



UNIVERSITAT
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Escuela Técnica Superior de Ingeniería Industrial

DISEÑO DE UN NUEVO MODELO DE BICICLETA BMX
(BIKE MOTO CROSS) EN UNA MULTINACIONAL
DEPORTIVA Y SIMULACIÓN DEL PROCESO EN SAP
S/4HANA

Trabajo Fin de Grado

Grado en Ingeniería en Tecnologías Industriales

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SUPERIOR ENGINYERIA
INDUSTRIAL VALÈNCIA

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ORGANIZACIÓN INDUSTRIAL

DESIGN OF A NEW BMX BIKE MODEL
(BIKE MOTOCROSS) IN A SPORTS
MULTINATIONAL AND SIMULATION OF
THE PROCESS IN SAP S/4HANA

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RESUM:

The primary goal of this final degree project is to simulate the design process of a new model of BMX bicycle in a multinational company that uses SAP for information management.

As a result, the work will begin with theoretical content in which the necessary information will be gathered from the end user to carry out the subsequent bicycle design. The QFD (Quality Functions Deployment) technique will be used to collect this information, which will provide a clearer picture of what is needed and will transform end-user demands into BMX bicycle requirements and user demands into technical specifications.

This will be followed by an overview of ERP (Enterprise Resource Planning) and the advantages of integrated information management for businesses that use this tool.

The production of such a bicycle model will be planned, and the implementation will make use of the company's real information management software (SAP). Simultaneously, an introduction to information management in the business world, as well as a study of the importance of logistics management in the company, will be made.

SAP will be used to define the project structure, including activities, duration, material purchases, deadlines, and so on, as well as the economic results. Finally, a technical and economic solution will be reached, with the total cost of the project broken down into each of its components.

SOMMARY:

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l) Introduction:

1) Purpose:

The goal of this project is to simulate the design process of a bicycle, specifically a new BMX model, using SAP software in the virtual company Global BMX, which serves as an entertainment platform for SAP users and programmers. The design is based on gathering the necessary information, implementing it in software, and finally launching it in the environment of a multinational company that uses SAP for information management.

The process for this design begins with the selection of the bicycle's modular parts, which are provided by the fictitious company Global BMX INC, whose corporate structure is established by the ERP's creators. Second, surveys of potential users of this bicycle model, as well as a market study, were conducted. As a result of all this information, the various materials were entered into the company's database via SAP's Material Management and Project System modules. The project structure was developed, with the necessary human, economic, and material resources assigned to each activity. Finally, the budgeted cost has been obtained.

2) Purpose and justification:

The primary goal of the work is to learn about ERPs, specifically SAP, and how they are integrated into businesses, as well as their significance in the world of information management. Other goals include understanding the design process of an engineering product, project planning and management, achieving a good technical solution that satisfies a market segment through an economical solution, and defining and planning all project activities. The goal of this work is to certify that the student possesses the skills required in the curriculum of the Degree in Industrial Organization Engineering taught at the School of Industrial Engineering of the Polytechnic University of Valencia and my French school ICAM (Institut Catholique des Arts et Métiers).

Another viewpoint is to equip the student with the necessary skills (planning, management, production, logistics, etc.) as well as a fresh perspective when approaching problems in the workplace.

3) Background:

a) Introduction BMX life Inc. :

To carry out this work, we will create a fictitious bicycle company, belonging to the BMX competition sports market in France and in the European Union.

BMX Life Inc. is a sub-brand of a world-renowned multinational company: Haro. It was created to meet the growing and specific demand for BMX racing bikes.

BMX Life Inc. created three BMX bikes for its launch (Freestyle and flat, racing, Ramp and street) which are now recognised by the BMX community for their low cost and high quality.

Today, BMX Life Inc. seeks to diversify by offering complementary quality equipment to its customers (BMX suits, protections, helmets, glasses...)



BMX Life Inc

b) Information management :

Companies nowadays generate massive amounts of data every day, which are not synchronized between workplaces and are processed on disparate platforms. Therefore, databases are required to manage all this information. However, the real challenge that organizations face is transforming the information collected in the database into useful information. This is where information systems come into play. A formal set of tasks/procedures/practices that act on a structured collection of data is referred to as an information system. They oversee gathering, compiling, and disseminating information required for the company's procedures and management operations to carry out its activities in accordance with its business strategy.

In turn, information systems serve two purposes:

- To assist with administrative functions
- To assist in the development of strategic competitive advantages over the competition, which drive performance in accordance with the market and its lines of business, while utilizing all technological innovations available.

This is when information management software (ERPs) enters the picture. However, selecting the best software for the company is a difficult task. The company is confronted with a variety of situations, including software products that were not designed to work together, the acquisition of generic software that is not specific to the type of company, and the partial automation of the software, which makes direct use impossible.

To select the best ERP, the following steps must be taken:

- Planning phase: where goals must be established and a technological configuration that meets those goals must be devised.
- Data storage phase: the goal of the data storage phase is to obtain useful data. As a result, the data must be separated, transformed, and loaded for the organization to locate, incorporate, and filter the data before storing it.
- Implementation phase: Inventive solutions must be implemented in this phase to examine the data and provide useful information as well as a competitive advantage.

From an economic standpoint, there are fewer constraints in the design phase, implying greater freedom of action; however, as the project progresses, constraints may emerge that influence and change the initial budgeted cost, because the project is being developed in an uncertain environment. As a result, predictions do not always come true.

Project monitoring entails measuring the results (time, cost, and quality) obtained during project implementation to see if they correspond to those predicted in the plan. It assesses whether each task began and ended on time, whether the expected results and quality were met, and whether budget deviations occurred.

The main goal will thus be to comply in terms of time, cost, and quality, while anticipating (as much as possible) potential constraints. This must be checked on a regular basis. The monitoring results are compiled and published in the project implementation report.

c) Logistics in the company:

Over time, logistics has evolved rapidly. Historically, logistics was based on acquiring the right material at the right time, in the right place, and at the right price.

Today, logistics has progressed to the point where specific departments within businesses have been established to handle the logistics process.

Company logistics includes the planning phase, as well as the regulation and monitoring of all activities involved, such as product acquisition, subsequent transport, and warehouse storage. In other words, it includes all activities from product procurement to point of consumption.

As a result, the movement of goods should be divided into two categories:

- Direct logistics: oversees the movement of goods from point of origin to point of consumption.
- Reverse logistics is the process of returning goods in the supply chain from the point of consumption to the point of origin as efficiently and cheaply as possible. It is also in charge of recovering or creating value from goods through the following methods: reuse or resale, repair, refurbishment, re-production, cannibalization, recycling, or, as a last resort, incineration, or disposal.

The following are the primary logistics activities:

TRANSPORT

This entails transporting goods from their origin to their destination. To ensure that the goods arrive in the quality and time specified in the contract, the most appropriate means must be used.

Its primary functions are as follows:

- Choosing the best mode of transportation
- Goods consolidation
- Choosing the best mode of transportation

MANAGEMENT OF INVENTORY

These are the procedures that determine procurement requirements and provide the best procurement technology. Inventory management is critical because it reduces the amount of circulating stock required, which means less need for space and lower costs (capital immobilisation cost, warehouse maintenance, handling, deterioration, spoliation, expiry and obsolescence).

The following are the main activities:

- Creating inventory policies at all levels.
- Sales forecasting
- Examining the quantity of various products in the warehouses
- Building the warehouse

PROCEDURE FOR ORDERING

It encompasses all operations involving the picking, packing, and distribution of goods.

It entails the following tasks:

- material placement in the warehouse
- Storage space delimitation and shaping

4) Enterprise Resource Planning (ERP) :

a) Introduction of ERP :

An ERP system is a collection of programs that allow a company to monitor and integrate its business processes. It makes use of a database in which data is updated and not duplicated. These systems enable all areas of the company to use the same database and thus be connected to each other while using the same data quality.

Accounting and financial, commercial, human resources, production management, and planning and project management applications are all part of this framework.

Their distinguishing features are as follows:

- Integrated system: ERP systems are distinguished by their integrated system. The core of the ERP is a central database that processes the applications that support the company's various functions.
- Design based on best practices: ERPs are a standard solution, which means they are parameterized so that they can be implemented in any company, but they must be configured for the specific company so that it adapts to its needs.
- Modular: ERP functionality is divided into modules, allowing the company to install the most appropriate ones to meet its needs.
- Customisability: ERPs allow for some degree of customization, allowing the system to be tailored to the specific needs of the organization.

Each module includes configuration tables (or parameters) with a limited number of options for customizing them to fit the company's procedures. If the alternatives provided are insufficient to meet the needs of the company, there are two options: modify parts of the code or use an external system by creating a link to it.

b) ERP types :

Following a brief introduction to ERPs, the most important manufacturers in the current market, as well as ERP by-products or modules, will be mentioned. today's market, as well as the by-products or modules of these programs:

ERP	MODULES OR BY- PRODUCTS
	SAP: SAP Business Suite, SAP All-in-One, SAP Business ByDesign, SAP Business One



skubana



sage 100cloud

The Sage Group:
Sage Software –
Accpac ERP,
PeachTree

ORACLE®

ENTERPRISE
RESOURCE PLANNING
CLOUD

**Oracle
Applications:**
Oracle, JD
Edwards,
PeopleSoft,
Siebel, Retek

	
	<p>Microsoft Business Solutions: Dynamics: Great Plains, Navision, Axapta, Soloman</p>

As you can see above, a list of the most important ERPs now, but this work will concentrate on SAP.

SAP (Systems, Applications, and Products for Data Processing) has developed a distinct understanding of the challenges associated with implementing technology solutions for business users. The software's purpose is to assist organizations in incorporating their business processes for the company to function properly. Systems that are flexible and modular can adapt to new business processes.

BMX Life Inc has therefore decided to use SAP as its ERP.

II) Market research:

1) Introduction

Market research is the systematic collection and analysis of data and information about customers, the market, and competitors. Its goal is to assist in the development of business projects, the launch or improvement of a new service or product, and the expansion into new markets. Market research provides insight into how users think and, through various variables (gender, location, age, and so on), can predict which segment of the population will purchase a particular product or service.

Some possible questions that may help to conduct this user study could be:

- Who are the likely customers?
- Is there a genuine market for BMX bikes?
- What level of quality do they expect?
- Is there room for growth?
- Can rivals be defeated?

