T.C

Hacettepe Üniversitesi

Mühendislik Fakültesi Endüstri Mühendisliği

Facility Design and Layout

Ankara, 2023

Contents

1. Background Information :

Established under the umbrella of Girişim Elektrik, Europower has been a steadily expanding company since its inception in 2008. With its headquarters in Ankara, the company operates from a campus spanning over 180,000 square meters, comprising offices, research and development centers, as well as production and storage area.

In addition, Europower extends its services globally through strategically positioned offices and facilities in the Netherlands, Macedonia, Algeria, and Ukraine.

1.1 Sector:

Europower operates in the energy sector, specifically focusing on the production and distribution of electrical power.

1.2 Products:

There is a wide range of products in the energy sector. To explain briefly;

- High Voltage Circuit Breakers and Disconnectors
- Different types of Air-Insulated and Gas-Insulated Medium Voltage Cells
- Circuit Breakers, Disconnectors, and Switching Products for Medium Voltage Systems
- Various types of Epoxy Resin Insulation Materials
- AC and DC Low Voltage Power, Control, and Distribution Panel Systems
- Concrete, Metallic, and different types of Transformer Centers and Distribution Systems

- Mobile Transformer Centers, the largest in Turkey and among the largest in the world
- Power Compensation Systems and Stations
- Inverter Stations and Energy Storage Systems
- Automation and SCADA Systems, Hardware, and Software
- Construction Systems for Solar Power Plants, including Ground-Mounted, Rooftop, Car Park, and Floating Types
- Railway Electrification and Switching Products

1.3 Processes:

- Turning Processes:

  Turning is a machining process in which a cutting tool, typically a non-rotary tool bit, describes a helix toolpath by moving more or less linearly while the workpiece rotates. The tool's axes of movement may be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear (in the nonmathematical sense). Commonly performed with a lathe, turning reduces the diameter of a workpiece, typically to a specified dimension, and produces a smooth part finish

- Milling Processes:

  Milling is a machining process where a rotating cutter removes material from a workpiece, which is moved right-angled to the axis of the tool. The milling process is done by the machine called a milling machine. This process can be used to create flat surfaces, slots, angles, pockets, and complex contours.

- Drilling Processes:

  Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multi-pointed. The bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the workpiece, cutting off chips (swarf) from the hole as it is drilled.

- Welding Processes:

  Welding is a fabrication process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint. There are different welding methods, including arc welding, MIG (metal inert gas) welding, TIG (tungsten inert gas) welding, and others.

- Painting Process:

  The painting process involves preparing the surface, applying the paint, and then allowing it to dry. Preparation might include cleaning the surface, sanding it to create a rougher surface for the paint to adhere to, and applying a primer. The paint is then applied, usually in several coats, and allowed to dry in between. This process can vary based on the type of paint used and the surface it's being applied to.

- Punch Process:

  Punch processes involve using a punch press to create holes or shapes in materials. It is a precise and efficient method commonly used in industries like metal fabrication and automotive manufacturing. The punch applies force while the die supports the material during the process. Punching offers high production rates, accuracy, and versatility for working with various materials. It can be automated for mass production or done manually for smaller-scale operations.

1.4 Objectives:

Europower and Girişim Elektrik have a main objective of providing sustainable and environmentally-friendly electrical solutions. The turtle depicted in Girişim Elektrik's logo provides a hint about their vision and mission. The existence of sea turtles in the oceans for millions of years and the journey of tiny turtle hatchlings from the sands to the vast oceans have inspired them in terms of longevity, growth, expansion, and dissemination.

1.5 Location:

Saray Mah. Atom Cad. No:15 Kahramankazan / ANKARA – TURKIYE

1.6 Competitors:

- Astor Enerji:

  Astor Energy is a leading renewable energy company dedicated to providing sustainable and innovative solutions for a greener future.

- Sönmez Trafo:

  Sönmez Transformer is a trusted manufacturer of high-quality transformers, offering reliable and efficient solutions for various industries.

- Cv Energy:

  CV Energy is a leading provider of comprehensive energy solutions, specializing in renewable energy projects and sustainable infrastructure development, with a particular focus on the solar energy sector.

