UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Escuela Técnica Superior de Ingeniería Industrial

Diseño de una bicicleta de montaña para niños de 6 a 9 años y simulación en SAP S/4HANA

Trabajo Fin de Grado

Grado en Ingeniería de la Energía

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ESCUELA TÉCNICA SUPERIOR INGENIERÍA INDUSTRIAL VALENCIA

TRABAJO FIN DE GRADO EN INGENIERÍA DE LA ENERGÍA

Design of a versatile bike for children aged 6 to 9 for a company run by SAP S/4HANA

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Select:

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ABSTRACT

Design of a versatile bike for children aged 6 to 9 for a company run by SAP

This final bachelor project concerns the design of a bicycle using commercially available components. The aim is to implement this product in a fictitious company using SAP business software. The bike chosen for development is a robust product for children aged 6 to 9, easy to ride and comfortable.

The project starts with the development phase of the bike, based on product design methodologies. Firstly, two analyses have to be carried out. On the one hand, the market analysis will allow us to determine which products exist for our target. On the other hand, the customer analysis will be useful to address possible needs. Secondly, the bicycle parts and technical specifications will be determined.

Once the bicycle is defined, the implementation phase in the SAP software starts. It is based on the simulation of a real process, both for the design and for the prototyping of the new bicycle model. Using the product characteristics previously determined by the analysis, the project will be planned in the SAP project management module.

This module is able to determine time and costs using information such as material and labour costs for each stage of the industrialisation and production process. The end result is the cost plan and duration of each activity throughout the project. In the end, a new product was developed using SAP enterprise resource planning (ERP) software in the management of the entire project.

RESUMEN

Diseño de una bicicleta versátil para niños de 6 a 9 años para una empresa dirigida por SAP

Este proyecto final de grado trata sobre el diseño de una bicicleta utilizando componentes disponibles comercialmente. El objetivo es implementar este producto en una empresa ficticia utilizando el software empresarial de SAP. La bicicleta elegida para el desarrollo es un producto robusto para niños de 6 a 9 años, fácil de manejar y cómodo.

El proyecto comienza con la fase de desarrollo de la bicicleta, basado en metodologías de diseño de producto. En primer lugar, se deben realizar dos análisis. Por un lado, el análisis de mercado nos permitirá determinar qué productos existen para nuestro target. Por otro lado, el análisis del cliente será útil para abordar posibles necesidades. En segundo lugar, se determinarán las piezas y especificaciones técnicas de la bicicleta.

Una vez definida la bicicleta, se inicia la fase de implementación en el software SAP. Se basa en la simulación de un proceso real, tanto para el diseño como para el prototipado del nuevo modelo de bicicleta. Utilizando las características del producto determinadas previamente por el análisis, el proyecto será planificado en el módulo de gestión de proyectos de SAP.

Este módulo es capaz de determinar tiempos y costos utilizando información como costos de materiales y mano de obra para cada etapa del proceso de industrialización y producción. El resultado final es el plan de costes y la duración de cada actividad a lo largo del proyecto. Al final, se desarrolló un nuevo producto utilizando el software de planificación de recursos empresariales (ERP) de SAP en la gestión de todo el proyecto.

SUMMARY

1 Introduction

1.1 Motivation

In the past, I have already had the opportunity to lead a product development project in a team. This end-of-bachelor work is an opportunity to deepen the knowledge I have acquired and above all to develop new skills, in particular with the discovery of the SAP business management software. Indeed, this skill is required to apply for many positions as a project manager engineer, a direction I would like to take.

The bicycle is a relatively complex and interesting product for this kind of project. It represents a solution to current environmental problems as it is the least polluting means of transport. The children's model I have chosen is similar to the models I have used myself for many years. I think it is important to encourage children to exercise physically and also to make them aware of the use of bicycles and respect for the environment from an early age.

1.2 Objectives

The objectives to be achieved with the completion of this final project are as follows:

- To become familiar with ERP (Enterprise Resource Planning) systems in general and acquire basic knowledge about them, in particular with SAP, the most widely used management software in the industry. In the course of this work, we will learn how to use the Project Builder module.
- To consolidate and apply the knowledge acquired in the product or business development projects, and in the industrialization, planning and market research courses.
- Learn to research, interpret and relate information from different sources and to think critically.
- To be able to synthesise, to restitute and communicate the results of the work carried out.

1.3 Introduction to Global Bike

To carry out this work on the design of a new model of bicycle, we will create a fictitious company: Global Bike. It is a multinational company. It is positioned on the bicycle market and wishes to diversify its offer by proposing new models for children. It is based in the United States and Germany and now wants to begin with its next product by focusing mainly on the French market.

Figure 1: Logo of the company Global Bike.

1.4 Information management

Information management involves identification, processing (analysis), storage and finally communication to the required people.

Information is content of a physical (mail or otherwise) or digital nature. It can be structured or unstructured. Moreover, the source can be internal or external to the company: a department of the company, the company market, the competition, the region, the government...

The flow of information must be carefully managed. Different issues are at stake depending on the type of information, which may be economic, financial, legal, social, environmental or other. In addition, information management can serve mandatory, functional or strategic objectives. The principal concern is of course, the development and durability of the company. Nevertheless, it is important to be vigilant, because too much information has the opposite effect. Therefore, it is important to establish an iterative framework for structuring data needs.

Information is essential to the decision-making process at both strategic and operational levels. At the managerial level, it enables teams to be coordinated, staff to be engaged and facilitates adaptation.

In addition, control is a source of innovation. It also allows you to understand your environment and thus prevent difficulties.

ERP stands for Enterprise Resource Planning. The basic ERP system enables the efficient management of all key processes required to run a business: finance, HR, production, supply chain, services, purchasing, etc., all within an integrated system. It is often referred to as the company's system of record.

However, today's ERP systems are anything but basic and bear little resemblance to the ERPs we knew decades ago. They are now delivered via the cloud and use the latest technologies, such as Artificial Intelligence and Machine Learning, to provide intelligent automation, increased efficiency and instant insights across the enterprise. Modern ERP software also connects internal operations to partners and networks around the world, giving businesses the collaboration, agility and speed they need to compete today.

Figure 2: Companies in the ERP market – source : www.holded.com

ERP systems include various modules. Each module supports specific business processes (such as finance, purchasing or production) and provides the employees in that department with the transactions and insights they need to perform their tasks. Each module connects to the ERP system, which provides a single version of reality and accurate data that is shared across departments.

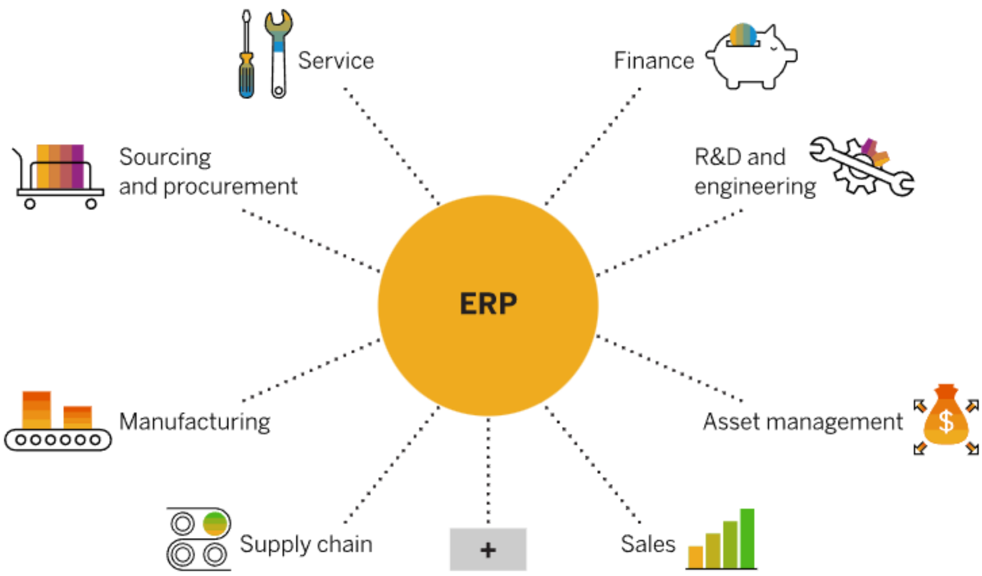

Figure 3 : Modules of an ERP system - source: www.sap.com

Feature-rich ERP systems include an R&D and engineering module. It is this module that we will use in this work with SAP. It provides tools for product design and development, product lifecycle management, product compliance and more, to enable companies to create new innovations, quickly and cost effectively.

2 Design

2.1 Market Analysis

A market analysis provides information about the sector, customers, competitors and scope of a market. In addition, we can determine the relationship between product and demand for a specific product or service. Thanks to this information, we can make more informed decisions about possible marketing strategies.

There are all kinds of children's bikes in all sizes. Some variants are dedicated to the development of young children on flat terrain, while others are designed for the first excursions into the wilderness of young teenagers. In between, there is a wide range of models that are suitable for every age group.

2.1.1 Advantages and disadvantages

The main advantage of children's bikes is the wide variety of models available, which promise to be perfectly adapted to the young cyclist's morphology, whatever their age.

These 'miniature' bikes are also generally less expensive than their adult counterparts.

However, due to the rapid growth of the child, this type of bike will quickly become unusable for the child concerned, as when he or she grows up, he or she will find himself or herself in possession of a bike that is too small for him or her.

2.1.2 Market Segmentation

They are different markets inside the market of the bikes for children. This is due to the fact that each age group needs a different kind of bike. Moreover, different distribution channels share the market. The market segmentation can depend on the wheel diameter, the age group or the distribution channel. Those segmentations are often organised this way :

- Segmentation by wheel diameter :

16 inches / 18 inches / 20 inches / 24 inches

- Segmentation by age group :

2-5 years old / 5-7 years old / 7-9 years old / 9-12 years old

- Segmentation by distribution channel :

Sporting goods chains / Online retail / Speciality shops

2.1.3 Technical characteristics

The difference between the bike we design and the mountain bike is that the mountain bike is mainly intended for off-road riding, whereas our bike is perfectly suited for all trails. It is not designed for riding on rough roads and trails nor off-road. It is a kind of hybrid, being the perfect compromise between a road bike and a mountain bike. In terms of characteristics, it is equipped with straight and high handlebars, which allows its owner to ride it in an upright position, unlike road bikes. With a wider suspended seat and a suspended fork, it offers its rider optimal riding comfort. On the other hand, it also has large wheels. Its tyres are rather wide for a perfect grip.

The main characteristics for the children bike are those :

- Smaller bikes : 20 inches for the 6-9 years old
- A low frame, so that the child can easily ride the bike
- The draisienne or tricycle model (under 3 years)
- The bike with a fixed gear, so that the wheels are locked when the child stops pedalling (3-6 years)
- Bicycle with small wheels (3-6 years)
- Bicycles with a chain protected by a casing, to prevent the child from getting hurt or dirty (3-6 years)
- The bike with a few gears (from 6 years)

Here is a summary of the elements that usually make up a bicycle :

Wheels	Peripherals	Frame and fork	The transmission
• Wheel • Tyre • Rim • Rim cover	• Stems • Saddle • Clamp • Handlebars • Stem • Mudguard	• Frame • Fork	• Chain • Chain protection • Brake • Pedals • Bottom bracket • Crank and sprocket

Table 1 - Usual components of a bike

Now that we have described the characteristics of road bikes, detailed the peculiarities of children's bikes and listed the usual components of a bike, we will explain the main and indispensable characteristics that a children's bike must have.

If the child does not race or ride a mountain bike, the hybrid bike is the best alternative. It should be easy to handle, with wide and flat handlebars, light, of a suitable size and easy to use for riding on all types of terrain. This way, the child can have fun with his friends in almost all circumstances. If the bike is too big or too heavy, it will soon be abandoned. Children's bicycles must be perfectly adapted to their owner's morphology.

The bike should be robust and suitable for sporting use. Indeed, a survey by the OpinionWay polling institute shows that sport helps children to develop. More precisely, 82% of parents of sporty children find that their children are more relaxed and calm after physical activity. 61% of these parents even noticed that their children were more concentrated thanks to sport. Many parents buy their children a bike for these reasons.

2.1.4 Numbers of the market

According to Market.us's in-depth report on the international children's bicycle market from 2022 to 2031, the outlook is interesting, with the market continuing to grow steadily. Revenue growth forecasts are significant.

The French bicycle market (all types of bicycles) has also seen a strong increase in 2021.

