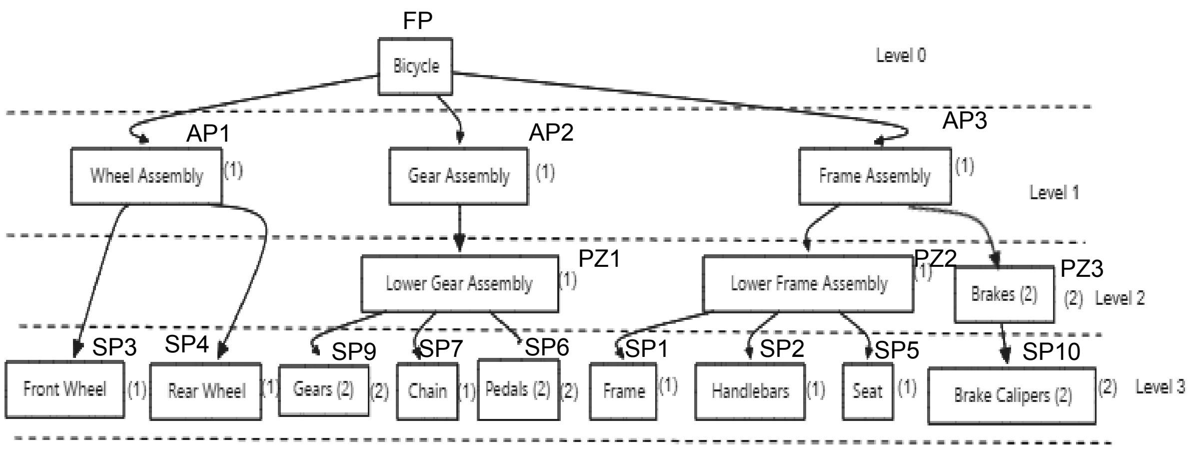
Furkan Panayır Task1

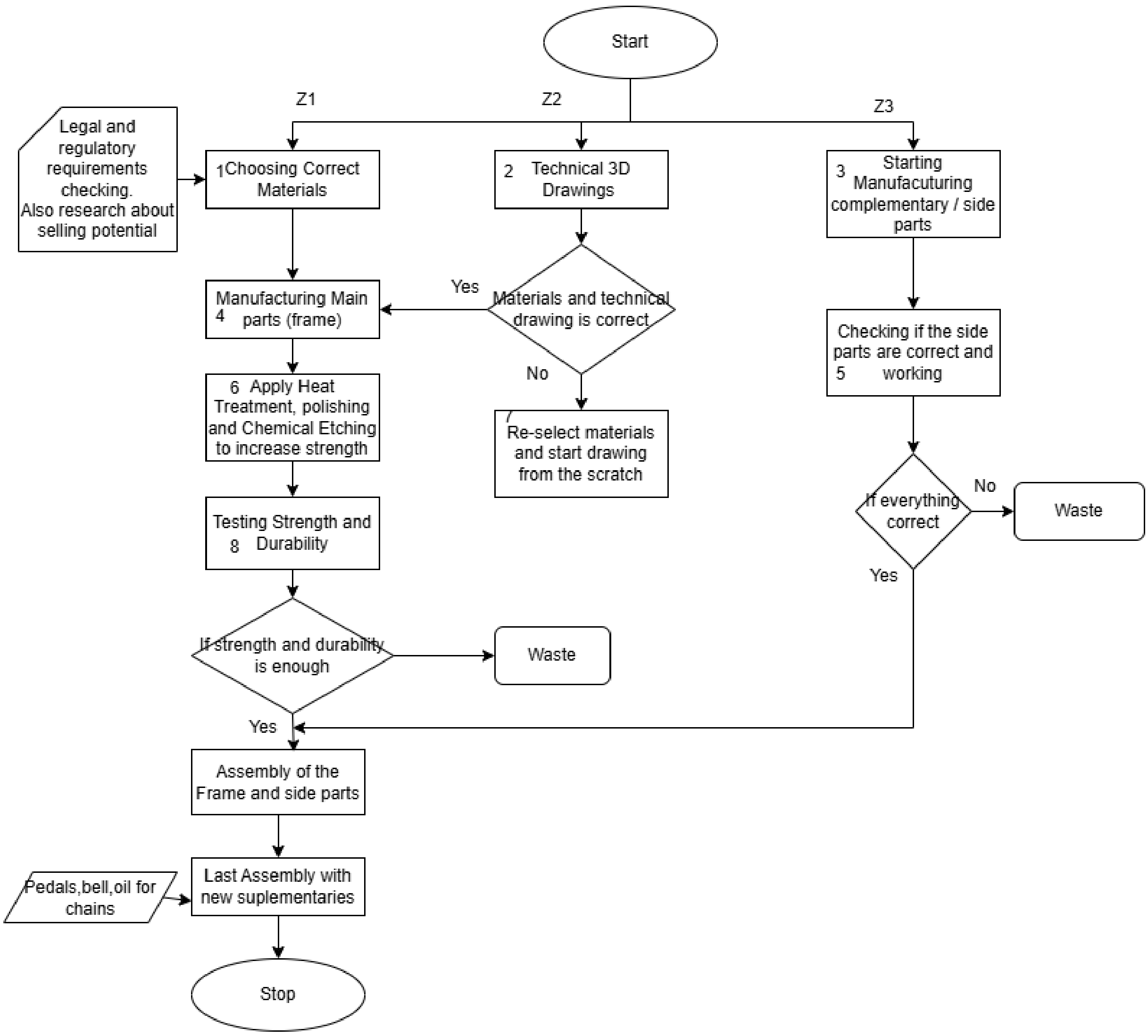
FINAL PRODUCT = BICYCLE

No	Name of Part	Symbol and Number of Part
1	Frame	SP1 (single part no1)
2	Handlebars	SP2 (single part no2)
3	Front Wheel	SP3 (single part no3)
4	Rear Wheel	SP4 (single part no4)
5	Seat	SP5 (single part no5)
6	Pedals (2)	SP6 (single part no6)
7	Chain	SP7 (single part no7)
8	Brakes (2)	**PZ3 (assembled lower part 3)**
9	Brake Calipers (2)	SP10 (single part no10)
10	Gears (2)	SP9 (single part no11)
11	Wheel Assembly	AP1 (assembled part 1)
12	Gear Assembly	AP2 (assembled part 2)
13	Frame Assembly	AP3 (assembled part 3)
14	Lower Gear Assembly	PZ1 (assembled lower part 1)
15	Lower Frame Assembly	PZ2 (assembled lower part 2)
16	Complete Bicycle	FP (final product)



Manufacturing Process of Bicycle

Furkan Panayir 160477



POZNAN UNIVERSITY OF TECHNOLOGY Department of Technology of Mechanical Engineering	CARD OF TECHNOLOGY ....No...............	**CT-1**

Name of part Name of part **The Bicycle Frame** Main structural component	The prepared for: -the series production

No operation	Name of operation	Name of Production workstation	Symbol of production worrkstation		Set up time	run time	Notes:
10	Cuting Material	Cutting Machine	FD2/250		0,4	0,3	
20	End Forming / Facing	Lathe	48we43		0,6	0,4	
30	Tube forming Bending and shaping	Hydraulic tube bender	HRB 40		0,5	0,6	
40	Frame welding Connecting tubes	Welding station	878D		0,7	0,5	Tungsten Inert Gas welding
50	Heat treatment Strengthening frame	Heat treatment furnace	ELF11/14B		0,2	0,7	Controlled cooling
60	Surface treatment Polishing and etching	Angle grinder	DWE4117		0,3	0,35	Chemical and mechanical processes
70	Strength testing Durability verification	Frame testing rig	HZ-1414 (lixian)		0,2	0,3	Load and stress testing
80	Final inspection Quality control	Quality control station	Kangu 18.004.1		0,05	0,15	Dimensional and visual inspection