1.7 Customers:

- TEDAŞ
- TEİAŞ
- BAŞKENT elektrik
- Turnkey projects

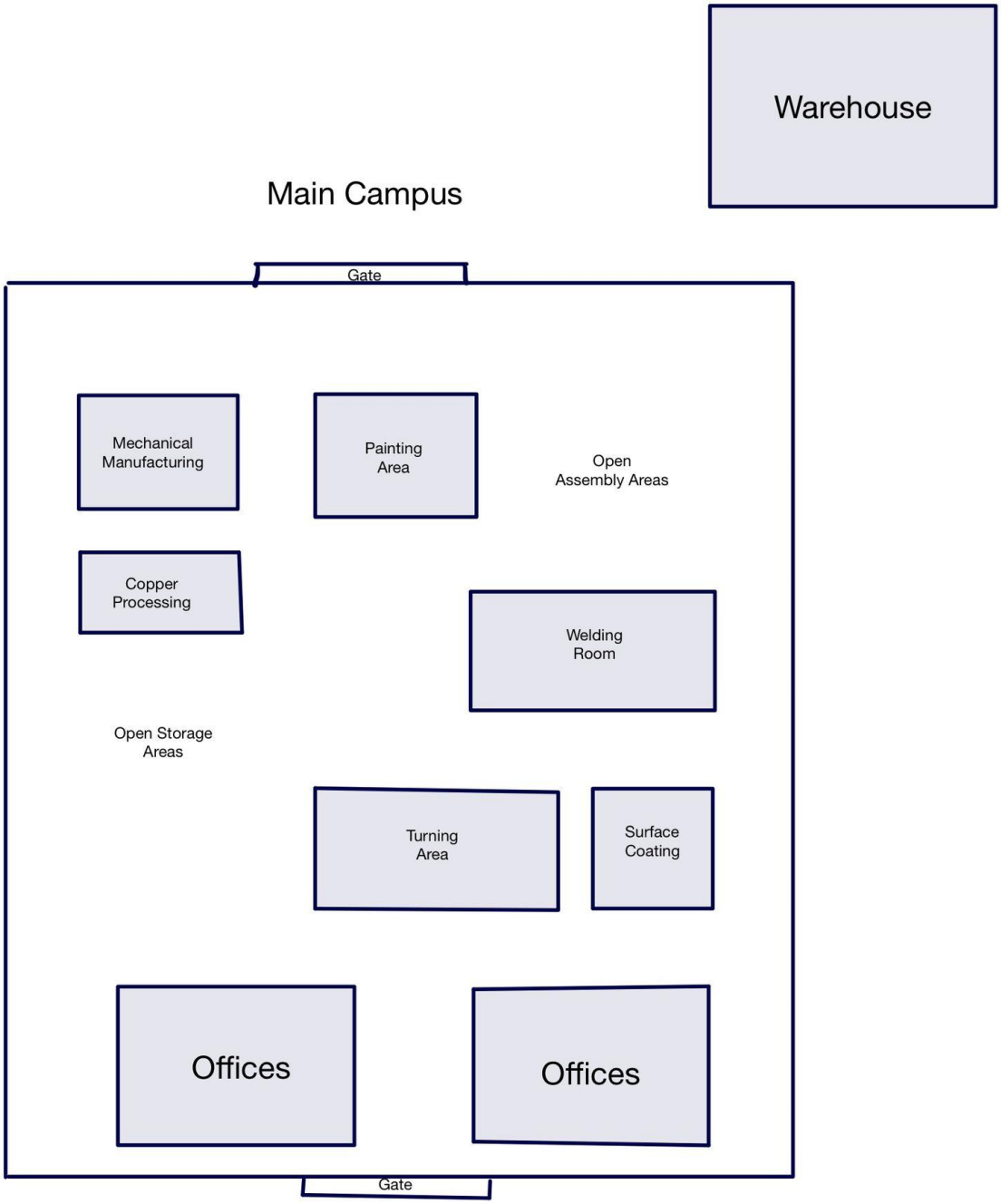
1.8 Supply Chain:

The company used to be highly dependent on external sources before reaching its current position, but over time, this situation has changed. They have started producing the necessary components for their products themselves by opening new factories, ranging from the smallest to the largest. They only collaborate with subcontractors or competitors when they need to fulfill orders beyond their capacity. Europower is now capable of managing the entire process from production to assembly for all of its products.

