D4.1 - Industrialized Scale System

Due date of deliverable: 30/11/2021

Responsible partner: METRICA6

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DOCUMENT DETAILS

Title	Industrialized Scale System

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Deliverable Type	Demo
Lead Partner	METRICA6
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Abstract	This document gathers all the information necessary to go through the industrialization process, understanding this as what is needed to reproduce and replicate the Smart Shelf. The focus is put in the materials acquisition, the resources of each company involved in the project to cover the tasks, costs associated, suppliers, assembly tasks, calculus of the best amount to produce at the same time, improvements detected, etc. As an outcome from this document, we count with the documentation generated through the months used to set ready the Scale System (D4.1). In the upcoming months of the project, we see how these technologies are integrated in the whole MIMEX.
Keywords	Industrialization process, scale system, smart shelf, rack

Dissemination level:		
PU	Public	
RE	Restricted to a group specified by the consortium (including Commission Services)	
CO	Confidential, only for members of the consortium (including Commission Services)	x

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CHANGE HISTORY

Version	Date	Changed by	Changes made
v_1	03/05/2021	Mario Conci (SPXL)	Created the draft document.
v_2	14/06/2021	Álvaro González (METRICA6)	First content added to define structure.
v_3	15/09/2021	Álvaro González (METRICA6)	Information added.
v_4	07/10/2021	Álvaro González (METRICA6)	Information added.
v_5	18/11/2021	José Manuel Díaz (METRICA6)	Review and corrections.
v_6	22/11/2021	Álvaro González (METRICA6)	Format corrections
v_7	24/11/2021	Mario Conci (SPXL)	Final review and Quality check

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EXPLANATION OF ACRONYMS AND ABBREVIATIONS

Acronym	Full name
BOM	Bill of Materials
PCB	Printed Circuit Board

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1. OVERVIEW OF THE DELIVERABLE

1.1. Scope

The goal of this document is to compile the information necessary to reproduce and replicate the Scale System (understanding this as the whole rack with 10 independent shelving systems), starting with the list of elements necessary for the manufacture, going through the assembly process and finishing with a feasibly reproducible technology. Through the document, the points listed represent the steps worked on to perform the process of industrialization and, inside each one, it is explained the actions performed to go back and forth between them until the successful end. For instance, regarding the materials acquisition, there is a need to compare between different providers which one can supply the Consortium with the required materials, but considering scaled costs, shipping times, or quality insurance to select the most suitable option for the project. Depending on the information received by the suppliers, it is also possible to know the most efficient amount to produce and take advantage on the offers of the suppliers but without compromising the real production needed (accordance with the production plan). It is of relevant need to perform a good production plan, because of the dependency of these actions to obtain a result as efficient as possible, even the assembly process can vary due to the repetitiveness of the tasks. In this point of the development of a technology, it is normal to perform tests with initial materials but end up with different materials and/or suppliers. Also, if new modifications or features are being considered, the points of this documents will be reviewed. As a final commentary for this point remark that every product or project is particular on its own and must be treated as it is. A previous document "Industrial Capabilities of the Consortium" was elaborated to anticipate the work needed for this document and further on attached as ***Appendix I***, it can be consulted too and can be found useful to understand the resources which backed this project up.

This document has been created as a deliverable of the project for the **Task 4.1** inside the **Work Package 4**. It is consistently the main document of the Scale System Industrialization and it gets support from the documents attached as:

- **Appendix I: Industrial Capabilities of the Consortium.**
- **Appendix II: Scale System BOM.**
- **Showcase videos (Links attached in the body of the document).**

We took in consideration the different pros and cons of each document format to finally get the most suitable way to gather, join, expose, explain and present the information regarding the whole industrialization process. Periodically, the information must be reviewed to achieve an accordance.

1.2. Audience

This document provides a detailed description of the Scale system. For this reason, its content should be considered as confidential and accessible to MIMEX consortium and EC only. Differently, the Demo can be shown to a wider audience.

1.3. Summary

This document gathers all the information necessary to go through the industrialization process, understanding this as what is needed to reproduce and replicate the Smart Shelf. The focus is put in the materials acquisition, the resources of each company involved in the project to cover the tasks, costs

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associated, suppliers, assembly tasks, calculus of the best amount to produce at the same time, improvements detected, etc. As an outcome from this document, we count with the documentation generated through the months used to set ready the Scale System (D4.1). It should be pointed out the information generated in other tasks of the project which threw some light too and helped at the time to finish this task. For example, with the help of work performed in T5.1, the developments could be tested in a more relevant environment and giving feedback about possible improvements. Additionally, the task 4.2 of the project was indeed intended to develop possible features for the rack, among other technologies to implement in the project. In the upcoming months of the project, we see how these technologies are integrated in the whole MIMEX. It is also useful to study further improvements related to mass production because of the direct impact on the costs, it can be through better suppliers, the preventive and scaled acquisition of the materials, the improvements made on the production process, making this document a good source to consult to start searching for alternatives.

1.4. Structure

In chapter 2, *Fields of Study to industrialize the Scale System*, we present all that conforms the industrial aspects of the Scale System and how deepen in and studying them can result directly on the cost impact of reproducing the technology. The tasks to perform were defined in previous points of the project, so the consortium had to search among its resources who can cover or how was possible to take care of the work to do. Sharing responsibilities between the members is a crucial point to organize and move forward in the same direction and at the same time. To help achieving this, the first document was elaborated to expose the intangible resources of each member, the expertise work areas, the teams involved in the project, common third parties consulted by the members when in need of external work, detection of needs for a specific task to be covered, etc. A good achievement for this point would be to understand how far can the Consortium go and how much work it can absorb to keep as much as possible inside the partners. It will be a nimbler environment to work if the conversations and instructions are held between the partners, avoiding also risks of information or strategic leaks to external agents.

Secondly, we gather all the physical elements present in the rack, conforming what is called a Bill of Materials (BOM), essential document in industrial products due to the support that it provides at the time to know what is needed to build it up. This document goes with every version of the product that represents, and it is compulsory to keep it updated at its most due to the importance that falls on it. Further information in point 2.2 (BOM) and **Appendix II**.

For the correct manipulation of the BOM, it has also been studied where and whom to contact to acquire the elements. This helps at the time to trace the elements and save time in the search of suppliers, contacting them again, or directly skip it to look for alternatives.

In the following point of the document, after finishing the providers matter, we focus more in detail in the additions to the rack. These additions are listed and explained in point *Procurement of Materials for the prototype* (2.3) supported by images to help the reader understand the purpose of each one. The functioning or purpose of these elements are far more explained in other Work Packages (WP2 & WP3), here we show a brief explanation just to give context over the general view of the rack.

Moving forward in the document, we start the assembly/manufacturing process *Assembly of the prototype – Tasks List* (2.4), putting all the elements together and studying the best way to do it. It requires a minimum of technical skills, because of the mechanical parts and a few electronic components, but without a major complexity.

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Finally, to set ready the rack, there is a specific point *Testing and Feedback* (2.5) where we deepen into the tests performed to complete a fine tuning of the equipment. It is showed the correct distribution of the items added to the rack, the correct fitting while complying with the specifications. It is reported a proper functioning of the rack, ensuring the correct products detection and the correct communication of the rack with local MQTT broker of the MIMEX environment.

To close this document, there is a last point named *Optimization and Improvements* where we point out the upcoming actions on the Scale System. This point comprehends aspects regarding the current configuration of the rack as possible ways to solve minor issues and future features that continues along with the development of the project. It is mentioned upcoming implementations or improvements as possible ways to improve the shelf.

All these points explain the process and the work performed, step by step, to achieve a successful replication of the Scale System to comply with the requirements that must comply with.

2. Fields of study to industrialize the Scale System

2.1. Industrial Capabilities of the Consortium

In order to take advantage of the synergy created by the members of the Consortium, we gather and compile the information regarding all means that could be used to work on the project, as long as the work is kept inside the members the easier it will be to perform under the correct course of the project planification.

Starting with an introspective point of view and the large path behind every partner, we see that the project is perfectly achievable. Joining all the know-how and intangibles, the Consortium is able to perform any actions related to strategic decisions, engineering tasks, market deployment, exploitation and commercialization of the project, among others. Only a few tasks remain external to the involved partners, being easily addressed and without any other compromising risks.

Also, due to the number of factors to consider, study and, of course, subjected to make a decision upon it, the involved partners are in a continuous learning process, inherent to the profile of the professionals involved in the project.

This point is far more explained in **Appendix I** if we need to look inside the Consortium for a partner to cover a specific task or require information. Refer to the mentioned document for more information about the capabilities of the partners.

2.2. BOM

In this point we collect every component or material that conforms the weighing system and the exact amount used. Along with it, the scaled costs of each item listed in the document with the respective provider.

The BOM itself is redacted in a spreadsheet which goes attached with the rest of the documents, taking advantage of the comfortability offered by the format so it could be easily updated every time a new change applied to the physical parts of the Smart Rack.

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The BOM is useful not only for the correct understanding of the structure of the Rack but also to work in improvements that may be applied to the acquisition of the items, being these related to the logistics, shipping times, reliability put on the supplier, etc.

This information improved the feasibility of the project. Due to the reusability of the information, it can be used in following tasks related to the costs optimization and improvement plans without compromising the proper functioning of the MIMEX environment.