Prepared by: Furkan Panayır 160477 Engineering Management	Date: 31.03.2025	Checked by:	Date:	Notes: All operations follow technical 3D drawings

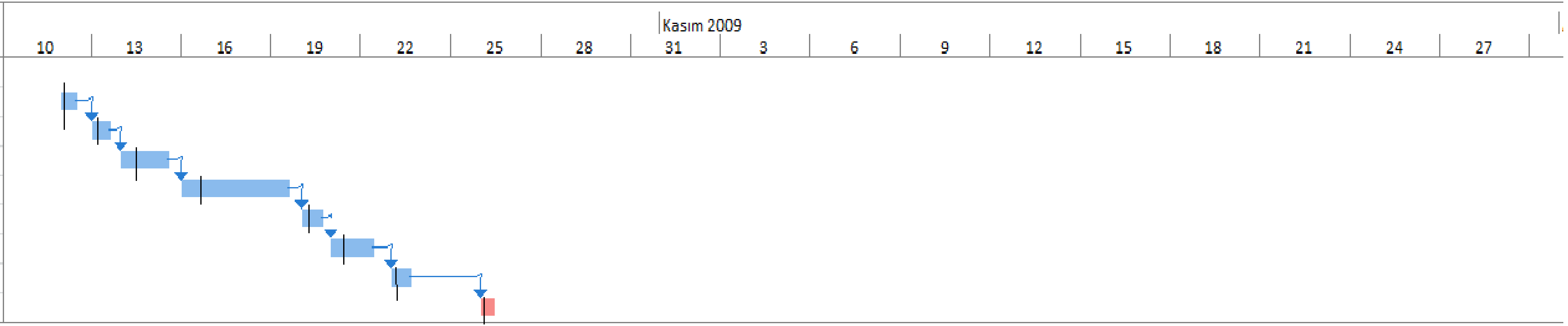
Instuction card Furkan Panayir 160477	Simbol of part : Z1	Code :
Operation: ***Bicycle frame production***	Workstation/ assembly station	No of operation: 8

Setting	Position	Range	Drawing	Operation content	Narzędzie	Parameters of production/assembly									Time of operation [min]
						D, d B	L	a_p	f	f_z	v_f	v_c	n	i	
-	-	-		Cuting Material	Cutting Machine FD2/250	-	-	-	-	-	-	-	-	-	42
-	-	-		End Forming / Facing	Lathe 48we43	-	-	-	-	-	-	-	-	-	60
-	-	-		Connecting tubes	Hydraulic tube bender HRB 40	-	-	-	-	-	-	-	-	-	66
-	-	-		Polishing and etching	Angle grinder DWE4117	-	-	-	-	-	-	-	-	-	39
-	-	-		Strength testing Durability verification	Frame testing rig HZ-1414 (lixian)	-	-	-	-	-	-	-	-	-	30

				Final inspection Quality control	Quality control station Kangu 18.004.1										12

Sketch and notes: Times:I translated total set up time and run time into minute, it was by hours at technologic process card	Machining fixtures and holders: grinder Tool fixtures and holders: Measuring tools:

Kimlik	ⓘ	Görev Modu	Task Name	Süre	Başlangıç	Bitiş	Öncüller	Kaynak Adları
1			Operation	Duration (	Start	End		
2			Cutting Material	204 dak	Pzt 12.10.0	Pzt 12.10.0		
3			Facing / End Formir	276 dak	Sal 13.10.0	Sal 13.10.0	2	
4			Tube Bending	750 dak	Çar 14.10.0	Per 15.10.0	3	
5			Welding Frame	776 dak	Cum 16.10.	Pzt 19.10.0	4	
6			Heat Treatment	432 dak	Sal 20.10.0	Sal 20.10.0	5	
7			Polishing	543 dak	Çar 21.10.0	Per 22.10.0	6	
8			Stress Testing	372 dak	Cum 23.10.	Cum 23.10.	7	
9			Final Inspection	138 dak	Pzt 26.10.0	Pzt 26.10.0	8	