1.9 First Observations:

GİRİŞİM Electric was established in 1999 by four electrical electronic engineers. As the company grew rapidly in recent years, it also established Europower. However, due to its fast growth, the company was unable to achieve a planned and organized factory layout. New factories and facilities were placed only in available locations, without being optimally designed. The company has employed industrial engineers for a year now, and these engineers are striving to optimize every process, from factory layout to product design. According to the occupational health expert who provided us with occupational health training and the engineers and employees we spoke to, the company experienced rapid and unplanned growth. As a result, chaos and disorder prevailed. Efforts have been initiated to prevent this.

2. Current Layout Sketch:



2.1 Explanations of Current Layout Problems:

Firstly, as mentioned earlier, the majority of the problems arise from the rapid expansion of the factory, which has led to an inability to execute accurate and organized facility layout. Now, I will briefly touch upon these issues.

Storage Problems:

One of the main storage issues is the location of the warehouse, which is situated outside of the factory premises. As a result, they are unable to place processed products and items that will undergo further processing directly into the warehouse. Instead, they resort to storing them in open storage areas within the factory or keeping them waiting inside the facility. This creates a state of chaos and makes it difficult to accurately count and manage the products. The counting of products is not centrally controlled by a main system. Each factory is responsible for counting their own products during internal orders. This occasionally leads to disruptions and delays. Additionally, certain items like transformer substations are quite large and are produced on-demand, making it impossible to store them in the warehouse. Production begins upon receiving the specific order, which can result in occasional delays.

As a result of these challenges, it is necessary to find suitable solutions to streamline the storage processes, improve inventory management, and minimize delays in fulfilling orders.

Material Handling Problems:

The transportation of materials within the factory has not been adequately considered during the design of the factory layout, leading to inefficiencies in determining how and through which routes the materials should be transported. As a result, some material transportation routes are lengthy, causing time delays. To address this issue temporarily, various transportation vehicles and specialized hand carts have been designed, but this is not the most optimal solution.

In addition to these, there were also issues with aisle widths. While some aisles were quite wide, there were others that were designed very narrow despite heavy human traffic. This not only slows down the flow but can also create occupational safety issues in certain areas.

Furthermore, the narrow aisles pose challenges for the movement of equipment, trolleys, and other materials within the factory. It can lead to congestion, bottlenecks, and potential accidents if not addressed properly.

2.2 Determining Interrelationship and Activity Relationship:

There are numerous products manufactured in factories, making it challenging to examine their interrelationships. Due to my limited knowledge of the actual movements of materials, I have analyzed the interrelationships from a qualitative perspective. To do so, I have gathered the closeness relationships of the units mentioned in the sections above.

Qualitative flow measurement; is an approach that focuses on observing and describing the behavior and characteristics of a flow without using precise numerical measurements. This method is useful when exact measurements are difficult or unnecessary, providing valuable insights in fields like fluid dynamics and environmental monitoring.

Flows can be qualitatively measured by using closeness relationship values. These values indicate the level of proximity or connection between different components or units within a system. By analyzing these closeness relationship values, one can assess the qualitative flow of materials, information, or influence between the units. This qualitative measurement helps understand the interrelationships and dynamics within the system, providing insights into how the units are connected and how they impact each other.

Value	Closeness
A	Absolutely necessary
E	Especially important
I	Important
O	Ordinary closeness okay
U	Unimportant
X	Undesirable

If we make the relationship chart of the factories that are drawn in the above sketch:
1.Welding room