Set	Sub-sys	Element	Quantity	Unitary Cost	Total Cost	Estimated supply time
Scale System	**Mechanical**	Camera Housing	1	25 €	25 €	1 week
		Rack + Products Lighting + LC	1	1.700 €	1.700 €	2 weeks
	Electronics	Camera	1	35.82 €	35.82 €	3 weeks
		Digital Weight Reader PCB	10	30 €	300 €	2 weeks
		Switch	1	498.60 €	498.60 €	1 week
		Ethernet Wire	10	4.98 €	49.8 €	1 week
					Total Cost	**2809.22 €**

Table 1 – Itemised cost of a single rack

In the previous table showed, is possible to see a brief result of the BOM and the cost related to the acquisition of the material to assemble one rack. As a small remark, it has been separated between the electronic components and the mechanical ones. To deepen in the data processed, especially the *Rack + Products Lighting + LC* and *Digital Weight Reader PCB* go to the **appendix II**, where the reader can consult several sheets explaining the aspects of the replication of the system. The times estimated are under the condition of stock availability, the global circumstances in terms of supplying affects the correct course of the production and manufacturing plans; this project, as many others, are under the circumstances of the global market, and suppliers have warned about stockage issues to

For instance, we can see an extract of the elements of each independent weighing system, and how this level of manufacturing is present ten times in the rack.

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1	VS036G0201	SHELF KIT 50x30 MIMEX	10
2	VS03601001	BOTTOM FRAME 50X30 MMX	1
2	VS03601701	TOP FRAME 50X30 MMX	1
2	VS03600101	COVER PLAN PR30 P50 7/10 MMX	1
2	VS03603501	WIRE FRONT FOR SHELF P50 H6	1
2	VS03603601	WIRE DIVIDER PR30 H6	2
2	VS036B00ZZ	LOAD CELL DINI ARGEO	1
2	00510211ZZ	WIRE HOLDER WHITE NYLON MWSEB-3-01A2-RT RICHCO	4
2	0043170012	WASHER D 6 UNI6592	4
2	0040566812	SCREW TCE M 6 X 30 UNI5931	4
2	2K60501100	PRICE HOLDER H5 L7 MM70	1

Figure 2 – Extract of the BOM

For example: The provider of each element and their unitary cost along with the scaled costs. There is also a specific sheet explaining the cost analysis, taking in consideration the scaled costs for every element offered by each provider. We can see next how the scalability progresses according to the providers' offers in the next summarized table:

Element	Unitary cost	Units needed		Scaled cost by units					
					50	100	200	500	1000
Camera	€ 35,82	1			€ 32,84	€ 24,37	€ 24,37	€ 20,91	€ 19,19
Shipping costs per order	€ 91,61				€ 91,61	€ 164,20	€ 276,55	€ 371,61	€ 764,82
				10	50				
Camera Housing	€ 25,00	1		€ 25,00	€ 25,00				
				10	50	100			
Rack + Products lighting + Load Cells	€ 1.700,00	1		1.700 €	1.500 €	1.400 €			
				10		100		500	
Ad-Hoc Digital weight reader	€ 50,00	10				43 €		40 €	
						100	200		
Switch	€ 498,60	1				465 €	450 €		
						100	200		
Ethernet wire	€ 4,98	10				4,63	4,45		
Total cost for a Rack		**€ 2.900,83**	**Costs according to the bundles**	-	**€ 2.697,85**	**€ 2.545,91**	**€ 2.529,83**	**€ 2.486,48**	**€ 2.484,87**

Figure 2 – Scaled analysis

We can observe in this table, with the actual offers of the providers, differences in the costs associated to the acquisition of the elements. Of course, the total cost decreases for larger purchases of materials, but is counter-productive to buy unequilibrated amount of materials and should be avoided. Looking at our case, there is a relevant gap when purchasing materials to assemble 50 Racks, saving 7% of the costs compared to the purchase for 10 racks. This cost improvement increases up to 13% when the materials are purchased for 100 racks. As expected, the unitary costs decrease, but the saving in the unitary cost is less relevant.

To give further information about the acquisition of the materials, following next, a table with the providers of the current elements of the shelf is added in Table 2.2.2.

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No.	Provider/manufacturer	Country	Web	Tel	Contact	Notes
1	DINI ARGEO/DINI ARGEO	Italy	http://www.diniargeo.es/	+39 0536 843418		Via della Fisica n. 20, 41042 Spezzano di Fiorano, Modena, Italia
2	LAUMAS	Italy	https://www.laumas.com/en/	+39 0521 683124	laumas@laumas.it	Via I Maggio, 6 - 43022 - Montechiarugolo (PR) - Italia
3	ELP	China	http://www.webcamerausb.com/	0086-755-83046295	sales@elpcctv.com	1311-1313,Building Tianliao, Tangchang Road, Tanglang Community, Taoyuan Street, Nanshan District, Shenzhen, China
4	IRS	Italy	https://www.ceflaretail.com/it/		Web form	Via Selice prov.le 23/a - 40026 Imola (BO) - Italy
5	B&B Lamiere	Italy	https://www.google.it/maps/place/B.E.B.+Lamiere+srl/@44.4483638,11.7926571,15z/data=!4m2!3m1!1s0x0:0x9c870a76760224ac?sa=X&ved=2ahUKEwjvmMf-7KjxAhWchv0HHU23BvEQ_BIwCnoECC0QBQ	+39 0545 84054		Via Trebeghino, 63, 48024 Massa Lombarda RA
6	Electro System S.r.l.	Italy	http://www.electrosystem.com/	+39 0542 640 798	electrosystem@electr	Via P. Nenni - Cap. 40026 - Imola
7	MOUSER	Spain	https://www.mouser.es/	936 45 52 63	espana@mouser.com	Parque de Negocios MAS BLAU I, Edificio Muntadas, Esc. B, C/ Solsones nº 2, Planta 2 Local C1 y C3, 08820 El Prat de Llobregat, Barcelona, Spain
8	Aisens	Spain	https://aisenstech.com/	(+34) 914 210 466	info@aisenstech.com	Calle Laguna del Marquesado 39-41, Nave 1. (P.I. La Resina)
9	FastCabling	Poland	https://www.fastcabling.com/	0086-20-82442660	sales@golbong.com	

Figure 3 – Material providers

As a conclusion for this part, it is observed that most of the providers are from inside the European Union, with exceptional cases, for example with the acquisition of the camera. This is an example of the existence of suitable providers for each element, on balance, there is no specific countries or markets excluded from the selection, it is just a matter of pros and cons evaluated for the corresponding acquisition. Sometimes, it will be cheaper buying materials from China, but at the cost of incrementing the shipping times, for example.

2.3. Procurement of materials for the prototype

In order to obtain a functional prototype capable to comply with the requirements of the project, the consortium added different elements to integrate new functionalities in terms of object detection (through the weighing system or the camera in the roof) and communications.

In this point, we started with the rack that was currently being used before starting the project: a vertical shelf of 2402x1030x776 cms (447 cms at the base) with illumination under every independent shelving system and the roof to provide the goods with a proper visibility.

Followed next, it is summarized the elements one by one which represent these new features.

Object Detection Camera: Located at the roof of the shelf, it is used for the object detection system thanks to the algorithm developed. Along with the Load Cells, they represent the object detection system. As seen in Figure 2.3.1 the Camera Model is: ELP USB2.0 Webcam 2Mpixels HD CMOS OV2710 VGA 120fps, 720P 60fps, 1080P 30fps. 2.9 mm lens with Plug&Play function. Connected with the MIMEX CPU.

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Figure 4 – ELP USB Camera

3D printed camera case: To hold the camera intended to track all the products in the rack (located at the top part of the shelf), a 3D printed case made of resin was developed to fit with the dimensions of the hole in the roof of the structure. Secured by 2 screws and helped with a methacrylate plate to make it even more safe without blocking the vision field of the camera. After studying the dimensions of the case, fixing points, join elements, thickness and perimeter of the methacrylate plate, etc, the final design was implemented. In figure 2.3.2, the reader can observe a representation.

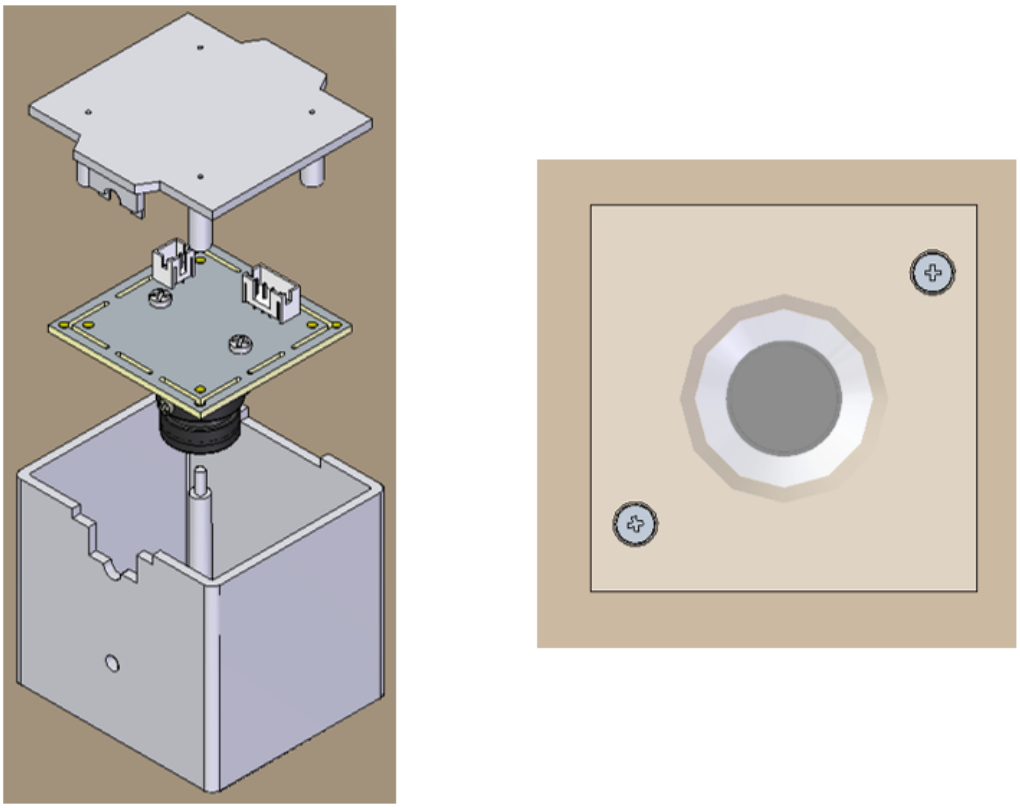

Figure 5 – Exploded perspective of the camera case and methacrylate protection plate

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Digital Reader: Electronic board designed specifically to replace commercial weight readers and optimize the cost of assemble every single rack. Each one of them is connected to the load cell below the independent shelving system, making a total of 10 digital reader.