But it is not just about gathering information; it is also about knowing how to use it. To be able to modify the product, you must attempt to detect a pattern or trend in the information gathered from users. Simultaneously, this information can be used to identify sectors or areas in which you can act and market the product. The collection of this information will allow data analysis for the product's subsequent design phases.

Data analysis is the process of converting a collection of data into information that can be used to benefit the organization. Some techniques, such as QFD, will make the final product more appealing to the public. This technique was used in this work because it is an external (outside of the company) and primary source of information (the data are obtained directly by the researcher himself and not from other sources).

2) Market objectives:

The goal of any market research is to gain a clear understanding of the product's characteristics to:

- A study of the product's demand behaviour
- A geographical and temporal distribution of the market in which it is requested
- Its potential competitive advantages
- Who has the most complete profile?
- As much information as possible about the competition: evolution, turnover levels, number of employees in the organization, market share, and so on.

Market segmentation is the process of dividing a market into sets with similar characteristics; this strategic process allows for more accurate coordination of efforts and resources.

This requirement arises because of the large number of companies and organizations operating in the market, each of which is very different from the others (in terms of culture, location, economic level, etc.), making it impossible to operate in the entire market, particularly for two reasons:

- Would be prohibitively expensive
- There is insufficient output for the cost-effectiveness.

These reasons give rise to the need to break down the market into sets whose components have similar characteristics and provide the organization with the components have similar characteristics and provide the organization with the components have similar characteristics and provide the organization with design and complement a marketing strategy to act overall with:

- Lower cost, higher efficiency
- Market segmentation has the following advantages:

It ensures consistency with the marketing concept by focusing on your products, processes, distribution channels, product value, and customer promotion.

- Concentrate your efforts and resources on segments that have potential users.
- In segments where you can hone your skills
- Help customers discover products that are best suited to their needs by collaborating with them. needs.

However, to be useful for the organization's goals, market segments must meet the following criteria:

- **Distinctive:** Each segment must be noticeably different from the others to respond to marketing actions in a distinct manner.
- **Quantifiable:** Certain aspects of each segment must be determined as precisely as possible: size, purchasing power, profiles, and so on.
- **Significant:** They must be large or productive enough to be targeted.
- **Accessible:** They must be accessible in an efficient manner.

3) Market segmentation:

a) Segmentation variables:

Geographic variable: This entails segmenting the market into regions, municipalities, countries, and so on.

Its variables are as follows:

- o Region
- o The city's size
- o Density of population

Based on our survey (74 answers) to French users of BMXs intended for competition, we obtained the following graph:

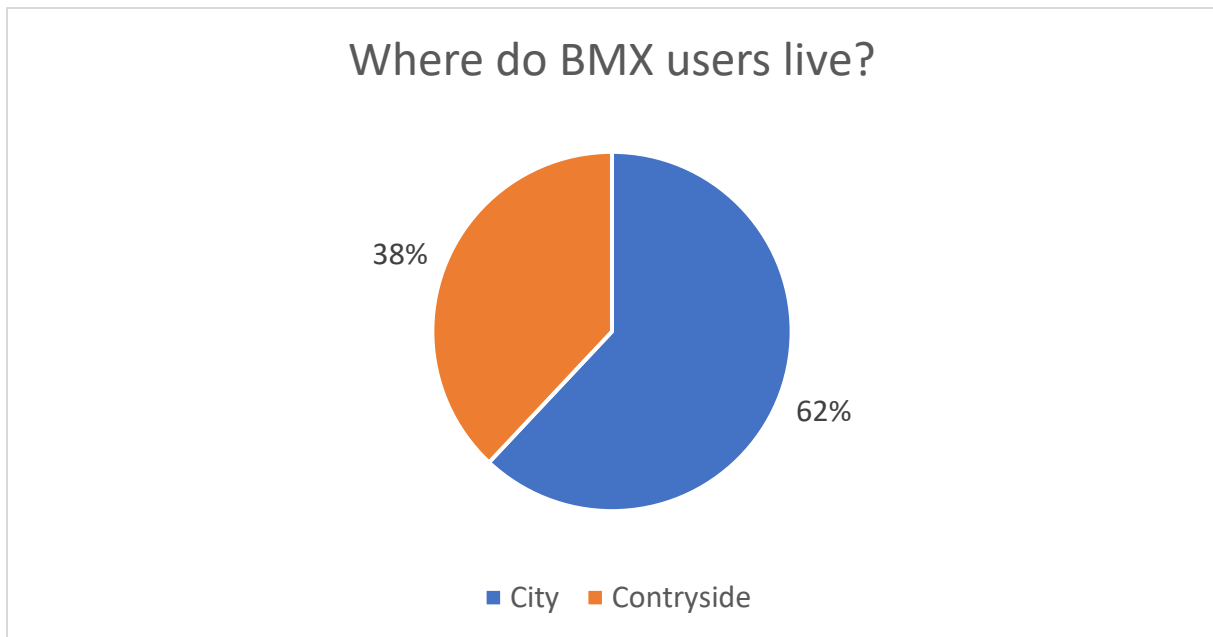


Figure 1: Where do BMX users live?

Demographic variable: The market is divided based on individual characteristics.

Its variables are as follows:

- Age \Residence
- Physical characteristics
- Residence

Based on our survey (74 answers) to French users of BMXs intended for competition, we obtained the following graph:

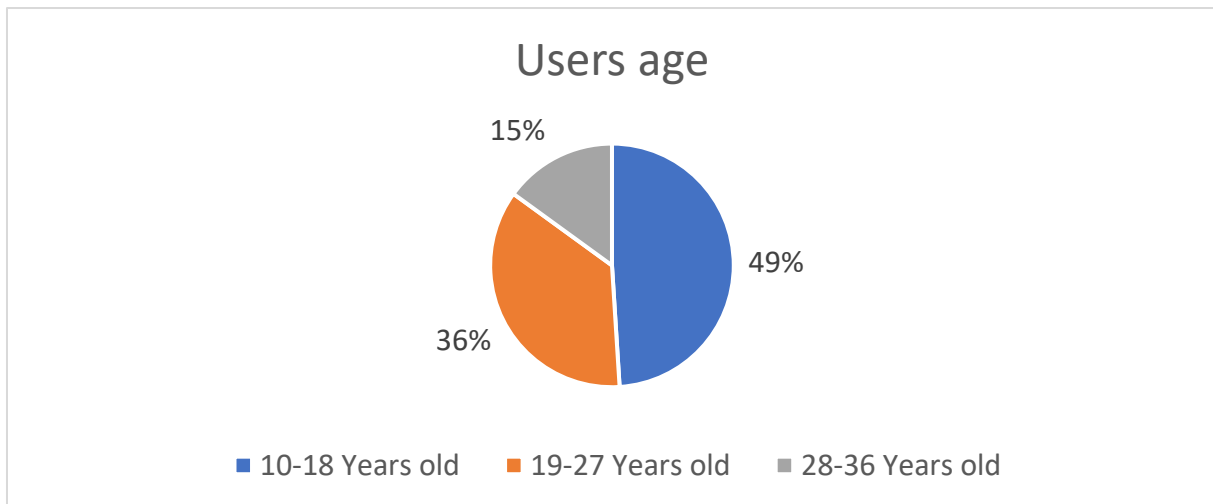


Figure 2: Age of users:

Distribution channel:

- Sporting goods chains
- Online retail
- Speciality shops

Based on our survey (74 answers) to French users of BMXs intended for competition, we obtained the following graph:

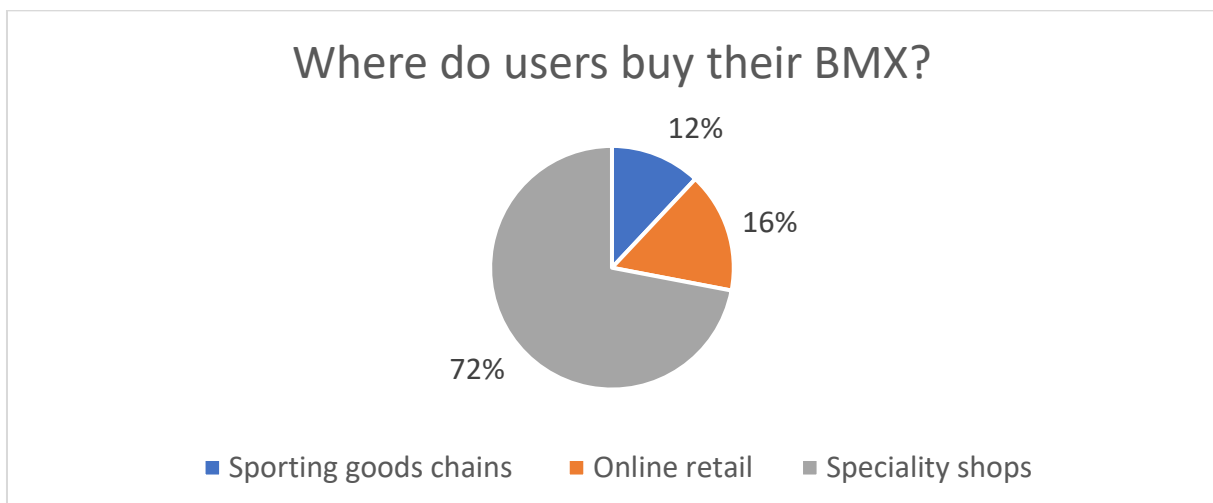


Figure 3: Where do users buy their BMX?

Price spends by BMX users:

Based on our survey (74 answers) to French users of BMXs intended for competition, we obtained the following graph:

How much do competition BMX users buy their BMX?

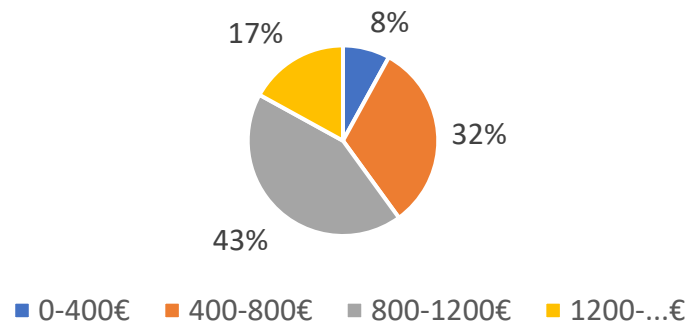


Figure 4: How much do competition BMX users buy their BMX?

4) Market research techniques :

BMX is designed for fast speed changes and offers great mobility to the riders, which should be reflected in the technical characteristics of BMX.

