Politecnico di Torino

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Analysis and Optimization of the management system of the Manufacturing Industry 4.0 Laboratory (Mind4lab) at Politecnico di Torino

Relatori:
Luca Mastrogiacomo

Candidati:
Matteo Reano

To my grandparents
For your endless love,
wisdom and support
Thank you for inspiring
and believing in me

Acknowledgements

Before proceeding through my thesis, I would like to spend a few words to thank everyone who has been close to me during these years. This thesis represents the conclusion of a course of study that allowed me to increase my knowledge.

First of all, I would like to thank the DIGEP Teams for giving me the opportunity to work on this project, in particular to thank my relator Luca Mastrogiacomo for having welcome me into the team.

I would like to thank my parents who inspired and courage me to grow and face difficulties, your support has never missed. To my brother, who pushed me to go always forward and believe in me asking for some help and testing my knowledge.

To my friends who have been more than friends. They always supported me for university studies, projects and especially discussions about jobs opportunities, without forgetting the external activities done together even during COVID-19.

Finally, I would like to thank Politecnico di Torino for having encourage my passion and for having provided me opportunities to grow especially to manage and organize myself in the best way in order to face any problems.

Summary

Introduction

The quality of a product or service refers to the degree to which the product or service is able to satisfy needs. These needs can be categorized into two main group: stated needs and implied needs. Stated needs refers to the explicit requirements or specifications of the product, while implied needs are related to implicit needs, customers' expectations.

Quality engineering is fundamental for optimizing process and developing products. Engineering or organizational innovation can be encouraged by a favorable operating environment, such as that of a Lean and Integrated System (LIS).

A Lean and Integrated System implements (at least) two organizational approaches: Concurrent Engineering and Lean Production.

Lean production is an assembly-line manufacturing methodology developed originally for Toyota's automobile manufacturing. This is why it is also known as Toyota Production System. The goal of Lean Production is described as to get the right thing to the right place at the right time, the first time, while minimizing waste and being open to change.

Engineer Taiichi Ohno from Toyota, who is credited with developing the principles of lean production, discovered that in addition to eliminating waste, his methodology led to improve product flow and quality.

This type of System can be extended not only for production industries but also to enhance workflows and processes in other sectors such as service.

The key to this system is the customer centrality. It is very important to collect and analyze customer needs and feedback in order to develop products or service that satisfy their requirements.

After having analyzed the whole process used nowadays into Mind4lab and in the Workshop lab, I endeavored to improve efficiency reducing waste of time.

My aim was to automate manual processes using tools to allow the lab manager to work continuously and manage time efficiently.

As outlined, my thesis is divided into 3 different parts: requirements, solutions and improvements proposal.

Requirements

The Department of DIGEP at Politecnico di Torino manages different typologies of laboratories, including the Production Workshop, Mind4Lab, Center IAM, Tomograph Laboratory, Center J-Tech, RMLAB, Reverse Engineering, Quality and Metrology Laboratory, and the Economics and Production Laboratory.

The needs exposed by Mind4Lab concern the managing and monitoring of individuals entering the laboratory. Since this Lab is predominantly used by thesis students and doctoral students, but also accessible to others, it is important to keep track of users to ensure the safety of the lab and its machineries.

The primary requirement for all users entering any laboratory, regardless of the subject, is to complete a four-hours safety course. This course concludes with a certificate that is valid indefinitely and it can be included as an additional credential on a curriculum vitae.

In order to access the lab, users also need a signature from the referring professor who has granted them the possibility to enjoy this opportunity. Additionally, a mandatory document has must to be signed by user, the referring professor and the RADL, the main manager responsible for the security of laboratories, who decides the type of personal protective equipment (DPI-PPE) required based on the user's role and responsibilities.

Therefore, these initial requirements are common to all the laboratories and there is need to keep track of all these details. After which, each laboratory has slightly different additional requirements. Since the thesis focuses on Mind4Lab, the specific needs of this lab are detailed here.

The laboratory manager needs to provide users with instructional material specific to each robot station they are going to use for training. Then, users must send the manager an email with documents that guarantee they have studied all the manuals.

Subsequently, the manager checks all the certificates and, if validated, he shares a Teams Calendar where all users must book a time slot for the requested robot station. Afterwards, users are allowed to access Min4Lab and start using the robot.

Another need required for all the laboratories is to keep track of the energy consumption, monitoring the actual use of each machinery.

Finally, all these needs are quite similar to all labs. This is why has been created a standardized process that follows a Lean Service.

For what concern Workshop Laboratory, has been used to analyze the actual process that was created by a previous colleague, who tried to automate some process.

After the analysis I had learn how to use Microsoft tools and every application that could be possible to adopt in order to develop my thesis. I changed the previous work because it was focused only on the workshop, while I tried to standardize a process that can be replicated in different laboratories. I Optimized the initial QR code to track the bureaucratic documents as online courses and required documents.

The Future Proposal explained at the end of the thesis will be useful to optimize the work of the workshop manager, reducing the waste of time to track the use of each machinery.

Solutions

The solutions for addressing all the identified needs commence with a critical analysis of a previous approach employed to manage the production workshop's workflow.

Initially, a temporary database was established to consolidate all user information, aligning with the requirements delineated in the previous chapter. However, this initiative encountered challenges related to suboptimal data retrieval processes and the time investment required from laboratory managers.

This chapter offers insights into the strategies implemented to streamline the entire workflow process from a lean perspective. The solutions are categorized into two primary areas: General entrance to DIGEP Laboratories and Entrance to Mind4Lab, of another specific laboratory.

General entrance to DIGEP Laboratories

The first need that has been analyzed was the general entrance since it represents the initial interaction between users and laboratories.

In an effort to reduce time wastage for both parties, the manager and the user, it has been proposed to centralize the initial bureaucratic documents, which are common requests across all laboratories as mentions in the Requirements Chapter.

The Process flow begins when a user arrives to the DIGEP Lab, typically accompanied by their referring professor.

The user is then required to scan the QR-Code at the general entrance, called "Ingresso Laboratori", as shown in the following picture.

Figure 1 – QR code "Ingresso Laboratori Digep"

This QR-Code directs the user to a Microsoft Forms page used for data collection. Unlike the previous process, this method optimizes the time spent filling out forms. The responses are automatically saved into a file excel on google drive using Microsoft's Power Automate application, which allows for the creation of automatic data flows.

The previous form asked to the user personal data such as Name, Surname, Student ID and email. In this case Power Automate is utilized to retrive the user's personal data from Office365, eliminating the need for users to input this information manually. This implementation significantly reduces the time spent of form completion, particularly as subsequent questions mainly involve selcting predefined choices rather than typing responsed. In this way, Lean Service has been reached splitting in half the questions asked into the form. Half questions mean half time, exspecially less than half time since the following questions are just mainly choice answers, as shown in the picture.

Ingresso Laboratori Digep

A fine modulo verranno inviati i documenti e informazioni per poter accedere presso i laboratori. Devi compilare prima di entrare nuovamente in Lab.
Once you submit the form, you will receive all documents and information in order to be able to access to laboratories. You have to compile them before entering again the Lab.