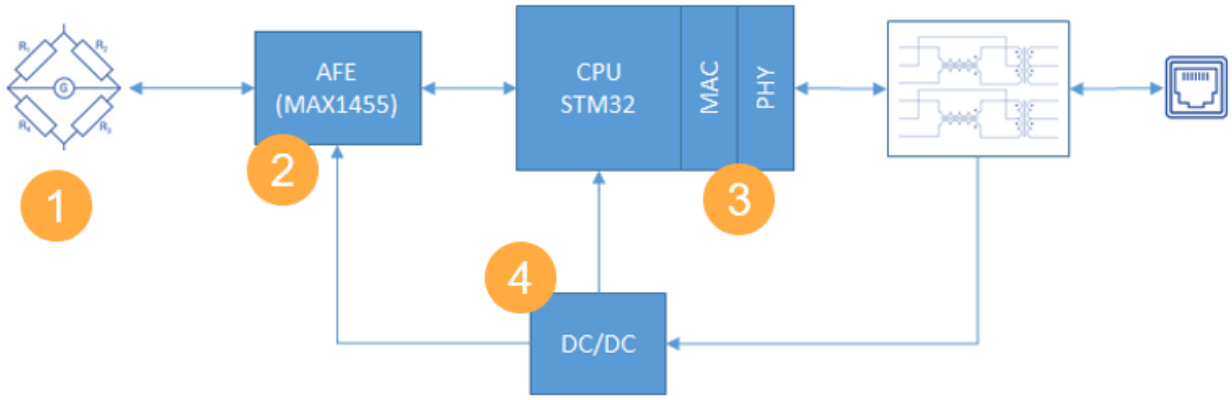

Figure 6 – Digital Reader Diagram

1. **Sensor (Load Cell).** Load cells for off center loads, suitable for example to build CE-M approved scales with a single load cell. It is located under each independent shelving system of the rack.

Figure 7 – SPO 40 Load Cell and Location

2. **AFE (Analog Front End).** Manages analog signals from Wheatstone bridge.
3. **CPU (Based on STM32 ARM core).** Convert analog signal from AFE to digital with 12-bit embedded ADC. Also, the CPU has implemented an Ethernet interface to communicate with system.
4. **Supply (DC/DC converter).** Based on PoE (Power over Ethernet) technology, the proposed device will supply Ethernet connection. This element adapts the level of incoming voltage to electronics component requirements, being this 5V.

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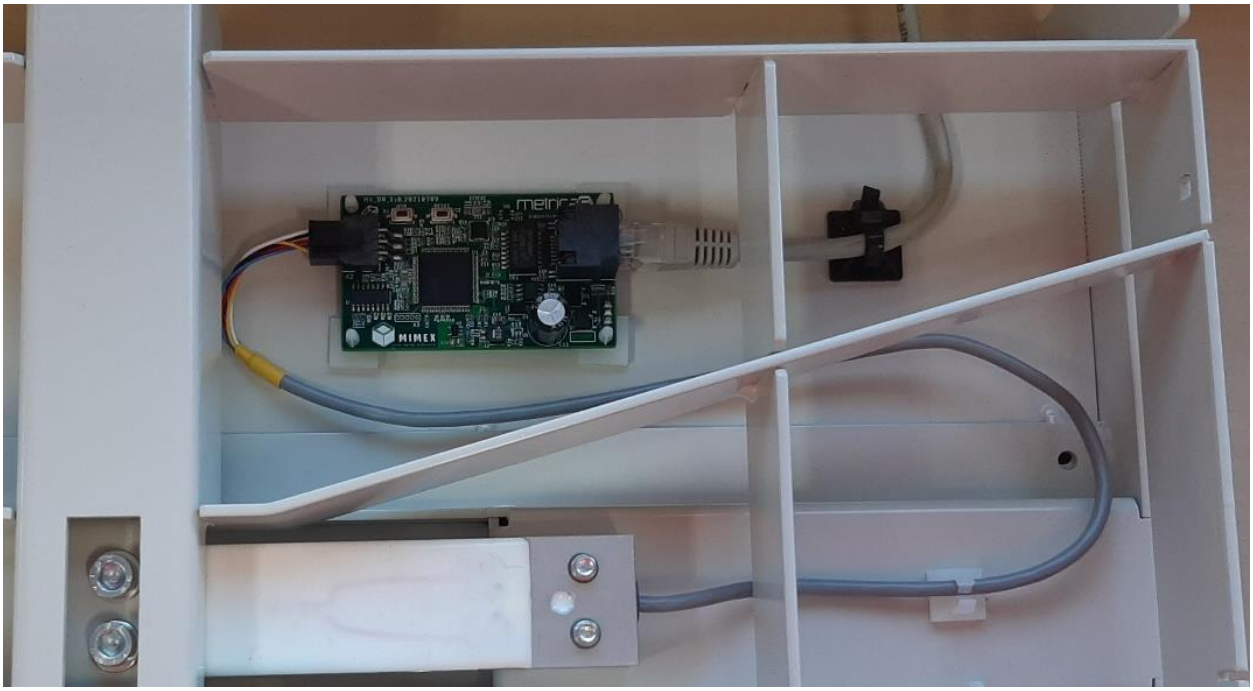

Figure 8 – Digital Reader inside the weighing system

Switch: Device added to correctly distribute the power supply ethernet to the electronic devices of the rack. The chosen model allows to supply the weight readers, but also the Light Controller to integrate in upcoming stages of the project.

Figure 9 – Switch selected for the PoE supply

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2.4. Assembly of the prototype – Tasks List

With the help of the initial instructions provided by CEFLA, the rack was set up to start with the improvements agreed to perform, incorporating the previous elements listed. The final Smart Shelf Manual will be elaborated in Task 4.4 as the deliverable of the task, considering its assembly, configuration and maintenance. In figure 2.4.1, we can see the general idea of how the elements of the main structure have to be assembled, also with the perspective to recognize them one by one and as a whole.

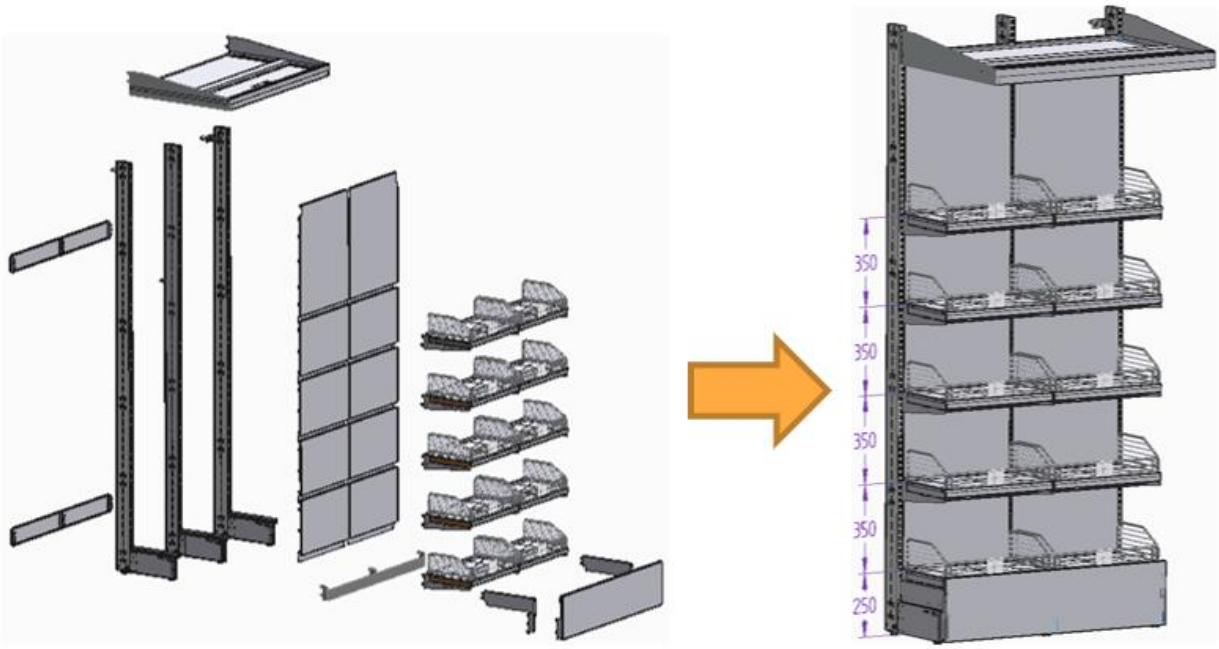

Figure 10 – Before and after the assembly of the main structure.

Trying to keep untouched the starting point of the assembly process, a few steps were added just to explain the addition of the elements without compromising the steps which already were conforming the process. This point represents a brief showcase of the actions to perform for the assembly, leaving as a result what is showed in Figure 11.

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Figure 11 – Before and after the assembly of the main structure.

Making an emphasize in this point, for the correct calculus of the time needed to assembly a rack, it was assembled and dismantled several times and under different circumstances. As an example, different technicians dedicated a few attempts to its assembly, with the help of the instructions and the experience gained through repetitive processes, it was possible to study the learning curve and the time improvements in the technician's ability to successfully assemble the rack. After this brief calculus, it was possible to obtain a high accurate time to specify how much time is needed to assemble one rack, and with the cost associated to the labor, specify the money spent by the organization just to assemble one rack. Another advantage of this repetitive process, is the possibility to observe possible improvements at the time to assemble the racks, changing the steps to take or the order in which they are taken.