We find the following characteristics:

The frame:

A BMX undergoes significant impacts throughout its life. Jumping from mogul to mogul is part of the sport, and these bikes need to have a strong frame to withstand the brutal impacts. Their sizes are similar, as their use requires a low, compact frame.

The wheels:

A BMX is usually equipped with 20- or 24-inch wheels. The tyres are designed to withstand the impact of jumps and tricks, while still being able to ride well on smooth surfaces. They are usually reinforced on the inside to prevent an unfortunate blowout during a landing.

Brakes:

BMXs are often used for tricks that require turning the handlebars in both directions: barspins. High-end BMXs use a special type of braking system that prevents the brake cable from getting tangled in the handlebars. This is also quite practical.

The brakes on a BMX are usually located on the rear wheel. This is often a braking system called a "V-brake". The V-brake crushes the tyre to slow it down and stop the bike.

Shock absorbers:

The only shock absorbers found on a BMX are the rider's legs and arms. This means that the suspension is state of the art. BMX riders must therefore anticipate shocks and adapt accordingly. The more the rider's back hurts at the end of the session, the less experienced they are.

5) Analysis of the competition:

The number of competitors on the market of the BMX is important. The key players in the global market for BMX are:

- Eastern
- Kink
- Mongoose
- Sunday
- Elite BMX

Here is a comparative table of 10 different BMX dedicated to racing, considering many characteristics:

	1	2	3	4	5	6	7	8	9	10
Straight handlebar	x		x	x	x	x		x	x	
Chain cover	x	x				x		x		
Frame in aluminium	x	x	x			x		x	x	x
Wheel diameter 20'	x	x	x	x	x			x	x	
Disk brake	x	x	x	x	x	x	x	x	x	x
Weight <12kg	x	x	x			x		x	x	x
Price (€)	1265 €	1043 €	673 €	759 €	609 €	1350 €	430 €	1499 €	1057 €	835 €

Table 1: Table comparative of 10 different racing BMX:

	SUM	Percentage (%)
Straight handlebar	7	70%
Chain cover	4	40%
Frame in aluminium	9	70%
Wheel diameter 20'	7	70%
Disk brake	10	100%

Weight <12kg	7	70%
Price (€)	Average	953 €

Table 2: Percentage and average of those 10 different racing BMX:

To conclude, we can see that the aluminum frame is essential to have a lighter bike. Furthermore, the disc brakes are an essential part of our BMX.

The wheel diameter seems to be mostly 20". The chain cover does not seem to be an essential part of our BMX.

So, we are going to create a BMX with an aluminium frame, disc brakes, a wheel diameter equal to 20" and a weight under 12kg with a price around 950€.

III) User study:

User research, or UX research, is a vital step in the user experience design process. Most often done at the very beginning of a project, it can encompass different methodologies, but overall, it consists of observing the target users (or persona) to better understand their needs, behaviours, and how the product or service designed can best meet them. User research is what will allow us to move from designing based on assumptions to creating a product that will meet the need or solve the problem faced by our users.

1) Different types of BMX competition:

The sport of BMX (Bicycle Moto Cross) originated in California, USA. Its goal was to resemble the motocross category. It has evolved over time, and it has been considered an Olympic sport since a few years ago (2008). Biker is a term used to describe people who participate in this type of sport.

There are five kinds of BMX riding styles:

- **Freestyle and flat:** A "freestyler" manoeuvres his BMX to perform tricks. Unlike BMX race, which is managed by the FFC in France, BMX freestyle is a free discipline not affiliated to any federation. In France, during an event, riders are graded on the tricks they perform and their level of difficulty, but also on originality and style. Flatland, on the other hand, was born in the early 1980s. In flatland, the series of tricks are performed without exception while balancing on at least one wheel on a large flat surface.
- **Racing:** This racing sequence is the essence of BMX. Indeed, BMX was conceived by young people who could not afford motocross and decided to convert their bikes to play the sport. In a race, the track is about 270-400m long. It is littered with obstacles such as double bumps or tables that the riders must clear in a very short time. The eight competitors (called "pilots") take their place on the starting grid and sprint for a lap. The first four go on to the next round and so on to the final. Acceleration, technique, tactics, speed and endurance are the essential qualities that riders need to have to win. BMX racing is used by riders for competitions.
- **Ramp and street:** The ramp or Vert' consist of performing tricks on U-shaped half-pipes measuring 3.10 to 3.90 metres in height. The radii of the curves differ from each other, increasing or decreasing the difficulty. The pilots perform the most spectacular aerial tricks. The Street appeared after the Dirt. The street furniture, the street, the stairs and their railings constitute the support of the figures. All the figures are allowed, no constraint is established. The equipment of the rider consists of traditional protections. BMX freestyle is developed for the different disciplines that perform tricks.

As a result, to achieve a good design, the first step is to create a user profile that is as complete as possible according to the target group, as knowing the target audience of the product in question is essential. This will consider things like age, gender, nationality, previous experience with similar products, occupations, special skills, level of motivation, and so on.

1) User profile:

To know the profile of our users, we have again called on a survey to find out their precise needs.

As we saw in the previous section, our Persona is a person between 10-18 years old, living in a city, who buys his competition BMX between 800-1200 euros in a specialized shop.

Our Persona:



- Arthurs, 16ans
- Chartres, 28000, FRANCE
- Arthur buys his competition BMX in a specialized shop
 - Price: 800-1200euros

We then asked in our survey what were the most important criteria of a BMX.

The survey revealed that:

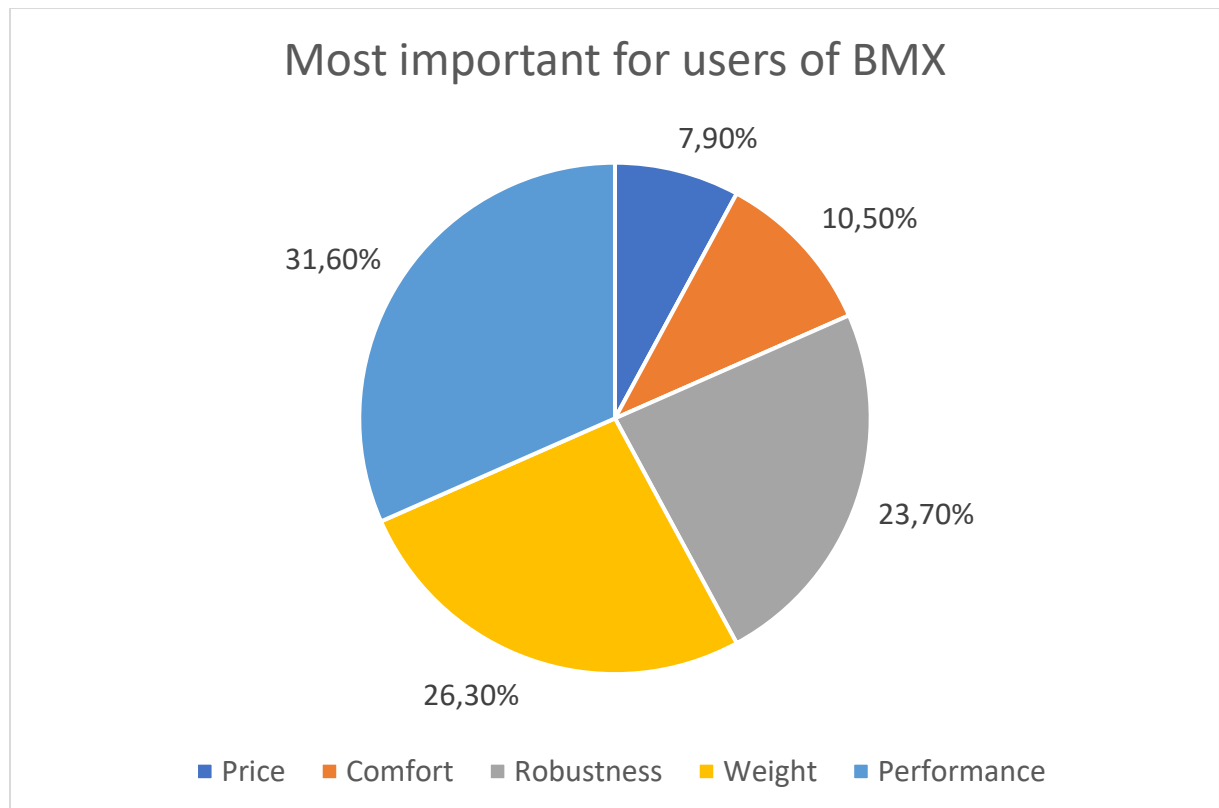


Figure 5: The most important for users of Racing BMX:

We therefore conclude that performance is the most important criterion (31.6%), followed by weight (26.3%) and robustness (23.7%).

We will therefore concentrate our bicycle criteria on these points.

2) Method QFD:

It is one of the quality tools. The QFD's goal is to fully develop the thinking about a new product or service by starting with the needs of the customers and determining the characteristics to be assigned to it as well as the relative importance of each. This procedure is depicted on a grid in the shape of a quality house:

- determining customer requirements and observations (**What**)
- defining the features of the product or service (**How**)
- establish a link between the characteristics and the needs of the customer (**How versus What**)
- target the desired technical performance (**How much**)
- determine the relationship between the features (**How versus How much**)
- compare the upcoming product to the competition

Industrial applications are frequently restricted to an initial QFD matrix. In theory, when implemented, the QFD objective should refine customer requirements and generate a second quality house based on the elements of the first.

Beginning with the initial matrix, commonly termed the House of Quality (Figure 1), the QFD methodology focuses on the most important product or service attributes or qualities. These are composed of customer wows, wants, and musts.

Once you have prioritized the attributes and qualities, QFD deploys them to the appropriate organizational function for action, as shown in Figure 2. Thus, QFD is the deployment of customer-driven qualities to the responsible functions of an organization.