1. Email del referente/docente strutturato in dipartimento | Email of your professor of department *

Inserisci la risposta

2. In qualità di | Acting as *

- ◯ Personale dipendente | Polito Staff
- ◯ Dottorando | PhD student
- ◯ Tesista | Thesist
- ◯ Assegnista | grant holder
- ◯ Borsista/collaboratore | collaborator
- ◯ Personale esterno | External
- ◯ Visiting

3. Dipartimento di appartenenza | Department to which you belong *

- ◯ DAD
- ◯ DAUIN
- ◯ DET
- ◯ DIATI
- ◯ DIGEP
- ◯ DIMEAS
- ◯ DISEG
- ◯ DISMA
- ◯ DENERG
- ◯ DIST
- ◯ DISAT

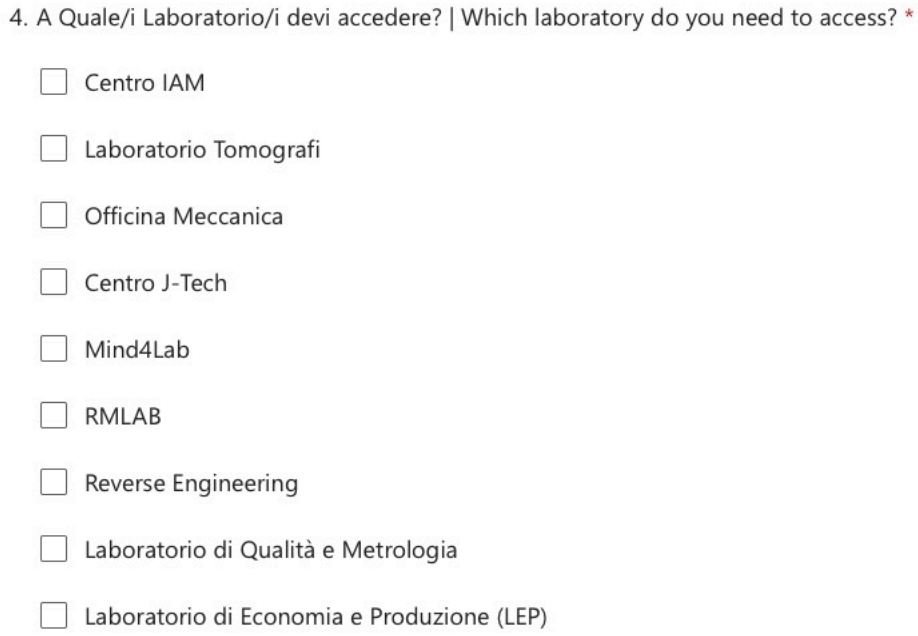


Figure 2 – Module Forms related to the QR code fig.1

The total time spent on completion is “20” seconds, while the previous form was completed in about “40” seconds.

Upon submission of the form, the user receives an automatic email outlining the requirements in order to be able to access the Labs.

This includes links to a four-hours online security course and a OneDrive folder containing necessary PDFs for signing and completion. Subsequently, the user must send all required documents to the general laboratory manager, either by replying to the email or directly sending attachments.

The laboratory manager is responsible for verifying the documents. Once he confirms the validity through a scan of another QR Code, the user will receive an email inviting him again to the general entrance of laboratories, where they can use their student smart card for authorization and gain access to the labs.

It follows the second QR code, used only by the manager of the main entrance of labs.

Figure 3 – QR Code "Verifica moduli sicurezza"

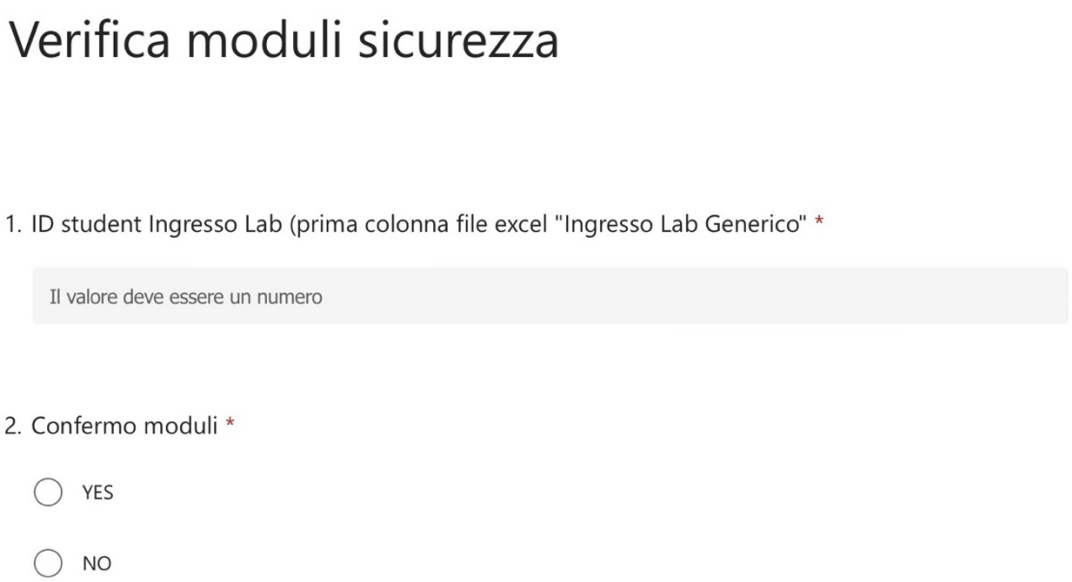


Figure 4 – Module Forms related to the QR code fig.3

The manager of DIGEP labs must fill out the form, writing the ID student for the entrance which corresponds to the "ID" column reported on the file excel.

The Process outlined above for the General entrance to DIGEP Laboratories serves as the first step in the overall process, granting students the necessary qualifications to enter the laboratories independently. This meticulous tracking of procedures ensure that all needs are met efficiently.

A sequential flow chart detailing the responsibilities of individuals and the process is provided below.

Flow Process analysis

The process explained in the previous chapter follows a Lean Service perspective, allowing the general DIGEP laboratory manager to optimize his time.

Prior to the implementation of the new workflow, the manager had to interrupt his work to go into the office, remove his gloves, and search for the documents needed by users to access the laboratories. With this new system, users can scan the QR code themselves, minimizing interruptions for workers. Although the general manager still needs to stop working to welcome users, but the time spent on bureaucratic tasks is significantly reduced.

This process can help workers save at least five minutes for each user entering the DIGEP laboratories. While this may not seem like a long time, It is sufficient to maintain the continuity of the manager's work without significant disruption.

Another advantage of the new system is improved documentation management. Users send all certificates via email, which can then be stamped or saved in a server or cloud folder. The latter option supports the goal of optimizing paper consumption and reduce waste.

Below are two flowcharts: the first one concerns the new process, while the second one relates to the old process.