According to a press release from the Union Sport & Cycle, which represents professionals in the sector, bicycle sales have increased by 4% in volume and 15% in value compared to 2020, in a market worth more than 3.4 billion euros, including parts and assistance. As a result, nearly 2.8 million bicycles were sold in 2021. Propelled by the transport strike at the end of 2019 and then by health restrictions, the sector was nevertheless severely disrupted last year by parts shortages, logistical problems, increases in transport costs and raw materials. Despite this, turnover has increased by 43% in 2 years. The year 2022 has started with many sales and the spectacular rise in petrol prices in March has added to the motivation of buyers.

These growths are mainly among working adults, who are increasingly using bicycles as a means of daily transport to work. In addition, the market has been strongly driven by electrically assisted bicycles (EABs), which set a new record at 660,000 units sold in 2021 (+28% over one year). EABs now account for almost one in four bicycles sold in France and 59% of the market in value.

However, the obvious anchoring of this means of transport in society can be beneficial to the children's bicycle market segment. Sales of children's bikes remain stable. We can add that electrically assisted children bikes are quite rare since children need to be physically active and the price can easily be considered too high for a bike which will only be used a few years.

The increase in the bicycle market benefits above all multisport retailers such as Decathlon or Go Sport, which account for two thirds of bicycle sales volumes but are still behind the cycle specialists in terms of EABs.

Here is a focus on the Quebec market, which is a possible market for our company which is already implemented there.

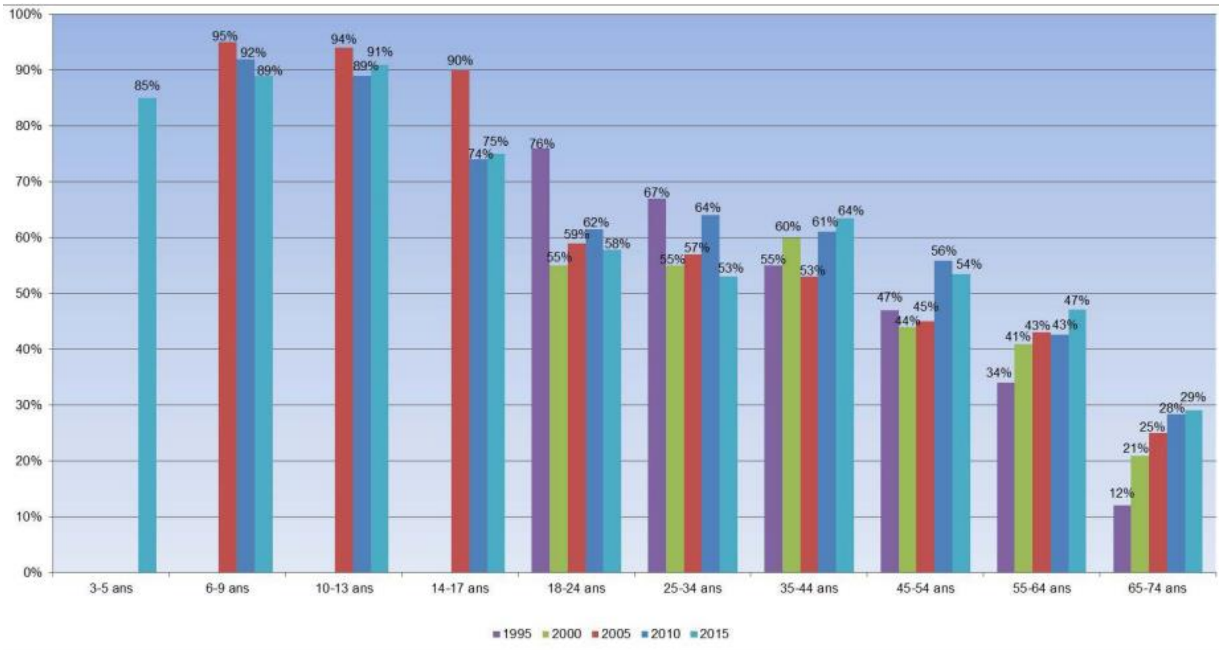

Figure 4 : Proportion of Quebecers using a bike for each age group - source: www.velo.qc.ca

This graph shows the percentage of Quebecers who used a bicycle during the year for each age group, in 1995, 2000, 2005, 2010 and 2015 to observe the evolution over 20 years. We can see that the largest proportion of users is in the 6-9 age group, along with the 10-13 age group, with a slight drop to 89% in 2015.

The prices of the market are approximately those following :

Entry-level children's bike	Mid-range children's bike	High end children's bike
From 150 €	250 €	500 €

2.1.5 Analysis of the competition

The number of competitors on the market of the children bike is important. The key players in the global market for children's bicycles are:

- Accell Group NV
- Dorel Industries Inc.
- TI Cycles Of India Limited
- Derby Cycle AG
- Tianjin Fuji-TA Bicycle Co. Ltd.
- Giant Manufacturing Co, Ltd.
- Hero Cycles Limited
- Milton Cycle Industries Ltd.
- Malvern Star
- Islabikes

The competitors that we will analyse in this study are on the European market and more importantly on the French market.

The analysis of the characteristics of the bikes sold by the competitors will help in the design of our bike. Comparative tables have been drawn up with 15 of the competition's products in order to extract as much information as possible and obtain a representative sample.

N°	Brand / Name of the bike	Weight (kg)
1	BTWIN Riverside 900	9,3
2	BTWIN Rockrider ST 500	12,4
3	Serious Rockville	10,9
4	Serious Rockville Street	12,4
5	Vitus Kids Azul	8,5
6	Ortler Copenhagen	13,4
7	SCRAPPER XC 20 1.9	11,6
8	SCRAPPER XC SPORT 20 1.8	13
9	VARIO XC DIABLO 20 DISK	10,8
10	AURELIA 420 SPORT 2	12
11	Supersuper Cooper Bamboo	14
12	Nogan Harley	14
13	VidaXL	13,5
14	LÖWENRAD	12,5
15	M.C Dis Neon Sport	15

Table 2 : Competition's products with their weight

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Different speeds	x	x	x	x	x	x	x	x	x	x					x
Straight handlebar	x	x	x	x	x		x	x	x	x	x		x	x	x
MudGard				x		x					x	x	x	x	
Luggage racks				x		x					x		x		
Basket						x									
Low bar						x					x	x			
Chain cover						x					x	x	x	x	
Single-deck	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Suspensions		x						x	x	x					
Stand			x	x		x					x	x	x	x	
Aluminium frame	x		x	x	x				x	x					
Weight <11kg	x		x		x				x						
Price (€)	280	210	300	350	369	420	150	170	250	230	340	230	184	224	160

	SUM	Percentage (%)
Different speeds	11	73,3
Straight handlebar	13	86,7
MudGard	6	40,0
Luggage racks	4	26,7
Basket	1	6,7
Low bar	3	20,0
Chain cover	5	33,3
Single-deck	14	93,3
Suspensions	4	26,7
Stand	7	46,7
Aluminium frame	6	40,0
Weight <11kg	4	26,7
Price (€)	Average	235,8 euros

Table 3 : Analysis of the competition's bikes

On the one hand, some features are "imposed" by the competition. On the other hand, some features are rare and could represent a way to stand out in the market. Our design choices should make our bike competitive and different from most bikes on the market. Here are the comments we can make about these results:

- 73 % of the bikes have different speeds. We can either choose to align on the competitors or to stand out by suppressing the speed system. This would increase lightness and simplicity of use and reduce the price. The user analysis will provide more information on the importance given to this system.

- The straight handlebar is a characteristic of almost every bike, we will also select it.
- The mudgards are used on 40 % of the bikes observed. They're not necessarily useful for children under 9 years old. Moreover, they can be added by the user if he wishes to.
- The luggage racks are rare, and the basket is even more rare. In fact, at this age children use bicycles recreationally and often do not have loads to carry.
- Only 20 % of the bikes observed have been designed with a low bar. We can observe in *Table 2* that the lightest of the 3 concerned bikes weighs 13,4 kg. The low bar is mostly used for bikes that offer comfort, with features such as mudguards and luggage racks, at the expense of performance. Indeed, to withstand the same stresses as a diamond frame, a frame with a low bar will be heavier for the same size of bike and the same material.
- One third of the bikes are equipped with a chain cover and almost half of them have got a stand. Like the mudguards and luggage racks, this equipment makes the bike heavier and more difficult to maintain.
- 40 % of the frames are made of aluminium, lighter than steel but less resistant to bumps and rough terrain. Aluminium is stiffer than steel but less able to absorb vibrations therefore less comfortable and less durable.

To conclude, we observe that only 25 % of the bikes weigh less than 11 kg, and they are all built with an aluminium frame, which makes them less robust and less able to absorb the vibrations. Moreover, they all cost at least 250 euros. Our goal will be to conceive a light but robust bike, it will weigh less than 11 kg but will have a steel frame. Non-essential features will not be retained. We will now make sure that this design will meet our customers' needs.

2.2 User profile

User research, or UX research, is an absolutely 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.

In reality, user research is what will allow us to move from designing based on assumptions to creating a product that will actually meet the need or solve the problem faced by our users.

2.2.1 Identification of the target

The persona is the first step in user analysis, it is a fictional representation of our target user that defines his title, demographic profile, end goal(s), and a scenario for using our product.

Nicolas and his parents Thomas and Alice

- Thomas is 42 years old and Alice is 36
- Nicolas is 7 years old and learnt how to ride a bike when he was 5
- They live in a small city : Auxerre, in France
- Nicolas wants to go on Sunday’s hikes with his parents
- Thomas and Alice are both employed and belong to the middle class

Our target is a child between 6 and 9 years old and his parents, considering they are the ones who buy the bike.

Our product will be used by children who want to ride or play in city parks or trails and sometimes on roads even if it’s not recommended for children under 10 years old.

In general, a child can learn to ride a bicycle without the small wheels at around 5 years old. As each child develops at his or her own pace, the age may vary before he or she is able to master a bicycle. Depending on the child's psychomotor skills, this may be between 4 and 8 years. The average is slightly above 5 years. Our bike will be designed knowing that between 6 and 9 years old, the vast majority of children can ride a bicycle without difficulty.

Up to the age of 10, a one-hour walk is already a good physical effort. Therefore, for our target group of 6-9 year olds, the maximum time of use of the bike will be about 1 hour. This information is useful in order to design a bike with the right robustness.

The behaviour of children between 6 and 9 years old when using a bicycle should also be observed. They are often careless, do not care about the condition of the bike and are not aware of the dangers both for its maintenance and for themselves. The perception of danger is eminently lower in children than in adults. Studies have shown that a child's angle of vision is reduced by at least 30% compared to that of an adult. Therefore, our product must not only be robust, resistant to falls and collisions and have no fragile parts, but it must also be safe for the young user.

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To find out what users expect, various surveys and interviews are conducted to determine what really matters to users and how they behave when using the product. The first results of the survey are the main demands of the users, that is to say the most important criteria for selecting a bike, the most sought-after characteristics. We presented a list of criteria to our target and ask it to rate every criterion depending on how important it is. Here is a list of the fifteen criteria which have been considered important by the users.

Global robustness
Frame rigidity
Maximum weight of the user
Saddle comfort
Posture comfort
Lightness
Stability at high speed
Steering responsiveness
Vibration absorption
Adaptability of the saddle to the user's size
Different speeds
Ease of straddling
Simplicity of use and maintenance
Different colours
Paint durability

Table 4 : Demands of the users - source: survey

The rest of the results and the analysis of these results will be detailed later.

2.2.2 Demand Analysis

2.2.2.1 The QFD Method

Based on the above information, it was decided to use the QFD method to draw conclusions that are as reliable as possible.

Also known as the House of Quality method, the QFD is a matrix approach to product or service design that best meets the customer's expectations. This method considers all the needs of the market and "desires" of future users from the design stage, in order to define the best manufacturing process in accordance with the quality requirements. The advantage of this method is that it is still possible to explore a wide range of solutions at this design stage.

It consists of:

- determining how to meet a customer expectation

- identifying the relationships between two sets of factors

- comparing the characteristics of a product with customer expectations and with competing products

This work should make it possible to choose solutions and to do better, faster, or cheaper than the competition. One of its main strengths is the integrative nature of the quality matrix, which allows us to measure user needs in a mathematical way, to recognise the most important parameters and those that are less useful and contribute to the cost overrun of the design without providing sufficient benefit.