As a conclusion for the assembly, we outline the necessity of 2 technicians to help each other on the assembly, it can be difficult and inadvisable to count only with one technician due to dangerous healthy risks (heavy loads, work up in a ladder while holding heavy loads, etc). According to the most experienced partner with the racks, it takes three to four hours to achieve the assembly of the basic structure of the rack, so adding to the total amount the time needed to attach the mentioned elements in the previous point (2.3), it takes close to four hours to fully assembly a MIMEX Smart Shelf.

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Considering a group of ten racks as the amount needed to obtain a MIMEX environment, we can conclude that it takes up to forty hours to assembly all of them. To be more specific about quantifying efforts, it has been calculated in terms of labor cost, how much is the cost of preparing the racks in a MIMEX shop. Of course, is a calculus that depends on the salaries stablished in the country, but in the case studied we set a labor cost of 35€/h. The calculus is set near to the next value:

$$4\frac{hours}{rack}\ X\ 35\ \frac{€}{hours}\ X\ 10\ racks = 1400\ €$$

Anyhow, this point will be far more detailed in Task 6.2 *Costs Analysis and manufacturing plan*, where the efforts will be put in more costs improvements.

With these considerations and clarifications made, it is represented the assembly process, remarking the fact that the final manual will be elaborated in Task 4.4, and, as a suggestion, counting with personnel who already assembled at least one of them, will improve the assembly times and resolve minor spontaneous doubts, as in every other industrial environment. Also, de learning curve will improve times, as long as the personnel remains the same.

Aligned with the study performed related to the materials acquisition, we can extract the idea that working with a MIMEX unit (understanding this as a micromarket by itself), it is a good way to organize the purchases.

To support this point, is also useful to consult the video recorded as a showcase for the installation of the additions named as *Showcase*.

2.5. Testing and Feedback

Once implemented all the mentioned additions, and making sure there is no missing parts on the structure, we will start with the check process. Starting with the easiest element:

- Camera case and methacrylate plate: camera case and the methacrylate plate, it is quickly accepted after checking the dimensions between the holes in the rack's roof and the camera itself. It just needs to ensure the safety of the camera.

Figure 12 – Camera and camera case positioned.

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As seen in Figure 12, that is the result of the camera and its protection, keeping the camera safe and operative in the inside.

- Digital Reader: Possibly, the most difficult point to work on in this point is the Digital Reader. After assembly the first three PCBs, the signals response was checked to ensure the correct electronic design and the manufacturing process of the electronic board, along with the firmware. Overcome the difficulties faced with the acquirement of the components, it was possible to perform the initial tasks of the manufacturing: welding, firmware testing, components correction, performance occurring as expected, etc. Being this point a matter of going back and forth in the insertion and removal of some of the components, until the correct response of the board. In figure 13 we can see an example of the condition of the PCB to test the performance. At that point, we see the progress in the PCB, when an external power supply was used before ensuring the PoE aspect.

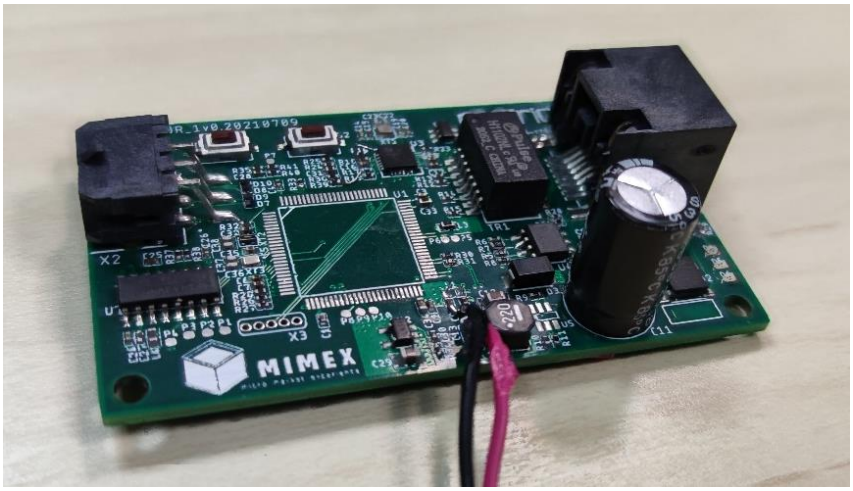

Figure 13 – PCB prepared to work with an external power supply.

At this point, we checked and confirm the functionality of the weight reader, showing the communication between the Load Cell and the protocol stablished to receive the reading. The next steps were focused on the PoE part, to fully complete the requirements agreed to achieve.

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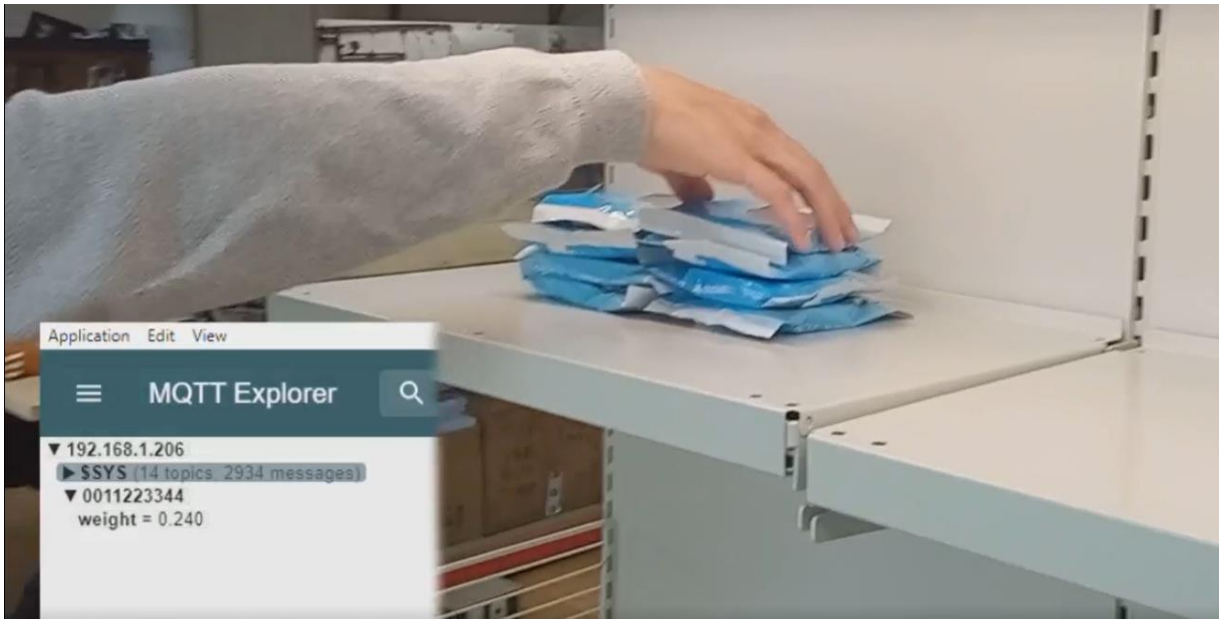

Figure 14 – Testing of the weigh measurement and its communication.

In figure 14, we can see one of the test conducted to verify the correct functioning of the reader. After checking the correct leveling of the surface where the products are placed, several samples were used, starting with a single unit and accumulating a few more. The system showed a proper correlation between the number of products placed and the weight detected, even placing different model of products (it is not intended in the project, just to check the performance). The total error obtained during the weigh test was comprehended between 1-3 % depending on the products weight (being higher when the product is lighter), but in any case, it is a totally acceptable error considering the requirements of the project. Also, in the image, we can see how the reader communicates properly through MQTT, ensuring the correct communication with the local MQTT broker.

The full test can be seen in: Métrica6 DR as in 10 2021

3. Optimization and improvements

To close this document, this last point puts on consideration future features to implement regarding the Scale System. The mentioned technologies were already developing during the course of the project in another task (T4.2), and they are intended to be implemented. The whole project has its own Testbed located in Trento (Italy) where all the technical aspects are under continuous tests, and its course is being tracked and documented in T5.1.

Between the technologies gathered and studied, we have to make a special mention for the next ones:

- **Lights controller:** This element was taken in consideration while working with the rack, thus it is easily attachable to the final result thanks also to the switch which goes with the rack to supply the digital weight readers. This makes possible to send visual messages thanks to the lights of the rack by just adding the option to manipulate each light individually. These messages are simple to

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understand, being this the main reason to work on an On/Off methodology when designing the controller.

- **Fridge Unit:** One of the potential functionality or service that a micro-market shop, as MIMEX, can successfully implement is related to the displaying of refrigerated products. Along the solution design and development path (T2.1-System requirements and technological scouting and T2.3-configurable environment), the consortium partners evaluated as a useful and exploitable feature the inclusion of a fridge unit in the MIMEX shop, that can give a benefit to this new kind of retail. Considering that the MIMEX solution will be also portable, for a mobile retail concept (container-like or movable shops), the fridge unit could represent a strong opportunity for the success of the whole solution, in terms of attraction for retailers and above all for potential users of cold beverages, fresh meal for fast lunch, that can appreciate very much the application of this format. A refrigerated unit was not foreseen within the project (in fact a development is planned for the inclusion of fresh products in the current FTI but not specifically products that needs a cold temperature storage). This refrigerated unit is still under the process of study in order to make it comply with the MIMEX requirements and overcome the difficulties inherent to the idea, but it is ongoing and it has its own roadmap to fully integrate it. In figure 3.1, we can see an example of the idea to implement in the MIMEX environment.