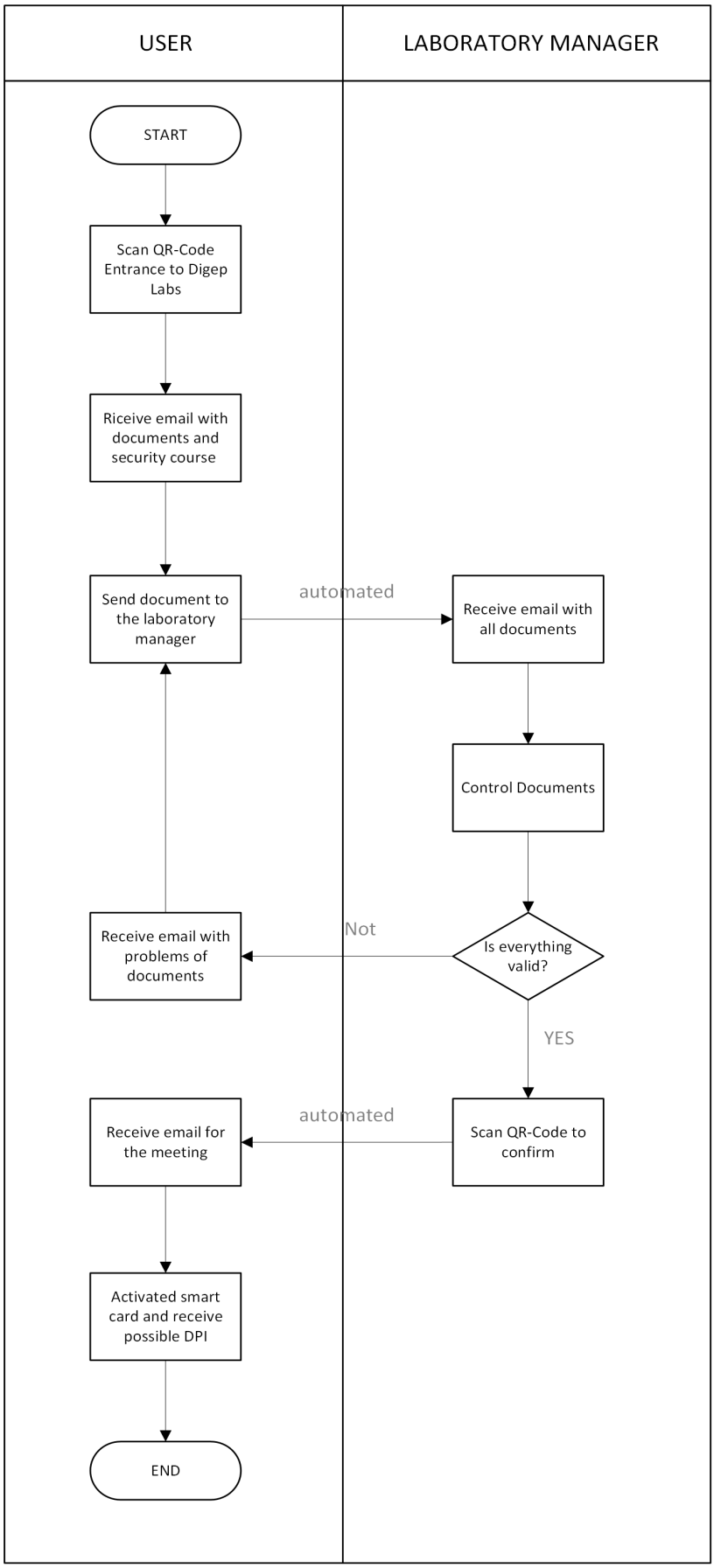


Figure 5 – Flow process of the new management system

As shown, the initial stages of the process do not require the presence of the manager, as it is handled by the automated system.

The manager becomes involved once the user sends an email with all required certificates for verification. After the manager validates the documents, an automated email is sent to the user in order to invite him back to the main entrance of the laboratories. At this point, the user's smart card is activated, granting him access to the labs.

This optimized process exemplifies the principles of Lean Service, enhancing efficiency and reducing unnecessary time expenditure, thereby benefiting both the manager and the users.

As seen, in the next picture related to the old process flow, the presence of the manager was required almost every time.

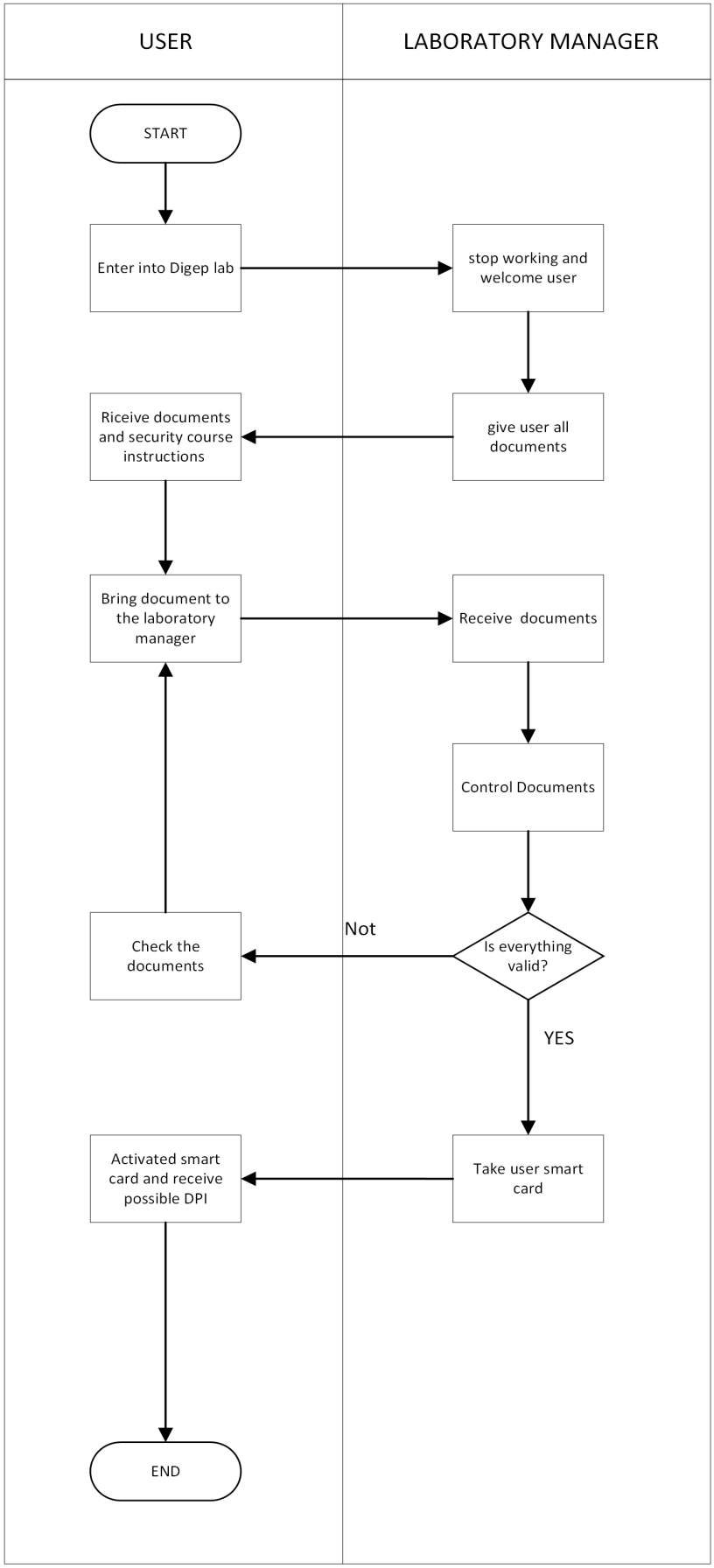


Figure 6 - Flow process of the previous management system

The logic beyond the process

For the process of entrance to the general DIGEP laboratories, Microsoft Power automate has been used. It is an app offered by Microsoft that allows users to create automatic flows connecting different applications. In this process, OneDrive Microsoft Excel, Office365, Microsoft Forms and Outlook have been used.

Firstly, a Microsoft Form module was created, which asks laboratory users a few questions such as the referent professor's email and department. The following picture is a screenshot of the first questions of the module.