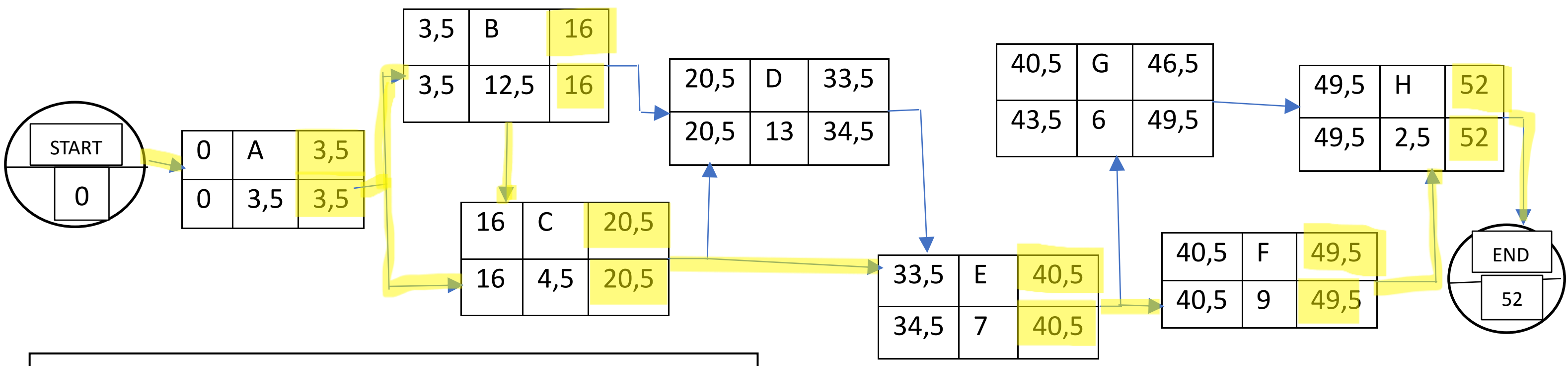


Duration in Minute, Setup time included. There are Intervals between Works (Pause Lines).

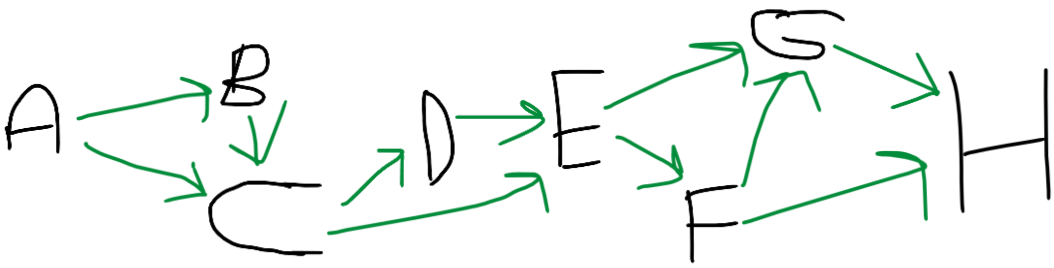
Setup Time: black line

FURKAN PANAYIR CRITICAL PATH TASK ABOUT BICYCLE PRODUCTION

Previous process	Proces designation	Duration of the proces (work hours)	Numer of workers
Start	A	3,5	4
A	B	4,5	3
A B	C	12,5	2
C	D	13	3
C D	E	7	2
E	F	9	4
E F	G	6	2
F G	H	2,5	1



(CRITICAL PATH IS HIGHLIGHTED IN YELLOW)



Bicycle Production

Adapt

- Using adjustable jigs and fixtures from the automotive sector can significantly improve the speed and precision of bicycle frame welding. These are designed for quick changes and can accommodate multiple frame geometries.
- Flexible modular fixtures can be adapted to handle different types of bike frames, from city bikes to racing models, which enhances production flexibility and reduces the need for new tooling.
- Real-time temperature control systems, typically used in aerospace metal processing, can be integrated into the heat treatment process. This ensures consistent quality and reduces the risk of overheating, which may weaken the aluminum frame.