Quality Function Deployment: Most Important Product/Service Attributes or Qualities

Figure 1 — House of quality template and benefits

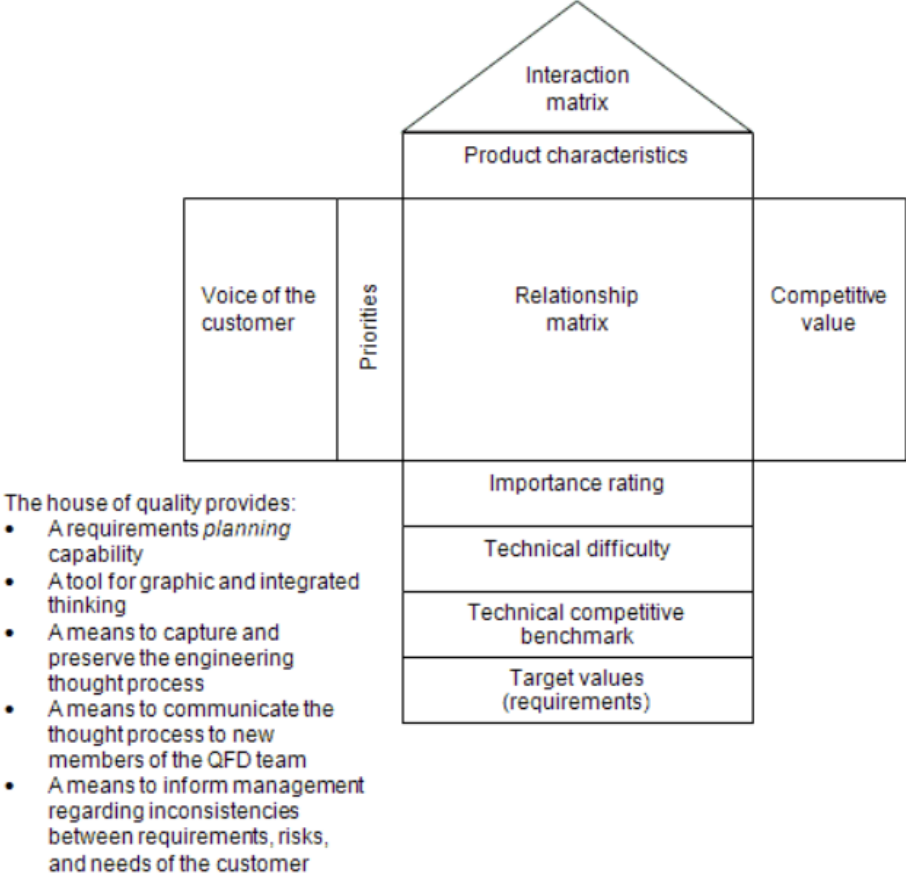
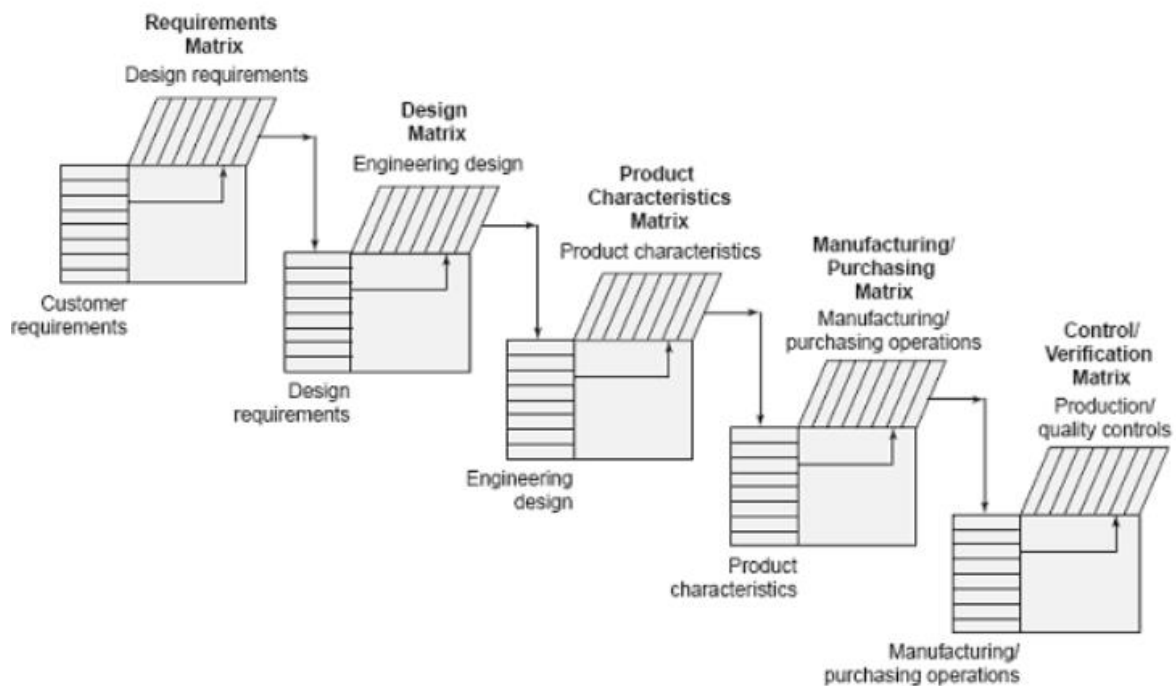


Figure 2 — Waterfall relationship of QFD matrices



In conclusion, the deployment of the quality function (QFD) contributes the following aspects at the time of product design:

- An objective view of the end-users' expectations of a product and the requirements that are demanded.
- It prioritises the most important qualities and, consequently, which of them are not essential.
- It provides a view of the product in relation to the competition and therefore which aspects need to be addressed.

a) Structuring and prioritisation of quality criteria:

To continue the QFD methodology, the user-assessed criteria listed above are grouped into 3 different categories for further prioritisation analysis:

- Weight
- Robustness
- Performance

	Percentage		Importance	Global importance
Robustness	38%	-This is resistant at a whole	40%	13,3%
		-The frame or fork doesn't break	35%	11,6%
		-Maximum weight of the user	25%	8,3%
Weight	20%	-Frame	32%	10,6%
		-Handlebar	28%	9,3%
		-Connecting rods	12%	4%
		-Fork	28%	9,3%
Performance	42%	-Chain	20%	6,6%
		-Pitch of the chain	20%	6,6%
		-Height of the chain teeth	20%	6,6%
		-Sprockets and wheels	20%	6,6%
		-Brakes	20%	6,6%

Table 3: Prioritisation of the criteria:

b) Kano classification:

The Kano diagram, developed in 1984 by Professor Noriaki Kano, is the result of a qualitative approach to considering customer expectations. It is a "multidimensional" approach based on the assumption that satisfaction and dissatisfaction are not based on the same types of criteria.

Kano's model defines three types of customer expectations:

- Basic expectations ("must be").

These are not necessarily stated but cause dissatisfaction if these latent needs are not met.

- Proportional expectations ("more is better")

These are also known as performance expectations. The waiting time for customer service can be analysed as follows: "The less I wait, the more satisfied I am".

- Attractive expectations ("delighters")

Generally unexpressed, these expectations provide a little extra for the customer and give great satisfaction. A perfect example is the spontaneous reward of a customer's loyalty.

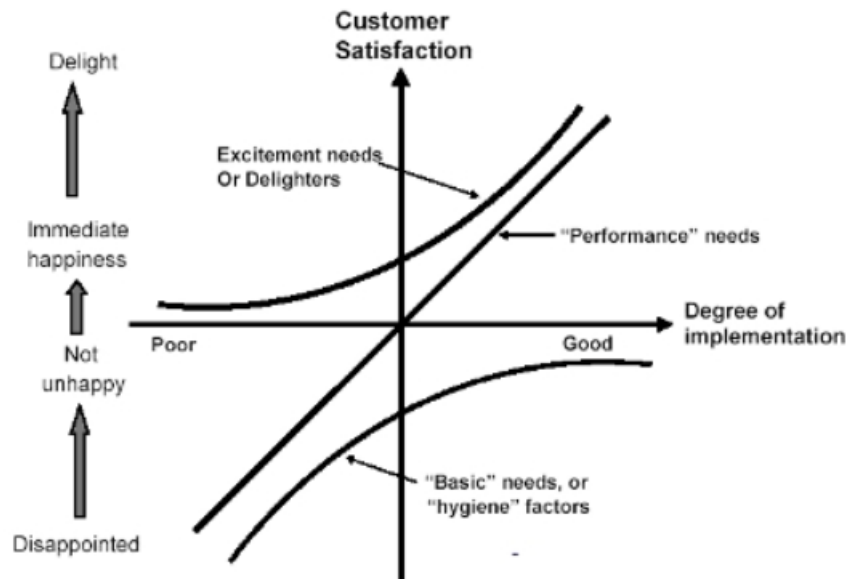


Figure 6: Kano Model

By exploring all the combinations of responses, a theoretical table is derived which reveals 6 groupings.

		Dysfunctional question				
		I like it	I expect it	I am neutral	I can live with it	I dislike it
Functional question	I like it	Questionable (not logical) (ignore)	Excitement attribute	Excitement attribute	Excitement attribute	Performance attribute
	I expect it	Rejection attribute	Indifferent attribute	Indifferent attribute	Indifferent attribute	Threshold attribute
	I am neutral	Rejection attribute	Indifferent attribute	Indifferent attribute	Indifferent attribute	Threshold attribute
	I can live with it	Rejection attribute	Indifferent attribute	Indifferent attribute	Indifferent attribute	Threshold attribute
	I dislike it	Rejection attribute	Rejection attribute	Rejection attribute	Rejection attribute	Questionable (not logical) (ignore)

Figure 7: Kano table

These 6 groupings will be associated by the following letters to classify the criteria that we defined before.

Excitement attribute (Attractive) A	Performance attribute (One-dimensional) O	Threshold attribute (Must-be) M	Indifferent attribute (Indifferent) I	Rejection attribute (Reverse) R	Questionable (not logical) (Questionable) Q
--	--	--	--	--	--

Criteria	Classification
This is resistant at a whole	M
The frame or fork doesn't break	M
Maximum weight of the user	M
Frame	I
Handlebar	I
Connecting rods	I
Fork	I
Chain	O
Pitch of the chain	O
Height of the chain teeth	O
Sprockets and wheels	O
Brakes	O

Table 4: Kano Classification of the criteria

c) Competitive position :

We are now assessing the competition with the most experienced users of 5 representative bikes in our market. The bikes selected for this evaluation are the following:

- GT SPEED SERIES PRO BMX RACE BIKE 2021
- BMX Race Inspyre Evo-C Disk Cruiser
- Haro Racelite Pro 20" 2021 Race BMX Bike
- Radio Quartz Pro L 20" 2022 Vélo BMX Race
- BMX Race DK Zenith Disc Pro

Each respondent was asked to rate on a scale of 1 to 5 how well each product met each criterion. The following table shows the average results, as well as the average of the ratings of the 5 BMX for each criterion. It also shows the quality objectives for our product.