Although there are different variants, here is an overview of one of the most used forms, which may help in understanding it:

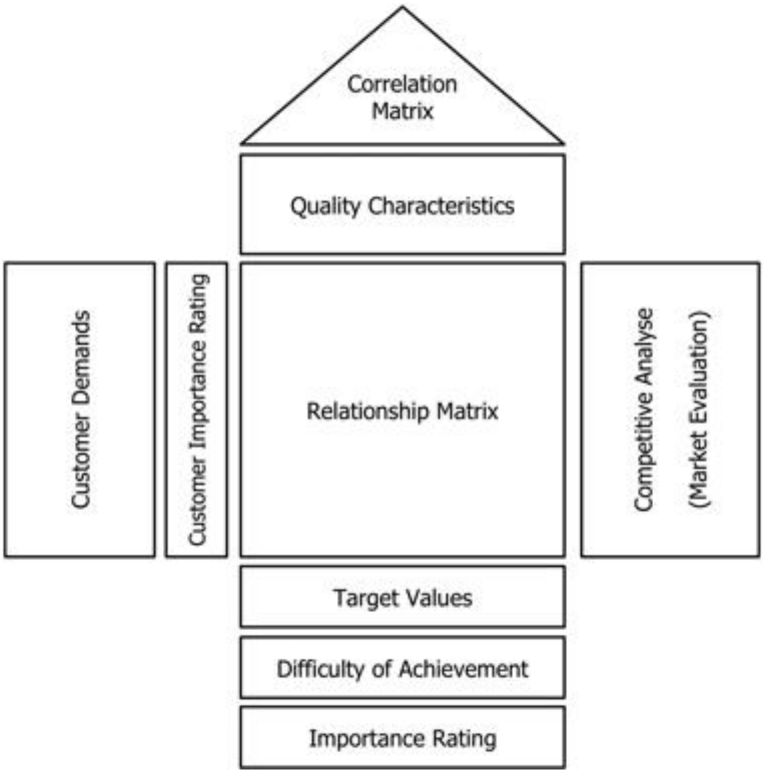


Figure 5 : Scheme of the House of Quality - source: https://www.silvafennica.fi/

2.2.2.2 Structuring and prioritisation of quality criteria

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

- Robustness
- Comfort
- Design

Robustness	Global robustness
	Frame rigidity
	Maximum weight of the user
Comfort	Saddle comfort
	Posture comfort
	Lightness
	Stability at high speed
	Steering responsiveness
	Vibration absorption
	Adaptability of the saddle to the user's size
	Different speeds
	Ease of straddling
	Simplicity of use and maintenance
Design	Different colours
	Paint durability

Table 5 : Categorization of the criteria

As the requests have already been identified and structured, the next step will be to assign a numerical value in the form of a percentage to represent the importance of this request for the users. Categorization of the criteria

The "prioritisation tree" technique is used.

This technique is based on prioritising the categories and then prioritising the criteria within each category. Multiplying the percentage of importance of a criterion by the percentage of its category then gives the overall percentage of importance of the criterion.

The prioritisation of criteria must be done by the user. Users are asked to evaluate the importance of each of the criteria. In this way, we obtain the following results:

	Importance (%)	Criteria	Importance (%)	Global importance (%)
Robustness	25%	Global robustness	57%	14%
		Frame rigidity	22%	6%
		Maximum weight of the user	21%	5%
Comfort	55%	Saddle comfort	11%	6%
		Posture comfort	8%	4%
		Lightness	19%	10%
		Stability at high speed	8%	4%
		Steering responsiveness	7%	4%
		Vibration absorption	12%	7%
		Adaptability of the saddle to the user's size	11%	6%
		Different speeds	9%	5%
		Ease of straddling	5%	3%
		Simplicity of use and maintenance	10%	6%
Design	20%	Different colours	55%	11%
		Paint durability	45%	9%

Table 6 : Prioritisation of the criteria - source: user survey

2.2.2.3 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:

1. Basic expectations ("must be"). These are not necessarily stated but cause dissatisfaction if these latent needs are not met.

2. 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".

3. 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.

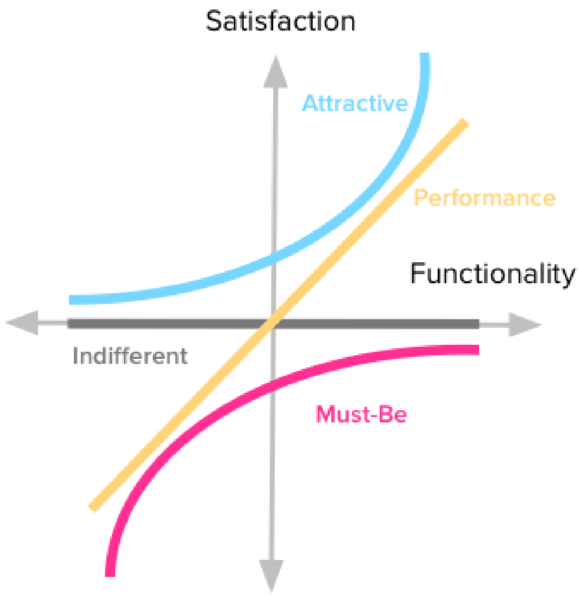


Figure 6 : Kano Model - source: https://wikiagile.cesi.fr/

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)

Table 7 : Kano Table – source : https://blog.seeburger.com/

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

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

Criteria	Classification
Global robustness	M
Frame rigidity	I
Maximum weight of the user	I
Saddle comfort	O
Posture comfort	M
Lightness	O
Stability at high speed	M
Steering responsiveness	M
Vibration absorption	O
Adaptability of the saddle to the user's size	M
Different speeds	I
Ease of straddling	A
Simplicity of use and maintenance	O
Different colours	A
Paint durability	O

Table 8 : Kano Clasification of the criteria

2.2.2.4 Competitive positioning

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:

- BTWIN Riverside 900
- Scrapper XC 20 1.9
- Serious Rockville Street
- VidaXL
- Aurelia 420 SPORT 2

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 bikes for each criterion. It also shows the quality objectives for our product.

Criteria	BTWIN Riverside 900	SCRAPPER XC 20 1.9	Serious Rockville Street	VidaXL	AURELIA 420 SPORT 2	Average	Objective
Global robustness	4,5	4,3	4,2	3,8	4,6	4,28	4,5
Frame rigidity	4,5	4	4,5	4	4,5	4,3	5
Maximum weight of the user	4	4,3	4,2	4,2	4	4,14	3,5
Saddle comfort	4	3,7	3	2,8	4	3,5	4
Posture comfort	4	4	4,2	4	3,8	4	4
Lightness	4,8	3,8	3	2,4	3,6	3,52	4,5
Stability at high speed	4	3,8	4	4	3	3,76	4
Steering responsiveness	4	4	3,6	4	4,5	4,02	4
Vibration absorption	3	3,8	3,2	4	4,8	3,76	3,5
Adaptability of the saddle to the user's size	4,5	4,3	4,6	4,4	4,5	4,46	4,5
Different speeds	4,5	4	4,3	1	4	3,56	1
Ease of straddling	3,3	3,6	3,5	3,3	3,5	3,44	3,5
Simplicity of use and maintenance	4	4	3,5	4	3,4	3,78	4
Different colours	4	3,5	3,5	3	4,5	3,7	3,5
Paint durability	4	3,5	3,5	3	4	3,6	3,5

Table 9 : Rating of the competition's products and objectives for ours

When designing a new product, in order 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
Global robustness	4,28	4,5	105%	14,25%	14,98%
Frame rigidity	4,3	5	116%	5,50%	6,40%
Maximum weight of the user	4,14	3,5	85%	5,25%	4,44%
Saddle comfort	3,5	4	114%	6,05%	6,91%
Posture comfort	4	4	100%	4,40%	4,40%
Lightness	3,52	4,5	128%	10,45%	13,36%
Stability at high speed	3,76	4	106%	4,40%	4,68%
Steering responsiveness	4,02	4	100%	3,85%	3,83%
Vibration absorption	3,76	3,5	93%	6,60%	6,14%
Adaptability of the saddle to the user's size	4,46	4,5	101%	6,05%	6,10%
Different speeds	3,56	1	28%	4,95%	1,39%
Ease of straddling	3,44	3,5	102%	2,75%	2,80%
Simplicity of use and maintenance	3,78	4	106%	5,50%	5,82%
Different colours	3,7	3,5	95%	11,00%	10,41%
Paint durability	3,6	3,5	97%	9,00%	8,75%
					100%

Table 10 : Adjusted importance of each criterion

2.2.2.5 Analysis of the relations between demands and technical parameters

Parameter	Type	Unit
Number of speeds	1	#
Handlebar type	2	Drop, flat, upright…
Material of the frame	2	Aluminium, steel, carbon…
Frame type	2	Diamond, low bar…
Mechanical resistance 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	°
Caster	1	mm
Standover	1	cm
Design	3	-

Table 11 : 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:

FEATURES / DEMANDS	Wheigt	Material of frame	Mechanical resistance of the frame	Frame rigidity	Frame type	Tyre width	Distance between wheels axles	Size of the saddle	Head tube angle	Seat tube angle	Caster	Standover	Handlebar type	Number of speeds	Design	Importance of the demands
Global robustness	9	9	9		9	3						1				15%
Frame rigidity	9	9	3	9	9											6%
Maximum weight of the user	9	9	9	3	3	1										4%
Saddle comfort	1							9								7%
Posture comfort								1		9			3			4%
Lightness	9	9	3	9	3	3	3	1				1	1	1		13%
Stability at high speed						1	3		3		9		3			5%
Steering responsiveness						1	3		3		9		1			4%
Vibration absorption		1	1	3		3		3								6%
Adaptability of the saddle to the user's size								3								6%
Different speeds														9		1%
Ease of straddling					9							9				3%
Simplicity of use and mainten:	3	1			3							3		3		6%
Different colours															9	10%
Paint durability															3	9%
Importance of the parameters	3,8	3,6	2,4	2,1	2,9	1,2	0,7	1,2	0,3	0,4	0,8	0,7	0,4	0,4	1,2	

9	Strong relation
3	Medium relation
1	Weak relation
	Without relation

Table 12 : 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:

Priority order	Features
1	Weight
2	Material of the frame
3	Frame type
4	Mechanical resistance of the frame
5	Frame rigidity
6	Size of the saddle
7	Tyre width
8	Design
9	Caster
10	Standover
11	Distance between wheels axles
12	Handlebar type
13	Number of speeds
14	Seat tube angle
15	Head tube angle

Table 13 : Priority order of the features

We can conclude that our priority should be to conceive a light bike with a frame having good mechanical characteristics, mostly a good resistance. A steel frame would be resistant, stiff enough and not too heavy. To avoid making it too heavy, a diamond shape should be chosen. The size of the saddle appears to be important. We should select a comfortable and large enough one. The number of speeds ends up as one of our last priorities.

Finally, we determine the stronger or weaker links that may exist between the parameters themselves. The following table shows their interconnections:

FEATURES / DEMANDS	Weight	Material of frame	Mechanical resistance of the frame	Frame rigidity	Frame type	Tyre width	Distance between wheels axles	Size of the saddle	Head tube angle	Seat tube angle	Caster	Standover	Handlebar type	Number of speeds	Design
Weight	x	9	9	9	3	3	3	1				1	1	1	
Material of frame		x	9	9											
Mechanical resistance of the frame			x		9										
Frame rigidity				x	9										
Frame type					x		1		1	1	3	9			9
Tyre width						x									3
Distance between wheels axles							x								
Size of the saddle								x							
Head tube angle									x		3				
Seat tube angle										x					
Caster											x				
Standover												x			
Handlebar type													x		3
Number of speeds														x	
Design															x

9	Strong relation
3	Medium relation
1	Weak relation
	Without relation

Table 14 : 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 low-cost and easy-to-use bicycle. For example, we choose not to add a multi-speed system. In the same way, we will not add mudguards or luggage racks, making our product lighter.

A caster between 45 mm and 55 mm and a head tube angle between 71° and 73° will make our bike both stable at high speed and manageable, as we will explain later in the section dedicated to the choice of components.

Its diamond-shaped steel frame will make it robust without making it exceed 11 kg. A slightly lowered bar would reduce the standover without affecting the mechanical performance.

A thick 15 cm wide foam padded saddle will make the ride comfortable.

The wheels will be equipped with mixed tyre, suitable for roads and paths thanks to its medium width and the structure of the studs. The adaptability to all paths, lightness and simplicity of the bike will be its main advantages.

We will choose a frame with two colours, attractive for children between 6 years old and 9 years old.

Finally, the handlebar will be straight, the most adequate shape for this kind of bike.

2.3 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.