2.Mechanical Manufacturing

3.Painting Area

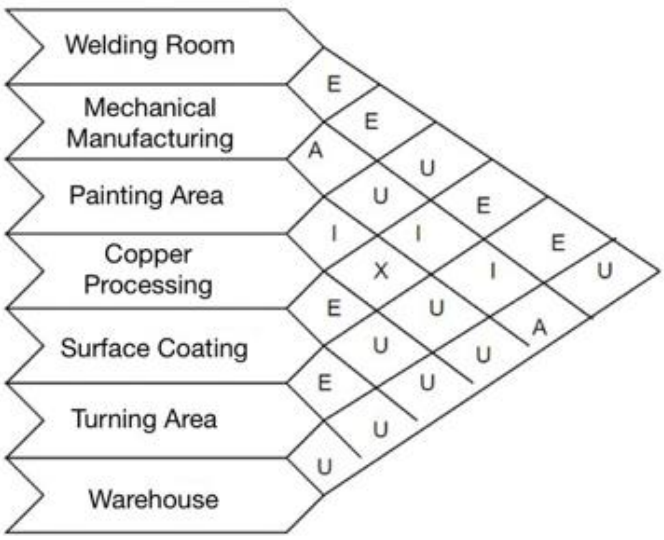
4.Copper Processing

5.Surface Coating

6. Turning Area

7. Warehouse

	1	2	3	4	5	6	7
1	-	E	E	U	E	E	U
2	E	-	A	U	I	I	A
3	E	A	-	I	X	U	U
4	U	U	I	-	E	U	U
5	E	I	X	E	-	E	U
6	E	U	U	U	E	-	U
7	U	A	U	U	U	U	-



2.3 Space Calculations:

Europower is a campus with over 180,000 square meters of production area, consisting of 7 enclosed and 2 open facilities. With the addition of their new solar energy factory, they are further expanding this area. As mentioned before, Europower is currently experiencing rapid growth. The originally projected space became insufficient for their needs two years ago. Being located in an industrial zone and having vacant plots of land nearby, they expanded their campus and increased the number of factories. Unfortunately, we couldn't obtain more specific information about the area of the factories or the warehouse.

3. Material Handling

3.1 What is Moving?

The company produces various products, but we specifically examined the production and delivery process of concrete transformer kiosks.

A concrete transformer kiosk is a structure made of concrete that houses electrical transformers. It provides a protected environment for the transformers, ensuring their safety and efficient operation. These kiosks are designed to withstand external elements and provide insulation. They play a crucial role in power distribution by securely housing transformers in various locations such as utility substations or industrial facilities. Concrete kiosks are categorized into three types: small, medium, and large, based on their dimensions.

3.2 When it is Moving?

Due to its large size, the product is not moved around much within the factory. The product is created, assembled, and painted in the same location. It is only transported during the delivery process.

3.3 Where is Moving?

The company has numerous customers both domestically and internationally. Toroslar Electricity and Başkent Electricity are among their main customers. Since they produce products upon order, they do not have a fixed and continuous delivery point.

3.4 How is it Moving and With What is it Moving?

Delivery is carried out using large trucks. Due to the size and weight of the product, only one kiosk is delivered at a time. The product is placed onto these trucks using an overhead crane. According to our observations, during transportation, the kiosk is not securely fastened to the truck's cargo bed. Additionally, the large size of the kiosk exceeds the capacity of the truck's cargo bed, causing one of the truck's doors to remain open. No precautions are taken for these situations, which we consider as a risk in terms of occupational safety. Furthermore, in cases where the delivery is at risk of not being on time, there are instances where the painting process of the kiosk is carried out inside the truck's cargo bed.

4. Storage Areas and Current Locations:

4.1 Space and Current Location:

The main and largest warehouse of the factory is located outside the main campus as indicated in the sketch. However, storage is also carried out in various locations throughout the campus. For example, as mentioned earlier regarding the material handling process, the product is stored directly at the place of production. Additionally, unfinished products can be kept in various open storage areas within the factory. As mentioned before, this situation makes inventory management quite challenging.

5. Location of the Company

The company's main headquarters is located in the industrial zone in Ankara.

The factory's location within an industrial zone was carefully chosen for several reasons. Firstly, it provides easy access to raw materials, streamlining the supply chain and ensuring efficient production processes. Secondly, being in close proximity to other factories fosters effective communication and allows for easy collaboration with subcontractors when necessary.