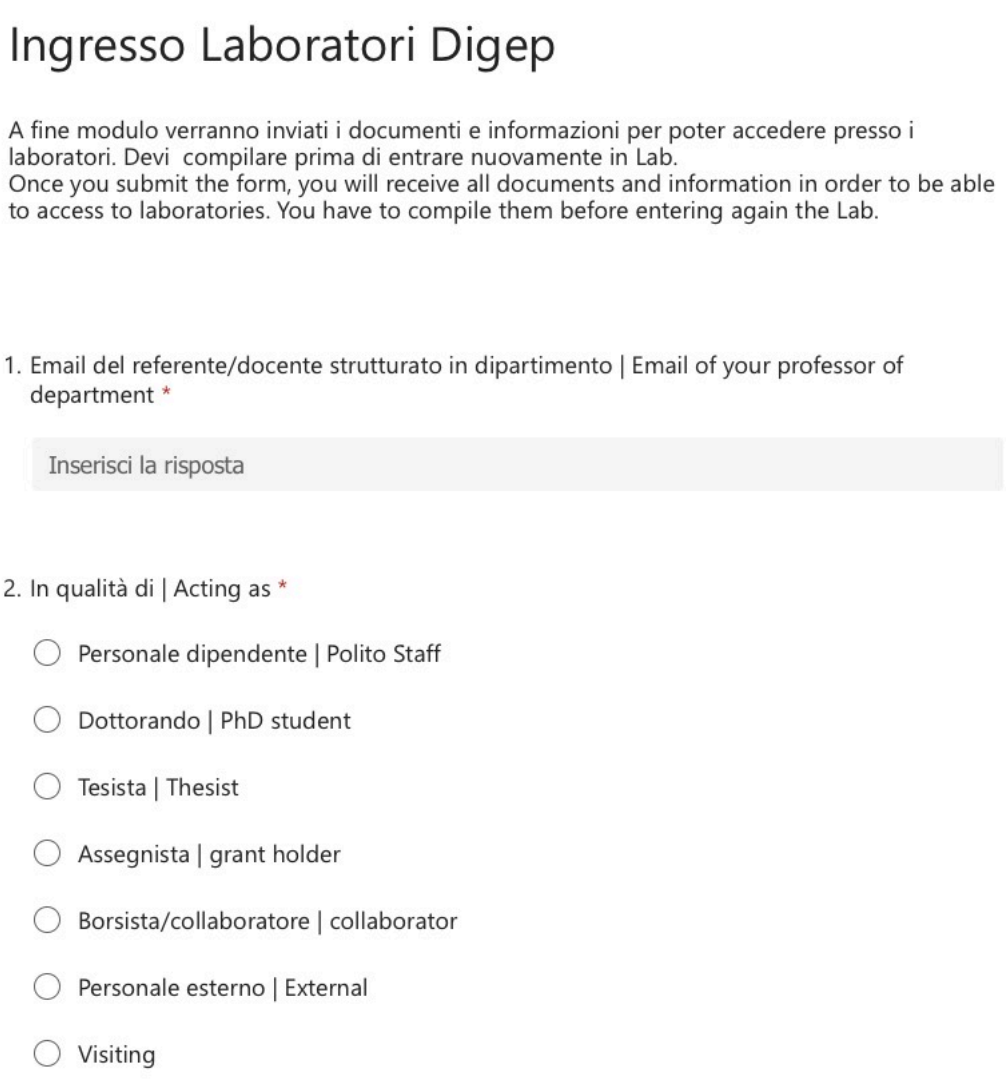
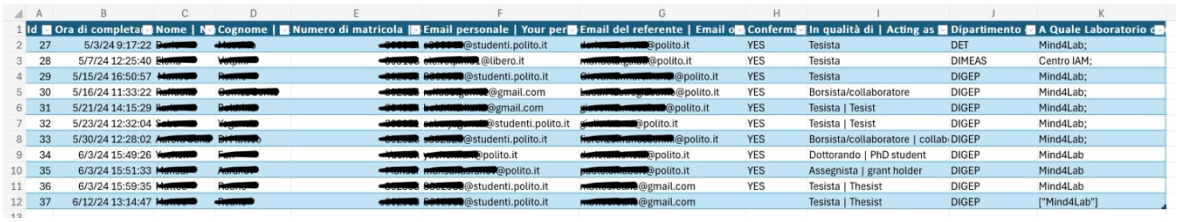


Figure 7 - The beginning of the module Forms related to the QR code fig.1

Once the user submits the form, Power Automate saves the data into an Excel file called “General Entrance” on OneDrive, which has already been created.

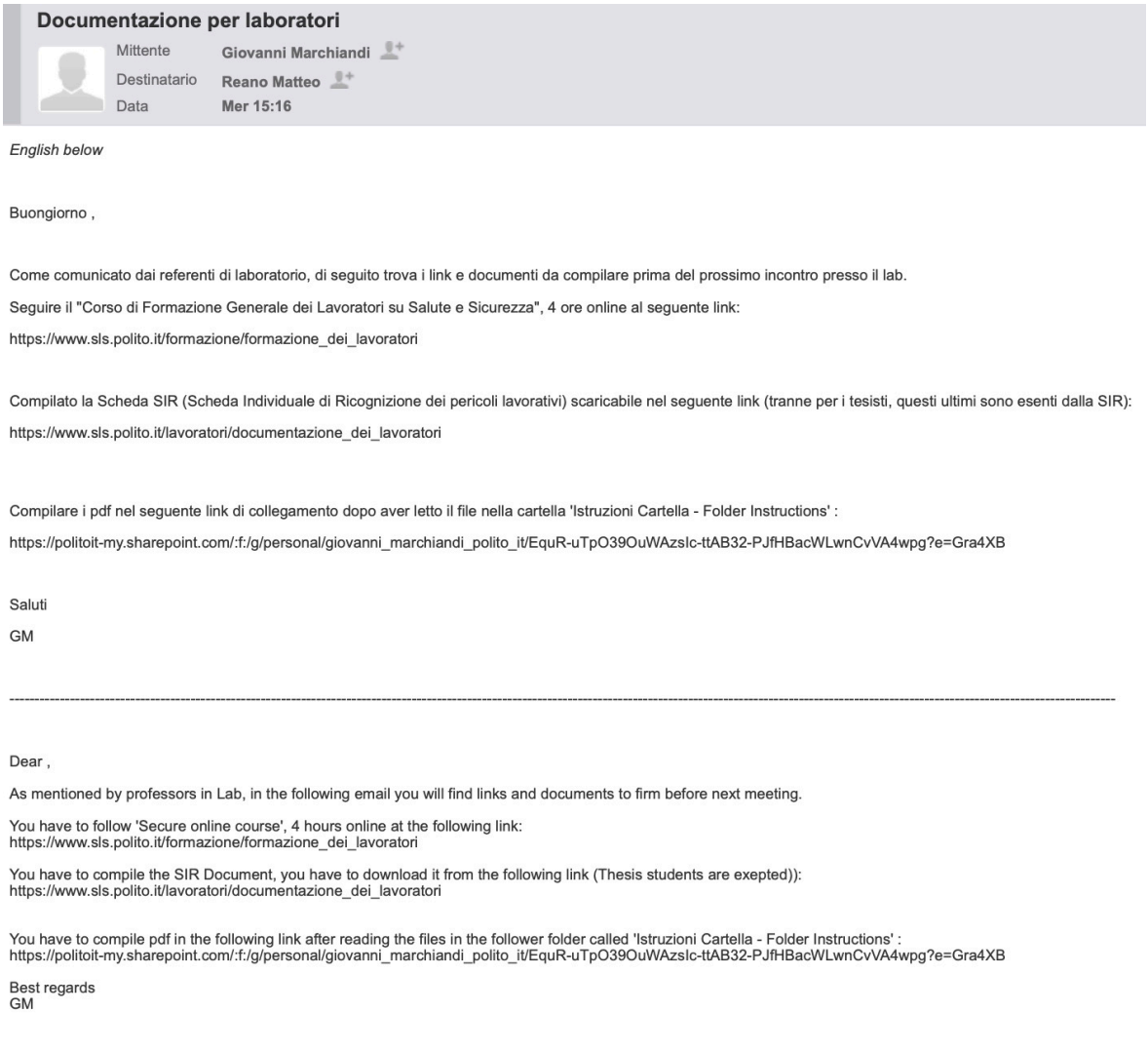
The following screenshot represents the visualization of the Excel file. It is quick to understand, easy to manage, and can be modified by the owner without any problems.