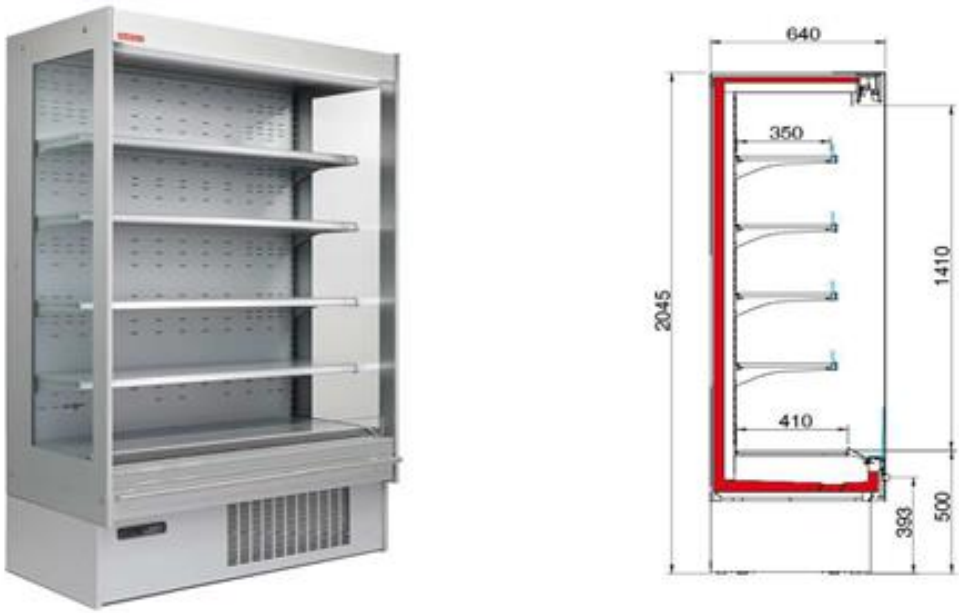

Figure 15 – Example of a model of a refrigerated unit to implement in MIMEX.

As mentioned in previous points, like in every industrial product, the production is under constant revision to review possible improvements or additions/removals. For instance, we can outline a possible modification in the frames of the independent weigh system to avoid the contact with the load cell wires due to errors detected in the signal reading, but that is just an example of actual conversations between the partners to

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improve the product. Another example would be the exact point where the camera is located, considering moving it backwards or forward to improve the object detection. As a final example, we can mention the slight inconvenient occurring when placing objects far from the center of the surface where they are placed, causing a torque that might influence the weight measured.

4. CONCLUSIONS AND RESULTS

This report, as the deliverable for Task 4.1 *Industrialization of the Scale System*, serves as the main support to industrialize the rack used in the MIMEX project. From a theoretical point of view, it collects all the industrialization steps to take every industrial process, all of these applied to the present project.

Most of the topics are directly in contact with possibilities of improvement. We put special attention on every factor which could possibly affect the correct course of the industrialization, being easily studied on future revisions to keep improving the model in terms of costs, times, functionalities, etc.

With the finalization of this task, we open the way for following tasks related with other industrialization topics, testing and improvements. The progress continues in Tasks 5.1, 4.4, 6.2.

For the attention of the reader, we expect the information to be helpful to understand the industrialization process to follow in order to reproduce this technology and to understand the topics studied to finally get to this point.

The information gathered here was supplied by each of the members of the consortium on their own analysis about capacities and scalability. In the case of Metrica6, their main industrial subcontractor, CAD Edificios Industriales, had a relevant input regarding the possibilities of industrialization (as in technical feasibility and cost-efficiency) and the supply of some of the materials used in prototypes and descriptions.

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APPENDIXES

Appendix I. Industrial Capabilities of the Consortium.

Appendix II. BOM and scalability analysis.

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Appendix I – Industrial Capabilities of the Consortium

1. Introduction

The goal of this appendix is to help the MIMEX consortium define its own industrial capabilities, which strategic partners may be useful for the industrialization and based on this information, know the future needs and how cover it. The information gathered here represents the first step made in T4.1.

This part of the document summarizes a wide variety of capabilities of each enterprise, concerning our own and strategic partners. Outcomes from this report are useful for other tasks (like Demonstrator of Scale System at M12, T4.4 Industrialization of smart shelf, Pilots 1-2 open the users at M18-22, and WP6. Business strategy and market expansion).

In Chapter 2, we discuss our own industrial capabilities (localization, logistic, main activities, team…) and most specially the task that each enterprise can carry out in the industrialization process of MIMEX. In Chapter 3, we present the potential partners that we worked successfully together, and they can collaborate in the industrialization. Finally, in Chapter 4, we search for potential needs in this process and look for the necessary option to cover this weakness.

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2. Industrial capabilities of consortium

2.1. Industrial capabilities (localization, logistic, main activities, involved team…).

2.1.1. Métrica6

Facilities, activities and logistic

The head office of Métrica6 is found in the Technological Park of Andalusia, PTA (Parque Tecnológico de Andalucía), in Málaga. The location counts with strategical advantages due to the geographical connections. We are located near the neuralgic point of the region, which means that we count with strong logistic advantages. We also have an international airport in Málaga and an internationally relevant port.

Our facilities count with a total of 116m2, including the office and the meeting room, and here is where the tasks related to product design engineering, mechanical calculus, electronic development, innovation consultory, marketing and administration are carried out.

In addition, the company counts with a workshop annexed to it with a total of 102m2 usable area where we take care of the tasks related to production, storage, assembly, product exposure and electronic development, all oriented to achieve the R&D production plans while keeping the characteristic flexibility that allow us to adapt to the market demand.

We count with several electronic stands not only in the workshop but also at the office so we can work on different tasks of the R&D plans. These stands count with variable low power sources, voltage measuring devices, signal generators, picoammeters, manual and digital multimeters, a welding stand fully equipped, examination and programming boards (Pick-It) and precision tools like pliers, magnifying glasses, precision weld, vaccum, clamps and additional workbenches, among other useful tools.

The electronic area of the of the workshop is more oriented to prototype testing and the making and assembly of a smaller amount of finished electronic boards for the final product. In this second part of the workshop, there is a simplified version of an electronic stand (basically without the measuring devices), where we also store the finished electronics used in the making of the products.

Aside of the electronic laboratory, the area of mechanic engineering and product design is located at the head office. This area counts with the proper infrastructure for the correct development of its researcher purpose, using mainly informatics systems and CAD software (Solid Edge ST10 license by Siemens). At the office, we count with smaller and more versatile tools like calibers, bubble levels, flexometers and scales, and shared devices like power supply.

The rest of the measuring tools are located at the workshop, generally used for checking the functioning of the systems built and their performance: quality check panels, flowmeter, pressure gauges, barometers and other pressure sensors, humidity sensors, thermocouple, thermometer, leak detectors, scales, flexometers, chronometer, etc.

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Involved Technician Team

Talking about the members of the team, Métrica6 currently has 17 members of technical profile involved in the MIMEX project: Electronic and mechanical engineers, developers of software, designer technician, production technicians, etc.

It is important to mention that we have a strong contact with educational institutions that help us upgrading the team if it is necessary, so we can keep adapting to the necessities of our projects.

2.1.2. Spindox

Spindox Labs is the R&D labs of Spindox dedicated to technological scouting and prototyping. Sindox Labs develops innovative solutions together with their customers, providing them with full implementation support. Spindox Labs participates and design national and European projects, developing research in partnership with university start-ups and spin-offs. The research developed by Spindox Labs as a system integrator ranges from computer vision to 3D modeling, from the Internet of Things to natural language processing, and from augmented reality to data science.

In the field of computer vision, Spindox Labs explores deep learning techniques—applying people tracking and object detection algorithms—to identify, track, and classify people and objects in real time within images and videos. In the field of 3D modelling, exploits the principles of photogrammetry to obtain multiple images of the same object or the same environment, enabling the automatic inspection or identification of anomalies. This approach also helps determine the valuable functions within large areas or sensitive infrastructures. Spindox Labs uses IoT devices for indoor and outdoor localization of objects and people and for real-time monitoring of their positioning to develop cutting-edge solutions in the field of logistics and security systems. Through research on natural language processing, Spindox Labs creates chatbots designed to perform complex tasks. Conversational agents, interconnected with virtual assistants and message platforms, provide support, assistance, and recommendations within specific domains of expertise. Spindox Labs uses data science to implement tools for monitoring, predictive maintenance, and identification of anomalies related to production processes and telecommunication networks with the ability to extract key indicators in real time for performance analysis and optimization.

As a system integration company Spindox does not own industrialization facilities but can count on a nurtured network of partners and clients that will contribute to the commercialization of MIMEX.

The team involved in MIMEX is composed of two Project managers with experience in management of R&D Projects. Two senior technical leads and senior developers with background in the abovementioned competences and research areas.

2.1.3. CEFLA

Facilities, activities and logistic

Cefla's headquarter is located in **Imola**, Emilia Romagna, in the heart of what is known as the Packaging Valley. This is an area with a high concentration of cutting-edge companies favoring trade and technological innovation.

Cefla has a worldwide presence and factories in Italy, Germany, Russia, China and the USA. **The group has more than 2,000 employees and 26 plants worldwide, including 14 production plants**.

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Founded in 1932 as a Cooperative Company specializing in electrical and thermo-hydraulic systems (Plants), over the years it has been able to evolve to become a solid identity, operating internationally in various businesses. One of Cefla's strengths is its multi-business structure, which allows it to be present in different market sectors which can find points of contact and collaboration in complex projects. The Business Units bring together skills and abilities to achieve the objectives in their respective contexts, united by a common project in which networks of relationships and talents integrate and mutually support each other.

Engineering: Business Unit that has been working for almost 90 years to design, build and manage technological systems in the industrial, construction and energy sector, improving the quality and comfort of the places where people live, work and spend their leisure time.

Finishing: Business Unit world-leading provider of surface finishing technologies, manufactures machines and coating equipment, industrial digital printers, and machines for decoration and lamination. All are designed as turnkey solutions for the embellishment of wood, glass, plastics, ceramics, fibre cement, composite materials and metal. Expertise acquired over the years and consolidated know-how in sectors such as the construction, furniture, packaging, aerospace and automotive industries at a global level have made this group a frontline player.

Medical equipment: Business Unit representing Europe's leading producer of dental equipment.

