting, and transport. Furthermore, the Lean concept aims to reduce process and production cycle time by minimizing waiting time between stages, process preparation time, and changeover time.

- Improve plants based on efficient material flow arrangement.
- Reduce the resources needed for quality control.
- Keep closer relationships with better quality and more reliable suppliers who can supply small batches of materials and parts directly to manufacturing processes suitable for production; minimize inventory.
- Use electronic communication with suppliers and customers.

- Streamline the overall product to eliminate product models that bring little added value to customers.
- Design products with fewer components that are more common.
- Design products and services where customer customization is possible based on standardized parts and modules and as new as possible.

2. Applying Lean manufacturing concept in Mercedes Benz Viet Nam:

Approach method/ Phương pháp tiếp cận



Figure 1: Approach method

Step 1: Recording videos of assembly process

Step 2: Analyzing the assembly process of Assembly line and making Standardized Work Instruction

Step 3: Multiply to all station at Assembly line

Step 4: Visualize automatically Bottlenecks based on job assignment of each operator

Step 5: Regular line balance and continuous improvement at all levels

Step 6: Introduce to all shop leaders for implementation

3. Roll-out procedure of project:

Stage 1: Analysis and SWI building (including: step 1, step 2)

At the first stage of the project, the intern team will record the working processes of the Assembly line, apply the Yamayumi analysis method, and Spaghetti Chart in order to create the first Standard Work Instruction (SWI). Based on analyzing the standard assembly processes, five primary work elements are considered:

- Installing: this process is known as eHPV (engineering hour per vehicle). It involves an operator installing the prepared pieces onto the automobile body. Connecting wires, filling gasoline tanks, and running machinery are all examples of this activity.
- Moving is classified into two sorts: the first is a move in which an operator travels a large distance to complete an operation, such as transferring a car to the next station or completing parts from a subassembly station to the main line. Another example is when an operator walks to trolleys and shelves storing components to pick up items and inspect them before installing them.
- Checking: checking sometimes known as second-hand checking, this operation involves one operator inspecting the conditions of produced parts to ensure that previous operators completed the process appropriately. An operator marks the installed region with a red marker after examining the condition of the component.
- Documentation: the action of an operator involving papers, stamping, and labeling.
- Waiting: an operator does nothing.



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Stage 2: Multiplying SWI concept and visualizing data (including: step 3)

With the first Standard Work Instruction concept, the intern team applies it to all Assembly line stations, and after that, the data of all stations is visualized in order to recognize bottleneck stations.

Stage 3: Giving proposal improvements (including step 4)

After the bottleneck at the assembly line, the intern team detailedly processes at bottleneck stations. Spaghetti charts have usually been used to visualize operators' paths during assembly. After analysis, improvements will be made to reduce production time while ensuring product quality and safety for operators. Improvements are often focused on the moving direction of the operators or the layout to cut down on the operator's travel time. Once the proposed improvements have been completed, a meeting will occur between senior managers, group leaders, and the intern team to discuss and select the most appropriate improvements.

Stage 4: Applying improvements (including: step 5, step 6)

The application of the selected improvements will be deployed by the group leaders on the assembly line. Furthermore, a follow-up meeting will take place weekly for senior managers and group leaders to give the results of improvements and show problems while running the improvement process.

4. Yamazumi chart

The Yamazumi chart, as previously indicated, represents the time duration of every single operator activity during a single working cycle, with adjustments made in a matter of seconds. It has the look of a stacked bar. A broad chronology is counted from the start uphill on a vertical graph. Overworked processes may be easily discovered using the Yamazumi chart. It is critical for balancing and changing the operations of the stations. Furthermore, eHPV (per vehicle engineered hour) and MV (manufacturing variable) activities are color-coded according to the kind of work.

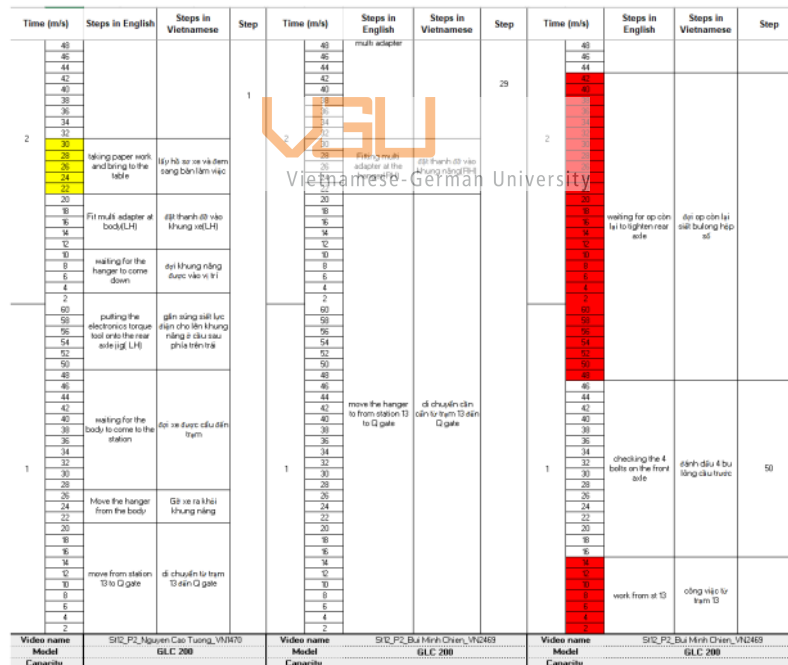


Figure 2: Yamazumi Time Analysis

White color: eHPV (engineering hours per vehicle) is considered value-added work. It refers to tasks that directly boost the value of a product from the customer's perspective, such as installing, tightening, connecting, and so on. Because these process stages are critical to the car's construction, they always account for most of the overall work element. The optimal green color ratio for the entire process is from 65% to 80%, and the greater the ratio, the leaner the output.

Yellow color: represents MV (manufacturing variable), which mainly indicates travel motion. These acts are considerably more significant, despite the fact that they do not immediately contribute to automobile installation. That is why they are referred to as non-value-added work. The most prevalent actions of this work part are shopping and checking. They might be deemed to be reduced if they take a long time. Time reduction of these tasks depends on the activity's nature; each work will use its method to reduce time suitably. The Spaghetti chart is appropriate for actions that need the operator to go a significant distance, such as shopping. Furthermore, they are not graded based on how long the checking stages take. As a result, these tasks must be recorded several times, and the time of those recordings will be compared to determine the most efficient communication technique with the Quality Department.

Red color: the color red denotes ~~virtually no value-added work~~ and is used to depict waiting time. The waiting element exists because the assignment is unreasonable or because operators do distinct procedures but are all in the same place. Thus one must wait for another to finish. This work aspect must be removed entirely in order to improve the process. By doing so, labor waste is eliminated, and the operators' idle time is reduced, increasing the proportion of eHPVs and improving assembly line productivity. The color red represents almost little value-added work and represents waiting time. The waiting element exists because the assignment is inappropriate or because the operators do different tasks but are in the exact location. As a result, one must wait for another to complete. This component of the job must be eliminated in order to enhance the process. This reduces operators' labor waste and idle time, boosting the proportion of eHPVs and enhancing assembly line productivity.

The bottom rows show the title of the video, the automobile model, and the aim of the day's manufacturing plan.

The content of the activities in English and Vietnamese is shown below. Because each part has its unique name, the interns should agree with the group leaders on how the parts should be referred to. Their names may not be academically proper for Vietnamese material, but they must comply with the operators' customary calling. Furthermore, the CGIS document is the primary source for the name. The color identification approach immediately determines whether or not activities are minimized. By removing non-value-added activities, the organization may save money and time to concentrate on more valuable duties.

5. Pie chart and Pareto chart

After analyzing and identifying problems at any bottleneck station, the intern team will analyze the graph and processes of that particular station to suggest appropriate improvements.

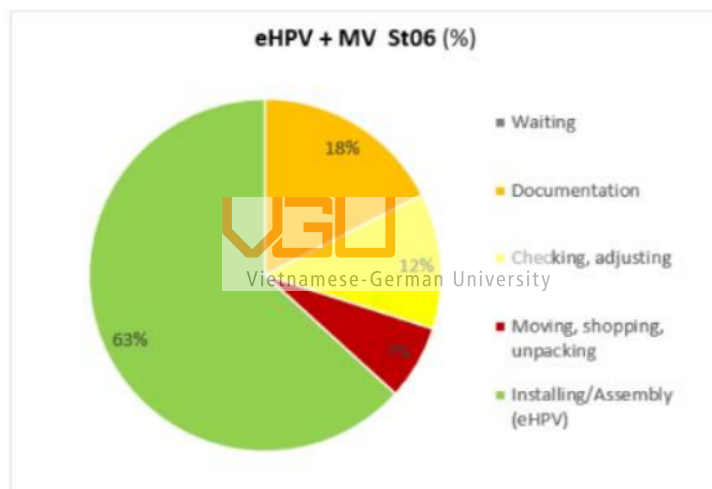


Figure 3: eHPV + MV St06

The graphs above shows the percentages of work elements at station 6. Through the graph, the work elements add no value to the product, like Waiting, Documenting, Moving, shopping, and unpacking account for a high percentage, so they should be cut. The methods used to reduce workers' working time are based on a detailed analysis of five work elements:

+Installing: assembly is considered a job that adds value to the product. Typically, the corporation will organize training sessions to improve workers' qualifications or equip them with advanced machines and new technologies to support workers in working to increase production efficiency.

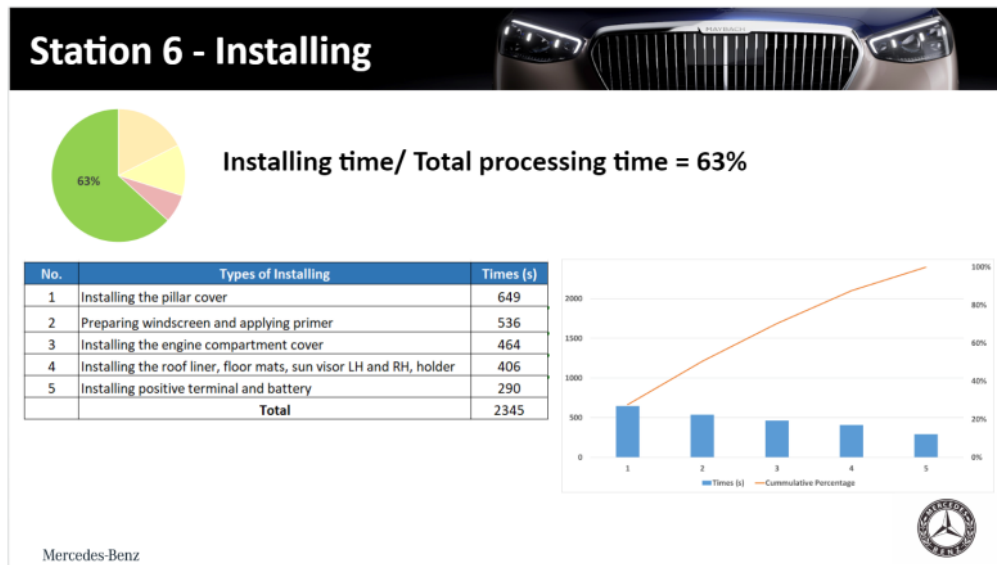
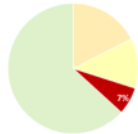


Figure 4: Installing time at Station 6

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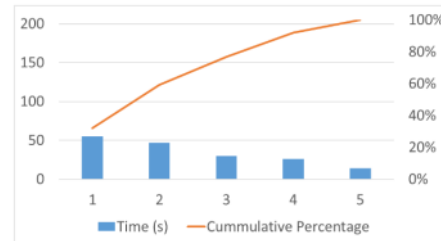
+ Moving: This type of work needs to be carefully considered before being put into the assembly process because it occupies a significant part of the worker's working time. We must consider many aspects to reduce this work, including operator movement habits during production and Layout.