Id	Ora di completa	Nome | N	Cognome |	Numero di matricola	Email personale | Your per	Email del referente | Email o	Conferma	In qualità di | Acting as	Dipartimento	A Quale Laboratorio c
27	5/3/24 9:17:22	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it	YES	Tesista	DET	Mind4Lab;
28	5/7/24 12:25:40	[redacted]	[redacted]	[redacted]	[redacted]@libero.it	[redacted]@polito.it	YES	Tesista	DIMEAS	Centro IAM;
29	5/15/24 16:50:57	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it	YES	Tesista	DIGEP	Mind4Lab;
30	5/16/24 11:33:22	[redacted]	[redacted]	[redacted]	[redacted]@gmail.com	[redacted]@polito.it	YES	Borsista/collaboratore	DIGEP	Mind4Lab;
31	5/21/24 14:15:29	[redacted]	[redacted]	[redacted]	[redacted]@gmail.com	[redacted]@polito.it	YES	Tesista | Tesist	DIGEP	Mind4Lab;
32	5/23/24 12:32:04	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it	YES	Tesista | Tesist	DIGEP	Mind4Lab;
33	5/30/24 12:28:02	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it	YES	Borsista/collaboratore | collab	DIGEP	Mind4Lab;
34	6/3/24 15:49:26	[redacted]	[redacted]	[redacted]	[redacted]@polito.it	[redacted]@polito.it	YES	Dottorando | PhD student	DIGEP	Mind4Lab
35	6/3/24 15:51:33	[redacted]	[redacted]	[redacted]	[redacted]@polito.it	[redacted]@polito.it	YES	Assegnista | grant holder	DIGEP	Mind4Lab
36	6/3/24 15:59:35	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@gmail.com	YES	Tesista | Thesist	DIGEP	Mind4Lab
37	6/12/24 13:14:47	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@gmail.com		Tesista | Thesist	DIGEP	["Mind4Lab"]

Figure 8 - Excel File illustrating data collected from the QR code fig.1

In the meanwhile, the data is being written into the file, the user receives the following email explaining what he/she needs to do to be able to enter the labs.



Documentazione per laboratori

Mittente **Giovanni Marchiandi**
Destinatario **Reano Matteo**
Data **Mer 15:16**

English below

Buongiorno ,

Come comunicato dai referenti di laboratorio, di seguito trova i link e documenti da compilare prima del prossimo incontro presso il lab.

Seguire il "Corso di Formazione Generale dei Lavoratori su Salute e Sicurezza", 4 ore online al seguente link:

https://www.sls.polito.it/formazione/formazione_dei_lavoratori

Compilato la Scheda SIR (Scheda Individuale di Ricognizione dei pericoli lavorativi) scaricabile nel seguente link (tranne per i tesisti, questi ultimi sono esenti dalla SIR):

https://www.sls.polito.it/lavoratori/documentazione_dei_lavoratori

Compilare i pdf nel seguente link di collegamento dopo aver letto il file nella cartella 'Istruzioni Cartella - Folder Instructions' :

https://politoit-my.sharepoint.com/:f:/g/personal/giovanni_marchiandi_polito_it/EquR-uTpO39OuWAzsIc-ttAB32-PJfHBacWLwnCvVA4wpg?e=Gra4XB

Saluti

GM

Dear ,

As mentioned by professors in Lab, in the following email you will find links and documents to firm before next meeting.

You have to follow 'Secure online course', 4 hours online at the following link:
https://www.sls.polito.it/formazione/formazione_dei_lavoratori

You have to compile the SIR Document, you have to download it from the following link (Thesis students are exepted)):
https://www.sls.polito.it/lavoratori/documentazione_dei_lavoratori

You have to compile pdf in the following link after reading the files in the follower folder called 'Istruzioni Cartella - Folder Instructions' :
https://politoit-my.sharepoint.com/:f:/g/personal/giovanni_marchiandi_polito_it/EquR-uTpO39OuWAzsIc-ttAB32-PJfHBacWLwnCvVA4wpg?e=Gra4XB

Best regards
GM

Figure 9 - E-mail sent automatically to the user after the submission of the module Forms fig.1

The user needs to fill in all the documents and complete the online safety course. Afterward, he/she must reply to the received email with all signed and completed documents attached.

Once the manager of the entrance of DIGEP lab receives all the documents, he must verify and confirm their validity with a specific QR Code, as shown in the picture below.

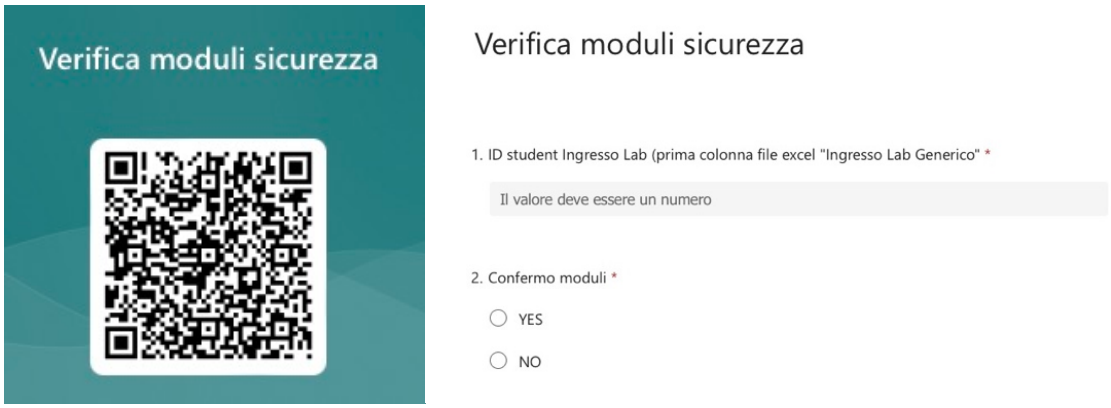
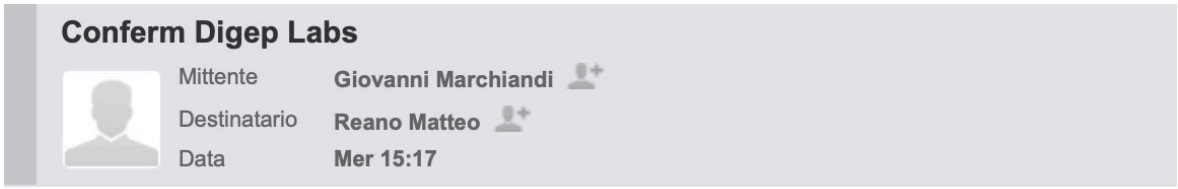


Figure 10 - QR code and module related to fig.3

After submission, the user will receive the following email inviting him/her to come to the main entrance of DIGEP labs to activate his/her student smart card.



Conferm Digep Labs

Mittente **Giovanni Marchiandi**

Destinatario **Reano Matteo**

Data **Mer 15:17**

English below

Buongiorno Matteo,

I moduli inviati via email sono stati confermati.

Dunque può ritornare nuovamente presso l'ingresso dei laboratori Digep in modo da attivare la smart card.

Si prega di rispondere alla suddetta email con il giorno in cui si vuole presentare.

Cordiali saluti

Giovanni Marchiandi

Dear Matteo,

The certificates you sent by email are confimed.

You are allwod to come again to the entrance of Digep Lab in order to abilitate your smart card.

Please, answer to this email illustrating when you are going to come into the lab.

Best regards

Giovanni Marchiandi

Figure 11 - E-mail sent to user after the validation by the laboratory manager

Meanwhile, the file excel has been updated to the exact row of the user who has been confirmed, as shown in the following picture.