Technological evolution and an unmistakably customer-oriented approach are the key features of an ever-growing group which has gained its leading status as a multi-brand enterprise. As Europe's number one dental unit manufacturer, Cefla Medical Equipment implements synergies from the design phase right up to industrialization in order to ensure premium product quality standards are respected.

Strongly supported by joint investment in research and development, Cefla Medical Equipment, via its network of brands, is a global partner able to provide the best solutions in each business area: dental units, radiology, sterilization, accessories and dynamic instruments.

Lighting: The Lighting Business Unit it's composed by C-LED and Lucifero's brands, and is dedicated to the design and manufacture of LED-powered products, innovative services exploiting unique smart technologies for lighting, and lighting solutions for architecture and horticulture. The BU is a melting-pot of state-of-the-art ideas, techniques and products, which start from the end user's comfort and aim to create lasting value for customers and partners.

Within the Cefla Group there is also **Zenith RS**, a company based in Russia that operates in the sector of the production of furniture solutions for Retail. Cefla, through its subsidiary Zenith RS, is able to design and set up complete commercial environments, from the layout of the store, to the supply of shelving, checkout counters and specialist furniture.

Zenith RS factory is based in Golitsynskiy - Odintsovo (Moscow), it has an area of 30,000 square meters in which 160 employees work. The relationship between Moscow and the Italian headquarter is continuous and this allows for direct contacts also in the Russian market.

Involved Technician Team

The team following the MIMEX project involves 5 people with a specialized profile: design, project management, R&D, communication.

2.1.4. FBK

Facilities, activities and logistic

FBK is the top Research Institute in Italy, ranked at the 1st place for scientific excellence within 3 different subject areas and for the economic and social impact according to the latest quality of research ANVUR evaluation.

With its 3,500 square meters of laboratories and scientific infrastructures and a community of over 400 researchers, 140 doctoral students, 200 visiting fellows and thesis students, 700 affiliates and accredited students combined, Fondazione Bruno Kessler acts as a scientific and technological hub, its premises and platforms hosting a lively ecosystem of co-located ventures, spin-offs, projects and training opportunities.

The result of more than half a century of history, through 11 centers dedicated to technology and innovation and to the humanities and social sciences, FBK aims to achieve excellent results in the scientific and technological field with particular regard to interdisciplinary approaches and the application dimension.

This is due to the constant focus on collaborations and exchange activities with public administration and institutions, small, medium-sized and multinational companies, European and international institutions, which broaden the capacity for innovation and involve the local community and the local economy in the circulation of knowledge and technologies.

The two research units working in MIMEX are from two of the centers that previously were included in the ICT center. The ICT center was recently divided in 5 centers.

Involved Research Units

The two research units involved in the project are TEV (Technology of Vision), which is part of the Digital Industry center, and E3DA (Energy Efficient Embedded Digital Architectures), which is part of the Digital Society center. E3DA counts 2 senior researchers, 3 PhD students, 1 junior researcher with competences in digital electronics, embedded systems, sensors and wireless technologies. TEV counts with experience in computer vision technologies, augmented reality, etc.

2.1.5. Hepsiburada

As Hepsiburada of Turkey, we provide 50 million products in over 40 categories to our customers and more than 40 thousand merchants in marketplace. We strive to meet the needs of 200+ million monthly visitors with our team connecting the Silicon Valley mindset with Grand Bazaar culture and blending data and experience.

We lead the development of the online shopping industry with HEPSIBURADA marketplace model that brings together tens of thousands of SMEs, with the region's largest Intelligent Operation Centre, and with state-of-the-art R&D Centre where; more than 450 engineers are working to derive technological innovations in retail and e-commerce sectors. Hepsiburada is building a giant ecosystem that benefits all our stakeholders, together with our various companies and subsidiaries such as Hepsijet as one of the largest logistic and cargo networks; HEPSIJET; delivery company bringing an innovative perspective to the logistics industry with more than 2000 employees and more than 50 trucks and service in all over turkey. Hepsiburada has own 6 logistic centers, main one which is more than one hundend thousand-meter square with advanced technologies, for cargo shipment.

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Hepsipay, our digital payment services provider with highly encrprted paymetn system in europe.

Hepsiexpress offering grocery delivery directly to the customer door at their desired times; HepsiAd, our advertisement platform for brands; Hepsiglobal, providing the opportunity to become a global player through e-export and many more to Hepsiburada's stakeholders.

As a tech company, HEPSIBURADA focuses on the transformative and constructive power of technology and contribute to social development, entrepreneurship, and innovation with our CSR initiatives. Hepsiburada continues investments and strive to achieve our goal to become the largest tech company ecosystem across a wide range of geographic area and to serve 1 billion prospective customers.

2.2. Own task of industrialization.

2.2.1. Métrica6

Once the project is developed, validated and going through the production phase for its commercialization, Métrica6 can work on different tasks:

- Electronic Hardware: Métrica6 counts with experience in previous projects and all the electronic equipment in order to manufacture, insert the corresponding firmware necessary and test of small lots of prototype of electronic boards.
- Customization: Metrica6 counts also with the technician personnel, wide experience and equipment necessary to make customization of the hardware parts of MIMEX: print vinyls of shelves, modelling and manufacture of enclosures of electronic components with a resin 3d printer, design of packaging, etc.
- Mechanic assembly. Métrica6 has expertise and the facilities necessary for the mechanic assembly of tech products, not only its own products but also from other organizations. Moreover, Métrica6 also counts with a variety of local providers of mechanical assembly who could support occasionally and demand peaks.

2.2.2. Spindox

Spindox Labs can contribute to the industrialization bringing the following competences: system integration on "enterprise-grade" platforms and solutions, web/mobile development with hybrid and native frameworks, on-premise and cloud infrastructure management, software quality assurance, OSS and telecommunication engineering services, IT operations and DevOps, cyber security. Some of Spindox's ICT partners are: Amazon web services, Microsoft, Oracle, and Sonarqube.

An asset to be considered is UBLIQUE, a suite of solutions for decision intelligence. Ublique is the decision intelligence platform supporting the decision-making process through the value chain. It's a suite of vertical solutions that integrate analysis procedures based on deterministic or stochastic statistical methods and machine learning. The techniques are oriented at mathematical optimization, predictive analysis and dynamic simulation.

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2.2.3. CEFLA

Among the expertise present in Cefla we highlight:

- Showroom and Research Center dedicated to the development of coating technologies on different materials (Finishing)
- Design of industrial plants dedicated to surface finishing (Finishing)
- Design and construction of furnishings dedicated to a wide range of retailers (Lighting, zenith RS)
- Center for research and production of LED and UV lighting products for crops and sanitization (C-Led)
- Center for the development and production of lighting elements for indoor and outdoor environments (Lucifero's)
- Research and development of medical equipment for dentists (Medical Equipment)
- Development and maintenance of industrial plants (Engineering)
- Development of energy cogeneration systems for companies and urban centers (Engineering)
- Services for patent management, communication, administration, management control and business development centralized in the Corporate based in Imola.

2.2.4. FBK

Being a research center, the role of FBK is mainly in the pre-industrialization phase, where the research knowledge is collected, validated and prototyped. Technology transfer towards industrial partners is a frequent practice and the interaction with SME, companies and start-ups influences and guides the development of tangible research results.

2.2.5. Hepsiburada

Hepsiburada is mainly involved in the activities in deployment and application of the MIMEX's concept. Hepsiburada will not actively be part of the research and development, however the final concept of the MIMEX store would be transformed to the business affiliates and transformed to the marker by conducting business development and innovation plan.

Hepsiburada's fundamental mission in the project is concept advancement and idea transformation from project to business and execute financially viable, sustainable MIMEX stores and franchises.

3. Known potential partners

3.1.1. Métrica6

Metrica6 has some the external strategic agents that pay services to it frequently because this can help at the time of considering other feasible ways of taking care of determined tasks. The proximity of this agents makes affordable the externalization of different industrialization tasks of MIMEX like:

- **Assembly electronic hardware:** Métrica6 counts with a variety of local important providers of electronic assembly who have collaborated with in previous projects achieving excellent results:
    - Fujitsu ten España S.A. This partner counts with a factory consisting in two plants and 400 employees in order to absorb big production plans.

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- MADES. Málaga Aerospace, Defense & Electronics Systems. They count with years of experience in manufacture and assembly tasks related to electronic systems. One of the biggest facilities in the PTA.
- Tesel. Servicios electrónicos avanzados S.L. Métrica6 has worked closely together with TESEL in numerous projects, always providing all the necessary services when needed.

- **Mechanic assembly**. As we said before, Métrica6 also counts with a variety of local providers of mechanical assembly who have collaborated with in previous projects with excellent results:
  - Proditema Humantech. This partner counts with a modest facility where they perform the activity, though they have always fulfilled our expectations.
  - Prosain. Mecanizados de precisión y fabricación de máquinas. They count with years of experience in machining tasks with different methods. They perform their activities in a large facility in the PTA.

    If necessary, both have the equipment and facilities sufficient to undertake the mechanical assembly of MIMEX products.
- **Packaging.** Métrica6 collaborate with a recognized local supplier of packaging for a variety of projects:
  - Cartonajes Malagueños SL. This provider counts with a big industrial facility where they work with large production plans and with efficient periods of delivery (10 days aprox.)

Moreover, we are always looking for other companies that could help improving our projects.

3.1.2. Spindox

Spindox Labs research supports big brands through challenges that arise during the digital transformation. Spindox Labs' technological capabilities involve multiple fields of applications, placing itself at the service of the business objectives of companies and groups operating in the various areas of the digital economy. Our main clients are brands in the following sectors: retail (Coop, Conad, Autogrill), automotive (Stellantis, Maserati), telco (Fastweb, Telecom, Vodafone), logistics (Ceva, System Logistic), CPG (Ferrero, Lavazza), Fashion (Moncler, Benetton, Missoni).