Station 6 - Moving



Moving time/ Total processing time = 7%

No.	Type of Moving	Time (s)
1	Preparing the partition wall	55
2	Shopping the B, C, D pillar cover	47
3	Shopping for the next car	30
4	Shopping parts for the engine compartment	26
5	Cleaning up	14
	Total	172



Mercedes-Benz



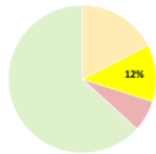
Figure 5: Moving time of Station 6

Common methods used to simulate worker movement is spaghetti diagrams and layout rearrangements.



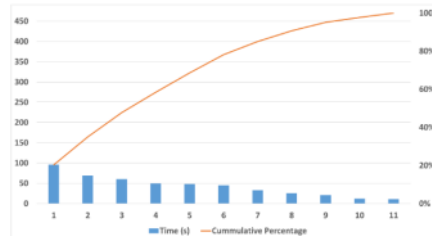
+ **Checking** is essential to ensure a complete assembly process and good product quality. However, the production time will be extended if the checking process is misused for its purposes or the inspection process is still unreasonable. At the Mercedes-Benz factory, all inspection procedures are intertwined with the assembly process. If one worker is in charge of assembly, another worker will perform the inspection to ensure impartiality. Moreover, it is necessary to consider whether the installation of the part is essential to check or not or whether the function can be checked with other factors to save time. This shows, even more the importance of a proper due diligence process. For example, for the insulation panel installed under the vehicle, both plan the undercarriage and insulate the body from the road surface. Therefore, after installing the insulation board on the body of the car, the operator should care whether the insulation board is stable and has been installed tightly on the vehicle instead of paying attention to the surface of the vehicle. Because it is definitely during the inspection of the car before delivery to the customer, this insulation will be scratched.

Station 6 - Checking



Checking Time /Total processing time = 12%

No.	Type of Checking	Time (s)
1	Removing the engine protective tape in engine compartment	96
2	2nd hand checking (4 holder,cover in A B C D pillar LH & RH)	69
3	Checking sunvisor	60
4	2nd hand checking seat belt on B pillar and LH&RH C-pillar	50
5	Checking primer with UV light	48
6	2nd hand checking the plug on the battery positive terminal	45
7	2nd hand checking the fuse box in engine compartment	33
8	2nd hand checking harness at partition wall	26
9	2nd hand checking retaining hook at the engine hood	21
10	2nd hand checking the battery positive terminal	12
11	Tightening and 2nd hand checking safety belt rear	11
	Total	473



Mercedes-Benz



Figure 6: Checking time of Station 6

+ **Documenting:** the profile stamping is usually to confirm that the part has been installed on the vehicle or has been re-checked for the second time after being installed on the vehicle. The long stamping time is often due to the workers unreasonably sharing one job with another. For example, a worker has stamped and visually checked the screws on the car, even though he used a screw checker once before. Visual inspection of fasteners is redundant as fasteners need to be checked for tightness after they have been installed rather than just checking the outer surface of the screw.

+ **Waiting:** waiting is the work step that needs to be reduced as much as possible and deserves the most attention. Based on lean manufacturing, a modern production line always wants waiting time to disappear from their line completely; they only accept some reluctant cases of waiting. Mercedes-Benz also applied this concept to production; the factory only required jobs to wait. For example, during the assembly process, each time the vehicle moves from one station to another, operators must wait for the car to be fixed on the pedestal to secure the vehicle before proceeding with the assembly. However, in some cases, Waiting is not acceptable. For instance, during assembly, an operator must wait for operators for unknown reasons, this timeout must be removed from the assembly process, and the group leader must perform calculations to reassign the work.

The improvement consideration meeting: Mercedes-Benz engineers will identify the problems and make the necessary improvements based on the issues analyzed. These improvements will be the main topic of debate in the improvement consideration meeting. The goal of this meeting is for the intern team, group leaders, and senior managers to evaluate the positives of the improvement and agree on what improvements should be implemented in the future.

6. Bar charts

a. Bar charts are used in visualizing the comparison between stations of the Assembly line:

The cycle time numbers for each station were displayed on a public dashboard. In Excel, a cycle time bar chart was constructed using data from a table coupled with SWI information.

The dashboard's primary role is to display the cycle time of each station as well as the deviation of the longest and quickest operators in each station. The appropriate takt time is computed and shown by the red line based on the production schedule and total working time of a day. Next, the display of the relevant data, the following step identifies the bottleneck as the station with a cycle time bar greater than the takt time frame (red line). Furthermore, the station's considerably significant deviation must be taken into account while assigning tasks to the operators.

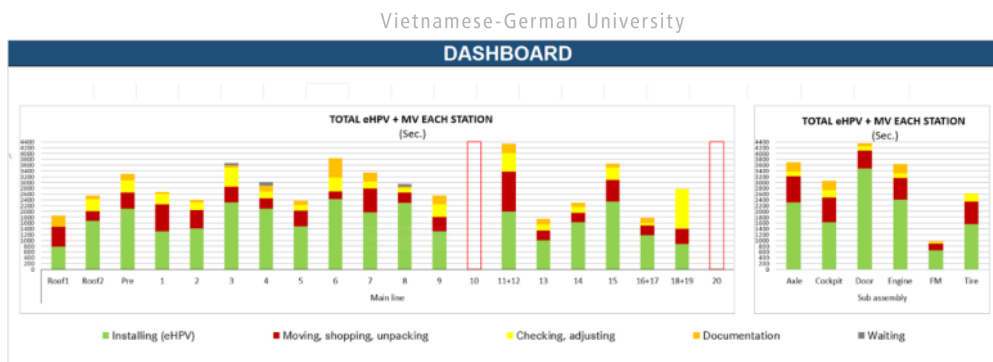


Figure 7: TOTAL eHPV + MV EACH STATION

Looking at the figure, we will see the distribution of the types of work: Installing, Moving, shopping, unpacking, checking, adjusting, and documenting at each station. The installation work takes up the most time at all stations. This car is an excellent testament to the efficient operation of the Mercedes-Benz factory, especially for the Assembly line. However, the types of work that

do not add value to the product (Moving, shopping, unpacking; Checking, adjusting; Documenting; Waiting) still take up a significant amount of time in the factory vehicle assembly process. Therefore, it is necessary to have the plan to reduce the time of these work steps.

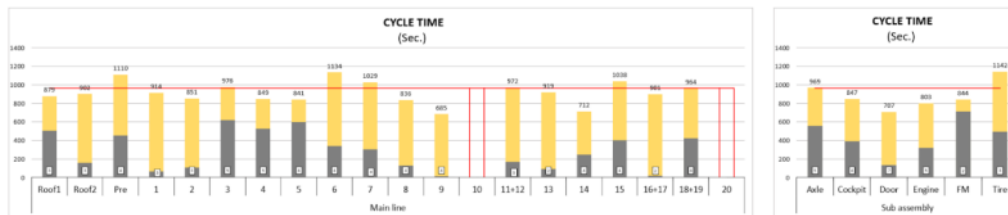


Figure 8: Cycle time of each station

With a takt time of 28 cars per day, many stations take longer to assemble than takt time, such as Station Preparation, Station 6, Station 11+12, Station 15, Station Tire, and Station Axle. These stations are currently bottlenecks of the plant, so they will be prioritized to analyze carefully and take necessary measures to overcome them. Moreover, the graph also shows the deviation between the operator of the Operator with the highest working time and the operator with the lowest working time of each station. A more significant Deviation (grey color) indicates an uneven distribution of work in a station.

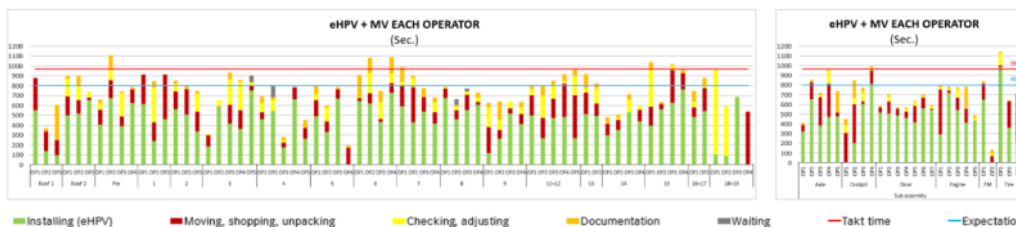


Figure 9: TOTAL eHPV + MV of each operator

In detail, the working time of each Operator is visualized on the chart to help the group leader have a basis for a more reasonable division of work. In addition, the types of work that each Operator has to do are presented through the chart showing the workload of each Operator.

Through the three charts above, the overview of the current situation at the stations on the assembly line is transparently presented to help senior managers and group leaders understand the current problems facing the plant. All data is collected and analyzed based on fact-based trust; this data is the foundation for improvements in stations.

b. Bar charts are used to visualize the result after improvements in each station of the Assembly line:

After identifying the Assembly line problems and finding solutions, the group leaders will implement the improvements in 2 months. The intern team will continuously update the upgrades and improved results during the improvement process every two weeks.

The figure above shows the information updated at station 6 after two months of implementing the improvement measures. Data is updated to prepare for follow-up meetings to correct the situation at the Assembly line after improvements have been made.

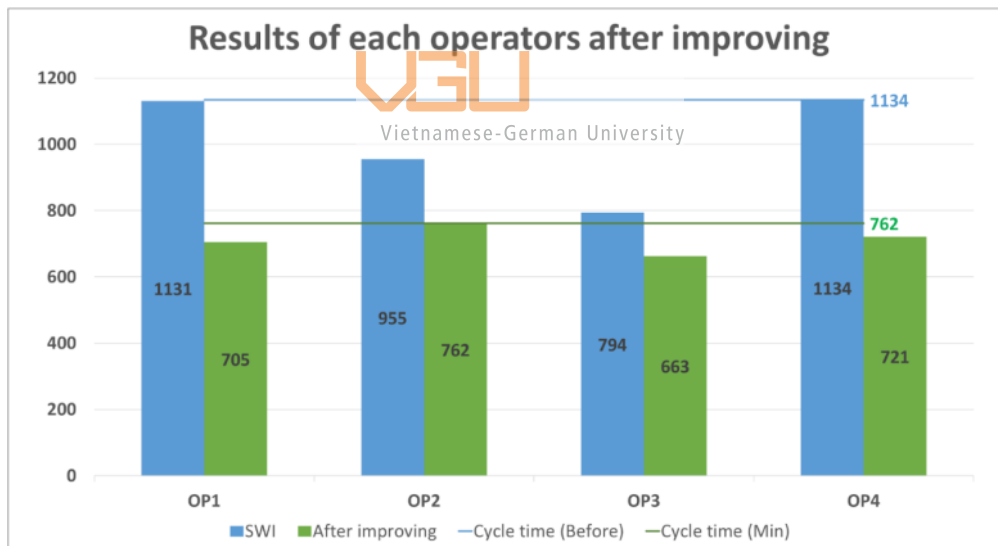


Figure 10: Results of each operator after improving

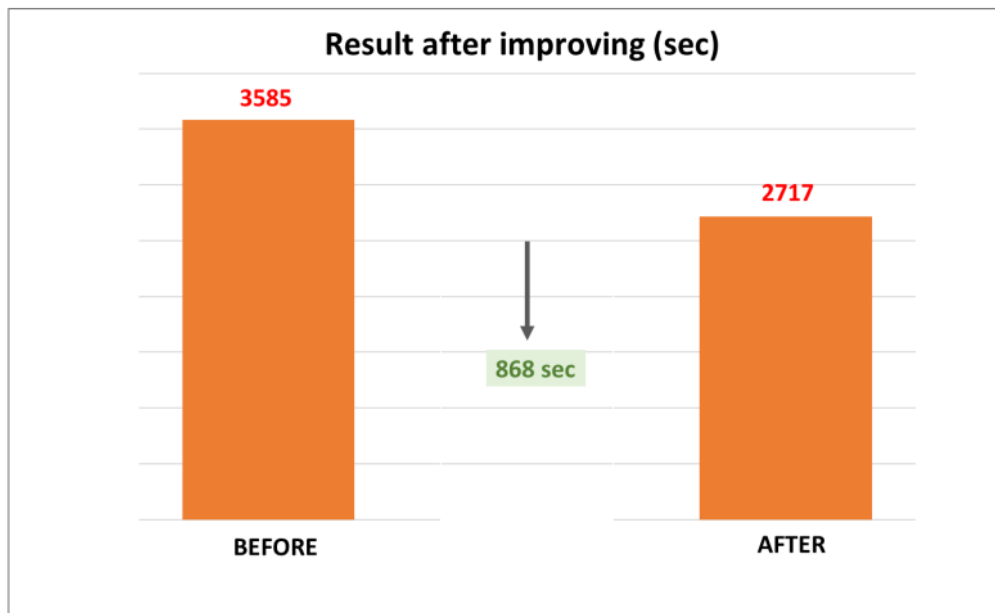


Figure 11: Result after improving in Station 6

Most of the operators' working time is drastically reduced compared to the beginning. This proves that the measures proposed by the intern team have worked and contributed to a part of the production activities on the Assembly line.