Moreover, the availability of a large and vacant area in the industrial zone offers ample space for the company to establish new departments and accommodate future expansion plans. Europower, as an example, has successfully expanded within its current location, demonstrating the potential for growth and development.

One of the considerations for selecting an out-of-town location is to mitigate the impact of noisy production processes, waste generation, and the utilization of potentially hazardous machinery. Placing the factory away from residential areas ensures the safety and well-being of nearby residents.

Additionally, the current location was strategically chosen to facilitate smooth transportation of incoming and outgoing products. By minimizing delays and disruptions caused by traffic congestion, the company can ensure timely delivery and maintain customer satisfaction.

Overall, the selection of the factory's location within an industrial zone takes into account various factors to optimize operations, promote growth, ensure safety, and enhance logistical efficiency.

6.Propose a Layout and Location Alternative

6.1 Layout Alternatives

We collaborated with an industrial engineer working at the factory to develop an alternative layout. In this work, we utilized the Corelab algorithm.

The Corelab algorithm is a method used in industrial engineering and operations management to optimize facility layout designs. It aims to determine the most efficient arrangement of machines, workstations, and other resources within a manufacturing or production facility. By considering factors such as workflow, material flow, and spatial constraints, the Corelab algorithm helps identify the layout configuration that minimizes transportation costs, reduces production bottlenecks, and enhances overall productivity. It utilizes mathematical optimization techniques and computer algorithms to find an optimal solution, balancing various factors to achieve an efficient and effective layout design.

Steps:

1. Select the sections to be placed in sequential order. The selection process is similar to the "Systematic Layout Planning" method.

2. The section with the highest sum of numerical closeness ratings (NCR) with other sections is placed first. (Note: Absolute values are used when calculating NCR.)

3. Repeat the following step until all sections are placed.

4. From the sections that have not been placed, select the section with the highest sum of NCR according to the A, E, I, O relationship. If there is a tie, select the section with the highest number of relevant relationships. If the tie persists, perform a random selection.

5. Place the initially selected section in the center of the facility, and place the subsequent sections based on the adjacency coefficient and NCR values. Continue this process until all sections are placed.

We conducted a Corelap study for the facility layout design of seven sections within the factory. The details of this study and the resulting layout will be shared.

1.Welding room

2.Mechanical Manufacturing

3.Painting Area

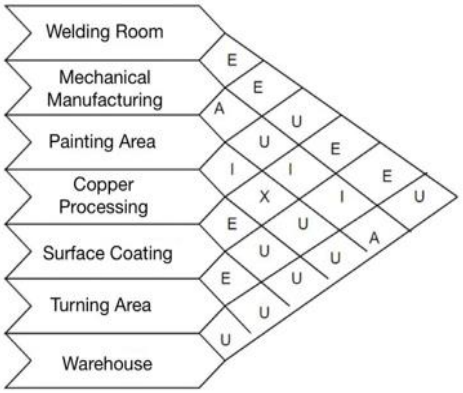
4.Copper Processing

5.Surface Coating

6. Turning Area

7. Warehouse

Corelap



THE DEGREE OF CLOSENESS

E:25

I:5

O:1

U:0

X:-125

PARTIAL NEIGHBORHOOD COEFFICIENT =0,5

A	125
E	25
I	5
O	1
U	0
X	-125

		DEPARTMANLAR							ÖZET							
		1	2	3	4	5	6	7	A	E	I	O	U	X	TOPLAM	SIRALAMA
DEPARTMANLAR	1	-	E	E	U	E	E	U	0	4	0	0	2	0	100	4
	2	E	-	A	U	I	I	A	2	1	1	0	2	0	280	2
	3	E	A	-	I	X	U	U	1	1	1	1	1	1	285	1
	4	U	U	I	-	E	U	U	0	1	1	0	4	0	30	7
	5	E	I	X	E	-	E	U	0	3	1	0	1	1	205	6
	6	E	U	U	U	E	-	U	0	2	1	0	4	0	55	5
	7	U	A	U	U	U	U	-	1	0	0	0	5	0	125	3