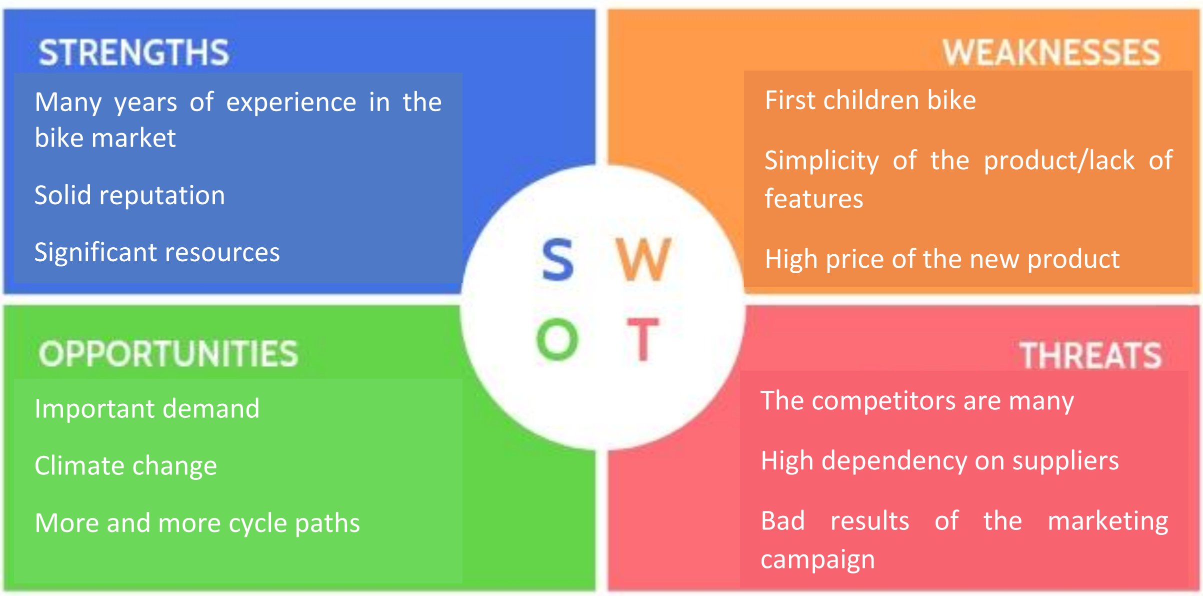


Figure 7 : SWOT Analysis

2.4 Study of the regulations

ISO 4210 is a regulation that was introduced in 1996 and was recently revised in 2014. It defines all terms and designations that relate to the safety and performance requirements of bicycle vehicles and sub-assemblies. These are important codifications to observe during design, assembly and testing.

ISO 4210 consists of the following parts, under the general title *Cycles — Safety requirements for bicycles:*

- — Part 1: Terms and definitions
- — Part 2: Requirements for city and trekking, young adult, mountain and racing bicycles
- — Part 3: Common test methods
- — Part 4: Braking test methods
- — Part 5: Steering test methods
- — Part 6: Frame and fork test methods
- — Part 7: Wheels and rim test methods
- — Part 8: Pedals and drive system test methods
- — Part 9: Saddles and seat-post test methods

The regulation of road vehicles at the time of manufacture in OECD countries varies both in terms of content and method of enforcement. However, they are always based on the same principle: any vehicle placed on the market must comply with standards designed to ensure an acceptable level of safety for users.

Within the European Union, these standards are all Community standards, even those published in France under the acronym "NF". There is one standard per product family. The ones that interest us here are the following:

- NF EN 14764 (July 2006) Street and off-road bicycles: safety requirements and test methods
- NF EN 14765 (June 2006) Bicycles for young children: safety requirements and test methods

2.5 Component selection

2.5.1 Frame and fork

Too many users choose a bike based on its appearance. However, the geometry of the frame, the most important criterion, should not be neglected. The geometry of the bike must be adapted to the rider's morphology, age, back flexibility and even to possible pathologies. Indeed, it directly influences the position on the bike. Thus, comfort and performance are irrevocably linked to it.

1	Length of seat tube
2	Length of top tube
3	Height of bottom bracket
4	Length of the chainstay
5	Angle of the seat tube
6	Angle of the head tube
7	Fork offset
8	Caster
9	Bottom bracket axle - fron wheel axle
10	Wheelbase
11	Standover
12	Head tube
13	Stack
14	Reach

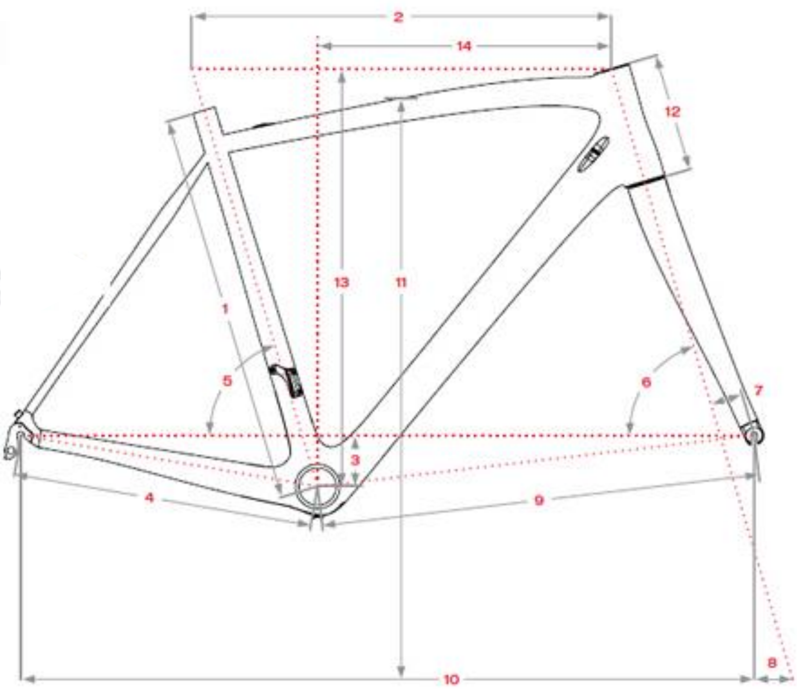


Figure 8 : Geometry of a bicycle – source: https://www.lexpertvelo.com/

The analysis of the user's needs has shown the importance that the user places on the frame in his bike. To start the production of our new bike, we will buy the components from our suppliers, including the frame.

Depending on the sales results, some parts may be designed rather than purchased in order to reduce the final cost, the frame in particular.

We are now determining the main geometric parameters that our frame should have:

- A lowered geometry with a 50 cm standover will facilitate straddling.
- The fork offset and the head tube angle influence the caster. At the same speed, the more the head tube angle is laid back, the greater the caster, the greater the

return torque. In this case, the bike is stable at high speed: it keeps its course easily without being battered by the terrain. Conversely, the steeper the steering angle, the lower the caster, the lower the return torque. The steering feels freer, easier to manoeuvre. The bike is "manageable". To ensure that the handlebars are within reach of a 6-year-old, that the wheel is far enough away from the bottom bracket and to find the right balance between manoeuvrability and stability, the caster will be of 50 mm and the angle of the head tube in relation to the horizontal will be 72º, with a slight offset of the fork.

- The angle of the seat tube to the horizontal will be 73°, which is optimal for any type of bike or user.
- All other parameters are chosen according to the morphology of a user aged between 6 and 9 years old, to ensure his comfort.

Here is the bike frame and fork that have been chosen:

Frame	
material	steel
weight	2600 g
type	low bar
brand	Decathlon
colour	white
price	100 €

Table 15 : Frame characteristics -source: https://www.decathlon.fr

Fork	
material	steel
weight	900 g
bike type	ATB/ MTB
brand	M-Wave
colour	white
brake type	v-brake
length of steerer tube	240 mm
price	17 €

Table 16 : Fork characteristics - source: https://www.internet-bikes.com/

We will be able to modify the colours of the frame and fork in our workshop if we decide to in the future.

2.5.2 Wheels and tyres

The optimal wheel size for a child's bike from 6 to 9 years is 20". We choose a mixed tyre, suitable for both roads and paths thanks to the structure of the studs, and a 20" inner tube with a cross-section of 1.7 to 2.2 with a schrader valve.

Front Wheel	
material	Steel/aluminium
weight	≈ 860 g
single wall rims dimensions	ETRTO 406x21C
brand	BTWIN
colour	light grey
size	20"
number of alu spokes	28
price	22 €
axle	OLD 100 mm

Table 17 : Front Wheel Characteristics - source: https://www.decathlon.es/

Rear Wheel	
material	Steel/aluminium
weight	864 g
single wall rims dimensions	ETRTO 406x21C
brand	BTWIN
colour	light grey
size	20"
number of alu spokes	28
price	19 €
axle	OLD 130 mm

Table 18 : Rear Wheel Characteristics - source: https://www.decathlon.es/

Mixed Tyre	
material	50% ethylene-propylene-diene rubber monomer, 50% natural rubber latex
weight	580 g
brand	BTWIN
wheel size	20"
dimensions	20X1.75 / ETRTO 44-406
price	11 €

Table 19 : Tyre Characteristics – source: https://www.decathlon.fr/

Inner Tube	
material	50% ethylene-propylene-diene rubber monomer, 50% natural rubber latex
weight	148 g
brand	Decathlon
wheel size	20"
cross section	1,7 to 2,2
Schrader valve	33 mm
price	3,20 €

Table 20 : Inner tube Characteristics - source: https://www.decathlon.fr/

2.5.3 Saddle

The saddle is designed to adapt to the physical constitution of children. It is intended for recreational cycling for less than 1 hour at low intensity and a back angle of 90°.

Saddle	
dimensions	240mm x 180mm
weight	430 g
brand	BTWIN
wheel size	20" to 24’’
colour	black
price	15 €

Table 21 : Saddle Characteristics - source: https://www.decathlon.fr/

2.5.4 Brakes

Brakes	
type	V-Brake
material	steel
weight	50 g
brand	ROCKRIDER
colour	black
price	14 €

Table 22 : Brake Characteristics - source: https://www.decathlon.fr/

2.5.5 Handlebar, stem, handles and brake levers

Handlebar	
material	steel
weight	450 g
brand	DECATHLON
colour	black
price	10 €

Table 23 : Handlebar Characteristics - source: https://www.decathlon.fr/

The stem is raised by 10° for a more comfortable position on the bike. It is also chosen because of its low cost.

Stem	
material	aluminium
weight	200 g
brand	BTWIN
colour	black
price	10 €
angle	10°

Table 24 : Stem Characteristics - source: https://www.decathlon.fr/

Handles	
material	100% Polyethylene
weight	180 g
brand	Rockrider
colour	black
price	4,90 €

Table 25 : Handles Characteristics - source: https://www.decathlon.fr/

These brake handles have a shape adapted to the child's morphology.

Brake levers	
material	40% Polyamide, 30% Polypropylene, 30% Steel
weight	185 g
brand	BTWIN
colour	black
price	11 €

Table 26 : Brake levers Characteristics - source: https://www.decathlon.fr/

2.5.6 Pedals

Pedals	
material	32% Polypropylene, 6% Steel, 2% Polycarbonate
weight	280 g
brand	BTWIN
colour	black
price	7 €

Table 27 : Pedals Characteristics - source: https://www.decathlon.fr/

2.5.7 Transmission

The children's crankset that we will choose is suitable for a 20 inch bike. With its 36 teeth, it is a medium-sized crankset that will allow the child to learn to pedal on the flat without too much effort, while also being able to reach a pleasant speed. The 127 mm cranks are adapted to the length of the child's legs and the child's bike frame. This sturdy silver steel crankset for children's bikes is suitable for a single-speed drive.

The crankset is designed to be mounted on a square axle bottom bracket of about 131 mm.

Crankset	
material	steel
weight	732 g
brand	LECYCLO
colour	silver
price	18 €

Table 28 : Crankset Characteristics - source: https://www.lecyclo.com/

Square bottom bracket axle	
material	steel
weight	400 g
brand	OXFORD
colour	black
price	5 €

Table 29 : Bottom bracket axle Characteristics - source: https://www.lecyclo.com/

Chain	
material	steel
weight	472 g
brand	YBN Chain
chain links	124
colour	silver
price	9 €

Table 30 : Chain Characteristics - source : https://www.lecyclo.com/

Sprocket	
material	steel
weight	214 g
brand	Decathlon
price	10 €

Table 31 : Sprocket Characteristics - source: https://www.decathlon.fr/

2.5.8 Seat Post

Seat Post	
material	steel
tube length	300 mm
tube diameter	25.4 mm
weight	610 g
brand	BTWIN
colour	black
price	6 €

Table 32 : Seat post Characteristics - source: https://www.decathlon.fr/

3 SAP Implementation

3.1 Creation of the components

For this part of implementation in SAP, we are starting from a database already implemented in a fictitious company. Many components already exist in this database but the work carried out so far has resulted in an own design whose components are not included in the pre-established data. Therefore, the components we have chosen during the design phase must be included in SAP via the Material Management (MM) module.