Modify

- The standard circular tube design used in many frames could be modified to an aerodynamic teardrop shape, which is ideal for high speed racing bicycles. This change would give a competitive edge in terms of performance.
- Instead of manual polishing, implementing a robotic polishing arm system would not only speed up the process but also ensure consistency in surface finish quality across all units.
- The production layout can be modified into a U shaped work cell to improve efficiency. Workers can move less and the materials can flow smoothly through consecutive steps, leading to reduced cycle time.

Combine

- The heat treatment and cooling stages, which are currently separated, can be combined into one automated continuous furnace system. This integration would save space, energy, and handling time, making the process more streamlined.
- Currently, drivetrain installation and frame alignment are separate steps. By merging them, quality issues like drivetrain misalignment can be detected earlier, thus reducing rework.
- Multi-functional workstations that combine welding and visual inspection tasks can reduce transition time between processes and make early defect detection more feasible during production.

Put to another use

- Cut off tube segments that are normally discarded can be reused in creating mounts for lights, fenders, or accessory brackets. This reduces material waste and creates potential new product lines.
- Quality control and testing stations, which usually sit idle during certain hours, can be repurposed to handle other types of component testing such as fork or handlebar strength evaluations.
- Scrap aluminum from cut tubes can be melted and reused in 3D printing small components such as cable holders or frame plugs, helping to close the material loop and promote sustainability.

Substitute

- In the current bicycle manufacturing process, chemical etching is used for surface treatment. This can be substituted with anodizing, which not only offers better surface durability but also provides a more environmentally friendly alternative. Anodizing enhances corrosion resistance and improves paint adhesion.
- Manual tube cutting, though cost-effective for small batches, can be substituted with CNC controlled saws that increase precision, reduce material waste, and lower long-term labor costs. This also reduces the chance of human error.
- Instead of using heavy steel reinforcements inside the frame, aluminum foam inserts can be substituted. This reduces the overall weight of the bicycle while maintaining internal strength and absorbing vibrations effectively.

Reverse

- Instead of installing accessories at the very end, installing components like the drivetrain or wheels earlier in the process allows for functional testing and reduces rework in case of misalignment.
- The workshop layout can be rearranged to follow a linear progression from raw material intake to final assembly, minimizing backtracking and improving logistics flow.

Eliminate

- Manual inspections conducted at multiple stages can be consolidated or replaced with inline digital sensors that check dimensions and alignment in real-time, improving speed and accuracy.
- Packaging used between in house transfers is often excessive. Eliminating or reducing this packaging can reduce plastic waste and save time during unpacking at each station.
- Repolishing components multiple times can be avoided by upgrading the abrasive material quality used in the first polishing stage. This ensures a better finish right away and saves time.

Furkan Panayir 160477 Engineering Management

Morphological Analysis – Sustainable Urban Bicycle for Students

Phase I: diagnostic problem

The problem is to analyze and potentially improve the design and production of a sustainable urban bicycle aimed at students.

Goal: Balance affordability, sustainability, and functionality in an urban commuting context.

Phase II: Parameter Identification

Parameter	State I	State II	State III
A. Frame Material	AI Aluminum	AII Recycled Steel	AIII Bamboo
B. Drive System	BI Chain	BII Belt	BIII Electric Hub
C. Brake Type	CI V-Brake	CII Disc Brake	CIII Regenerative
D. Assembly	DI Manual	DII Semi-automated	DIII Fully automated
E. Testing	EI Manual	EII Semi-automated	EIII Fully automated

Phase III: Problem Synthesis

- **A2B3** (Recycled Steel + Regenerative): An ideal match for cost-effective, energy-regenerative systems.
- **A3B2** (Bamboo + Belt): Unconventional but eco-friendly but may need reinforcement.
- **A2B1** (Recycled Steel + Chain): Traditional, economical combination.
- **A3B3**: Challenging due to bamboo's compatibility with Electric Hub.