7. Spaghetti

The operators do not stand in the position and remain there throughout the workday. They continue to move to different areas to assemble, retrieve parts from trolleys, and stamp job cards at the station desk, among other things. As a result, the quantity of time to carry is substantial, and driving time is a crucial factor to be resolved.

A spaghetti diagram is a tool that helps visualize the course of the moving tasks in order to decrease the time spent on this job aspect. This approach requires a plan to imitate the location as well as the position of everything surrounding it. The journey line is then drawn from the action's start point to its completion point. The outline allows the intern to estimate the distance of the task's moving path or determine whether there is a hidden waste of walking in it.

Throughout the working process, each operator is supposed to have their walking route; in other words, each operator has one Spaghetti diagram. However, only potentially time-wasting actions such as moving steps are resolved.

The interns do the Spaghetti diagram in the following manner:

- Adjust to identify the fixed layout of each station
- Insert the fixed layout into Powerpoint
- Locate the beginning point and create a moving line, then place the arrow shape at the end of the line
- Mark the step number next to the line

After sketching the process stages' moving path, team members assess which step's distance should be reduced. Discussions on the improvement are scheduled between team members and involved employees. The new optimized path will then become the action's usual movement pattern. There are two basic ways to improve the comfort level. The distance between the satisfactory and inconvenient paths can be reduced, or the operation can be delegated to another operator.

IV. Analysis of the current situation:

1. Production flow of Mercedes-Benz Viet Nam:

Mercedes-Benz Viet Nam, established in 1995, has been strongly contributing and becoming a vital factor for the development of the domestic automobile industry. Recently, the main products of MBV are Sedan (C200, C300, E180, E200) and Sport Utility Vehicle (GLC200, GLC300). With an area of 95000 m² and 100% foreign investment, the MBV capacity is estimated at 5000 cars mainly served for the Asian markets and Europe markets.

Current capacity: 29 cars/ day

Working time: 8h-17h. Operators have 1 hour for lunch and 0.5 hours for set-up time each morning. Therefore, the available processing time is: $(9 - 1 - 0.5) * 60 * 60 = 27000$ (s)

Takt time for 29 cars: $27000 / 29 = 931$ (s)

Automobile manufacturing process:



Figure 12: Flow chart of car manufacturing process

The assembled components will be packaged and distributed by the Global Logistics department to the MBV factory. After being shipped to the factory, the components are randomly tested to ensure quality before being assembled.

At the Body shop, individual steel and aluminum components are linked together by electrical pulses from welding clamps controlled by compressed air. Before leaving the body shop, the above process results will be checked at the quality control gate.

Next, the welded chassis will be moved through the Paint shop. Here, the chassis will be powder coated, and this is a modern and environmentally friendly powder coating system. Next, the chassis will be coated with paint and an anti-corrosion layer. Areas with a high risk of rust will be covered with glue (PCV). Then it will cover the base layers to create color and top coat. After painting and drying, the bodywork is randomly checked at the quality inspection gate. Finally, all key locations are sprayed with a layer of wax to prevent the inside out.

At the assembly line, the chassis will go through 15 stations to assemble the basic parts, wiring, interior, and engine, then refuel and test drive based on quality standards, tests on Measurements and test runs are simulated on natural conditions to ensure the quality.

number of vehicles. At the end of the assembly line, there will be a quality control gate to cross-check all vehicles.

After a vehicle is assembled, in addition to the self-inspection of the workers and the checks at the inspection gate at the end of each line, each vehicle will be re-inspected by the production department, the quality department, and the quality control specialist—random depth of finished vehicles based on the customer's point of view. After completely finishing all processes of Quality Check, finished products will be transported to retailers.

2. Production flow of Assembly shop:

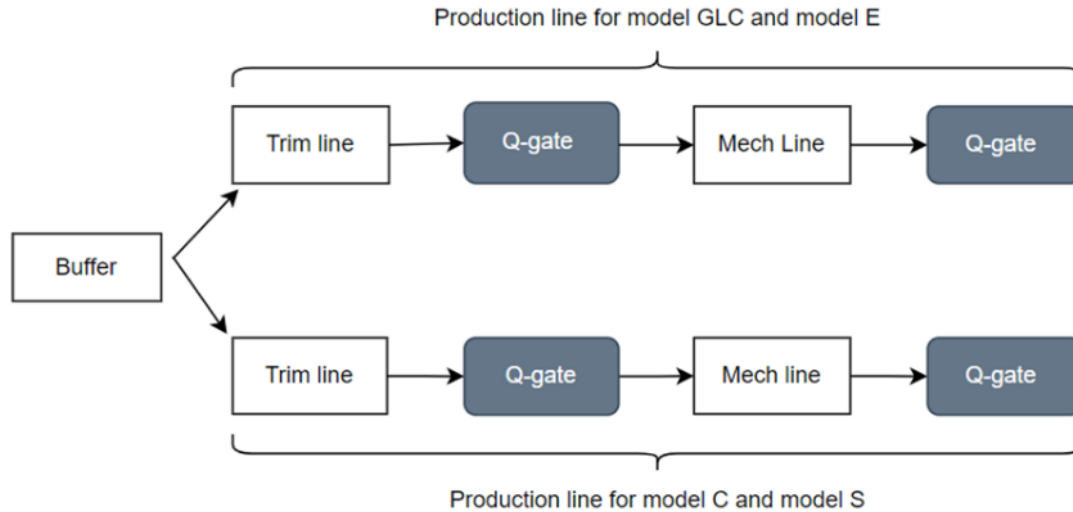



Figure 13: Flow chart of assembly line

The home assembly line of Mercedes Benz Vietnam includes two main lines producing two different car lines; however, these lines cannot operate at the same time. The overall process is CKD (Knock Down), which means they must assemble many parts before they can be put into the car. As previously stated, they are in charge of installing all parts and external and interior locations of the car from St Roof1 to St.9 (Trim/Line). Following that, Mech Line will be entrusted with the axle and frame and various testing to verify the car is drivable. Before proceeding to the end of the line for inspection and the finishing line for cleaning, each finished vehicle on the assembly line must fulfill the brand's standards. The Quality Management department will be involved to guarantee that the standard cars meet the standards for which Mercedes-Benz has long been proud. The notion of Continuous Flow Manufacturing is applied to the serial methods of automobile assembly in the Assembly Shop Line. After leaving the Paint Shop Buffer, the automobile will have been through a total of 20 stations (18 stations are in control of Assembly, and two stations are under the supervision of the Quality Management department). There will also be five outdoor substations and significant components transferred by the trolley to the main line.

STT	Line	Station	Process	No. Operators
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1	Buffer	Roof1 + Roof 2	<ul style="list-style-type: none"> ● Pushing doors trolley to roof 1 and fitting fender protection ● Uninstalling doors, aluminum roof (LH) and putting protection foil ● Uninstalling doors, aluminum roof (RH) and putting protection foil ● Preparing aluminum roof, preparing roof frame ● Installing crossmember (Rear) ● Moving door trolley (SA Door station), moving aluminum roof (Roof2), sorting and stamping jobcard ● Applying glue on crossmember, gauge, installing aluminum roof and roof recks, plugs (rear side and rear door), buffer stop, gas pressure strut, intermediate layer, door lock element, striker and sealing ● Applying glue on crossmember, gauge, installing aluminum roof and roof recks, plugs (rear side and rear door), buffer stop, gas pressure strut, intermediate layer, door lock element, striker and sealing ● Installing roof reck ● Tightening aluminum roof and roof recks LH & RH ● Plugs (rear side and rear door), buffer stop, gas pressure strut, intermediate layer (buffer stop and tail lamps), door lock element, striker and sealing (RR) ● Sticking barcode, putting ID code in car 	
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2	Buffer	Preparation	<ul style="list-style-type: none"> • Removing the door, bring it into the trolley • Removing the hood and clean the hood • Pushing the trolley into the sub-door station and replace the empty-door trolley. • Installing the hood and hood brace. • Installing rubber buttons, anti-fork, rear bonnet keychain. • Installing rubber stopper, front bonnet fork, cooling water pipe, • windshield washer hose, tail light 	4
3	Trim line	Station 1	<ul style="list-style-type: none"> • Installing the rubber stopper • Installing insulation panels for the transmission tunnel, engine compartment and rear undercarriage • Installing fuel pipe, brake oil pipe • Installing fuel tank 	3
4	Trim line	Station 2	<ul style="list-style-type: none"> • Installing the rubber stopper • Installing insulation panels for the transmission tunnel, engine compartment and rear undercarriage • Installing fuel pipe, brake oil pipe • Installing fuel tank 	3
5	Trim line	Station 3	<ul style="list-style-type: none"> • Installing the power cord • Installing glass washer fluid tank, hydraulic unit, SAM box, and sensor touch 	4
6	Trim line	Station 4	<ul style="list-style-type: none"> • The election wins, the calf wins • Fitting the cockpit 	5

			<ul style="list-style-type: none"> ● Installing electrical box, luggage compartment fuse box, and rear keygo luggage compartment ● Installing toolbox 	
7	Trim line	Station 5	<ul style="list-style-type: none"> ● Installing the battery ● Installing the seat backrest ● Installing alarms, number plates, logos 	3
8	Trim line	Station 6	<ul style="list-style-type: none"> ● Installing the battery ● Installing the column panels in the car ● Installing the ceiling in the car, carpet in the middle of the car, sunshade left and right ● Preparing glasses and applying primer on glasses 	4
9	Trim line	Station 7	 <ul style="list-style-type: none"> ● Fitting glass ● Assembling the horse ● Installing fishtail, wiper, rear bonnet 	3
10	Trim line	Station 8	<ul style="list-style-type: none"> ● Installing floor mats, door step cushions ● Installing the main control panel, insert the gas pedal 	3
11	Trim line	Station 9	<ul style="list-style-type: none"> ● Fitting the chair 	4
13	Mech line	Station 11	<ul style="list-style-type: none"> ● Installing the exhaust system ● Installing air ducts and radiators ● Installing cooling water pipes and tanks, glass washer pipes, gas pipes 	4

			<ul style="list-style-type: none"> • air conditioner, servo steam tube • Installing left and right headlights 	
14	Mech line	Station 12	<ul style="list-style-type: none"> • Installing the front bumper • Installing rib cladding, rib paneling • Installing fenders and wheels 	4
15	Mech line	Station 13	<ul style="list-style-type: none"> • Installing the front bumper • Installing rib cladding, rib paneling • Installing the fender cover and install the wheel • Filling gas, coolant, brake fluid • Fitting the steering wheel • Installing spare wheel • Refuel 	4
16	Mech line	Station 14	<ul style="list-style-type: none"> • Installing air conditioner filter • Adjusting front and rear doors • Fastening the keychain • Checking the front and rear capo clearance • Connecting the power supply 	2
17	Sub line	Sub axle	<ul style="list-style-type: none"> • Installing Front axle: half assembly, strut bar, steering system, steering clutch, drive shaft M005 • Rotating front axle, installing shielding, brake hose • Installing radiator, rear axle 	4
18	Sub line	Sub engine	<ul style="list-style-type: none"> • Installing horizontal shaft, differential, engine support and scanning code of engine 	4