3.1.3. Cefla

Cefla, in a de-verticalization view of the production chain and consequent increasing of the goods and services purchasing on its business model, has a wide range of suppliers which, thanks to the differentiation of the Business Units, allows us to approach the development of products using the most advanced technologies available on the market. Therefore, the improvement of supply performance is increasingly a key lever for the overall optimization of business results.

The purchasing department has seen increasing importance to control some pillars of corporate competitiveness, such as: the quality of the product, its price / cost and the level of the service provided. In one word, the strategic use of suppliers is now an essential prerequisite for successfully managing of the entire supply chain.

Cefla has worked successfully together with partner that can collaborate in the industrialization. Some of them are:

- **Mechanic Cefla's partner**: Cefla counts on a variety of local important providers:
  - IRS – Imola Retail Solution: this partner counts on a wide experience in industrialized shopfitting solutions for food and non-food market.
  - OMAS: is an engineering company focused on processing sheet metal and pipes. Counts on different technologies as laser cutting, robotized bending and welding.
  - B&B Lamiere: specialized in sheet metal prototype, focused on quick response and customized products.
  - SCM: is focused on sheet metal and pipes components
  - Becca Paolo Industrie: this partner is leader in the production of high precision components and counts on a wide selection of CNC machines.
  - CMD: specialized in laser-cutting, welding and medium-heavy carpentry.
- **Electrical-Electronic Cefla's partner**: Cefla counts on a variety of local important providers:
  - Electrosystem: is leader in the market of the production of hardware and software for the industry, produces and assembles electronic boards and industrial wiring.
  - Elettrotecnica Imolese: partner of several technical institutes and universities, is specialized in hardware and software engineering, industry 4.0 & IoT, switchboard construction, electrical system, service & remote service.
  - Schneider Electric: partner for commercial electrical components, provides energy and automation digital solutions.
  - DINI ARGEO: for this project we have begun a partnership with this company, specializing in the production of weighing systems. With their mechanical, electronic and I.T. knowledge, Dini Argeo offers solutions in the area of mechatronics, ranging from mobile weighing systems to scales for commercial and industrial use. This includes a wide range of components, electronic solutions and software, for industrial automation and systems integration.

3.1.4. FBK

FBK has collaborated with a wide group of organizations in terms of research, providing their abilities and knowledge in the fields of Cybersecurity, Digital Society, Digital Industry, Digital Wealth and Wellbeing, Health Emergencies, Sustainable Energy, Sensor & Devices or Theoretical Studies in Nuclear Physics and related areas. Although they generate both scientific and industrial results, they mainly leave the industrial part to partners not only in a national level but also in an international one, being worked aligned with companies like BOEING, Cisco Systems, IBM, NVIDIA.

They belong also to a large network of public organizations and other research centers whom they keep stable relationships to collaborate in order to make use of their know-how, compromising with the continuous study of their action fields.

3.1.5. Hepsiburada

Due to main business focus of the Hepsiburada and as a retail and e-commerce service provider; there are so many partners in SME level or the corporates levels. Hepsiburada is conducting business with. In MIMEX,

though; according to products enlisted to be sold in MIMEX; Hepsiburada will partner with them. Main, plausible business partners are from retails, FCMGs' manufacturers, electronic accessory suppliers.

4. Needs of industrialization

4.1. Detected needs

At this point so far, after gathering all the resources to achieve the project at stake, the partners do not expect facing dead end points and they see strong enough to cover the necessities of the project.

Métrica6 worked towards the design, development and reproduction of the Digital weight reader in order to substitute the commercial ones, optimizating the cost inherent to the assembly of the racks of MIMEX.

There is a topic, in fact, that needs of external help in order to deploy the Pilot 1 located in Istanbul. The partner needs of architectural knowledge to build up the MIMEX environment, where profiles are studied to achieve this part. Once they count with environment, with the help of the rest of the partners, they can manage to keep the expected path.

4.2. Potential partners

For the exposed aspect in the previous point, HEPSI stablished contact with an architectural profile to work on the Pilot 1 architecture, sorting this issue out.

Sezer Bahityar is the contact who performed the work, helping developing the blueprint with the disposition of the MIMEX environment. She was invited to an internal meeting where she introduced the idea and the projection of the work to perform in order to set the MIMEX in the selected location in Istanbul.

The Consortium gave the approval to continue with this option and saw the advantage of contracting the services of this agent instead of assigning bigger efforts from between the partners.

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Appendix II – BOM Scale System

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Set	Sub-sys	Element	In charge	Internal Reference	External Reference	Description	Manufacturer	Provider	Quantity	Unitary Cost	Total Cost	Comentaries
Scale System	Mechanical	**Camera housing**	METRICA6	M.001.001	M6_CMR_HSG	Enclosure that protects the camera and works as a fixing support to the rack structure + methacrylate + fixing elements	METRICA6	METRICA6	1	€ 25,00	€ 25,00	Made of FormLabs Photopolymer Resin White (FLGPWH04)
		Rack + Load Cell + Products lighting	CEFLA	M.003.001	VS036G0001	GR SEZ MIMEX 100X40 H240	CEFLA	CEFLA	1	€ 1.700,00	€ 1.700,00	Aggrouped as a whole: Metalic structure with the load cells and the illumination system
	Electronics	**Camera**	SPINDOX	M.005.01	ELP-USBFHD01M-L29	The HD 1080P USB CMOS board camera module (model: ELP-USBFHD01M serials) is ideal for many applications like security systems, portable video system, video phones, industrial machine monitoring and toys. It use high quality image sensors made by OmniVision, one of the world leaders in this field of electronics.	ELP	ELP	1	€ 35,82	€ 35,82	The dimensions of the lens are obtained directly from the provider. Taxes and customs duty excluded
		DIGITAL WEIGHT READER PCB	METRICA6	M.012.001	M6_AH_PCB	Ad-hoc designed pcb to replace comercial weight readers and read the load cells signals	METRICA6	METRICA6	10	€ 50,00	€ 500,00	In development
		Switch+power supply	METRICA6	M.013.001	5900-83 16 Port 90W Managed PoE Switch	Switch added to supply energy to every single independent weight system	Fast Cabling	Fast Cabling	1	€ 498,60	€ 498,60	
		Ethernet wire	METRICA6	M.006.01	A146-0473	Ethernet wire to connect the Digital reader with the switch	Infolider tecnología	Infolider tecnología	10	€ 4,98	€ 49,80	
									Total cost for a Rack		**€ 2.809,22**	

Figure 1. Scale System BOM.

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Element	Unitary cost	Units needed		Scaled cost by units					
					€ 50,00	€ 100,00	€ 200,00	€ 500,00	€ 1.000,00
Camera	€ 35,82	€ 1,00			€ 32,84	€ 24,37	€ 24,37	€ 20,91	€ 19,19
Shipping costs per order	€ 91,61				€ 91,61	€ 164,20	€ 276,55	€ 371,61	€ 764,82
				€ 10,00	€ 50,00				
Camera Housing	€ 25,00	€ 1,00		€ 25,00	€ 25,00				
				€ 10,00	€ 50,00	€ 100,00			
Rack + Products lighting + Load Cells	€ 1.700,00	€ 1,00		€ 1.700,00	€ 1.500,00	€ 1.400,00			
				€ 10,00		€ 100,00		€ 500,00	
Ad-Hoc Digital weight reader	€ 50,00	€ 10,00				€ 42,50		€ 40,00	
						€ 100,00	€ 200,00		
Switch	€ 498,60	€ 1,00				€ 465,40	€ 450,00		
						€ 100,00	€ 200,00		
Ethernet wire	€ 4,98	€ 10,00				€ 4,63	€ 4,45		
Total cost for a Rack	**€ 2.900,83**	-	**Costs according to the bundles**	-	**€ 2.697,85**	**€ 2.545,91**	**€ 2.529,83**	**€ 2.486,48**	**€ 2.484,87**

Figure 2. Scaled Costs.

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LEVEL	CODE	DESCRIPTION	Q.TY
0	VS036G0001	MIMEX RACK 100X40 H240	
1	1A30211401	COLUMN A25 9X3 H240	3
1	1D150E0E01	BASE FOOT H15 PR30 UNIVERSAL	3
1	1A31010112	FEET FOR BASE UNV M10X65	3
1	1D15010112	FIXING KIT BASE COLUMN UNV	3
1	1G910101ZG	FIXING KIT COLUMN/WALL 4,5X6	3
1	VS03603001	BACKPANEL A25 H35 P50 MIMEX	8
1	VS03603101	BACKPANEL A25 H60 P50 MIMEX	2
1	VS03603201	CROSS REAR BRACKET P100 MIMEX	2
1	2R01011100	ANTI-RELEASE SPRING A25	
1	VS036G0201	SHELF KIT 50x30 MIMEX	10
2	VS03601001	BOTTOM FRAME 50X30 MMX	1
2	VS03601701	TOP FRAME 50X30 MMX	1
2	VS03600101	COVER PLAN PR30 P50 7/10 MMX	1
2	VS03603501	WIRE FRONT FOR SHELF P50 H6	1
2	VS03603601	WIRE DIVIDER PR30 H6	2
2	VS036B00ZZ	LOAD CELL DINI ARGEO	1
2	00510211ZZ	WIRE HOLDER WHITE NYLON MWSEB-3-01A2-RT RICHCO	4
2	0043170012	WASHER D 6 UNI6592	4
2	0040566812	SCREW TCE M 6 X 30 UNI5931	4
2	2K60501100	PRICE HOLDER H5 L7 MM70	1
1	VS03603701	UPPER PART RH BRACKET P30 MIMEX	1
1	VS03603801	UPPER PART LH BRACKET P30 MIMEX	1
1	VS03604801	UPPER PART P100 PR65 P30 MMX	1
1	VS03605201	CAMERA HOLDER	1
1	0041910612	SCREW TBCE M 4 X 10 ISO7380	10
1	VS03604601	FRONT PROTECTION PANEL H25 P100 MIMEX	1
1	VS036047ZG	CROSS BOTTOM BRACKET P50 MIMEX	2
1	VS03604501	BASE FOOT LH PANEL 30 MIMEX	1
1	VS03604401	BASE FOOT RH 30 MIMEX	1
1	4R050150ZZ	CABLE ALIM 230V L500 C/SPN	1
1	4R050106ZZ	ALMT B DIGI SHELF 85W P/1BINE	1
1	4R030020ZZ	DIGI SHELF 1,9X0,7L=195 -1,95M	1
1	4R030377ZZ	CABLE FM L150 P/CLG LED	1
1	4R03036JZZ	CABLE TM P/CLG FORMAN/DECOR	10
1	4R060007ZZ	LED LAMP DIGIT2.0 UNIKA P50	8
1	4R060003ZZ	LED LAMP DIGIT2.0 UNIKA P100	1
1		PACKAGING	
1		LABOR	

Table 3. Rack + Products Lighting + LC.