Criteria	GT SPEED SERIES PRO BMX RACE BIKE 2021	BMX Race Inspyre Evo-C Disk Cruiser	Haro Racelite Pro 20" 2021 Race BMX Bike	Radio Quartz Pro L 20" 2022 Vélo BMX Race	BMX Race DK Zenith Disc Pro	Average	Objective
This is resistant at a whole	3,8	3,7	2,7	4,2	4,3	3,74	4
The frame or fork doesn't break	4	4,3	3,5	4,3	4,5	4,12	4,5
Maximum weight of the user	4,2	4,1	3,7	4,5	4,7	4,24	4,5
Frame	4,1	4,5	3,8	4,2	4,1	4,14	4,5
Handlebar	3,8	4	3,5	3,8	4,3	3,88	4
Connecting rods	3,4	3,1	2,5	3,5	3,9	3,28	3,5
Fork	4,1	4,3	3,5	4,1	4,6	4,12	4
Chain	4	4,1	4,1	4	4,5	4,14	4
Pitch of the chain	3,7	3,6	3,3	3,8	4,3	3,74	4
Height of the chain teeth	4	4,1	3,5	4,2	4,5	4,06	4
Sprockets and wheels	3,8	3,7	3,1	3,7	4,1	3,68	3,5
Brakes	4,1	4	3,4	4,1	4,7	4,06	4,2

Table 5: Rating of the competition's products and objectives for ours

When designing a new product, to see how much the market standard needs to be improved to reach the target, the average of the analysed products is compared to the target set by the design team. This is how the improvement ratio is defined. With this improvement ratio, multiplied by the importance given by the users to each parameter, we obtain the adjusted importance ratio. In the following table we can see the results calculated as a percentage:

Criteria	Average	Objective	Improvement	Importance	Adjusted Importance
This is resistant at a whole	3,74	4	107%	13,3%	14,23%

The frame or fork doesn't break	4,12	4,5	109,22%	11,6%	12,67%
Maximum weight of the user	4,24	4,5	106,1%	8,3%	8,8%
Frame	4,14	4,5	108,7%	10,6%	11,5%
Handlebar	3,88	4	103,1%	9,3%	9,6%
Connecting rods	3,28	3,5	108%	4%	4,32%
Fork	4,12	4	95,23%	9,3%	8,86%
Chain	4,14	4	96,6%	6,6%	6,4%
Pitch of the chain	3,74	4	107%	6,6%	7,06%
Height of the chain teeth	4,06	4	98,5%	6,6%	6,5%
Sprockets and wheels	3,68	3,5	95,1%	6,6%	6,27%
Brakes	4,06	4,2	103,45%	6,6%	6,83%

Table 6: Adjusted importance of each criterion

d) Analysis of the relations between demands and technical parameters:

Handlebar type	2	Drop, flat, upright...
Material of the frame	2	Aluminium, steel, carbon fiber...
Frame type	2	Diamond, low bar...
Robustness of the frame	1	Mpa
Frame rigidity	1	N/m
Weight	1	Kg
Distance between wheels axles	1	Cm
Tyre width	1	Mm
Size of the saddle	1	Cm
Head tube angle	1	°
Seat tube angle	1	°
Design	3	-
Maximum speed	1	m/s

Table 7: Classification of the technical characteristics

The type of variable refers to the nature of the parameter. Type 1 parameters can be measured with physical variables. Type 2 parameters are measured with discrete variables and type 3 parameters are qualitative, they have no direct way to be measured.

In the following table we can see their interactions with the criteria representing user needs:

Demands/Features	Handlebar type	Material of the frame	Frame type	Robustness of the frame	Frame rigidity	Weight	Distance between wheels axles	Design	Maximum speed
This is resistant at a whole	9	9	9	9	9		1		
The frame or fork doesn't break	9	9	9	9	9		1		
Maximum weight of the user	9	9	9			9			
Frame		9	9	9	9			5	
Handlebar	9							5	
Connecting rods						5		5	
Fork						9	1	5	9
Chain						5	9	1	9
Pitch of the chain								1	9
Height of the chain teeth	1	1	1	1	1				9
Sprockets and wheels	1	1	1	1	1			1	9
Brakes	1	1	1	1	1			1	9
Number	Relation								
1	Weak								
5	Medium								
9	High								

Table 8: Relations between features and demands

The importance of a parameter is calculated by summing the products of the importance of the demands by the degree of relationship between the parameter and the demands.

The results of this table allow us to classify the features by priority order:

Order	Features prioritize
1	Materials of the frame
2	Weight
3	Maximum speed
4	Robustness of the frame
5	Frame rigidity
6	Frame type
7	Handlebar type
8	Design
9	Distance between wheels axles

Table 9: Priority order of the features

Finally, to finish this QFD, we make a double entry table to compare the impact of the parameters between them. We notice that the weight is the most important parameter, i.e., all the parameters have an influence on the weight and vice versa. This will be a point to work on when designing the BMX.

	Handlebar type	Material of the frame	Frame type	Robustness of the frame	Frame rigidity	Weight	Distance between wheels axles	Design	Maximum speed
Handlebar type	X					9		9	
Material of the frame		X	9	9	9			1	
Frame type			X	9	9	9		9	
Robustness of the frame				X	9			1	
Frame rigidity					X			1	
Weight						X	1	1	9
Distance between wheels axles							X	5	
Design								X	5
Maximum speed									X
Number	Relation								
1	Weak								
5	Medium								
9	High								

Table 10: Interconnections between the features

This study allows us to determine the technical characteristics and to choose the components of our product in such a way as to best satisfy the user's request, with the added objective and constraint of proposing a reasonable price and easy-to-use bicycle.

Nos études nous ont montré que le client voulait un BMX accès sur la performance, le poids et la robustesse.

Notre BMX aura donc les caractéristiques suivantes :

- BMX<12kg
- Freins à disques
- Frame in aluminium
- wheel diameter equal to 20"
- Around 800 euros.

3) SWOT analysis :

SWOT stands for strengths, weaknesses, opportunities, and threats. It allows any business leader to draw up a roadmap.

A SWOT analysis is used to develop a company's marketing strategy and to evaluate the success of a project, by jointly studying different data, such as the company's strengths and weaknesses, but also the competition or the potential markets.

This analysis, carried out at the launch of a company or a new product, should enable the manager to set up a roadmap, identifying the strengths and opportunities on which he or she can rely and the weaknesses and pitfalls with which he or she will have to deal.

The SWOT analysis allows a general development of the company by crossing two types of data: internal and external. The internal information considered will be the strengths and weaknesses of the company. The external data will concern the threats and opportunities in the vicinity. To establish its strengths and weaknesses, the entrepreneur must look internally at the resources available to it, whether human, financial, intangible (a patent) or material (a production capacity).

The current bicycle market is stable and even steadily increasing. In addition, governments are investing heavily in cycling infrastructure and facilities due to increased environmental awareness. Thus, investing in the creation of new products seems to be a smart strategy.

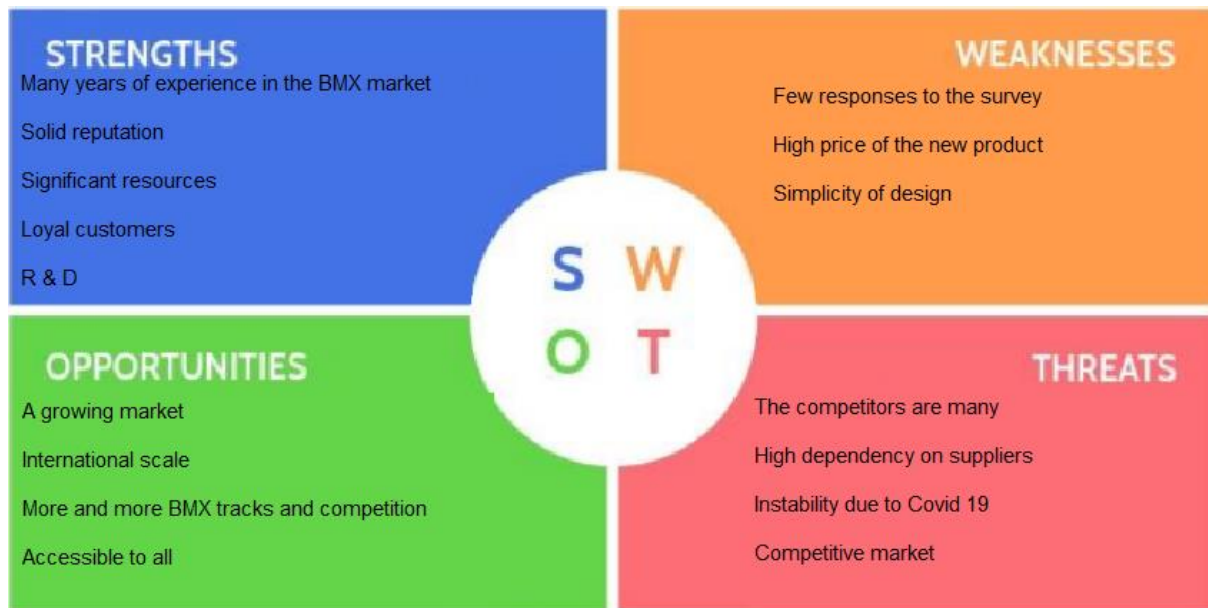


Figure 8: SWOT analysis

4) Law and standards:

When a bicycle is placed on the market, it is subject to two regulations, one European, the other sporting. The first is the EN 14781 standard of June 2006, published in France by AFNOR under the reference NF EN 14781. Then there is the UCI homologation process for frames and forks.

French laws on bicycle safety are defined by Decree No. 95-937 of 24 August 1995 on the prevention of risks resulting from the use of bicycles.

It is defined by the following nine laws:

Article 1: It is forbidden to manufacture, import, hold for sale, offer for sale, rent, make available as part of a service, or distribute free of charge bicycles that do not meet the requirements of this decree.

Article 2: It is forbidden to manufacture, import, hold for sale, offer for sale, rent, make available as part of a service, or distribute free of charge bicycles that do not meet the requirements of this decree.

Article 3: Bicycles must comply with the essential safety requirements set out in the annex to this decree and include the lighting and signaling equipment indicated therein.

Article 4: Compliance with the safety requirements is attested by the words "Conforms to the safety requirements", which must be affixed by the manufacturer, importer, or person responsible for the first placing on the market, in a visible, legible and indelible manner, on the bicycle frame and on the packaging.