			<ul style="list-style-type: none"> • Installing pipes of intercoolant, belt, insulation, starter and alternater • Installing propeller shaft, shaft cover, lubricant-cooler, oil filling, tightening torque converter bolts • Installing oxygen sensor, exhaust system cable, transmission, ground cable and engine mount rear • Moving engine, shopping parts, scanning ID and stamping 	
19	Sub line	Sub door	<ul style="list-style-type: none"> • Assembling front LH door • Assembling front RH door • Assembling rear RH door • Assembling rear LH door 	7
20	Sub line	Sub tire	<ul style="list-style-type: none"> • Checking and stamping HOMO • Installing valve • Getting trolley, preparing for 4 wheels, arranging rim and spare tire • Installing wheel 1, wheel 2, wheel 3, wheel 4, spare wheel • Replacing tire trolley and pushing trolley to station 15 	4
21	Sub line	Sub cockpit	<ul style="list-style-type: none"> • Shopping, preparing and installing part on dashboard • Installing air duct, steering column, bluetooth sensor • Installing part after putting dashboard on frame 	3

			<ul style="list-style-type: none"> • Cable harnessing, installing part on air condition box • Moving cockpits to station 4 	
22	Sub line	Sub Front module	<ul style="list-style-type: none"> • Shopping and positioning cross member lower part • Installing SA Front Module • Visual and 2nd checking • Moving front module to station 14 	3



Vietnamese-German University

3. The current layout of Mercedes-Benz factory:

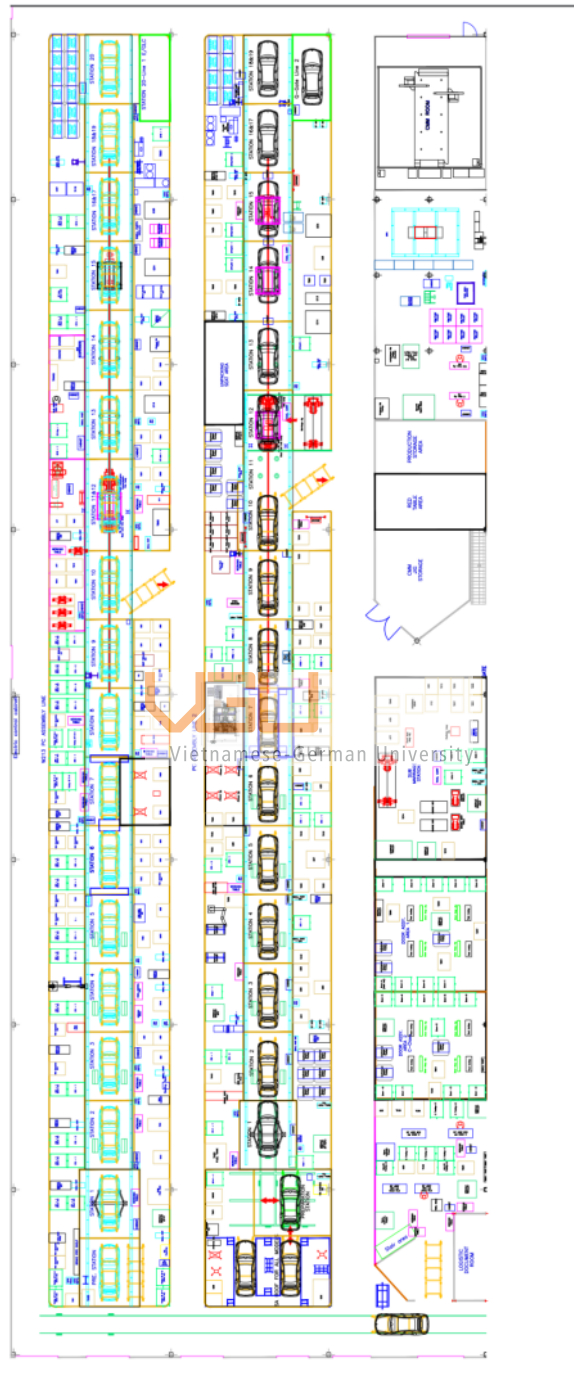


Figure 14: Layout W206

Advantages of a standard layout:

Layout affects worker productivity:

- It helps to maximize the use of tools and machines.
- It reduces property loss due to the over-handling of tools and machines.
- It minimizes health hazards and material handling.
- It maximizes space usage.
- It maximizes the production area inventory control.

Sufficient production space inside the production area avoids crowding and clutter and limits potential damage accidents can cause.

The production site infrastructure should be designed considering the following issues:

- The number of officers and workers.
- Several machines, their respective sizes.
- Range, scope, and production sequence.
- The number of desks, cabins, and workstations required in the production area.
- Floor space for placing worker tools and personal items such as helmets, uniforms, and goggles.
- Adjacent facilities, such as dining spaces, smoking areas, and restrooms, significantly affect worker performance.
- Adequate space and paths to the premises, entrances, and exits to the work area.
- Place additions for new machines and product design or production volume increases.

Since the layout in the Assembly shop is quite extensive, this thesis focuses only on the station door layout as an example of the current state of the layout in the Assembly shop. The status of the layout at the station door is always a dilemma for the Assembly shop's entire production line. The problems that the layout is having are:

The layout really takes up too much space: although the Sub Line has six subs station, however, the area of the Sub Station Door occupies nearly 50% of the area of the entire subline. According to Mercedes-Benz statistics, despite occupying a lot of area of the Sub line, the station door's

operating efficiency is still not appreciated because the time to complete a product of the station has not been improved. compared to other stations. The layout of the car lines has not been integrated with each other: the layout of the two GLC models and E, C models has not been integrated with each other. This means that the 2-door station layouts of the two car lines are still two separate layouts, so when changing the vehicle model during the production process, workers have to move to another layout of the station door to continue working. . So this problem makes the layout take up more space than desired.

The layout did not comply with the assembly process of the Assembly workers and logistics workers, causing the workers to face many difficulties in the assembly process. Each time the logistics workers level up the goods, it affects the working time of the workers of the Assembly shop. Sometimes, Assembly workers have to wait for logistics workers to finish delivering their interests, then Assembly workers can continue the assembly process. The current assembly and delivery processes on the layout have not been agreed upon with each other. Assembly and logistics workers are still unclear about their roles in the replenishing and unreplenishing process. Especially they still don't have a plan for one-day delivery at the station door; therefore, all operating activities on the station door have not been standardized and clearly assigned tasks. The improper layout, combined with the unstandardized process, made the working flow of the Assembly line complicated and inefficient.

Based on the two problems mentioned above, this thesis will focus on analyzing solutions and giving reasonable solutions to solve them. The recommended steps to standardize the station door are:

1. Standardize the assembly process at the station door
2. Make a replenishment plan for logistics tracking and leveling the station door
3. Based on the assembly process proposed in step 1, and the delivery plan in step 2, engineers will conduct an analysis of the station door replenishing process and draw a spaghetti chart to illustrate the process. supply goods
4. Provide a standard assembly process, a standard delivery process, and a reasonable division of work for both assembly workers and logistics workers
5. Based on the available information about the assembly and delivery process, redraw the new layout with the goal of reducing the layout area by integrating the layout of E, C and GLC models.

The assembly part is supplied according to the demand of the Assembly line. A team leader will call if the goods are about to run out. Therefore, operators cannot control the process of supplying and receiving goods to follow the production plan

⇒ One of the dilemmas in the sub door station workflow is that there is no specific replenishment plan. All replenishing operations are controlled based on the experience of the production workers on the station only. Whenever the workers check the goods on the sub door station, if they realize that the goods will be short in the production process of the next car, they will call the logistics side to deliver the goods in time. This sometimes leads to missing goods or information between two departments (Logistics and Production). The most frequent problems are:

- + **Lack of assembly parts:** Production workers incorrectly checked the amount of inventory available at the station, leading to the incorrect notification of the number of goods, and the production line was interrupted.
- + **Incorrect assembly of parts:** this problem often occurs during the transition from model to model at the sub Door. Because the information about the needed parts and the delivery time is transmitted by word of mouth from the production assembly worker to the warehouse inventory officer and then through many more word of mouth to the Logistics worker; as a result, the information needed to be more accurate. The consequence is that Logistic workers often need to find the goods. For example, when moving from model C to model E production, workers realize that a left mirror of model E is missing for new vehicle production and report it to the inventory officer to request a supply. However, transmitting information through too many people leads to incorrect information. Instead of being given a left minor of model E, the production worker is given a left minor of model C.

Moreover, Sub Door Station issues were only mentioned in daily meetings, but there needed to be an agreement to improve the assembly and replenishing processes. According to a survey at Mercedes-Benz, every two weeks, the supply problem causes many difficulties and interruptions in the factory's operation. However, after many meetings to solve this problem, the managers still needed help.

V. Improvement and result:

1. Make a replenishment plan for the Door station:

In this part, the intern team will use the VBA code to automatically plan the delivery process at Sub Door and monitor the actual delivery plan to see if it is according to the program. ? (In this section, we will show the code, explain the rules of delivery at Sub Doo, and show how the factory applies Just In Time in the delivery).

⇒ To solve the problem of the delivery plan, we first need to understand the level of goods: At the substation door, the parts will be divided into four types:

- + Six cars per time: each time the item is supplied, the number of rows of this part will be enough for six cars. Therefore, this part needs to be reissued before the 6th car is completed so that there is plenty of goods in the next vehicle.
- + Twelve cars per time: for each delivery, the quantity of this part will be enough for 12 cars. Therefore, this part needs to be reissued before the 12th vehicle is completed to have a sufficient supply of goods in the next vehicle.
- + Twenty-four cars per time: for each delivery, the quantity of this part will be enough for 24 cars. Therefore, this part needs to be replenished before the 24th vehicle is completed to have a sufficient supply of goods in the next vehicle.
- + Top up by packing month: each month, this part will be provided in sufficient quantity in the production plan. For details of this type, we do not need to make a detailed supply plan because the goods are supplied, and the amount is enough for one month, so it is only required once a month.