	A	B	C	D	E	F	G	H	I	J	K
1	d	Ora di completa	Nome | N	Cognome |	Numero di matricola |	Email personale | Your per	Email del referente | Email o	Conferma	In qualità di | Acting as	Dipartimento	A Quale Laboratorio d
2	27	5/3/24 9:17:22	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it	YES	Tesista	DET	Mind4Lab;
3	28	5/7/24 12:25:40	[redacted]	[redacted]	[redacted]	[redacted]@libero.it	[redacted]@polito.it	YES	Tesista	DIMEAS	Centro IAM;
4	29	5/15/24 16:50:57	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it	YES	Tesista	DIGEP	Mind4Lab;
5	30	5/16/24 11:33:22	[redacted]	[redacted]	[redacted]	[redacted]@gmail.com	[redacted]@polito.it	YES	Borsista/collaboratore	DIGEP	Mind4Lab;
6	31	5/21/24 14:15:29	[redacted]	[redacted]	[redacted]	[redacted]@gmail.com	[redacted]polito.it	YES	Tesista | Tesist	DIGEP	Mind4Lab;
7	32	5/23/24 12:32:04	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]polito.it	YES	Tesista | Tesist	DIGEP	Mind4Lab;
8	33	5/30/24 12:28:02	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it	YES	Borsista/collaboratore | collab	DIGEP	Mind4Lab;
9	34	6/3/24 15:49:26	[redacted]	[redacted]	[redacted]	[redacted]@polito.it	[redacted]polito.it	YES	Dottorando | PhD student	DIGEP	Mind4Lab
10	35	6/3/24 15:51:33	[redacted]	[redacted]	[redacted]	[redacted]polito.it	[redacted]polito.it	YES	Assegnista | grant holder	DIGEP	Mind4Lab
11	36	6/3/24 15:59:35	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]gmail.com	YES	Tesista | Thesist	DIGEP	Mind4Lab
12	37	6/12/24 13:14:47	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]gmail.com	YES	Tesista | Thesist	DIGEP	["Mind4Lab"]
13											

Figure 12 - Excel file illustrating data updated after the validation.

The cell of the column “Conferma” and of the last row has been updated reporting the answer “YES”.

This chapter demonstrates the view of all data and processes saved. As shown, the file that keeps track of the data is easy to understand and manage. The owner can easily modify the file like a normal Excel file.

The only important data that is recommended to do not change is the student ID, which is a progressive number indicating the response ID of the Forms module.

It is recommended to do not modify the columns table of the Excel file since Power Automated is connected to them.

Since all data is moved using Power Automate, which generates the flow, screenshots of the logic behind the process have been included.

The first picture illustrates the flow that connects the first QR code for the entrance to the mail and Excel file to keep track of the data.

Figure 13 - Power Automate flow of the first QR Code fig.1.

The second picture explains the logic for the second QR code used to confirm validity and invite the user to the main entrance of DIGEP lab to activate his/her smart card.

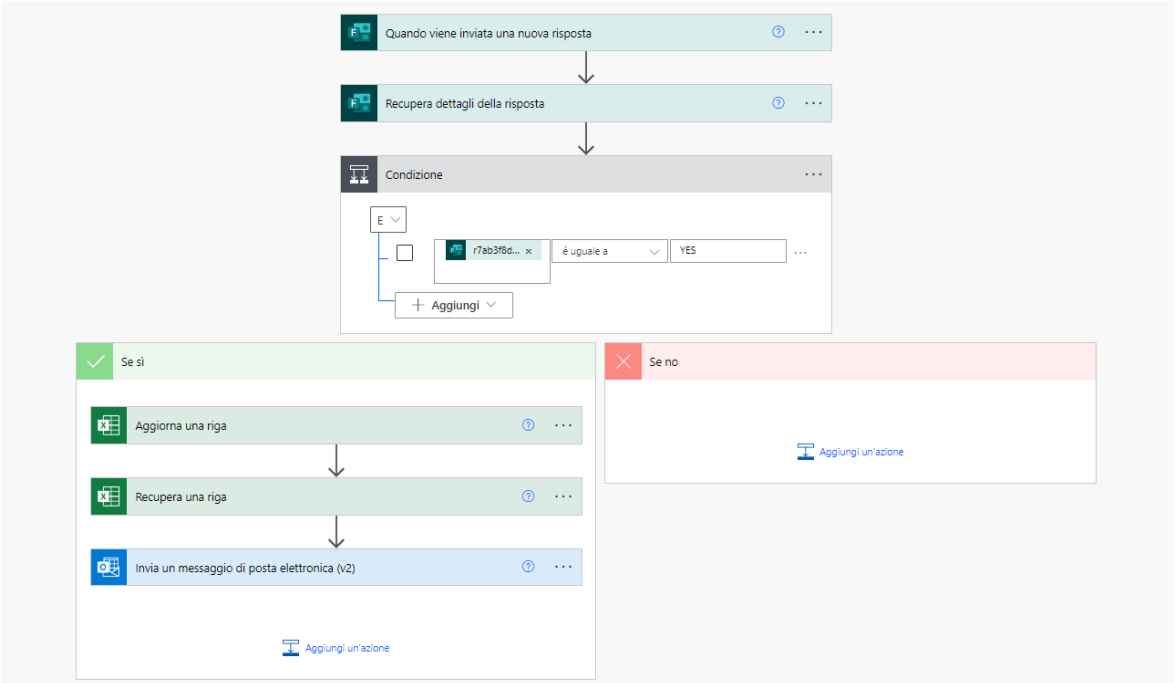


Figure 14 - Power Automate flow of the first QR Code fig.3

The following screenshot illustrated the use of Office365 to collects personal data such as Name, Surname, Student ID Smart Card.