62,5	125	62,5
125	3	125
62,5	125	62,5

62,5	187,5	187,5	62,5
125	3	2	125
62,5	187,5	187,5	62,5

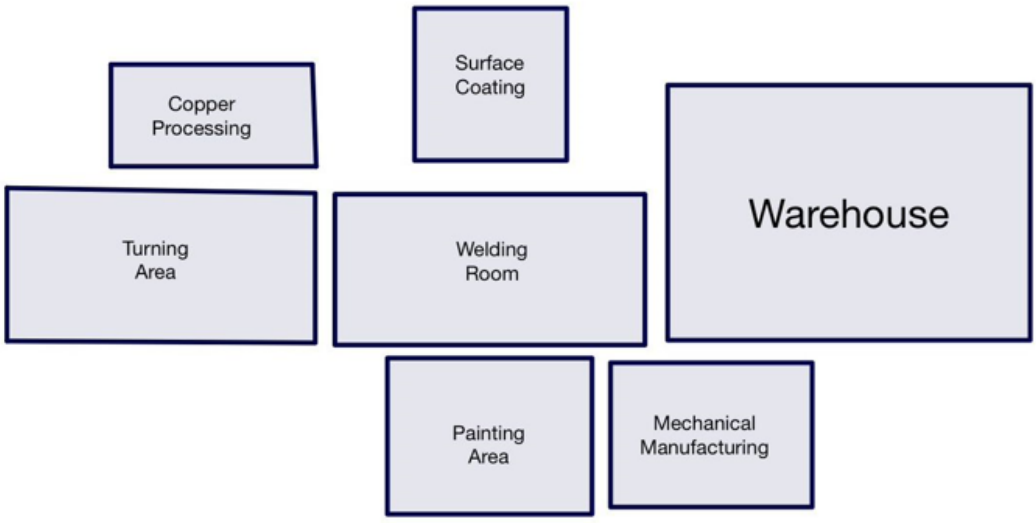
		125	62,5
62,5	312,5	7	187,5
125	3	2	187,5
62,5	187,5	187,5	62,5

62,5	187,5	187,5	62,5
187,5	1	7	187,5
187,5	3	2	187,5
62,5	187,5	187,5	62,5

62,5	187,5	312,5	187,5	62,5
125	6	1	7	187,5
62,5	312,5	3	2	187,5
0	62,5	187,5	187,5	62,5

4	5	
6	1	7
	3	2

The resulting layout for the seven sections, based on the conducted study.



6.2 Location Alternatives:

As mentioned before, the current location of the factory has various advantages, with the most significant one being its potential for expansion.

Options for modifying the location of an existing factory include:

1. Expanding an existing facility: This involves increasing the size or capacity of the current factory by adding new buildings, floors, or sections. It allows for accommodating growing production demands or introducing new processes without the need to relocate the entire facility.

2. Add new locations while retaining existing facilities: This option involves establishing additional facilities in different locations while keeping the existing factory operational. It enables the company to expand its geographical reach, tap into new markets, or optimize the supply chain by strategically locating production facilities closer to customers or suppliers.

3. Shut down one location and move to another: This option involves closing down the current factory and relocating operations to a different location. It may be chosen if the existing facility is no longer suitable due to factors such as limited space, outdated infrastructure, or unfavorable market conditions. Moving to a new location offers the opportunity to design a more efficient and modern facility.

4. Do nothing: This option entails maintaining the current location and operations without making any changes. It may be chosen if the existing facility is still meeting the company's needs effectively, and there are no immediate requirements for expansion or relocation.

The selection among these options depends on various factors, including growth projections, market conditions, operational needs, cost considerations, and strategic goals of the company.

Europower has implemented options 1 and 2 by leveraging the advantages of being located in an industrial zone. They have expanded their operations and opened new factories in different locations. Additionally, to expand globally, they have established various international offices. **(**Turkey- Netherlands- Macedonia- Algeria – Ukraine)

In conclusion, Europower has implemented the alternative options for location and taken the necessary steps to expand into the global market.

7. Evaluate the Alternatives:

If the proposed layout alternative is implemented, it will significantly reduce both time and cost losses, particularly in terms of material handling. The reduced distance that workers need to cover will increase their satisfaction. Additionally, as the current irregular flow within the factory decreases, we believe that many workplace accidents can be prevented.