Article 5: To have been manufactured in accordance with the French safety standards or those of a Member State of the European Union or of another State party to the agreement establishing the European Economic Area concerning it, the references of which are published in the Official Journal of the French Republic; in this case, the manufacturer or his authorized representative established on the territory of a Member State of the European Union or another State party to the agreement establishing the European Economic Area, or the importer, or, failing this, any person responsible for placing the product on the market, shall make available to the officials responsible for inspection a file containing a description of the means by which the manufacturer ensures that his production complies with the aforementioned standards, as well as the address of the places of manufacture and of storage.

Article 6: Any bicycle that is the subject of one of the operations mentioned in article 2 above must, in addition to the information required in article 4, visibly, legibly and indelibly bear the name, company name or trademark as well as the reference of the manufacturing batch.

The address of the manufacturer or his representative, the importer or the person responsible for placing the product on the market may appear only on the packaging.

Article 7: Bicycles may only be delivered to the final consumer, rented, made available as part of a service or distributed free of charge when fully assembled according to the rules of the trade. They must also be fully paid for.

Article 8: When a bicycle is sold, rented, made available as part of a service or distributed free of charge, it must always be accompanied by a notice containing

- The address of the manufacturer or his authorized representative, the importer or the person responsible for placing the bicycle on the market.
- The maintenance operations to be carried out by the user.
- Information necessary for the adjustment of the components intended to be adapted to the user's morphology.
- Information necessary for the assembly and fixing of components that can be easily dismantled by the user. e) Information on after-sales service and the supply of spare parts.

Article 9: Without prejudice to the application of criminal sanctions and administrative measures provided for in Book II of the Consumer Code, the following is punishable by the fine provided for 5th class offences:

- Any person who places on the market, holds for sale, hire or provision of services, or for distribution free of charge, a bicycle which does not bear the indication provided for in article 4, or which is not presented under the conditions provided for in article 7, or which is not accompanied by the notice provided for in article 8;

- The person responsible for placing the product on the market who does not present the documents referred to in Article 5 to the officials responsible for inspection.

In the event of a repeat offence, the fine provided for the repeat offence of 5th class offences is applicable

5) Elements of a BMX:

This visual glossary has been added to help readers who are unfamiliar with the world of mountain biking identify the various bicycle elements that will be selected in the technical specifications as part of the final product to be assembled.



Figure 9: Decomposition of a BMX:

We start with the frame and the fork, two very important components to guarantee the robustness of the bike.

1- FRAME:

	Frame
Material	Heat treated 6061 aluminium
Weight	2,5kg
Brand	Source BMX
Price (Euro)	150,09
TOP TUBE LENGTH:	20.8"
HEAD TUBE ANGLE:	74°
SEAT TUBE ANGLE:	71°
LENGTH OF STAY IN CHAIN:	14.35"
WHEEL SIZE:	20"
drop size: 10mm	10mm
HEADSET TYPE:	Integrated 1-1/8".
Price (euro)	152



Figure 10: Frame

2-FORK:

	Fork
Material	4130 CrMo
Weight	0,946kg
Brand	Source BMX
Wheel size	20"
Price (Euro)	64,95



Figure 11: Fork

3-HANDLEBARS:

	Handlebar
Width:	26"
Up Sweep:	3°

Back Sweep:	7°
Bar clamping diameter:	7/8" standard
Bar type:	2pc
Weight:	0,500Kg
Brand:	Source BMX
Price (euro)	26,2



Figure 12: Handlebar

4-Headset:

	Headset
Brand	Source BMX
Weight	0,068kg
Price (euro)	35,99



Figure 13: Headset

5-FULL DISK BRAKE KIT:

	BRAKE
Material	Cast 6061 alloy
Price (euro)	69,99



Figure 14: Full disk brake kit

6/7: Front and rear HUB:

	Front and rear HUB
Price	136
Material	M20 alloy axle assemble
Brand	Ebay
Weight	0,338kg



Figure 15: Front and rear HUB

8- GEARING:

	Gearing
Material	steel 4140
Brand	Source BMX
Weight	0,160g
Price (euro)	15,99



Figure 16: Gearing

9- RIMES (Wheels):

	Rimes
WHEEL SIZE:	20" X 1.75"
Material	Fully sealed alloy
WEIGHT:	Front 0,898Kg, Rear 0,970Kg
Brand	Source BMX
Price (euro)	75,99



Figure 17: Rimes (wheels)

10- TYRES:

	Tyres
Size	20"
Brand	Source BMX
Weight	0,375Kg x2
Price (euro)	11,99 x2



Figure 18: Tyres

11-CRANKS + BB:

	Cranks + BB
Material	4130 CrMo
Brand	Source BMX
Weight	0,943Kg
Price (euro)	55,99



Figure 19: Cranks + BB

12-PEDALS:

	Pedals
Material	6061-T6 alloy from Saltplus
Brand	Source BMX
Weight	0,434Kg
Price (euro)	19,99



Figure 20: Pedals

13- SEAT:

	Seat
Weight	0,244Kg
Brand	Source BMX
Price (euro)	27,16



Figure 21: Seat

14-STEM:

	Stem
Material	Cold forged alloy Stem
Weight	0,298Kg
Brand	Source BMX
Price (euro)	19,87



Figure 22: STEM

15- CHAIN:

	Chain
Weight	0,350Kg
Links	3/32"
Brand	Source BMX
Price (euro)	7,19



Figure 23: Chain

16-SADDLE POST:

	Saddle post
Material	Steel
Weight	0,220Kg
Brand	Source BMX
Price (euro)	31,49



Figure 24: Saddle post

17-SADDLE CLAMP:

	Saddle clamp
Brand	Source BMX
Price (euro)	11,99



Figure 25: Saddle clamp

IV) SAP DESIGN PROCESS MANAGEMENT:

1) Introduction:

SAP Business Suite is a collection of programs that give an organization the ability to execute and optimize a large portion of its routines, such as transactions, sales, manufacturing processes, purchasing, and so on.

It can perform specific processes for specific organizations or develop independent modules that can work with or complement other software. Its application is skillful and practical for any business sector or organization.

SAP is built on the NetWeaver integrated technology platform.¹ The suite can support almost any vendor's operating systems, databases, applications, and hardware components.

SAP Business Suite is divided into 5 modules:

- SAP CRM (Customer Relationship Management)
- SAP ERP (Enterprise Resource Planning)
- SAP PLM (Product Lifecycle Management)
- SAP SCM (Supply Chain Management)
- SAP SRM (Supplier Relationship Management)

SAP CRM (Customer Relationship Management)

SAP CRM, the first module presented, manages current and future customer relationships. It automates all customer-facing processes, including sales, marketing, and customer service. It also supports customer analytics, e-commerce, and social media, enhancing communication across multiple channels.

SAP ERP (Enterprise Resource Planning)

The SAP ERP module, which will be implemented later, makes enterprise resource planning easier.

It is one of the most powerful modules in the SAP Business Suite because it covers all aspects of business operations: Human Resources, Accounting, Projects, Finance, and so on.

SAP PLM (Product Lifecycle Management)

SAP PLM manages the product lifecycle, from the initial design concept to production, generating a global vision of production and a global vision of the product. Furthermore, it enables you to effectively control all processes associated with the product, from development to market integration.

SAP SCM (Supply Chain Management)

This module is about supply chain planning and management. By streamlining the customer demand process, SAP SCM enables the company to reduce costs. customers. It makes use of AI (Artificial Intelligence) and predictive analytics.

SAP SRM (Supplier Relationship Management)

SAP SRM, the final module discussed, manages supplier relationships. It allows to accelerate both purchasing and the processes of both purchasing and payment of goods, providing a centralisation of the flow of money, by optimisation of operations, contract compliance, or cost management.

After explaining the modules that comprise the SAP Business Suite, the prototype was implemented in the SAP ERP software. The Material Management (MM) modules in this software will be used to manage materials, and the Project System (PS) will be used to implement the project.

2) Creation of materials:

To begin, the master data for the materials is entered. The material is created after some user data is entered. The material is created using user data. You can access the transaction MM01 from the main menu via the Command Prompt or the SAP menu by following the path:

Logistics -> Materials Management -> Material Master -> Material -> General Create -> Immediately.

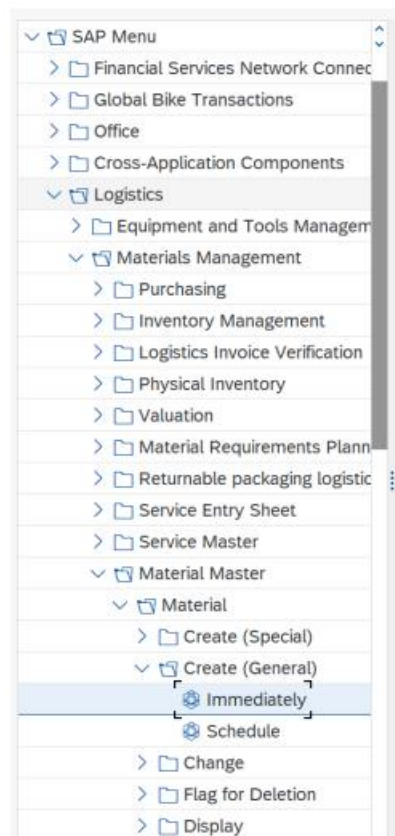


Figure 26: Menu path to create trading goods - source: SAP

The materials to be implemented in SAP are listed in the table below. This table displays the material, its description, its sap name, its description, its respective prices, and the number of units to be used for each. The number of units of each to be ordered the material 1: "FORK" will be used to demonstrate the process.

Number	Material	SAP name	Weight (Kg)	Price (€)
1	FORK	FRK-14	0,946	64,95
2	FRAME	SRM	2,5	152
3	HANDLEBAR	HR1	0,5	26,2
4	HEADSET	HDT	0,068	35,99
5	FULL DISC BRAKE KIT	DBK	0,05	69,99
6	FRONT AND REAR HUB	FRH	0,338	136
7	GEARING	GEA	0,03	15,99
8	RIMES	RMS	1,968	75,99
9	TYRES	TRS	0,75	23,98
10	CRANKS + BB	CBB	0,943	55,99
11	PEDALS	PDS	0,434	19,99
12	SEAT	SEAT	0,244	27,16
13	STEM	STM	0,298	19,87
14	CHAIN	CHN	0,35	7,19
15	SADDLE POST	SDDP	0,22	31,49
16	SADDLE CLAMP	SDDC	0,02	11,99
		TOTAL	9,659 Kg	774,77

Table 11: SAP names

STEP 1: Characterisation of the material.