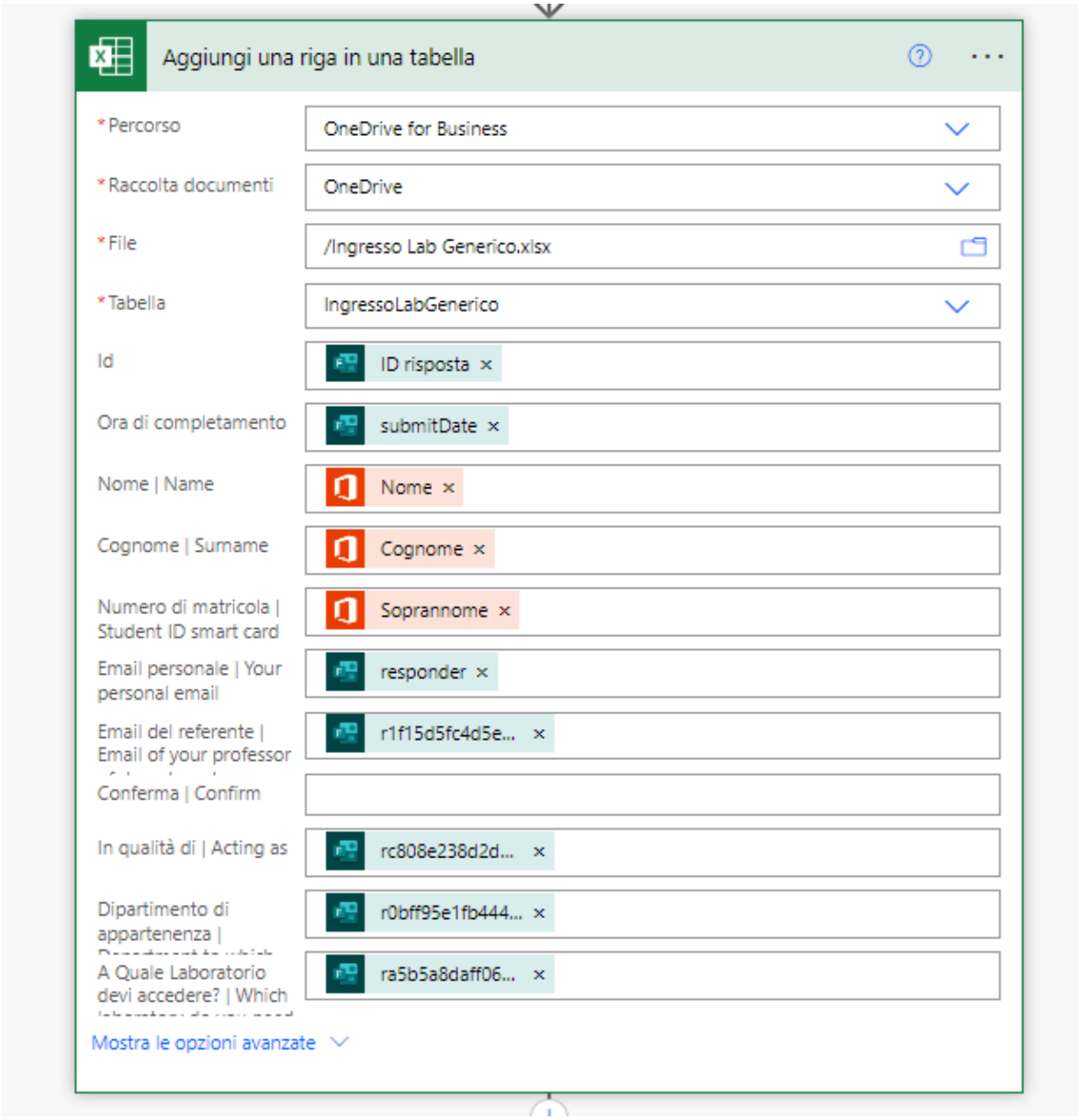


Figure 15 - Power Automate program connecting Forms and Office365 to the Excel file

Entrance to Mind4Lab

Mind4Lab is one of the DIGEP laboratories that specifically uses robots. At the moment, there are nine robot stations primarily used by thesis students and PhD students.

As a laboratory, the general entrance QR Code must be completed first.

To join Mind4Lab, another form called “Entrance to Mind4Lab” is required. As mentioned before, general questions such as name, surname, and email are not required since these can be obtained from Office365 through Power Automate.

Then only required information are the email of the referent professor, the department, confirmation of the security course, confirmation of DPI -PPE training and allocation, and which robot station will be used.

All the information needs to be saved into a new Excel file specific to this laboratory, created in the same manner as the previous one. The process flow between Forms and Excel has been standardized using Power Automate.

Standards are very important for a lean mindset, and they make it easy to expand to other laboratories or add new machineries.

The last piece of information, regarding which robot station will be used, is needed in order to send a specific email to the user with a folder containing all the manuals for that robot. Users are required to study the manuals and, once they have finished, they have to send the documents, certificates, and the ID number received to the Mibd4Lab Manager.

The process of sending the email with all manuals and the ID number for lab entrance is automated through Power Automate. The following pictures show the questions asked with Microsoft Form for the entrance to this laboratory.

Figure 16 - QR Code "Entrance to Mind4Lab"

Ingresso | Entrance to Mind4lab

1. email del referente | email of your professor *

Inserisci la risposta

2. Dipartimento | Department

- ◯ DAD
- ◯ DAUIN
- ◯ DET
- ◯ DIATI
- ◯ DIGEP
- ◯ DIMEAS
- ◯ DISEG
- ◯ DISMA
- ◯ DENERG
- ◯ DIST
- ◯ DISAT

3. Hai seguito corsi sulla sicurezza? | Have you done the security course? *

- ◯ SI
- ◯ NO

4. Hai ricevuto la formazione per i DPI? | Have you been formed about DPI? *

- ◯ SI
- ◯ No

5. Quali DPI hai ricevuto? | Which DPI did you receive? *

- ☐ Mascherina
- ☐ Guanti
- ☐ Scarpe
- ☐ Nessuno

6. Quale robot userai? | Which Robot Station are you going to use?

- ◯ ABB milling Robot cell
- ◯ Automated Warehouse
- ◯ Dual arm collaborative robot cell
- ◯ Mobile Robot Arm
- ◯ Omron Collaborative Robot
- ◯ Optitrack desktop computer
- ◯ UR10 cobot cell
- ◯ Yaskawa Collaborative Robot (20 Kg)
- ◯ Workstation ML and HoloLens

Figure 17 - Module Forms related to the QR Code fig.16.

Once the manager receives the certificates by email from the users, they have studied the manuals, he must scan the “Verifica Attestati” QR Code to confirm the validity of the documents by entering the User ID for the entrance to the lab.

Figure 18 - QR Code "Verifica Attestati"

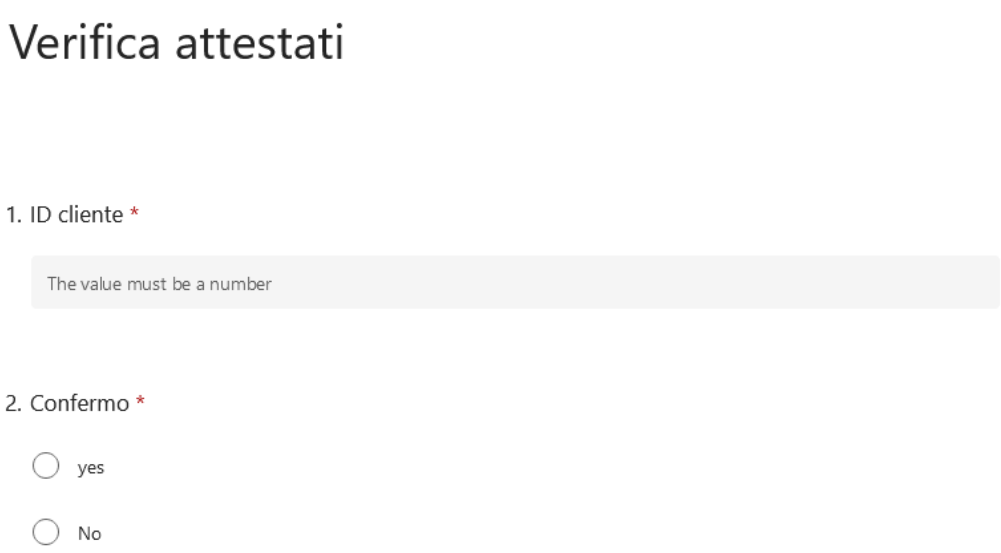


Figure 19 - Module Forms related to the QR Code fig.18.

Thereafter, an email will be automatically sent to the user with an invitation to join Microsoft Teams, where the guest can book specific days and time to join Mind4Lab. From this moment, the user can enter the lab independently and start using the assigned robot station.

This process is very important for the laboratory manager as it significantly helps in handling the bureaucracy tasks, thus reducing their workload. This way, the manager is free to organize his time for other tasks. This crucial analysis was conducted to reduce time waste and optimize laboratory management, highlighting the Lean Process.

The next need analyzed is keeping track of the time each robot is used. To solve this, two other QR Codes have been created for each robot station. The first QR code corresponds to the Start of use. It is created with Microsoft Forms, and it asks the ID given for entrance of the lab. It is used to keep track of the current user.

When the form is submitted, the completion time and ID are recorded in the specific sheet of that robot station in the Laboratory's Excel file.

A picture of this first QR code of the robot station called "Mobile Robot Arm" is reported.