To create a trading good material master record, we follow this menu path:

Logistics ▶ Materials Management ▶ Material Master ▶ Material ▶ Create (General) ▶ Immediately

This will produce the following screen.

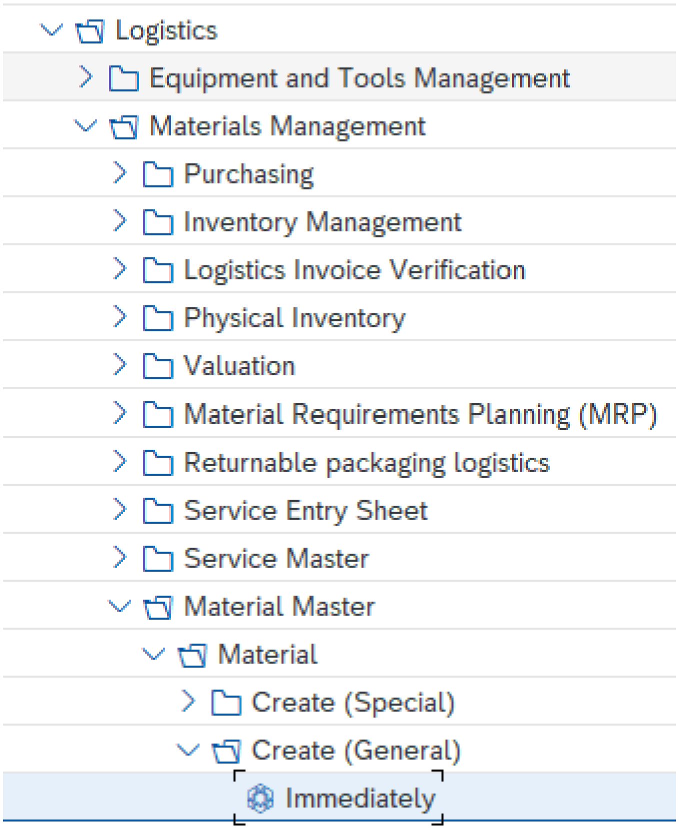


Figure 9 : Menu path to create trading goods - source: SAP

By clicking on *Trading Goods* we obtain this window that we fill for each component:

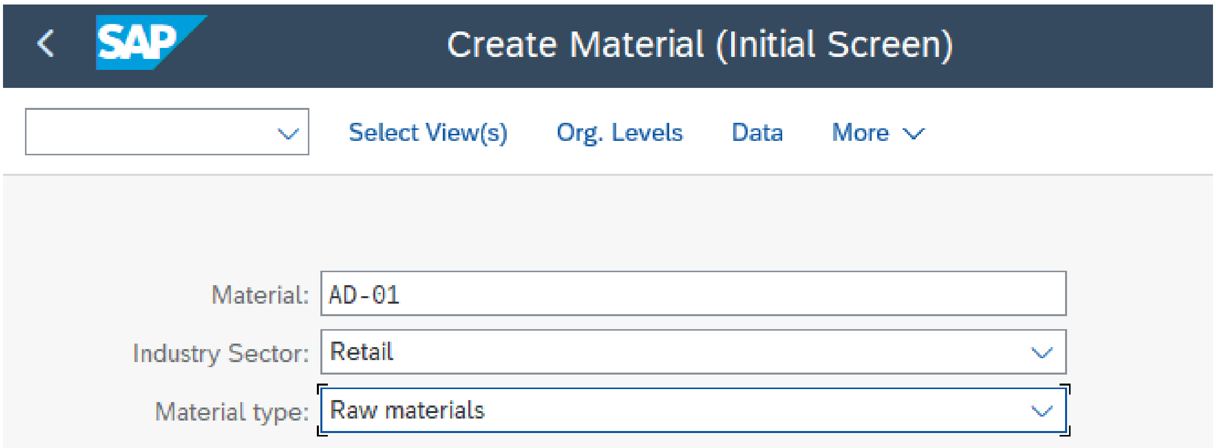


Figure 10: Component creation

We enter first the name of the material that has been determined beginning with the initials AD and the number associated to each component like listed in this table:

Component	SAP Name
Frame	AD-01
Fork	AD-02
Wheels	AD-03
Tyres	AD-18
Inner tubes	AD-19
Saddle	AD-06
Brakes	AD-07
Handlebar	AD-08
Stem	AD-09
Handles	AD-20
Brake levers	AD-11
Pedals	AD-12
Crankset	AD-13
Bottom bracket axle	AD-14
Chain	AD-15
Sprocket	AD-16
Seat post	AD-17

Table 33: Components with their SAP names

Then we choose *Retail* as industry sector and *Raw Materials* as material type, as they are all goods which don't need any transformation but will be assembled as a part of the bike.

The next window allows to select the views that must be modified for the creation of the article. In the case of this project, we select only those shown in this figure:

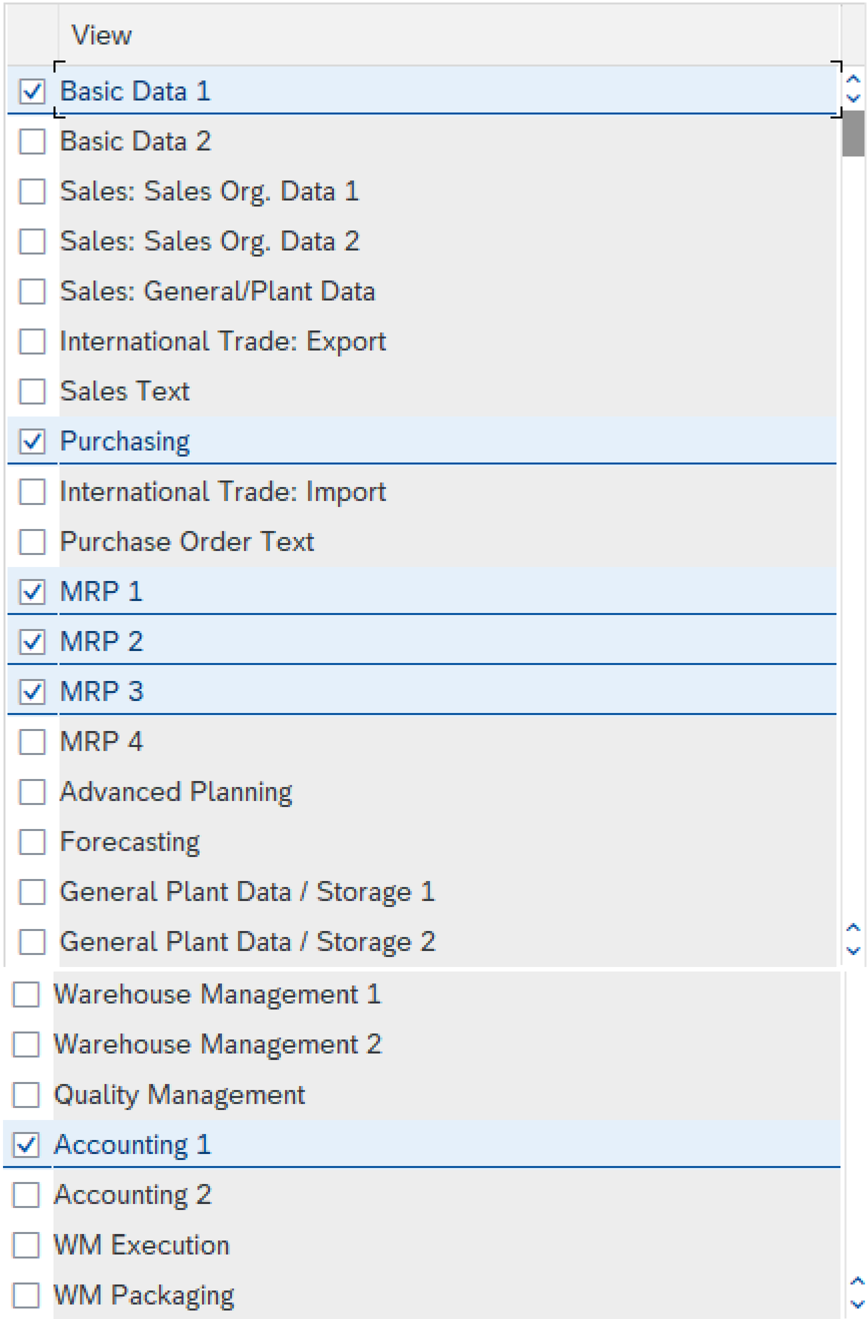


Figure 11: Views creation for components

On the Organizational Levels screen, we enter plant **HD00** which stands for the Heidleberg plant and as Stor. Location we enter **TG00** for trading goods.

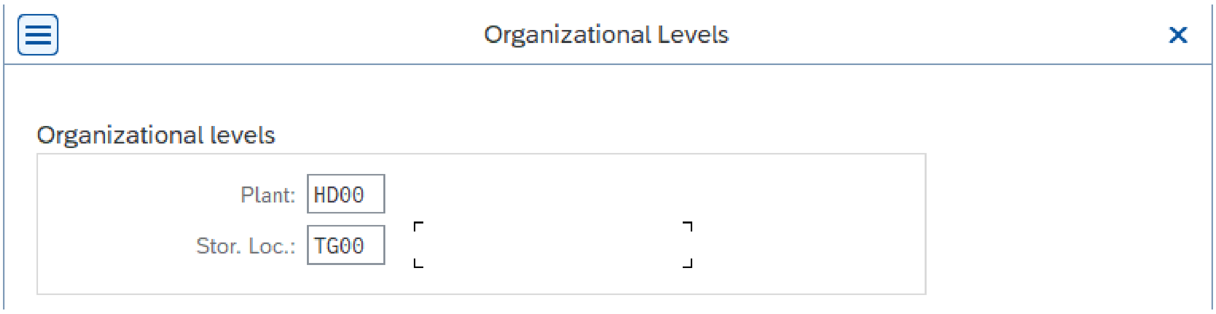


Figure 12: Organization levels definition

Next, we proceed to fill in all the necessary data for each previously selected view. First, we will modify the Basic Data 1 tab. We enter the name of the component (frame, fork...), we choose PC as the unit of measurement, which means that it is a part, BIKES as the group of items since each part will be part of the finished bike and finally we assign the component its weight in grams.

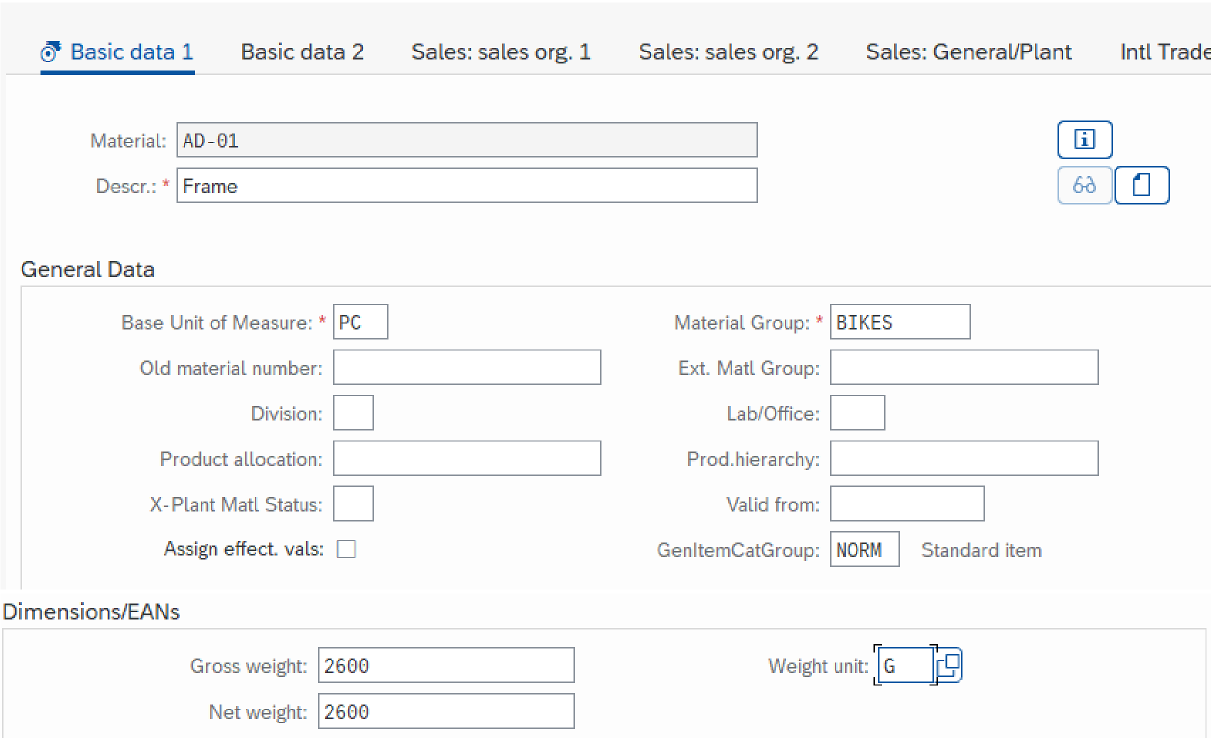


Figure 13: Basic Data window

In the purchasing view, there is only to select Europe (E00) as the purchasing group. In the MRP 1 view, we select these data:

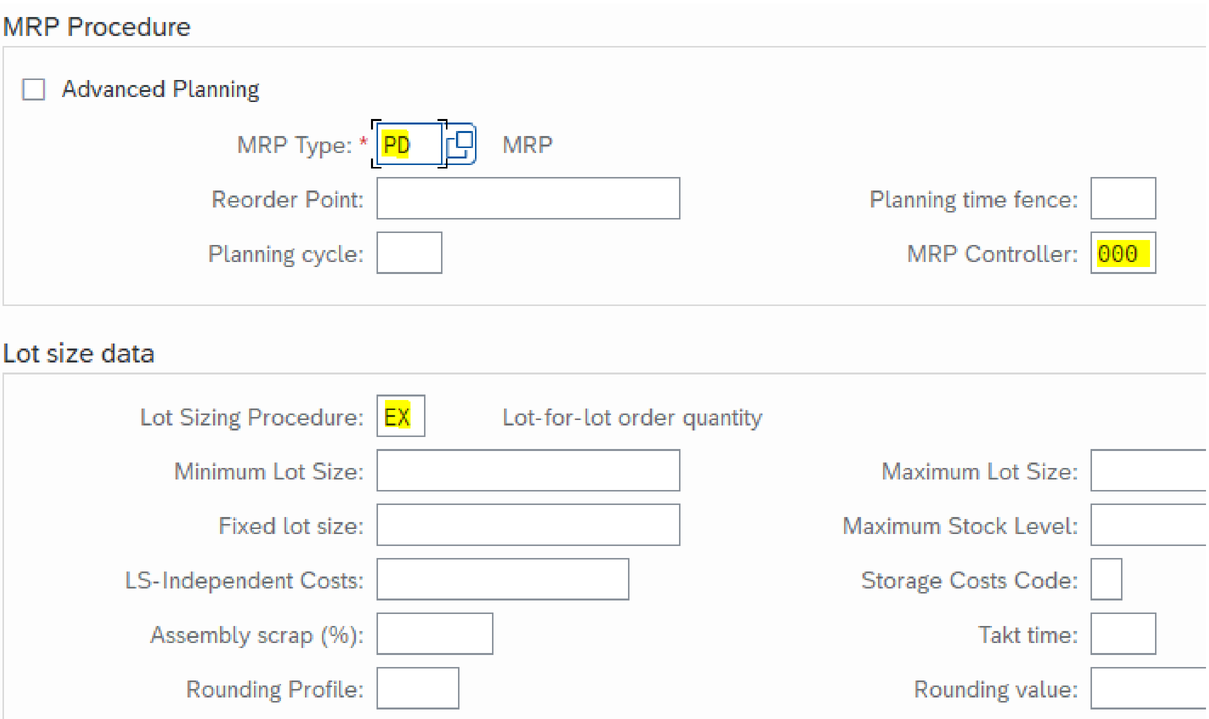


Figure 14: MRP 1 window

For MRP 2:

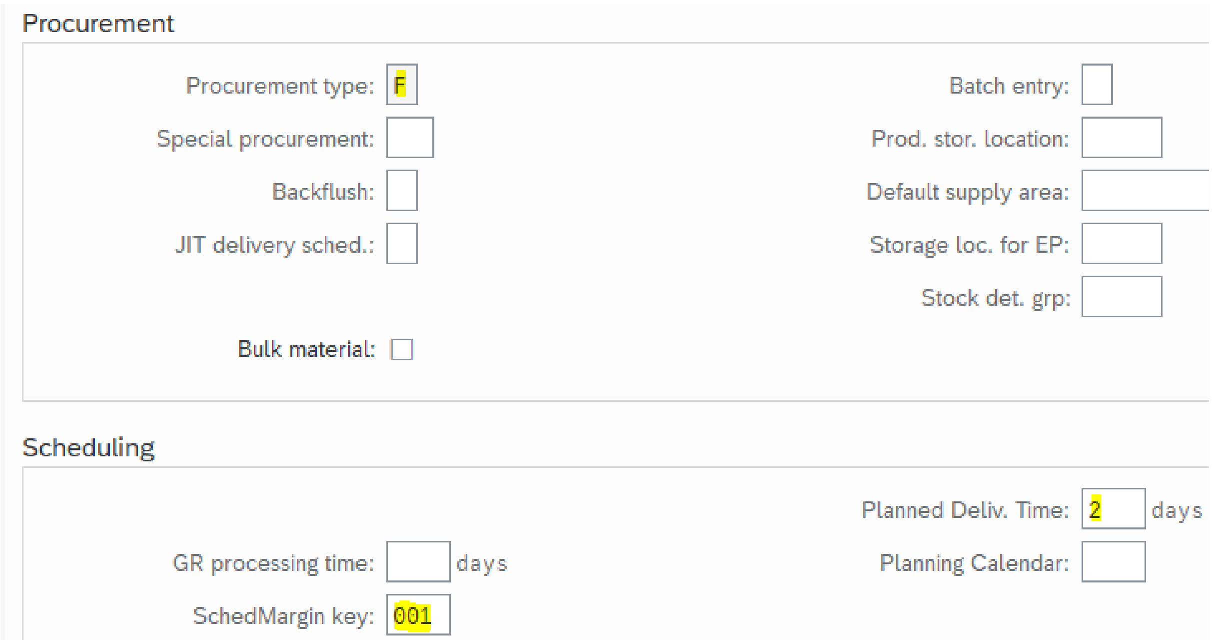


Figure 15: MRP 2 window

For MRP 3:

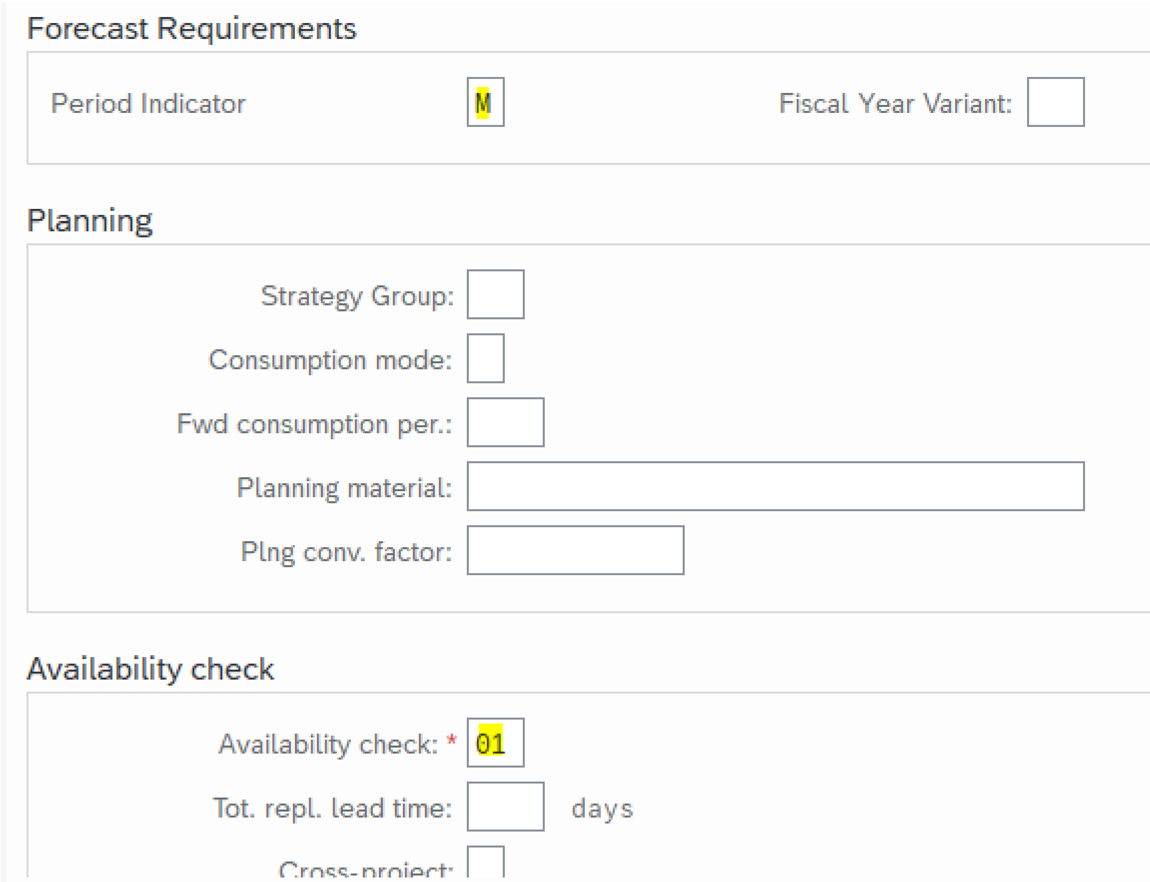


Figure 16: MRP 3 window

Finally, we complete the Accounting 1 view. The code 3000 (Merchandise Category) will be assigned to the valuation class box, and we price the component. The base quantity will always be determined as 1 since only one of each component is needed for a bike, indeed we will enter the brakes, wheels, tyres and inner tubes in packs of 2 units since most distributors sell them this way. Finally, the variable price option V is selected.

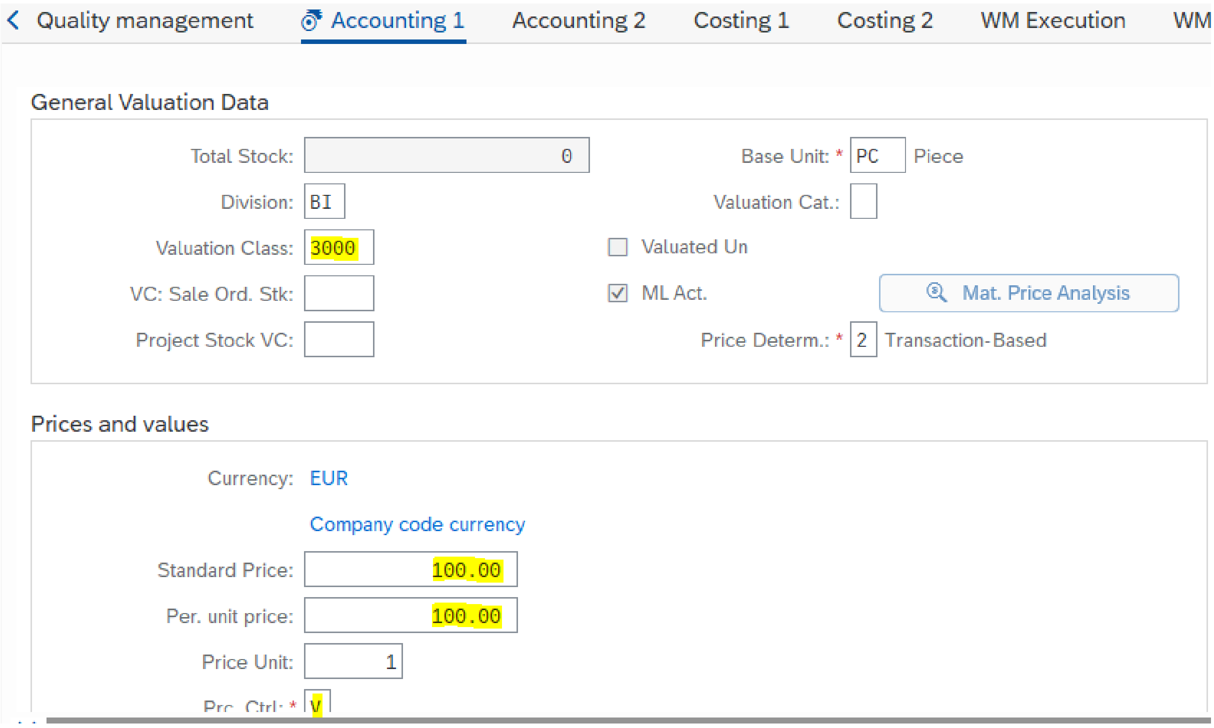


Figure 17: Accounting window

3.2 Creation of the project and its stages

Now that we have created the components that will be used to build our bike, we need to create a new project in the SAP project builder module. The first step is to define the project structure.