This step consists of assigning the name, sector, and type of material.

Material: FRK-14

Industry Sector: Mecanical engineering

Material type: Full products

Material:	FRK-14
Industry Sector:	Mechanical engineering
Material type:	Full products

Figure 27: Creation of material: characterisation.

STEP 2: Views are chosen.

In this step, you choose the views to which you will assign material properties. The following views must be completed: base data 1, MRP 2, 3, purchasing, and accounting 1. 2, 3, and 1 for purchasing and accounting

View
<input checked="" type="checkbox"/> Basic Data 1
<input type="checkbox"/> Basic Data 2
<input type="checkbox"/> Sales: Sales Org. Data 1
<input type="checkbox"/> Sales: Sales Org. Data 2
<input type="checkbox"/> Sales: General/Plant Data
<input type="checkbox"/> International Trade: Export
<input type="checkbox"/> Sales Text
<input checked="" type="checkbox"/> Purchasing
<input type="checkbox"/> International Trade: Import
<input type="checkbox"/> Purchase Order Text
<input checked="" type="checkbox"/> MRP 1
<input checked="" type="checkbox"/> MRP 2
<input checked="" type="checkbox"/> MRP 3
<input type="checkbox"/> MRP 4
<input type="checkbox"/> Advanced Planning
<input type="checkbox"/> Forecasting
<input type="checkbox"/> General Plant Data / Storage 1
<input type="checkbox"/> General Plant Data / Storage 2
<input type="checkbox"/> Warehouse Management 1
<input type="checkbox"/> Warehouse Management 2
<input type="checkbox"/> Quality Management
<input checked="" type="checkbox"/> Accounting 1
<input type="checkbox"/> Accounting 2
<input type="checkbox"/> WM Execution
<input type="checkbox"/> WM Packaging

Figure 28: Creation of material: selection of views.

STEP 3: Organisational levels.

In this step the plant and storage location are assigned to the material.

Centro: Planta de Heidelberg (HD00) Almacén: Productos terminados (TG00)

Figure 29: Creation of material: organisational levels.

STEP 4: Completion of the fields corresponding to the views selected earlier.

DATOS BASICOS 1:


- Unidad de medida base: unidades
- Grupo de artículos: bikes

Figure 30: Creation of material: organisational levels.

MRP 1 Windows :

MRP Procedure

Advanced Planning

MRP Type: * **PD**  MRP

Reorder Point: Planning time fence:

Planning cycle: MRP Controller: **000**

Lot size data

Lot Sizing Procedure: **EX** Lot-for-lot order quantity

Minimum Lot Size: Maximum Lot Size:

Fixed lot size: Maximum Stock Level:

LS-Independent Costs: Storage Costs Code:

Assembly scrap (%): Takt time:

Rounding Profile: Rounding value:

Figure 14: Creation of material: organisational levels.

MRP 2 Windows:

Procurement

Procurement type: **F** Batch entry:

Special procurement: Prod. stor. location:

Backflush: Default supply area:

JIT delivery sched.: Storage loc. for EP:

Bulk material: Stock det. grp:

Scheduling

GR processing time: days Planned Deliv. Time: **2** days

SchedMargin key: **001** Planning Calendar:

Figure 31: Creation of material: organisational levels.

MRP 3 Windows:

Forecast Requirements

Period Indicator **M** Fiscal Year Variant:

Planning

Strategy Group:

Consumption mode:

Fwd consumption per.:

Planning material:

Plng conv. factor:

Availability check

Availability check: * **01**

Tot. repl. lead time: days

Figure 32: Creation of material: organisational levels.

ACCOUNTING 1:

The image shows two tabs from a SAP system interface. The top tab is titled "General Valuation Data" and contains the following fields and options: Total Stock (0), Base Unit (PC Piece), Division (BI), Valuation Cat. (empty), Valuation Class (3000), Valuated Un. (checkbox, unchecked), VC: Sale Ord. Stk. (empty), ML Act. (checkbox, checked), Project Stock VC. (empty), Price Determ. (2 Transaction-Based), and a button for "Mat. Price Analysis". The bottom tab is titled "Prices and values" and contains: Currency (EUR), Company code currency (blue text), Standard Price (64.95), Per. unit price (64.95), Price Unit (1), and Proc. Ctrl. (down arrow icon).

Figure 33: Creation of material: organisational levels.

3) Creation of the project structure:

In this section, we will start working on the project. The goal is to create a model that operates in a hierarchical fashion. To that end, the project is divided into so-called WBS elements, to which the corresponding information will be assigned. With this subdivision, it will be possible to act more precisely and easily keep track of the project.

1) Creation of the project:

To create the project, use the following path:

Logistics -> Project System - > Project -> Project Builder or via transaction CJ20N.

"BMX PROJECT" is the name given to the project.

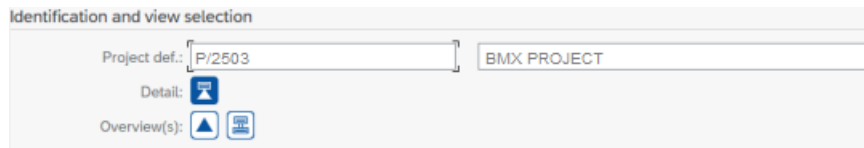


Figure 34: Creation of the project

2) Creating WBS elements:

The main goals of the WBS are to divide the project into manageable units, define end dates, and determine the and costs.

The work breakdown structure (WBS) divides the project into structure elements step by step. In the Project System, these are known as work breakdown structure elements (WBS elements).

As a result, the following WBS elements were created:

WBS ELEMENTS	DESCRIPTION
P/2503	BMX PROJECT
P/2503-1	DESIGN
P/2503-1-1	PROCUREMENT
P/2503-1-2	PROTOTYPING
P/2503-1-3	TESTING
P/2503-1-4	VERIFICATION
P/2503-2	PRODUCTION
P/2503-3	WAREHOUSE
P/2503-4	LOGISTICS

Table 12: Table of WBS elements

This results in the following hierarchy chart:

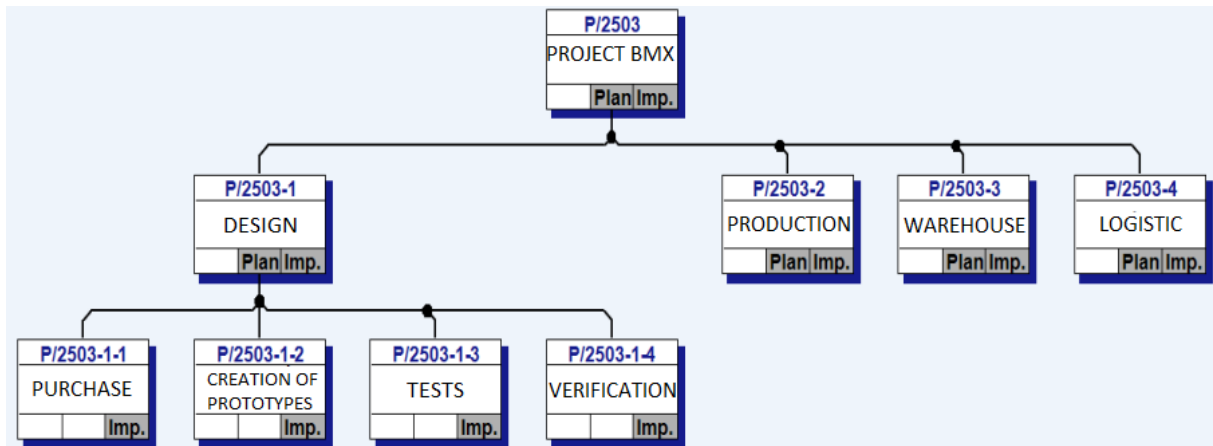


Figure 35: WBS elements graphic

3) Creation of operations:

Network activities will be added to the project (detailing the information in the WBS elements).

The activities describe the project's process flow. With network activities, you can plan dates, resources, and costs.

N° ACTIVITY	OPERATION	DESCRIPTION	WBS ELEMENT
0010	Purchasing process	Procedure by which by which the materials	P/2503-1-1
0020	Assembly of prototypes	Assembly of the parts for the creation of the prototypes	P/2503-1-2
0030	Quality tests	It includes all the quality tests that the bicycle must to pass to be to be incorporated in any European country	P/2503-1-3
0040	Approval of prototypes	Meeting where the decision-makers accept the prototypes or modify modified in some aspects	P/2503-1-4
0050	Production order	Release process of order to production	P/2503-1-4
0100	Frame assembly	Frame assembly (handlebars, headset, fork, etc.)	P/2503-2
0110	Wheel assembly	Assembly of wheels (inner tube, spokes, rims, etc.)	P/2503-2

0120	Saddle assembly	Saddle assembly (saddle, flange, seat post, etc.)	P/2503-2
0130	Final assembly	Operation where the parts are put together to obtain the bicycle	P/2503-2
0070	Order storage	Process where the warehouse managers will store the bicycle	P/2503-3
0080	Dispatch order	Process where the warehouse managers will manage the shipment of bicycles	P/2503-4
0090	Transport	Distribution to the different plants	P/2503-4

Figure 36: Creation of operations

In addition to these, other fixed cost transactions arising from the procedures have been included.

N° ACTIVITY	OPERATION	DESCRIPTION	WBS ELEMENT
0140	Consultancy	Payment to consultants for authorisation of bicycle	P/2503-1-3
0150	Cost of electricity and water	Cost of electricity and water	P/2503-2
0160	Cost of transport	Cost of transporting bicycles to shops	P/2503-4

Table 13: Creation of operations

4) Relationship building:

So far, all activities have been assigned to the higher-level WBS element. Furthermore, there is no relationship between activities, which means that they all begin at the same time. As the constraints are grouped into relationship networks, this will change. The relationship between activities will be determined at this point based on the duration of the tasks and the precedence constraints.

The task list for activity 0020 is depicted in the figure above. Activity 0010 is the preceding activity and activity 0030 is its successor via an End-Start (IF) relationship, which means that the successor activity (0030) cannot begin until the preceding activity (0020) is completed.

This relationship will be present in all proposed activities: an activity cannot begin if the preceding activity has not completed. The current work is organized in such a way that there are parallel and sequential activities.