Statistical list of parts and quantities will be listed in the following versions:

C 300			
	Number	Part name	Số part cấp/ lần
TROLLEY 1	A 206 690 63 00	ORNAMENTAL MOLDING LH B-PILLAR DRIV.DOOR	24
	A 206 690 64 00	ORNAMENTAL MOLDING RH B-PILLAR DRIV.DOOR	24

	A 206 690 67 00	ORNAMENTAL MOLDING LH B-PILLAR	24
	A 206 690 68 00	ORNAMENTAL MOLDING RH B-PILLAR	24
	A 206 690 69 00	ORNAMENTAL TRIM LH DRIV.DOOR	24
	A 206 690 70 00	ORNAMENTAL TRIM RH DRIV.DOOR	24
	A 206 690 73 00	ORNAMENTAL TRIM LH RR-DOOR	24
	A 206 690 74 00	ORNAMENTAL TRIM RH RR-DOOR	24
	A 206 720 17 00	SEALING RAIL OTR LH DRIV.DOOR	24
	A 206 720 18 00	SEALING RAIL OTR RH DRIV.DOOR	24
	A 206 730 27 00	SEALING RAIL OTR LH RR-DOOR	24
	A 206 730 28 00	SEALING RAIL OTR RH RR-DOOR	24
TROLLEY 2	A 206 725 05 00	WINDOW GUIDE RAIL LH DRIV.DOOR	24
	A 206 725 06 00	WINDOW GUIDE RAIL RH DRIV.DOOR	24
	A 206 735 07 00	WINDOW GUIDE RAIL LH RR-DOOR	24
	A 206 735 08 00	WINDOW GUIDE RAIL RH RR-DOOR	24
TROLLEY 3	A 099 760 77 02	DOOR HANDLE	24
	A 206 725 03 00	SEALING RAIL INR LH DRIV.DOOR	24
	A 206 725 04 00	SEALING RAIL INR RH DRIV.DOOR	24
	A 206 735 03 00	SEALING RAIL INR LH RR-DOOR	24
	A 206 735 04 00	SEALING RAIL INR RH RR-DOOR	24
TROLLEY 4	A 206 727 09 00	REINFORCEMENT CTR LH IMPACT-ABSORBER	24
	A 206 727 10 00	REINFORCEMENT CTR RH IMPACT-ABSORBER	24
	A 206 727 04 00	PANELING WINDOW FRAME FRT RH	24
	A 206 737 06 00	PANELING WINDOW FRAME RR RH	24
	A 206 727 03 00	PANELING WINDOW FRAME FRT LH	24
	A 206 737 05 00	PANELING WINDOW FRAME RR LH	24

TROLLEY 5	P C 206 810 061	OUTER MIRROR LH PCA / AUSSENSPIEGEL LI PCA	24
	P C 206 810 062	OUTER MIRROR RH PCA / AUSSENSPIEGEL RH PCA	24
TROLLEY 6	P C 206 737 061	DOOR.P REAR LH PCA / VERKLD. TUER HINTEN LI PCA	6
	P C 206 727 061	DOOR.P FRONT LH PCA / VERKLD. TUER VORN LI PCA	6
TROLLEY 7	P C 206 737 062	DOOR.P REAR RH PCA / VERKLD. TUER HINTEN RE PCA	6
	P C 206 727 062	DOOR.P FRONT RH PCA / VERKLD. TUER VORN RE PCA	6
TROLLEY 8	P C 206 720 062	DOOR.M FRONT RIGHT PCA / ZB TUER.M VORN RECHTS PCA	6
	P C 206 720 061	DOOR.M FRONT LH PCA / ZB TUER.M VORN LI PCA	6
TROLLEY 9	P C 206 730 062	DOOR.M REAR RH PCA / ZB TUER.M HINTEN RE PCA	6
	P C 206 730 061	DOOR.M REAR LH PCA / ZB TUER.M HINTEN LI PCA	6
TROLLEY R Door	A 204 682 01 08	ABSORBING DOOR OUTR.PNLNG	TOP UP THEO PACKING MONTH
	A 204 682 02 08	ABSORBING DOOR OUTR.PNLNG	
	A 206 545 41 00	BRACKET FRT LH LOUDSPEAKER	
	A 206 545 42 00	BRACKET FRT RH LOUDSPEAKER	
	A 206 545 43 00	BRACKET RR LH LOUDSPEAKER	
	A 206 545 44 00	BRACKET RR RH LOUDSPEAKER	
	A 206 720 62 01	COVER TRIM INR LH MIRROR.TRIANGLE PREM.SOUND- SYS	

	A 206 720 63 01	COVER TRIM INR RH MIRROR.TRIANGLE PREM.SOUND- SYS	
	A 206 720 99 01	DOOR HOLDER COMPL DRIV.DOOR	
	A 206 727 05 00	REINFORCEMENT LH IMPACT- ABSORBER	
	A 206 727 06 00	REINFORCEMENT RH IMPACT- ABSORBER	
	A 206 727 07 00	REINFORCEMENT FRT LH IMPACT- ABSORBER	
	A 206 727 08 00	REINFORCEMENT FRT RH IMPACT- ABSORBER	
	A 206 730 58 02	DOOR HOLDER COMPL RR-DOOR	
	A 206 735 59 00	IMPACT ABSORBER LH	
	A 206 735 60 00	IMPACT ABSORBER RH	
	A 206 735 61 00	IMPACT ABSORBER LH	
	A 206 735 62 00	IMPACT ABSORBER RH	
	A 206 811 01 00	SEALING MIRROR LH	
	A 206 811 02 00	SEALING MIRROR RH	
	A 223 820 15 00	LOUDSPEAKER MID.RNG.SPEAKER SOUNDSYS	
Ron cao su	A 099 727 03 00	DOOR SEAL	96
Kính lớn	A 206 725 15 00	SIDE WINDOW PANE LH	24
	A 206 725 16 00	SIDE WINDOW PANE RH	24
	A 206 735 15 00	SIDE WINDOW PANE LH	24
	A 206 735 16 00	SIDE WINDOW PANE RH	24
Kính tam giác	A 206 730 25 00	SIDE WINDOW FIXED LH	24
	A 206 730 26 00	SIDE WINDOW FIXED RH	24

GLCX3004M					
	Number	Part name	Quantity	Q/cá r	Số part cấp/lần
TROLLEY 4	A 253 690 01 87	ORNAMENTAL MOLDING OTR LH B- PILLAR			12
	A 253 690 02 87	ORNAMENTAL MOLDING OTR RH B- PILLAR			12
	A 253 690 03 87	ORNAMENTAL MOLDING OTR LH B- PILLAR			12
	A 253 690 04 87	ORNAMENTAL MOLDING OTR RH B- PILLAR			12
	A 253 720 01 24	SEALING RAIL OTR LH			12
	A 253 720 02 24	SEALING RAIL OTR RH			12
	A 253 725 01 82	ORNAMENTAL TRIM LH			12
	A 253 725 02 82	ORNAMENTAL TRIM RH			12
	A 253 730 01 19	WINDOW GUIDE LH			12
	A 253 730 02 19	WINDOW GUIDE RH			12
	A 253 730 59 04	SEALING RAIL OTR LH			12
	A 253 730 60 04	SEALING RAIL OTR RH			12
	A 253 735 01 82	ORNAMENTAL TRIM LH			12
	A 253 735 02 82	ORNAMENTAL TRIM RH			12
	TROLLEY 1	A 253 725 25 01	SEALING RAIL INR LH		
A 253 725 73 00		WINDOW GUIDE RAIL LH			24
A 253 735 01 01		SEALING RAIL INR LH			24

	A 253 735 03 25	WINDOW GUIDE RAIL LH			24
TROLLEY 2	A 253 725 26 01	SEALING RAIL INR RH			24
	A 253 725 74 00	WINDOW GUIDE RAIL RH			24
	A 253 735 02 01	SEALING RAIL INR RH			24
	A 253 735 04 25	WINDOW GUIDE RAIL RH			24
Ốp viền đen	A 253 727 03 71	PANELING WINDOW FRAME LH			24
	A 253 727 04 71	PANELING WINDOW FRAME RH			24
	A 253 737 03 71	PANELING WINDOW FRAME LH			24
	A 253 737 04 71	PANELING WINDOW FRAME RH			24
TROLLEY 5	P C 253 727 141	DOOR.P FRNT LEFT PCA VERKLD.TUER VORN LINKS PCA			6
	P C 253 737 161	DOOR.P REAR LEFT PCA/ VERKLD.TUER HINTEN LINKS PCA			6
TROLLEY 6	P C 253 727 162	DOOR.P FRNT RIGHT PCA/VERKLD. TUER VORN RECHTS PCA			6
	P C 253 737 162	DOOR.P REAR RIGHT PCA/ VERKLD. TUER HINTEN RE PCA			6

TROLLEY 7	P C 253 720 141	DOOR.M FRONT LEFT PCA/ ZB TUER.M VORN LINKS PCA			6
	P C 253 730 161	DOOR.M REAR LEFT PCA/ ZB TUER.M HINTEN LINKS PCA			6
TROLLEY 8	P C 253 720 142	DOOR.M FRONT RIGHT PCA / ZB TUER.M VORN RECHTS PCA			6
	P C 253 730 162	DOOR.MREAR RIGHT PCA / ZB TUER.M HINTEN RECHTS PCA			6
TROLLEY R Door	A 253 725 13 00	IMPACT ABSORBER RR LH		1	TOP UP THEO PACKIN G MONTH
	A 253 725 14 00	IMPACT ABSORBER RR RH		1	
	A 204 682 02 08	ABSORBING DOOR OUTER PANELING		1	
	A 222 820 22 00	LOUDSPEAKER TWEETER SOUNDSYS		1	
	A 253 811 05 00	SEAL MIRROR LH		4	
	A 253 811 06 00	SEAL MIRROR RH		1	

Based on the quantity of goods supplied each time, we can plan to supply the whole station door:

"Date"	Number of the produced car per day	30 cars	Plan																								
	TAKT TIME	15 phút																									
	Starting time (Morning)	7:40																									
	Starting time (Afternoon)	12:25	Car	0																							
	The number of remaining parts in trolley 1	2	Planning time	7:40	7:41	7:42	7:43	7:44	7:45	7:46	7:47	7:48	7:49	7:50	7:51												
TROLLEY OF THE PLASTIC RON	A 099 727 03 00	DOOR SEAL	6	24																							
	A 253 725 67 00	SIDE WINDOW PANE LH ESG	24	24																							
	A 253 725 68 00	SIDE WINDOW PANE RH ESG	24	24																							
TROLLEY OF THE LARGE GLASS	A 253 735 01 10	GLASS PANE LH	24	24																							
	A 253 735 02 10	GLASS PANE RH	24	24																							
TROLLEY Ò THE REARVIEW MIRROR	A 253 810 64 03	MIRROR OTR LHD RH ASPH MEMORY.FUNCTION TWA	24	24																							
	A 253 810 81 03	MIRROR OTR LHD LH ASPH STV MEMORY.FUNCTION	24	24																							
TROLLEY WITH THE BLACK EDGING	A 253 727 03 71	PANELING WINDOW FRAME LH	24	24																							
	A 253 727 04 71	PANELING WINDOW FRAME RH	24	24																							
	A 253 737 03 71	PANELING WINDOW FRAME LH	24	24																							
	A 253 737 04 71	PANELING WINDOW FRAME RH	24	24																							
TROLLEY 3	A 099 760 72 00	DOOR HANDLE	12	12																							
	A 099 810 77 00	MIRROR BOWL LHD LH	12	12																							
	A 099 810 78 00	MIRROR BOWL LHD RH	12	12																							
	A 253 720 01 48	COVER WINDOW FRAME LH MIRROR-TRIANGLE	12	12																							
	A 253 720 02 48	COVER WINDOW FRAME RH MIRROR-TRIANGLE	12	12																							
	A 253 730 01 55	FIXED WINDOW LH	12	12																							

Figure: Door station replenishment plan

Data inputs for planning include:

- Number of cars produced that day
- Starting time (Morning): the starting time of that morning
- Starting time (Afternoon): the time to start working at the end of the day that day

Number of parts left in trolley (1): the number of remaining parts of trolley 1. The engineer will base on the number of parts left in trolley 1 the previous day to calculate the supply plan because trolley 1 contains 24 parts. (maximum number of parts at trolleys). For example, if the remain amount of trolley 1 is 2 the remain amount of all trolleys is 2. If the remain amount of trolley 1 is 7, the remain amount of the six cars per time is 1 and the remain amount of the twelve cars per time is 7.

The plan will be detailed by the minute of the day and divided into 2 shifts: morning shift and afternoon shift. The working time of the morning shift will start from 8:30 a.m. - 11:45 a.m. and the starting time of the afternoon shift will start from 12:45 a.m. to 4 p.m.