To do this we start by going to the Project Builder module which we find in the drop-down menu in the section *Logistics*:

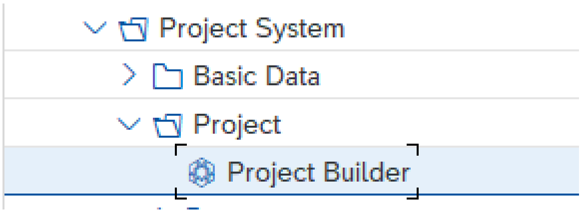


Figure 18: Path to Project Builder

We call our project P/2335 Children Bike 335 and we select "Cost Projects (Europe)" in *Project Profile*:

Figure 19: Project definition's window

The next step is the creation of the WBS (Work Breakdown Structure) elements. In the case of this project, four WBS elements will be created to structure and divide the project into phases.

- Engineering: This phase will include all the processes that have been carried out in the first part of this work, from preliminary studies to the selection of components. This WBS element will be named P/2335-1.

- Prototype: This phase will include the purchase of the required components and their assembly.

- Testing: This phase will include the testing of the prototype and the review of some possible points for improvement.

- Production: This phase will include the training of operators, production, distribution and marketing.

Subdi...	Level	WBS element	Description
	1	"	Development of Cildren Bke
	2	" 1	Engineering
	2	" 2	Prototype
	2	" 3	Testing
	2	" 4	Production

Figure 20: WBS creation

Now that we have created the main stages of our project, we can view the following hierarchy graphic:

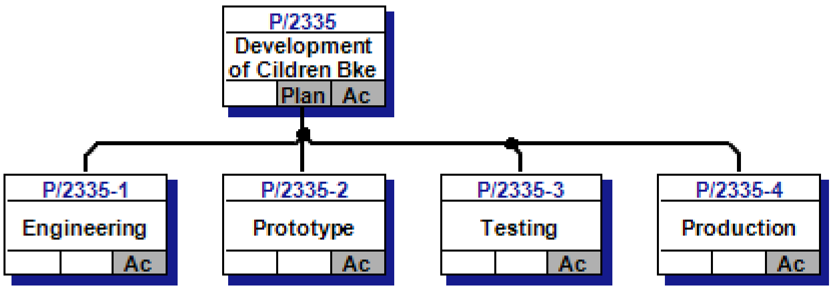


Figure 21: Hierarchy graphic of the project

With the WBSs already created, it is time to create the activities to be performed in each of these WBSs. These activities will be set up to represent the actual process, in order, of the activities that are carried out in this project. First, we will detail the activities and their durations, on the one hand the duration between the beginning and the end of the task and on the other hand the number of effective working hours.

WBS	Activity	Duration	Equivalent in hours
Engineering	Contextualisation and definition of the project	1 day	8 hours
	Study of the regulations	1 day	8 hours
	Market analysis	3 days	24 hours
	Collection of user data	6 days	24 hours
	Analysis of user data	2 days	16 hours
	Determination of technical characteristics	2 days	16 hours
	Component selection	2 days	16 hours
Prototype	Component purchase	5 days	3 hours
	Assembly of components	1 day	2 hours
Testing	Quality control	2 days	16 hours
	Adjustments to aspects to be improved	2 days	16 hours
Production	Component purchase	5 days	3 hours
	Operator training	1 day	4 hours
	Production	5 days	40 hours
	Distribution	4 days	32 hours
	Marketing	4 days	32 hours

Figure 22: List of the activities with their duration

We implement these activities in SAP by creating a network in our project. We insert the necessary information in the table below: the durations, work centers and the WBS to which each activity belongs. The work centers are defined as follows:

- DVLP1000: This work center includes all activities related to Engineering, Development or Marketing.
- PROC1000: This work center is for purchasing and material supply.
- ASSY1000: This work center is for the assembly of parts.
- INSP1000: This work center is intended for quality control.

Acti...	Description	Normal ...	No...	Work	Un...	Work center	Plant	Std T
0010	Contextualisation and def. of project	1	DAY	8.0	HR	DVLP1000	HD00	
0020	Study of the regulations	1	DAY	8.0	HR	DVLP1000	HD00	
0030	Market analysis	3	DAY	24.0	HR	DVLP1000	HD00	
0040	Collection of user data	6	DAY	24.0	HR	DVLP1000	HD00	
0050	Analysis of user data	2	DAY	16.0	HR	DVLP1000	HD00	
0060	Determination of technical characteristi	2	DAY	16.0	HR	DVLP1000	HD00	
0070	Component selection	2	DAY	16.0	HR	DVLP1000	HD00	
0080	Component purchase	5	DAY	3.0	HR	PROC1000	HD00	

Figure 23: Implementation of the activities

Now that we have defined the activities, we have the following hierarchy:

Project Structure: Description	Identification
Children Bike 335	P/2335
Development of Cildren Bike	P/2335
4000186	4000186
Engineering	P/2335-1
Contextualisation and def. of p	4000186 0010
Study of the regulations	4000186 0020
Market analysis	4000186 0030
Collection of user data	4000186 0040
Analysis of user data	4000186 0050
Determination of technical cha	4000186 0060
Component selection	4000186 0070
Prototype	P/2335-2
Component purchase	4000186 0080
Assembly of components	4000186 0090
Testing	P/2335-3
Quality control	4000186 0100
Adjustments to aspects to be i	4000186 0110
Production	P/2335-4
Component purchase	4000186 0120

Figure 24: Project's hierarchy with its activities

We will now add the existing temporal relationships between each activity. SAP offers 4 different relationships: *FS* means Fin-Start, *FF* means Fin-Fin, *SS* means Start-Start and *SF* means Start-Fin. For this project, we will only use the FS relationship which means that when a task is finished, we can start another one since we have obtained the necessary information to continue the project.

Some tasks can be done in parallel. This is the case for the study of the regulations, which is carried out at the same time as the market and user studies, but which must still be completed before determining the technical characteristics. This is also the case for marketing, which can start to be developed as soon as the development of the final product is finished, therefore after the testing phase. We decide that it should be completed before launching the distribution of the product.

After having defined the relations between activities, we obtain this network graphic:

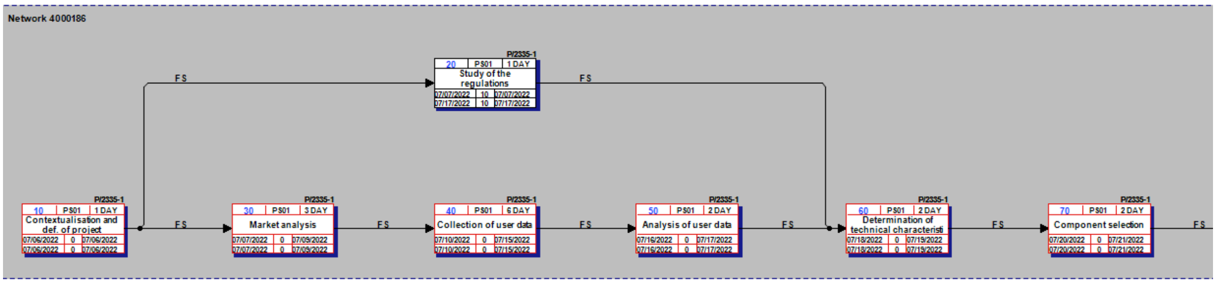


Figure 25: Engineering part of the network graphic

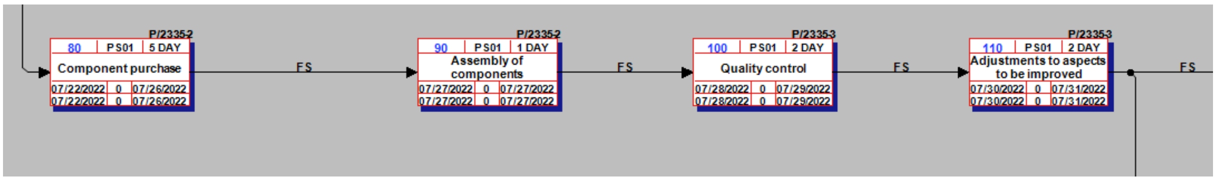


Figure 26: Prototype and Testing parts of the network graphic

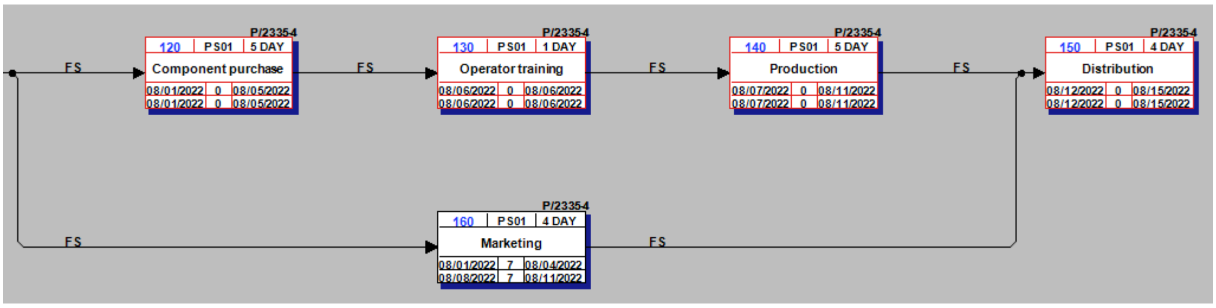


Figure 27: Production part of the network graphic

Each activity is represented with the following information:

- its associated WBS and its duration in the top right-hand corner
- its earliest start date at the bottom left
- its latest start date just below
- its earliest finish date at the bottom right
- its latest finish date just below

By analysing the diagram provided by SAP, it is possible to know which is the critical path of the project, which will be the one including the activities of user study, market study, and then the one including the mass production of the product. Thus, the study of regulations and marketing are the only activities that do not belong to the critical path, which is why they are the only ones with holgura different from 0.

Figure 28: Example of activities from the network graphic

From this graph we can observe that the project will run from 07/06/2022 to 08/15/2022.

3.3 Component assignment

The next step in the project will be to allocate the materials needed for each of the tasks. In our case, we are assembling a prototype from already manufactured components and then producing 200 bikes. Thus, we need to include the materials we defined earlier in the material procurement activities for these two phases. In the first phase we assign only 1 component of each, while in the second phase we assign 200 components of each.

In order to assign the materials to this task, we access the component overview option in which we will add all the materials created with their definition (AD-01, AD-02 ...) and the unit of measurement, which in this case we remember are PC parts. We obtain the list below:

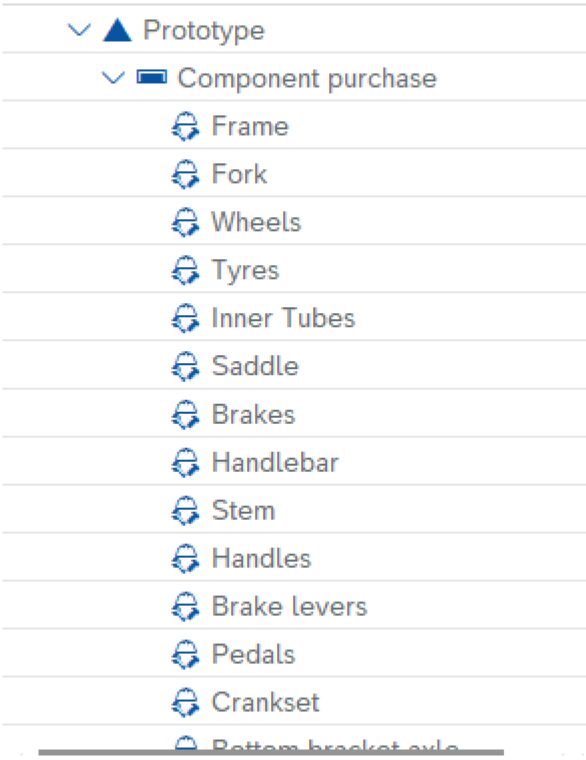


Figure 29: 'Component purchase' activity with its components

3.4 Milestones creation

We can now add milestones to mark the important stages of the project. So we add 3 milestones:

- Engineering, to mark the end of the product design
- Prototype evaluated, to mark the end of the prototype testing and product adjustment stages
- End of project, once all stages have been completed and the product has been distributed.