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ITEM	DIAGRAM	QUANTITY	DESCRIPTION	ENCAPSULATED	VALUE	REFERENCE 1	DISTRIBUTOR 1	REFERENCE 2	DISTRIBUTOR 2	UN. COST	COST
1	C1, C2, C3, C4, C5, C6, C7, C8, C16, C17, C18, C19, C20, C21, C25, C26, C27	17	Ceramic capacitor	0402	100nF/25V	CL05B104KA5NNNC	MOUSER	CL05A104KA5NNND	MOUSER		- €
2	C9, C14	2	Ceramic capacitor	0402	470pF	C0402C471K5RAC	MOUSER	CC0402KRX7R9BB471	MOUSER		- €
3	C10, C12	2	Ceramic capacitor	0805	100nF/100V	C2012X7R2A104K125AA	MOUSER	HMK212B7104KG-T	MOUSER		- €
4	C11	1	Ceramic capacitor	E5-10	100uF	107CKS100MLQ	MOUSER	EKMQ101ELL101MJ16S	MOUSER		- €
5	C13, C29	2	Ceramic capacitor	0805	10uF	LMK212ABJ106MG-T	MOUSER	CL21A106KPFNNNE	MOUSER		- €
6	C15, C24, C32	3	Ceramic capacitor	0402	1uF	CL05A105KO5NNNC	MOUSER				- €
7	C22, C23	2	Ceramic capacitor	0402	6pF	CC0402CRNPO9BN6R0	MOUSER	UMK105CG060DVHF	MOUSER		- €
8	C28, C31	2	Ceramic capacitor	0402	470nF	LMK105ABJ474KV8F	MOUSER	CC0402KRX5R6BB474	MOUSER		- €
9	C30	1	Ceramic capacitor	0402	1,5uF	C1005X5R1A155M050BC	MOUSER	C1005X5R1E155K050BC	MOUSER		- €
10	C33, C34	2	Ceramic capacitor	0402	2,2uF	LMK105BJ225MV-F	MOUSER				- €
11	C35, C38	2	Ceramic capacitor	0402	9pF	CC0402DRNPO9BN9R0	MOUSER	CL05C090CB5NNNC	MOUSER		- €
12	C36, C37	2	Ceramic capacitor	0402	4pF	CC0402CRNPO9BN4R0	MOUSER	UMK105CG040CVHF	MOUSER		- €
13	D1, D2	2	Diode bridge	SMD	1,5A/600V	ABS15J	MOUSER				- €
14	D3	1	Rectifying diode	DO214AC	-	SMAJ58A	MOUSER				- €
15	D4	1	Green led diode	0603	-	LTST-C190KGKT	MOUSER	APT1608CGCK	MOUSER		- €
	D5, D6	2	Red led diode	0603	-	LTST-C190KRKT	MOUSER	AP1608EC	MOUSER		- €
16	D7, D8, D9, D10	4	Diode TVS	SOD882	6V/30A	D5V0H1B2LP-7B	MOUSER				- €
17	L1, L3, L4	3	Inductance	0603	120R	BLM18PG121SN1D	MOUSER	MPZ1608S121ATAH0	MOUSER		- €
18	L2	1	Inductance	5030	22uH	NRS5030T220MMGJ	MOUSER				- €
19	R1, R2, R3, R4, 37, 38	6	Resistor	0402	0R	RC0402JR-7D0RL	MOUSER	CR0402-J/-000GLF	MOUSER		- €
20	R5	1	Resistor	0402	24,9k/1%	RC0402FR-0724K9L	MOUSER				- €
21	R6	1	Resistor	0402	178k/1%	RC0402FR-13178KL	MOUSER	RC0402FR-07178KL	MOUSER		- €
22	R7	1	Resistor	0402	357R/1%	RC0402FR-07357RL	MOUSER	AC0402FR-07357RL	MOUSER		- €
23	R8	1	Resistor	0402	100k	RC0402JR-13100KL	MOUSER	AC0402JR-07100KL	MOUSER		- €
24	R9	1	Resistor	0402	100R	RC0402FR-10100RL	MOUSER	CR0402-JW-101GLF	MOUSER		- €
25	R10	1	Resistor	0402	54,9k	AC0402FR-0754R9L	MOUSER	ERJ-2RKF54R9X	MOUSER	- €	- €
26	R11, R16, R17, R18, R19, R21, R27, R32, R33, R34, R40, R41	12	Resistor	0402	10k	RC0402JR-7D10KL	MOUSER				
27	R12, R13, R14, R15	4	Resistor	0402	50R	AC0402JR-0750RL	MOUSER				
28	R20, R22	2	Resistor	0402	270R	RC0402JR-07270RL	MOUSER				
29	R23	1	Resistor	0402	12k1	RC0402FR-1312K1L	MOUSER				
30	R24, R25, R28, R39	4	Resistor	0402	33R	CR0402-FX-33R0GLF	MOUSER				
31	R26	1	Resistor	0402	1k5	CR0402-FX-1501GLF	MOUSER				
32	R29	1	Resistor	0603	470R	AC0603JR-07470RL	MOUSER				
33	R30, R31	2	Resistor	0402	470R	RC0402JR-13470RL	MOUSER				
34	R35, R36	2	Resistor	0402	75R	RC0402FR-1375RL	MOUSER				
35	S1, S2	2	SMD button	SMD	-	PTS636SKG25	MOUSER				
36	TR1	1	Ethernet Transformer	SOIC-16	-	H1102NL	MOUSER				
37	U1	1	Microdrive ARM-M4	QFP-100	-	STM32F429VIT6TR	MOUSER				
38	U2	1	LDO regulator	SOT23-5	3,3V/450mA	NCP161ASN330	MOUSER	LDLN025M33R			
39	U3	1	Ethernet Transceptor	QFN-24	-	LAN8742A-CZ	MOUSER				
40	U4	1	IC Gestión PoE	SOIC-8	-	TPS2375DR	MOUSER				
41	U5	1	Buck Regulador	SOT23-6	5V/600mA	LV2862XLVDDCT	MOUSER				
42	U6	1	ESD Supresor	SOT23-6	6V/30A	USBLC6-4SC6	MOUSER				
43	U7	1	AFE Load Cell	SOP-16	24bits	ADS1231IDR	MOUSER				
44	X1	1	RJ45 connector pinout	SMD	-	RJCSE-5081-01	MOUSER				
45	X2	1	Load Cell Connector	SMD	-	43045-0606	MOUSER				
	X3	1	Programming connector	TH	-						
	XT1	1	Quartz cristal	2x1,6	25MHz	XRCGB25M000F2P00R0					
	XT2	1	Quartz cristal	1,6x1	32,768kHz	ECS-.327-9-16-TR	MOUSER				
	XT3	1	Quartz cristal	1,6x1	25MHz	ECS-250-10-47Q-CES-TR	MOUSER				

Table 4. Digital Weight Reader PCB.

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No.	Provider/manufacturer	Country	Web	Tel	Contact	Notes
1	DINI ARGEO/DINI ARGEO	Italy	http://www.diniargeo.es/	+39 0536 843418		Via della Fisica n. 20, 41042 Spezzano di Fiorano, Modena, Italia
2	LAUMAS	Italy	https://www.laumas.com/en/	+39 0521 683124	laumas@laumas.it	Via I Maggio, 6 - 43022 - Montechiarugolo (PR) - Italia
3	ELP	China	http://www.webcamerausb.com/	0086-755-83046295	sales@elpcctv.com	1311-1313,Building Tianliao, Tangchang Road, Tanglang Community, Taoyuan Street, Nanshan District, Shenzhen, China
4	IRS	Italy	https://www.ceflaretail.com/it/		Web form	Via Selice prov.le 23/a - 40026 Imola (BO) - Italy
5	B&B Lamiere	Italy	https://www.google.it/maps/place/B.E.B.+Lamiere+srl/@44.4483638,11.7926571,15z/data=!4m2!3m1!1s0x0:0x9c870a76760224ac?sa=X&ved=2ahUKEwjvmMf-7KjxAhWchv0HHU23BvEQ_BIwCnoECC0QBQ	+39 0545 84054		Via Trebeghino, 63, 48024 Massa Lombarda RA
6	Electro System S.r.l.	Italy	http://www.electrosystem.com/	+39 0542 640 798	electrosystem@electr	Via P. Nenni - Cap. 40026 - Imola
7	MOUSER	Spain	https://www.mouser.es/	936 45 52 63	espana@mouser.com	Parque de Negocios MAS BLAU I, Edificio Muntadas, Esc. B, C/ Solsones nº 2, Planta 2 Local C1 y C3, 08820 El Prat de Llobregat, Barcelona, Spain
8	Aisens	Spain	https://aisenstech.com/	(+34) 914 210 466	info@aisenstech.com	Calle Laguna del Marquesado 39-41, Nave 1. (P.I. La Resina)
9	FastCabling	Poland	https://www.fastcabling.com/	0086-20-82442660	sales@golbong.com	

Table 5. BOM Providers.

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