Phase 4: Combine with parameter C (Brake Type)

- **A2B3C2** (Recycled Steel + Electric Hub + Disc): Balanced.
- **A3B2C1** (Bamboo + Belt + V-Brake): Viable.
- **A2B1C3** (Recycled Steel + Chain + Regenerative): Limited compatibility.
- **A3B3C3**: Not recommended due to structural mismatch.

Step 5: Add parameter D (Assembly method)

Combinations:

- **A2B3C2D2**: Recycled Steel + Electric Hub + Disc + Semi-automated (good balance).
- **A3B2C1D2**: Bamboo + Disc + V-Brake + Semi-automated (feasible).
- **A3B3C3D3**: Not possible to make due to structural mismatch.

Step 6: Add parameter E (Testing approach)

- **A2B3C2D2E2**: Optimal balance (semi-automated testing).
- **A3B2C1D2E2**: Reasonable for moderate production.
- **A3B3C3D3E3**: Impractical due to base incompatibility. (Also Expensive)

Final Results Matrix:

Combination	Frame Material (A)	Drive System (B)	Brake Type (C)	Assembly (D)	Testing (E)	Viability	Notes
A2B3C2D2E2	Recycled Steel	Regenerative	Disc Brake	Semi-automated	Semi-automated	Optimal	Cost effective, eco friendly, good for mass production
A3B2C1D2E2	Bamboo	Belt	V-Brake	Semi-automated	Semi-automated	Possible	Lightweight and sustainable; may need strength evaluation
A2B1C3D1E1	Recycled Steel	Chain	Regenerative	Manual	Manual	Acceptable	Old-school mix manual labor intensive, but affordable
A3B3C3D3E3	Bamboo	Electric Hub	Regenerative	Fully automated	Fully automated	Not recommended	Structural incompatibility; high cost, low feasibility
A1B2C1D2E1	Aluminum	Belt	V-Brake	Semi-automated	Manual	Feasible	Light, standard solution; good for affordability
A2B3C2D3E3	Recycled Steel	Regenerative	Disc Brake	Fully automated	Fully automated	High cost	Technically optimal, but expensive and slower

							to implement
A3B1C2D1E1	Bamboo	Chain	Disc Brake	Manual	Manual	Unstable	Frame material may not tolerate torque from chain drive

Final Analysis

Based on the complete morphological analysis, two optimal combinations are possible:

1. **A2B3C2D2E2**

Recycled steel frame, regenerative drive system, disc brakes, semi-automated assembly and testing.
Advantages: Scalable, eco-friendly, practical for city use
Considerations: Reinforce frame durability

2. **A3B2C1D2E2**

Bamboo frame, disc brakes, V-brake system, semi-automated processes.
Advantages: Lightweight and sustainable, low cost
Considerations: Evaluate frame integrity and safety standards

After the Analysis – What Needs to Be Done?

1. Changes in Production

- The machines might need to be retooled or updated to work with new systems like regenerative brakes and semi-automated assembly.
- We will need new equipment for testing the bikes, especially if we choose semi-automated or automated methods.
- If we use materials like bamboo or recycled steel, we must make sure our machines can work with them. They are different from traditional materials like aluminum.

2. Hiring New People

- Some workers should have experience with special brakes or electric parts.

- We may also need experts for new materials, for example people who know how to work with bamboo.
- If we change the way we test bikes, we will need technicians or testers who can do the job correctly.

3. New Documents

We will need to write or update several documents:

- Assembly guides and instruction manuals for the new bike models.
- Safety certificates and product information sheets for public use.
- Any documents needed for selling the bikes in different countries or regions (like CE marking in the EU).

How Morphological Analysis Helps:

This method is very useful because it helps in many areas:

- We can design new products, like a smart or eco-friendly bike.
- We can use new materials, such as bamboo or recycled steel.
- We can reach new customer groups, for example students or city commuters.
- It helps us find new ideas to beat the competition, such as offering bikes that are easier to recycle or charge.
- It helps us think about new ways to promote the bikes, like using sustainability as a marketing tool.
- It shows us where we can sell the bikes, maybe in new cities or countries with a focus on green transport.