This results in the graph below, which shows that the total duration of the project is 20 days.

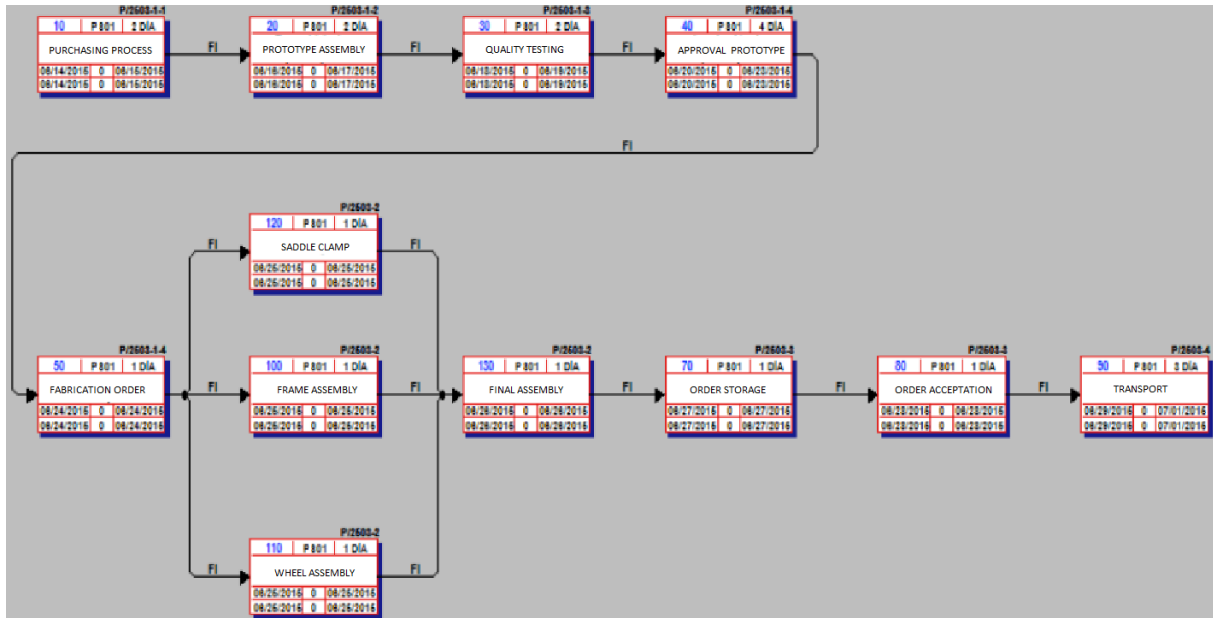


Figure 36: Activity network

This network depicts the project's flow. Visual representations of the project's structural elements and internal dependencies are available.

Networks serve as a guide for project planning, study, control, and monitoring of deadlines, resources, and hours throughout the execution period.

The gantt chart, on the other hand, is a very useful visualisation tool that is presented below. The Gantt chart visualizes the project schedule and provides an overview of the project's earliest and latest start and finish dates:

WBS elements:

- Networks
- Activities in the network
- Orders that are scheduled
- Orders for production
- Milestones
- Capacity specifications

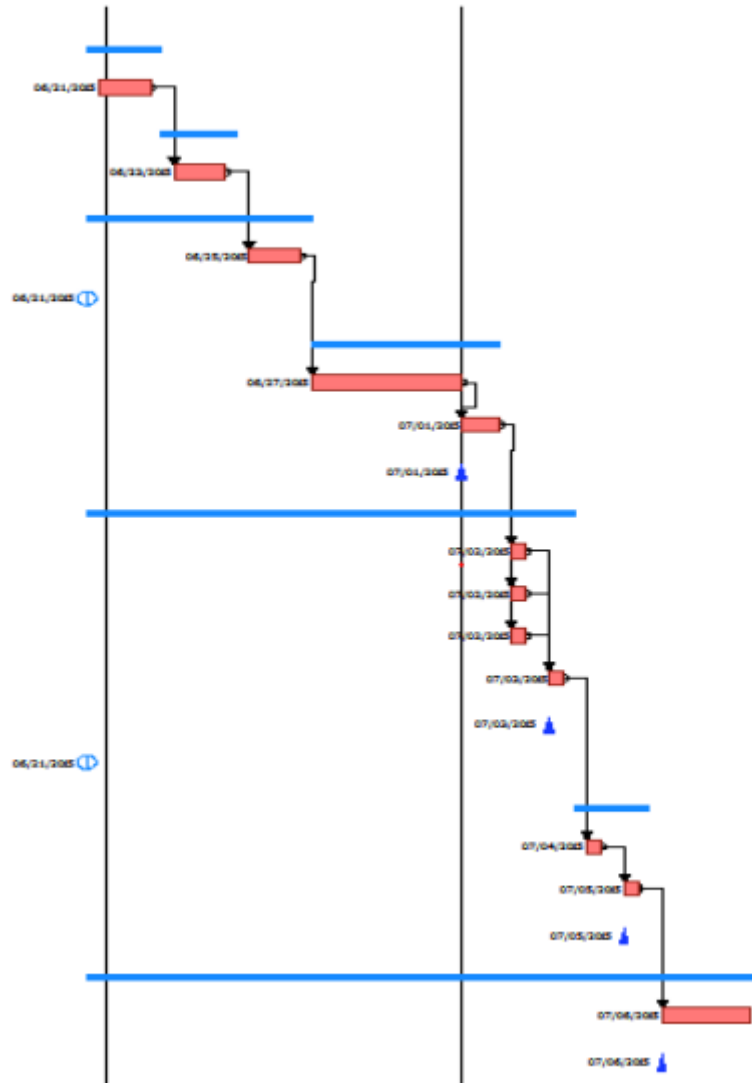


Figure 37: Gantt chart

5) Allocation of materials:

Materials will be assigned to operations during this step. It was decided to include all the materials in a single operation (the "Purchase process" operation (0010)) for their introduction. Furthermore, the required quantity of each is specified. In this case, the quantity for the creation is in batches of 20 BMX bicycles.

V) Final degree project budget:

1) Planification budget:

The project will have a total duration of 20 days with a workload of 34 hours, distributed as follows:

OPERATION	HOURS
Purchasing process	1
Prototype assembly	7
Quality testing	2
Prototype approval	1
Production order processing	1
Frame assembly	4
Wheel assembly	3
Saddle assembly	2
Final assembly	5
Processing of storage order	1
Dispatch order processing	1
Transport	6

Table 14: List of operations

In the table below, we can see the price of each component per unit, and then the number needed to have 20 BMX. The price for 20 BMX is €15175.6, which is €758.78 per BMX.

Number	Material	Price (€)	Price for 20 BMX
1	FORK	64,95	1299
2	FRAME	152	3040
3	HANDLEBAR	26,2	524
4	HEADSET	35,99	719,8
5	FULL DISC BRAKE KIT	69,99	1399,8
6	FRONT AND REAR HUB	136	2720
7	GEARING	15,99	319,8
8	RIMES	75,99	1519,8
9	TYRES	23,98	479,6
10	CRANKS + BB	55,99	1119,8
11	PEDALS	19,99	399,8
12	SEAT	27,16	543,2
13	STEM	19,87	397,4
14	CHAIN	7,19	143,8

15	SADDLE POST	31,49	629,8
16	SADDLE CLAMP	11,99	239,8
	TOTAL	774,77	15495,4

Table 15: Purchase budget for 20 BMX

Fixed costs:

In addition to the costs for the purchase of materials, there are other fixed costs, which increase to 1725,00 for 20 bicycles.

These are:

FIXED COSTS:	PRICE:
Consultancy	1.000,00 €
Electricity and water	245,00 €
Transport	480,00 €
Total fixed costs	1.725,00 €

Table 16: Fixed costs

Cost of the workplaces:

Initially it has been estimated that the cost of the work centres will be €10 per operator per hour.

Given that there are 2 operators with a total dedication of 34 hours, the cost of such a centre would be 680€.

Thus, the total planned cost before the project is carried out and will be presented to the client, is a total of 17580,6€

COST	20 BMX
Materials	15495,4€
Fixed	1725,00 €.
Work centre	680,00 €
TOTAL COST	17900,4€

Table 17: Total cost for 20 BMX:

Costs of user and market research:

These costs are not accounted for in SAP because they are upstream activities that have not been incorporated into the SAP process. These costs will be listed here, but they will not be considered when comparing the planned budget to the actual budget because doing so would simply add another cost of the same value to both budgets.

As a result, these costs are:

COST	DAYS	HOURS/DAY	EUROS	EUROS TOTAL
User study	2	8	5	80
Market research	3	6	7	126
TOTAL COST				206

Table 18: User and market research costs.

COST	20 BMX
Materials	15495,4€
Fixed	1725,00 €.
Work centre	680,00 €
User study + Market research	206, 00 €
TOTAL COST	18106,4€

Table 19: Total cost

2) Real budget:

The budget obtained in SAP, and thus the actual budget, is 18437€. The planned budget (18106,4€) differs from the actual budget (18437€), as can be seen. As previously stated, it is logical and normal for the planned budget to differ from the actual budget, as there may be situations that modify (in real life, increase) the costs that could not be anticipated at the outset.

Thus, this difference could have resulted from a variety of factors, such as reprocessing in production operations, the need for more assembly hours than planned, changes in the supplier's initial prices, and so on.

Conclusion:

This TFG was the opportunity to carry out a project in its entirety through the simulation of the process of designing a bike, manufacturing a prototype, and then small series production of the product. Starting from the need to develop a new bike, we had to analyse the target market, the competition as well as the demands of users through the discovery of techniques to best design a product, comparing technical parameters to user needs in a consistent manner. The QFD method provided significant results. Thus, the knowledge in terms of market and user analysis have been deepened. The implementation in SAP of the result of this study was then the occasion to discover in part the functioning of one of the most used ERP in the world. Although this is a simulation, the work performed provides hands-on experience in product analysis and design methodologies and techniques. The discovery of SAP is only superficial but allows a first take-over that can still prove useful in business. Only the Project System and Material Management modules were used. In addition, the project was conducted from the fictitious company Global Bike already entered in the database, in the same way as the labour costs and work centers. In conclusion, valuable experience has been gained in the various phases of a project, using the knowledge acquired during the formation and acquiring new skills such as mastering new analytical and management tools. The complexity of SAP software demonstrates the importance that ERP can have in large companies today.

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