To do this we access the window shown below:

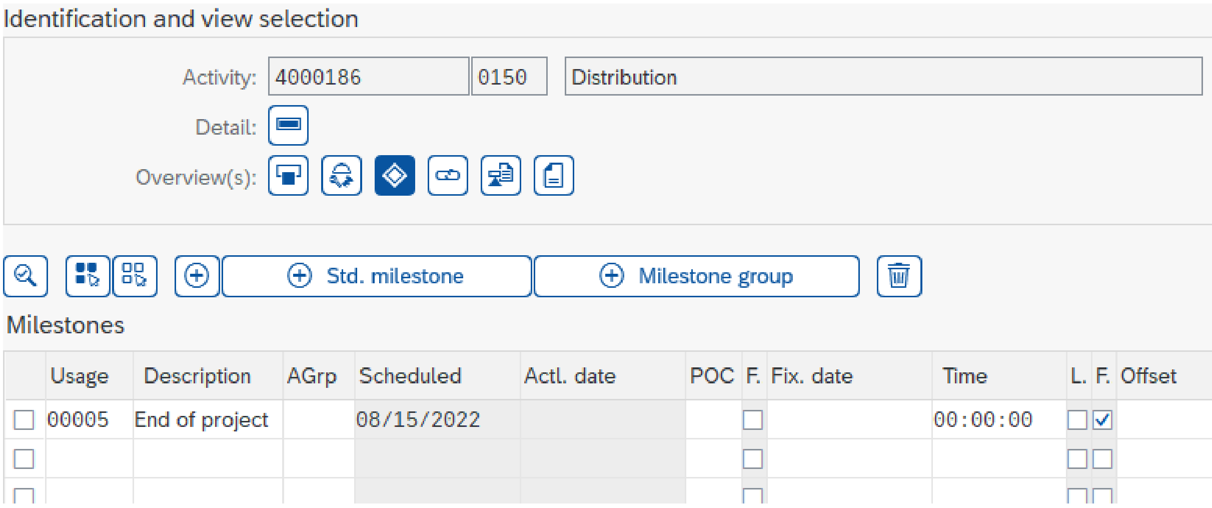


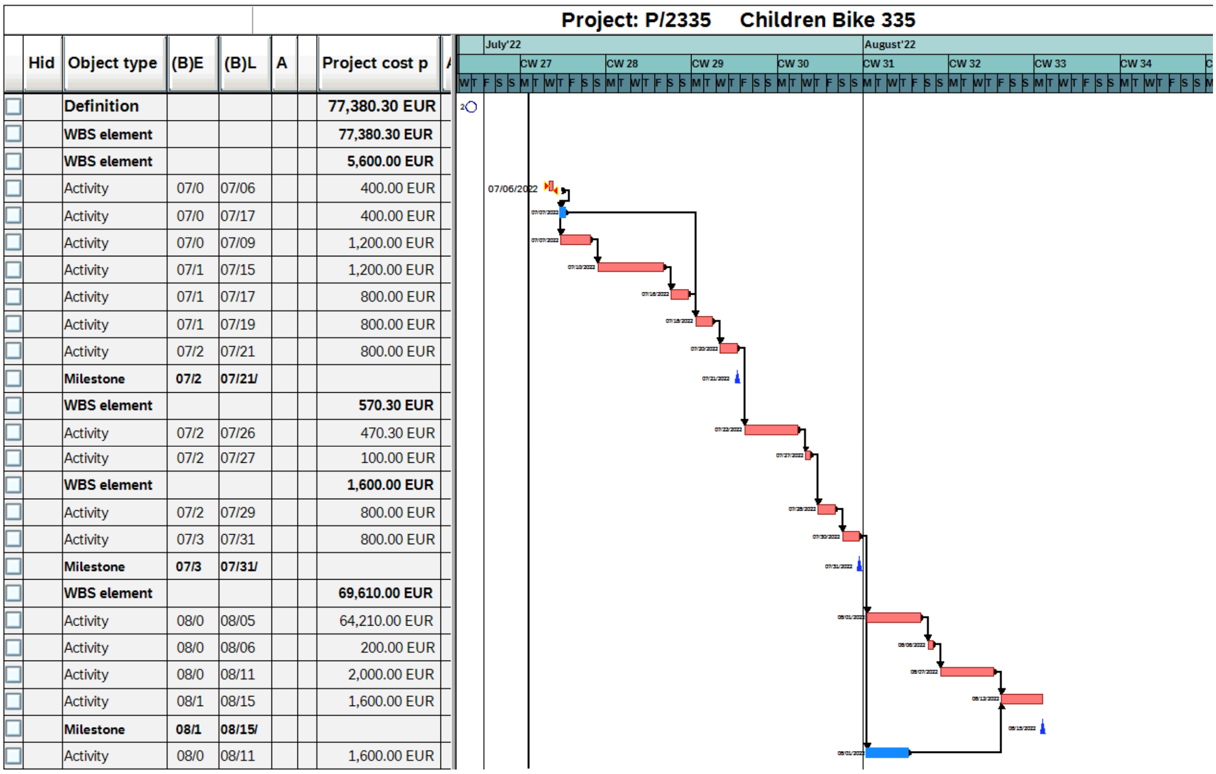
Figure 30: Milestones creation

3.6 Gant diagram

The Gant diagram was invented by Henry Gantt, a teacher and later draughtsman who became a mechanical and organisational engineer. It was while working alongside Taylor that he developed his famous diagram in 1910 to improve the organisation of workshops. It was later improved by other engineers and became a tool for managing projects with a large number of tasks, usable for all types of projects.

Symbolised by an orthonormal reference frame combining the list of activities on the ordinate with the units of time on the abscissa, it enables all the planned tasks of a project and their deadlines to be visualised simply. Also, for each activity there is a duration represented by a rectangle of varying length, depending on the amount of time allocated to it beforehand. Each of these tasks can be linked to resources such as human or material resources. We can assign connections to them, as we have defined in SAP, since a task, for example, can only start if the previous one is completed. We can also program start or end dates or define a progress status.

The project builder module can build the Gantt diagram of our project:



Hid	Object type	(B)E	(B)L	A	Project cost p
	Definition				77,380.30 EUR
	WBS element				77,380.30 EUR
	WBS element				5,600.00 EUR
	Activity	07/0	07/06		400.00 EUR
	Activity	07/0	07/17		400.00 EUR
	Activity	07/0	07/09		1,200.00 EUR
	Activity	07/1	07/15		1,200.00 EUR
	Activity	07/1	07/17		800.00 EUR
	Activity	07/1	07/19		800.00 EUR
	Activity	07/2	07/21		800.00 EUR
	Milestone	07/2	07/21/		
	WBS element				570.30 EUR
	Activity	07/2	07/26		470.30 EUR
	Activity	07/2	07/27		100.00 EUR
	WBS element				1,600.00 EUR
	Activity	07/2	07/29		800.00 EUR
	Activity	07/3	07/31		800.00 EUR
	Milestone	07/3	07/31/		
	WBS element				69,610.00 EUR
	Activity	08/0	08/05		64,210.00 EUR
	Activity	08/0	08/06		200.00 EUR
	Activity	08/0	08/11		2,000.00 EUR
	Activity	08/1	08/15		1,600.00 EUR
	Milestone	08/1	08/15/		
	Activity	08/0	08/11		1,600.00 EUR

Figure 31: Gantt Diagram of the project

We can clearly see in this diagram the start and end dates of each task and the End-Start relationships symbolised by black arrows. The critical route is represented by the tasks in red while the others are blue. Milestones are represented by blue triangles. The table on the right also shows the calculated costs of each activity and the overall project cost of 77,380.30 euros.

3.8 Project budget

Once the implementation of SAP is complete, it is time to obtain the project budget. SAP makes it possible to obtain it from the labour cost and expenses related to the bicycle components that we entered. The path to the budget is shown in the following figure.

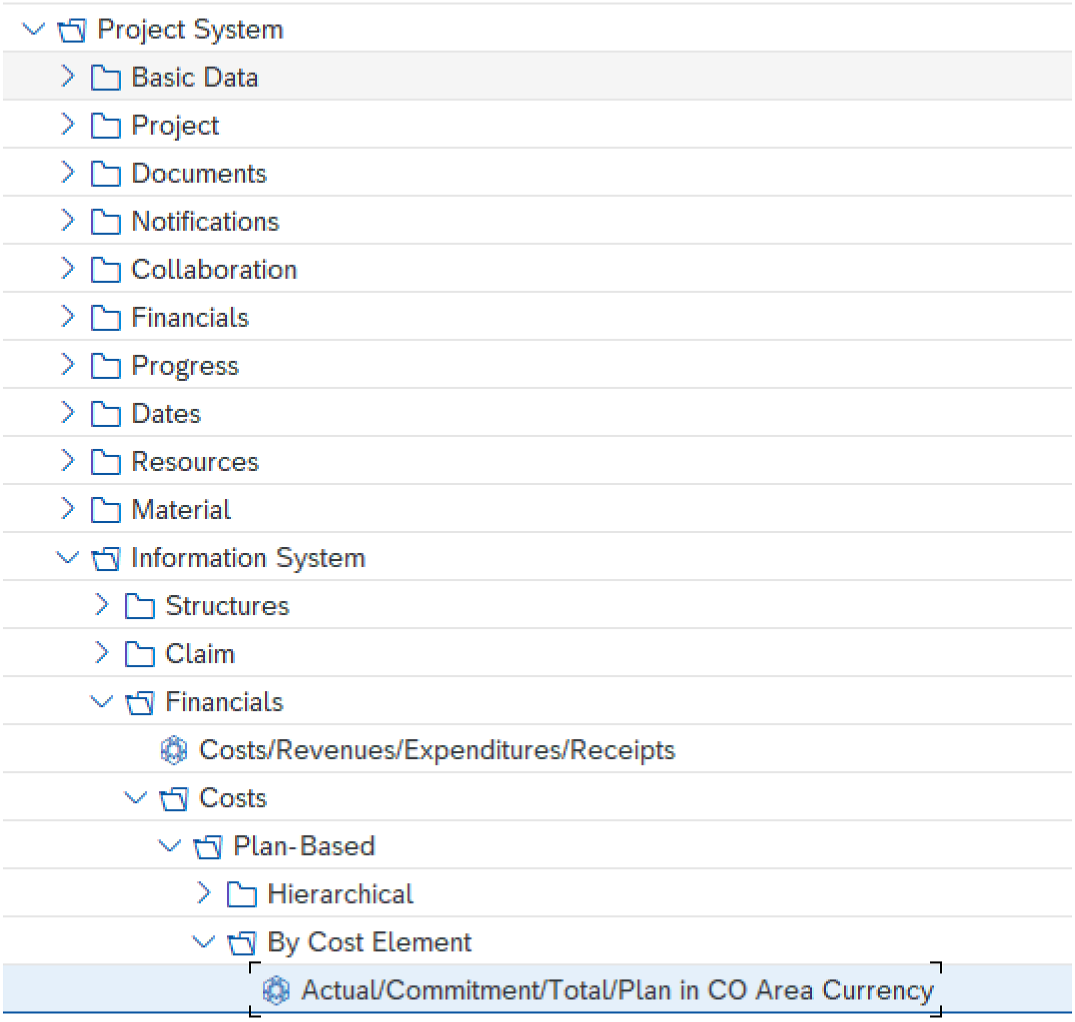


Figure 32: Path to the project budget

Although we did not enter labour costs into the software, we assigned work centres to each task. These predefined work centres each have an assigned labour cost, and the software simply multiplies these values by the number of hours we entered for each task to obtain the budget below.

Act/Com/Total/Plan	As of::07/04/2022		Page: 2 / 6	
			Column 1 / 4	
Object	PRJ P/2335		Children Bike 335	
Name of Person Resp.				
From Fiscal Year	2022	To Fiscal Year	2023	
From Period	1	To Period	12	

Cost Elements	Actual	Commitments	Total	Plan
720000 RM Consumpt Expense		64,380.30	64,380.30	64,380.30
800000 Labor				13,000.00
* All Cost Elements		64,380.30	64,380.30	77,380.30

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Figure 33: Report of the project budget

In this report we find again some of the values displayed in the table next to the Gantt chart. The detailed costs show that the purchase of the components represents 64,380.30 euros while the cost of the work is 13,000 euros. We remind that the components of the bike were "bought" as a private individual which explains the high price of the project. If the project had really been completed, it could have benefited from trade agreements, greatly reducing the costs of components.

With this module, it is possible to quickly visualise all the labour or material costs for each activity or WBS.

4 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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6 Index

6.1 Tables

6.2 Figures