Takt time will be calculated based on the formula: $27000 / \text{Number of the replenished part per time}$. The engineer will base on the part type and the number of parts provided each time to plan the supply of each trolley.


```

For i = 7 To 247
    dem_o_rong = WorksheetFunction.CountIf(Range(Cells(5, i), Cells(5, i)), "")
    If (i - 6) Mod takt_time = 0 And dem_o_rong = 0 Then
        xe = xe + 1
        Finish_morning = i
        Sheets("GLC 3004M").Cells(4, Finish_morning).Value = xe
    End If
Next
For j = 1 To 240
    dem_o_rong = WorksheetFunction.CountIf(Range(Cells(5, j + 247 - 1), Cells(5, j + 247)), "")
    If xe = car_per_day Then
        Exit For
    End If
    If j Mod takt_time = 0 And dem_o_rong = 0 Then
        xe = xe + 1
        Finish_afternoon = Start_afternoon + j + 248
        Sheets("GLC 3004M").Cells(4, Finish_afternoon).Value = xe
    End If
Next
End Sub
'Column = ws.Cells(1, Columns.Count).End(xlToLeft).Column

```

How to use the file: After inputting all the information about the Number of the produced car per day, Stating time (Morning), Starting time (Afternoon), The number of remaining parts in trolley 1, and the engineer will click the button Plan. The file will automatically run the VBA code to get on the replenishment plan for the station door.

After the plan is made, the intern will proceed according to the delivery process including the time of delivery, the time of the delivery process, the quantity of goods to be issued,... After everything is stable, the team intern will document the best practice and put it into action.

2. Holding a meeting to solve the delivery problem at Sub Door:

To solve it thoroughly, the team recommends that there should be some surveys based on the

mentioned replenishment plan, recording all the delivery processes to come up with the most standard process. After recording all the techniques, the intern team will draw up the layout to illustrate all the cases and choose the best and most reasonable delivery case. The information that will be collected during the survey is as follows:

- + Time to complete all cars in a day
- + Order of delivery of trolleys during the day
- + Number of trolleys supplied each time
- + Supplying time from the trolley
- + The position of each trolley in the assembly process and the supplying process
- + Distance traveled by each operator in the replenishing process

After finding possible solutions, the intern team will hold a meeting to propose solutions, and the managers decide whether they agree on the process or not. In order to illustrate the process most intuitively, all processes will be drawn on PowerPoint.

2. Analysis of the current process of Station Door:

Link:

33

https://docs.google.com/presentation/d/12PsP9tK_BgOix8xWpFbN5rzrngwqSl6s/edit#slide=id.p

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(Reader should download the Power Point to your computer to see clearly the animation effects and operations that have been set up for the file.)

Aisle



Figure: The current layout of the station door for the GLC model and E, C model

The process of replenishing six cars per time trolleys: In this process, logistics workers will receive goods for four trolleys 5,6,7,8 because these four trolleys can only hold enough parts for a maximum is six cars.

Step 1: The new group of trolleys (trolley (5), trolley (6), trolley (7), and trolley (8)) will be pulled from the warehouse to the factory and temporarily placed on the factory aisle.

Step 2: Logistics workers will remove the trailer from the new trolley (5), trolley (6), trolley (7), trolley (8) and connect each old trolley (5), trolley (6), trolley (7), trolley (8), which is almost empty, to the trailer.

Step 3: Logistics workers will pull each new trolley (5), trolley (6), trolley (7), trolley (8) into the correct position of trolley (5), trolley (6), trolley (7), trolley (8) on the factory layout. (During this process, the rearview mirror trolley is between trolley (6) and (7). So, to facilitate pulling the old group of trolley (5), trolley (6), trolley (7), trolley (8) out of the layout, the rearview mirror trolley will be pulled over an empty path to the right of the door station. When the new group of trolley (5), trolley (6), trolley (7), and trolley (8) are pulled into the correct position on the layout, workers will also pull the rearview mirror trolley into the right position.)

Step 4: Logistics workers will pull empty trolley (5), trolley (6), trolley (7), and trolley (8) back to the warehouse and prepare for the following replenishing process.

The replenishing process of 12 cars per time trolleys: In this process, logistics workers will supply goods for a group of trolley (1), trolley (2), trolley (4) (trolley (1), trolley (2), trolley (4) can only hold enough parts for 12 cars.) and a group of trolley (5), trolley (6), trolley (7), trolley (8) (2nd time).

Step 1: The worker drags the new trolley (1), trolley (2), and trolley (4) from the warehouse to the factory and temporarily places it on the factory aisle.

Step 2: Logistics workers will remove the top of the trailer from the new trolley 1,2,4 and connect each empty trolley (1), trolley (2), and trolley (4) to the trailer.

Step 3: Logistics workers drag trolley (1), trolley (2), and trolley (4) to their correct position on the layout

Step 4: Logistics workers carry the empty trolley (1), trolley (2), trolley (4) to the warehouse and prepare for the following replenishing process.

Step 5: The new group of trolley (5), trolley (6), trolley (7), trolley (8) will be pulled from the warehouse to the factory and temporarily placed on the factory aisle.

Step 6: Logistics workers will remove the trailer from the new trolley (5), trolley (6), trolley (7), trolley (8) and connect each old trolley (5), trolley (6), trolley (7), trolley (8), which is almost empty, to the trailer.

Step 7: Logistics workers will pull each new trolley (5), trolley (6), trolley (7), trolley (8) into the correct position of trolley (5), trolley (6), trolley (7), trolley (8) on the factory layout. (During this process, the rearview mirror trolley is between trolleys (6) and (7). So, to facilitate pulling the old group of trolley (5), trolley (6), trolley (7), trolley (8) out of the layout, the rearview mirror trolley will be pulled over an empty path to the right of the door station. When the new group of trolley (5), trolley (6), trolley (7), and trolley (8) are pulled into the correct position on the layout, workers will also pull the rearview mirror trolley into the right position.)

Step 8: Logistics workers will pull empty trolley (5), trolley (6), trolley (7), and trolley (8) back to the warehouse and prepare for the following replenishing process.



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The replenishing process for 24 cars per time trolley: in this process, logistics workers will receive goods instead of 3 trolley clusters:

Trolley with the black edging, trolley with the plastic ron, trolley with the rearview mirror, trolley with large glass

Trolley (1), trolley (2), trolley (4)

Trolley (5), trolley (6), trolley (7), trolley (8)

This is considered the most prolonged replenishing process at the Door station and deserves the most attention as this process will replace all important trolleys at the station. Therefore, to complete this process well, workers must follow the replenishing rules and remember the order of goods to arrange the trolleys in the layout while saving time efficiently. The delivery process includes 14 steps:

Step 1: Logistics workers will pull trolleys: trolley with the black edging, trolley with the plastic ron, trolley with the rearview mirror, and trolley with large glass from the warehouse to the factory.

Step 2: The logistics worker pulls these four trolleys and places them in the path of the right side of the door station layout.

Step 3: The logistics worker will return to the warehouse to continue transporting the new trolley (1) and trolley (2) from the warehouse to the door station.

Step 4: Logistics workers pull two old trolleys (1) and two old trolleys (2) from the door station attached to the trailer

Step 5: Logistics workers continue to pull a new trolley (1) and a new trolley (2) to replace the old trolley (1) and trolley (2).

Step 6: The logistics worker pulls the empty Trolley (1) and Trolley (2) to the warehouse and prepares for the next shipment

Step 7: The logistics worker continues to pull a new trolley (4), a trolley (1), and a new trolley (2) to replace the empty trolleys (1) and trolleys (2), trolleys (4) on the layout (because in step 4, the worker pulls two old trolleys (2) and two old new trolleys (1) out of the layout. However, in step 5, the worker only pulled one new trolley (1) and one new trolley (2) into the door station, so there are still two spaces left: 1 for trolley 1 and 1 for trolley 2)

Step 8: Workers pull the old trolley (4) out from the door station and leave it temporarily on the way

Step 9: Worker pulls trolley (1), trolley (2), and trolley (4) to the door station

Step 10: Workers connect the trailer to trolley four and drag it to the factory

Step 11: The new trolley (5), trolley (6), trolley (7), and trolley (8) will be pulled from the warehouse to the factory and temporarily placed on the factory aisle.

Step 12: Logistics workers will remove the top of the trailer from the new trolley (5), trolley (6), trolley (7), and trolley (8) and connect each trolley (5), trolley (6), trolley (7), trolley (8) which is almost empty, to the trailer and pull all four trolleys: trolley with the black edging, trolley with the plastic ron, trolley with the rearview mirror, trolley with large glass that has been put temporarily in the factory aisle

Step 13: Logistics workers will pull the trolley with the black edging, trolley with the plastic ron, trolley with the rearview mirror, trolley with large glass, trolley (5), trolley (6), trolley (7), trolley (8) into the correct position of that trolley on the factory layout (The order to pull the trolleys in is: the black edging, trolley with the plastic ron, trolley with large glass, trolley (5), trolley (6), trolley with the rearview mirror, trolley (7), trolley (8))

Step 14: Logistics workers will pull empty trolley (5), trolley (6), trolley (7), trolley (8) back to the warehouse and then come back to pull the trolley with the black edging, trolley with the plastic ron, trolley with the rearview mirror, trolley with large glass back to the warehouse.

3. Improvement on the new layout

The procedures for surveying and redrawing the layout:

Although a relatively standard process had been created for both GLC, E, and C models, the managers realized that a larger improvement in the layout was needed to save even more time. After realizing the similarities in the assembly process and the material supply process to the Doo station, a decision was made to combine the layout of GLC mode, model C, and E into a single model.

The procedures for surveying and redrawing the layout are

1. Re-survey the workflow at both layout GLC and layout C, E
2. Re-measure standard sizes on both layouts
3. Simulate the standard delivery process on PowerPoint

(File PowerPoint for replenishment process of Station Door

Link:

https://docs.google.com/presentation/d/172uTKNcGgLtXXvPHvg7CFde_Xc8yaSug/edit?usp=sharing&ouid=116269611032027540391&rtpof=true&sd=true

4. Hold a meeting to agree on the new process and layout
5. Putting the new layout into practice

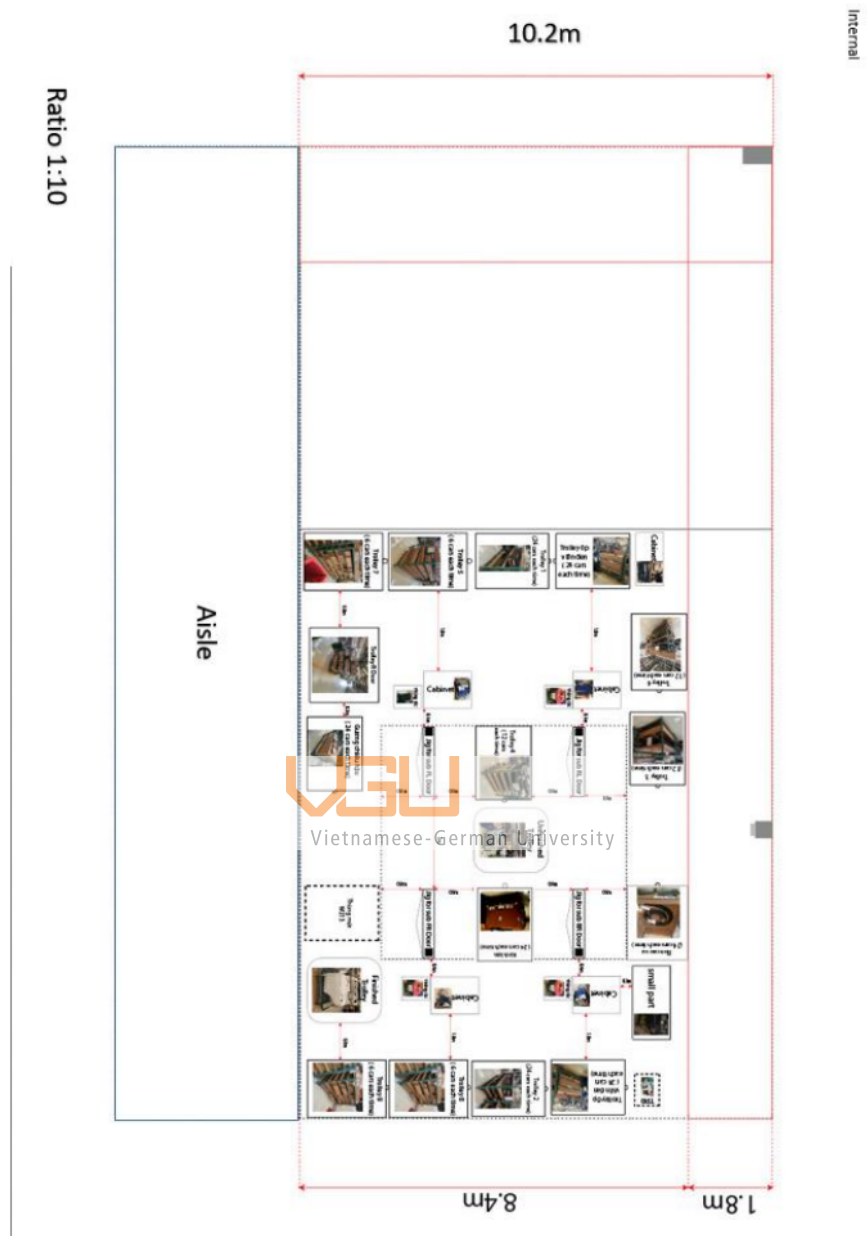


Figure: The new layout of station door for both GLC model and E, C model

After carefully analyzing the supply and assembly process at the Door station, a new layout was created with the objective of increasing production capacity and reducing floor space. The following criteria will be used to assess the effectiveness of the new layout:

- a. The area of the old layout is 214 square meters, whereas the area of the new layout is only 176 square meters. The layout of the GLC car will be combined with the layout of the C car, so (in the new layout), the area on the side of the GLC layout will be empty. The space conserved is 38 m². This demonstrates the efficacy of the new layout, as Mercedes now has space to design additional production lines in the factory. Moreover, almost all trolleys and equipment on the layout are cut down.
 - Number of jigs on the layout cut from 6 jigs to 4 jigs
 - The number of trolleys has been cut by almost half
 - The number of cavity machines and assembly tools is halved.
- b. Integrated Layout: The new layout of the station Door is integrated because it combines the layout of the GLC and the layout of the E, C car. Integrating both layouts into a single one has proven the effectiveness of the spaghetti approach to layout drawing. SWI also provides significant and necessary data about working time, workflow, and order of work steps to make layout analysis more efficient.
- c. Lean layout: the layout has been combined with the standard, and it is processed, clear about the work of each worker will be responsible. In addition, the order of jobs has been to help reduce the production time of each vehicle significantly. Changeover time will be cut down significantly. Instead of having to spend about 15-30 minutes for each changeover from a model in production to another model. Changeover time will be reduced and no longer in the production process. Processes on the layout have also been changed slightly to integrate with the new layout and cut down on the entire production line's uptime.
- d. The layout works with a plan: unlike previous layouts. The new layout will work with the replenishment plan (described above). The manager can monitor the station's activities and control the production schedule for the day at this station.

3. The replenishing process on a new layout

Based on the production process of Mercedes Benz, the new layout still divides into three trolley groups: and six cars per time trolleys, twelve cars per time trolleys, twenty-four cars per time trolleys.

The process of replenishing six cars per time trolleys: In this process, logistics workers will receive goods for four trolleys (5),(6),(7),(8) because these four trolleys can only hold enough parts for a maximum is six cars.

Step 1: The logistics worker will pull four new trolleys (5),(6),(7), and (8) from the warehouse to the Station Door of the Assembly shop.

Step 2: The logistics worker pulls four old trolleys (5),(6),(7), and (8) out of the station door and attaches them to the trailer.

Step 3: Logistics workers pull four new trolleys (5),(6),(7), and (8) into the correct position on Station Door.

Step 4: Logistics worker pulls four old trolleys (5),(6),(7), and (8) into the correct position on the station Door.

⇒ The process of replenishing goods for four trolleys (5),(6),(7), and (8) has been clearly reduced. In the old stocking process, instead of having to pull the rearview mirror trolley to another position so that four trolleys (5), (6), (7), (8) can be easily pulled out of the production line as In the old layout, this process on the new layout has been removed. All operations on the new layout with four trolleys (5),(6),(7), and (8) have been streamlined to help the reduce assembly time of the whole line.

4. The new improvement process for Station Door

The replenishing process of 12 cars per time trolleys: In this process, logistics workers will supply goods for a group of trolleys (4) (trolley (4) can only hold enough parts for 12 cars), and a group of trolleys (5), trolley (6), trolley (7), trolley (8) (2nd time).

Step 1: The logistics worker pulls two trolleys four from the warehouse to the Station Door

Step 2: The logistics worker pulls the 2 4 trolleys out of the Station Door and attaches them to the trailer.

Step 3: The logistics worker pulls two new four trolleys into the station door layout

Step 4: The logistics worker pulls two empty four trolleys to the warehouse.

Step 5: Logistics workers will pull four new trolleys (5),(6),(7), and (8) from the warehouse to the Station Door of the Assembly shop.

Step 6: The logistics worker pulls four old trolleys (5),(6),(7), and (8) out of the station door and attaches them to the trailer.

Step 7: The logistics worker pulls four new trolleys (5),(6),(7), and (8) into the correct position on the Station Door.

Step 8: Logistics worker pulls four old trolleys (5),(6),(7) and (8) into the correct position on the station Door.

⇒ For the new layout, trolley(1), and trolley(2) will be sorted into 24 cars per time trolleys, so these two trolleys are not mentioned here. In this delivery, the 5 trolleys that are concerned are (4), (5), (6), (7), (8). Since the number of trolleys provided this time on the new layout is different from the number of trolleys provided on the old layout, the replenishing process is also different from that on the old layout.

The replenishing process for 24 cars per time trolley: in this process, logistics workers will receive goods instead of 3 trolley clusters:

- Trolley with the black edging, trolley with the plastic ron, trolley with the rearview mirror, trolley with large glass
- Trolley (4)
- Trolley (1), trolley (2), trolley (5), trolley (6), trolley (7), trolley (8)

This is considered the most prolonged replenishing process at the Door station and deserves the most attention as this process will replace all important trolleys at the station. Therefore, to complete this process well, workers must follow the replenishing rules and remember the order of goods to arrange the trolleys in the layout while saving time efficiently. The delivery process includes 16 steps:

Step 1: logistics worker pulls four trolleys: Trolley with the black edging, trolley with the plastic ron, trolley with the rearview mirror, trolley with large glass from the warehouse to the station Door.

Step 2: The logistics worker moves the Unfinished trolley to an empty location to take the old trolley with large glass out of the station Door. Logistics workers continue to take four trolleys: Trolley with the black edging, trolley with the plastic ron, trolley with the rearview mirror out of the station Door.

Step 3: The logistics worker pulls four new trolleys Trolley with the black edging, trolley with the plastic ron, trolley with the rearview mirror, trolley with large glass into the correct

positions on the layout. The logistics worker pulls the Unfinished trolley to its original location.

Step 4: Logistics workers pull four old trolley Trolley with the black edging, trolley with the plastic ron, trolley with the rearview mirror, trolley with large glass to the warehouse.

Step 5: The logistics worker pulls four new trolleys: trolley (5), trolley (6), trolley (7), trolley (8) from the warehouse to the Station door

Step 6: The logistics worker pulls four old trolleys: trolley (5), trolley (6), trolley (7), and trolley (8) out of Station Door.

Step 7: The logistics worker pulls four old trolleys: trolley (5), trolley (6), trolley (7), trolley (8) to the warehouse.

Step 8: The logistics worker pulls the new trolley (1), trolley (2) from the warehouse to the Station Door.

Step 9: The logistics worker pulls the old trolley (1) and trolley (2) out of the Station Door.

Step 10: The logistics worker pulls the new trolley (1), trolley (2) into the correct position on the layout.

Step 11: The logistics worker pulls the new trolley (5), trolley (6), trolley (7), and trolley (8) into the correct position on the layout.

Step 12: Logistics workers pull old trolley (1), trolley (2) to the warehouse.

Step 13: The logistics worker pulls 2 trolleys (4) from the warehouse to the Station Door

Step 14: The logistics worker pulls 2 trolleys (4) out of the Station Door and attaches them to the trailer.

Step 15: The logistics worker pulls two new trolleys (4) into the station door layout

Step 16: Logistics workers pull two empty trolleys to the warehouse.

⇒ There are a total of 16 steps to complete the delivery of 24 cars per time trolley. Although the number of steps has increased by 2 steps compared to the old layout, the work steps on the new layout are more streamlined. Besides, this supply also replenishes trolley (1) and trolley (2).

The process of moving the Unfinished Trolley trolley at the Door Station: the unfinished trolley is considered the most flexible trolley in the door station. This Trolley is responsible for transporting all unfinished doors to the door station for assembly and transporting the finished assembled doors out of the door station. Although this trolley is considered the main active trolley in the assembly

process, it does not have a specific process of its own. The order of the doors placed on the trolley is not in a certain order and sometimes confuses Assembly workers when mounting the doors on the jig.

There are 4 doors that will be placed on the Unfinished trolley:

- RL(rear left door)
- FL(front left door)
- RR(rear right door)
- FR(front right door)

The order of the doors is drawn as shown below with the black end matching the black end on the jig, the curvature of the door matching the pointed end defined on the jig.

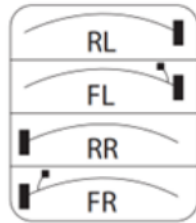


Figure: The order of doors in the Unfinished trolley



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Figure: The jig for sub RL Door

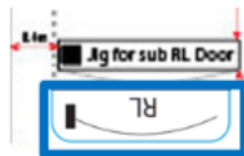


Figure: The process of assembling the RL door into the jig for sub RL Door

The order and direction of the doors placed on the trolley will be determined by the layout. Based on the layout, the engineer will design the order and orientation of the rear doors that will take the least time to get out of the Unfinished trolley and put the doors back into the Unfinished trolley after

installation. After monitoring the process and agreeing on how to arrange the doors on the unfinished trolley, the best arrangement is:

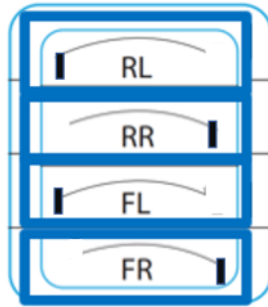


Figure: How to arrange the doors on the unfinished trolley

With this arrangement, each time when taking the door out of the trolley or placing the door in the trolley, Assembly workers needn't rotate the door. The process consistent with the above arrangement is:

1. Assembly worker pushes an unfinished trolley with 4 unassembled doors inside station Door

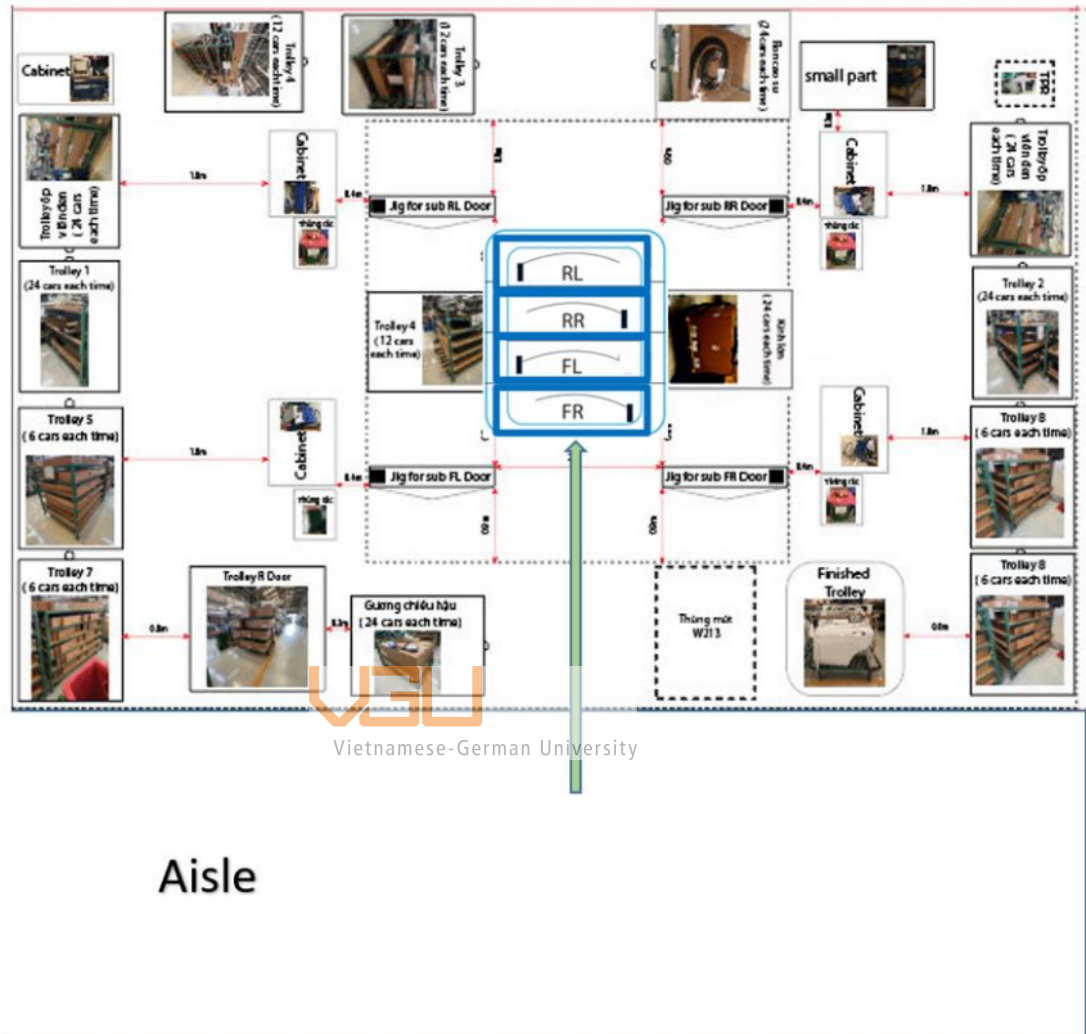


Figure : Push an unfinished trolley with 4 unassembled doors inside station Door

2. Assembly workers put 4 doors (RL, RR, FL, FR) on 4 jigs (Jig for RL door, jig for RR door, jig for FL door, jig for FR door).

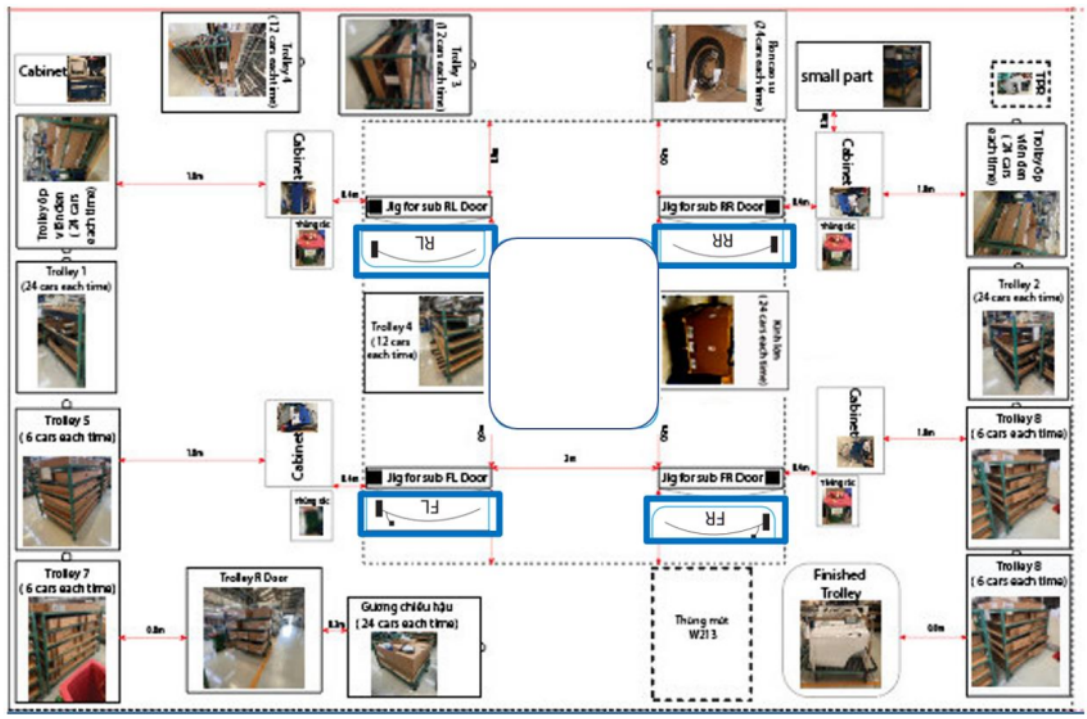


Figure: Put 4 doors on 4 jigs



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- After the doors have been installed, the Assembly worker places the 4 finished doors into the Unfinished trolley

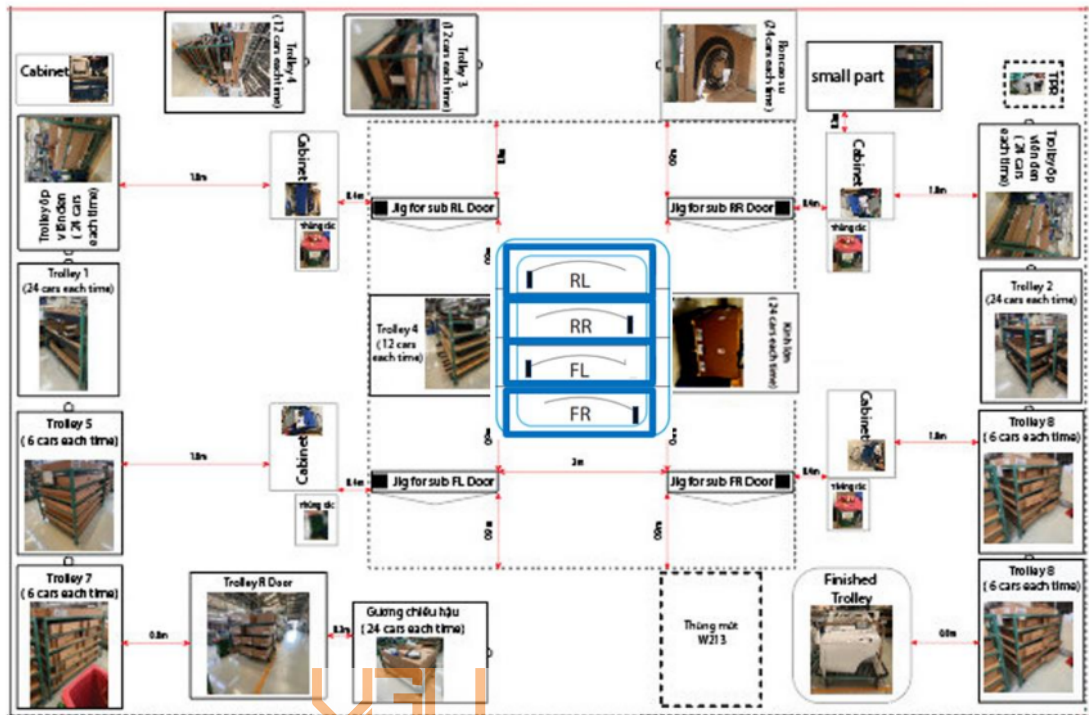
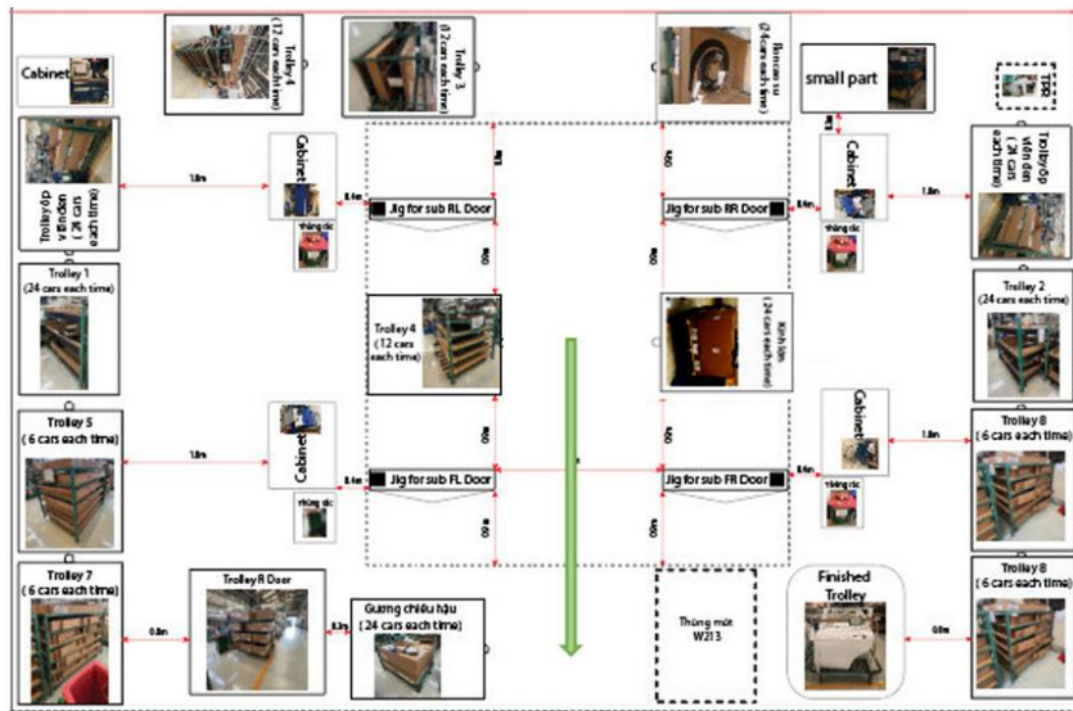


Figure: Places the 4 finished doors into the Unfinished trolley

- Push the Unfinished trolley out of the station Door



Aisle

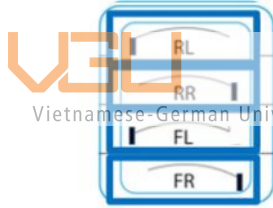


Figure: Push the Unfinished trolley out of the station Door

With the new process and new arrangement for the Unfinished trolley, the assembly time will certainly be significantly reduced.

- Before assembling the door: Reduces the time it takes to get the door from the unfinished trolley to get to the jig
- After completely assembling the door : Reduces the time it takes to get the door from the jig to re-board the unfinished trolley
- Doors are arranged on the unfinished trolley according to a specific rule, so the impact of damaging the door and scratching the door is avoided.

⇒ As a result, the assembly time is also significantly reduced, making Door Station no longer a bottleneck of the factory.

The advantage of the new procedure on the new layout:

In general, to be able to work well in the new layout, the work steps have been simplified and there are significant improvements:

- a. The process becomes simpler: in the old layout, every time a trolley is changed, the worker moves some trolleys first to get the trolley he wants to change. However, in the new layout, the processes are designed to be extremely simple and most trolleys are replaced by just 4 main steps:

1. Push the trolley from the warehouse to Station Door
2. Pull the old trolley out of Station Door
3. Drag the new trolley onto Station Door
4. Push the old trolley back to the warehouse.

With the new layout, every trolley is placed in the most convenient locations for assembly. for example, For trolleys containing components for mounting the left door will be placed near the zig used for mounting the left door,

- b. Independent process, does not affect other processes: in the old layout, the replenishing process often had to affect several other trolleys on the conveyor belt even though that trolley was not replenished. This affects other workers while working and slows down other processes. However, in the new layout, all processes have been designed independently, helping to avoid affecting other trolleys as little as possible. Proof of the effectiveness of the new process is that it has been shown to limit the removal of irrelevant trolleys during each replenishing. Trolleys with the most goods being trolley (5), trolley (6), trolley (7), trolley (8) will be placed closest to the path to facilitate the delivery of goods several times a day.



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