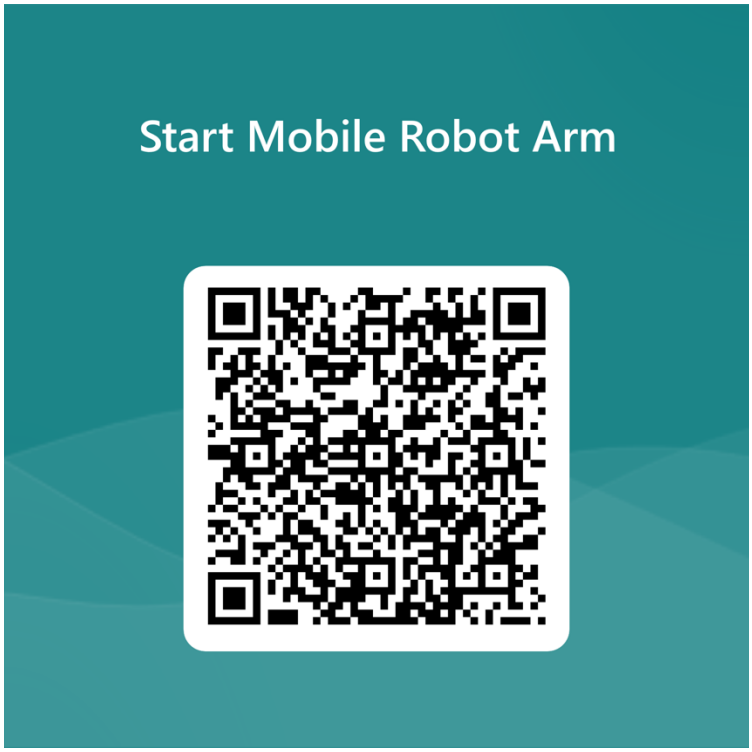


Figure 20 - QR Code "Start mobile robot" connected to the specific Mobile Robot Arm.

Figure 21 - Module Forms related to the QR Code fig.20.

Once the user finishes using it, he has to scan the final QR code to record the time used. The submission time, recorded as the end of the robot's utilization, is used to calculate the actual time spent on it. End use minus Start Use gives the actual time utilized.

Figure 22 - QR Code "Finish Mobile Robot Arm".

Figure 23 - Module Forms related to the QR Code fig.22.

This two QR Code are the same for each robot station but are named differently to save them into different sheets in the Excel file, keeping track of each robot's usage.

Finally, to have a quick view about the robot usage, another sheet in the Excel file, called "Robot Used", summarizes the total time from all pages of different robots, and a histogram graph is displayed. The graphs always help to highlight the data.

Flow Process analysis

The process explained in the previous chapter follows a Lean Service perspective, allowing the Mind4Lab laboratory manager to optimize his time effectively.

Before the implementation of the new flow process, the manager of Mind4Lab had to interrupt his own work to go to the main entrance, welcome the new user, and explain all the requirements necessary before entering the lab. Specifically, the manager had to manually share the link for Microsoft Teams group, write down the user's email, and explain all the required documentation.

With this new system, users can scan the QR code by themselves, significantly reducing the need for the manager to be interrupted for extended periods. It is no longer mandatory for the manager to be present during the user's first entrance to the lab. This allows the manager to optimize his time, avoiding unnecessary delays caused by bureaucratic tasks.

This process can help the manager to save at least 5 minutes for each user entering the Mind4Lab laboratory and especially the presence to the lab when new user arrives.

Another positive aspect is the management of documentation. Through this flow, users receive an email containing a share folder with all manuals for the robot. Then, they must reply to the email, sending the certificates included at the end of the manuals, which attest to their completion of the required study. The manager can choose to either print these documents or save them in a server folder. This option helps Politecnico optimize paper consumption and reduce waste.

Below is a flow chart of this specific process.

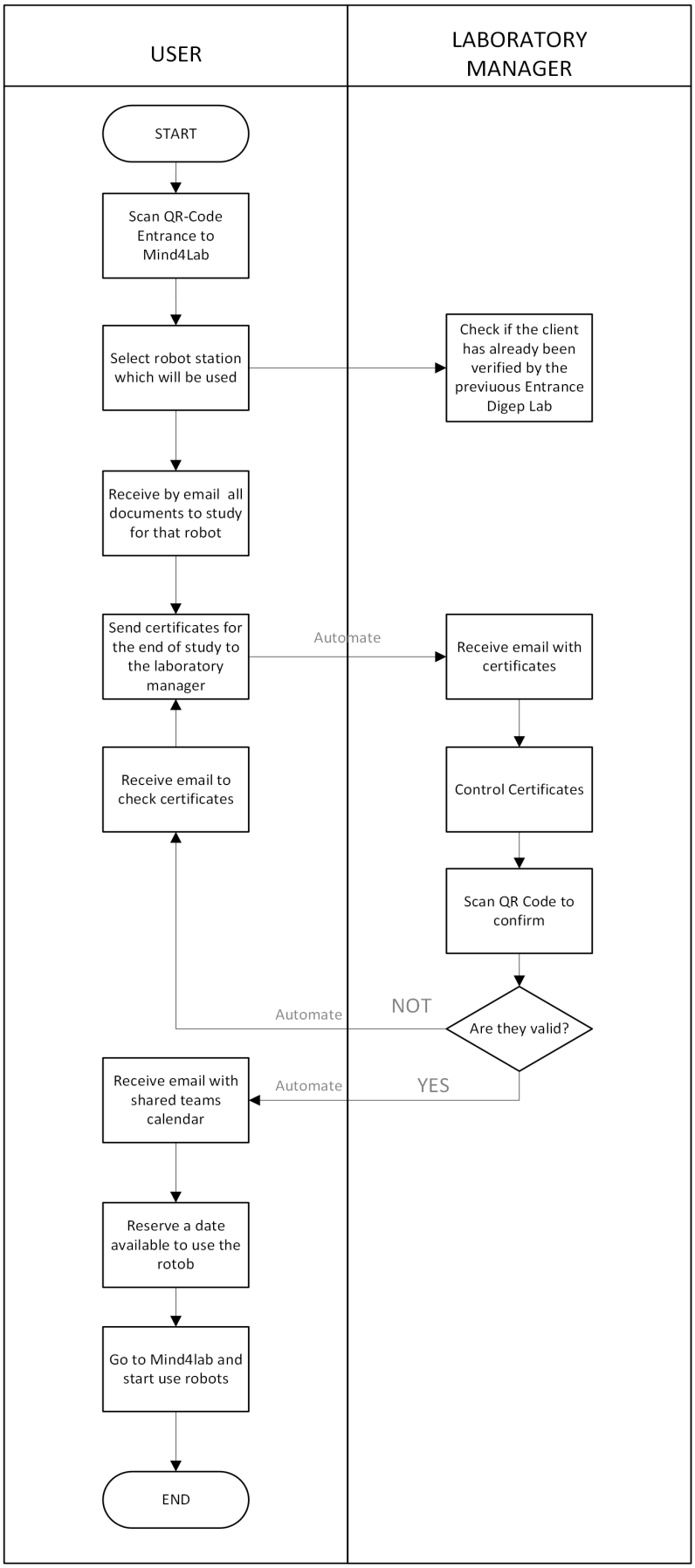


Figure 24 - Process Flow Chart of the new management system.

As shown in the flow chart, the manager's presence is not required at the beginning of the process, only to check if the user has already been verified at the main entrance of the DIGEP Lab. This verification can be done remotely since the manager will receive an email notification providing an affirmative or negative response, without needing to come to the lab. Since all data are reported and saved in a OneDrive Excel file, the manager only needs an electronic device.

Once the user sends to the manager an email with all the certificates, the manager must validate all documents. After validation, an automatic email will be sent to the user, inviting him to a share Teams calendar where he has to book a day and a time slot available for the robot request.

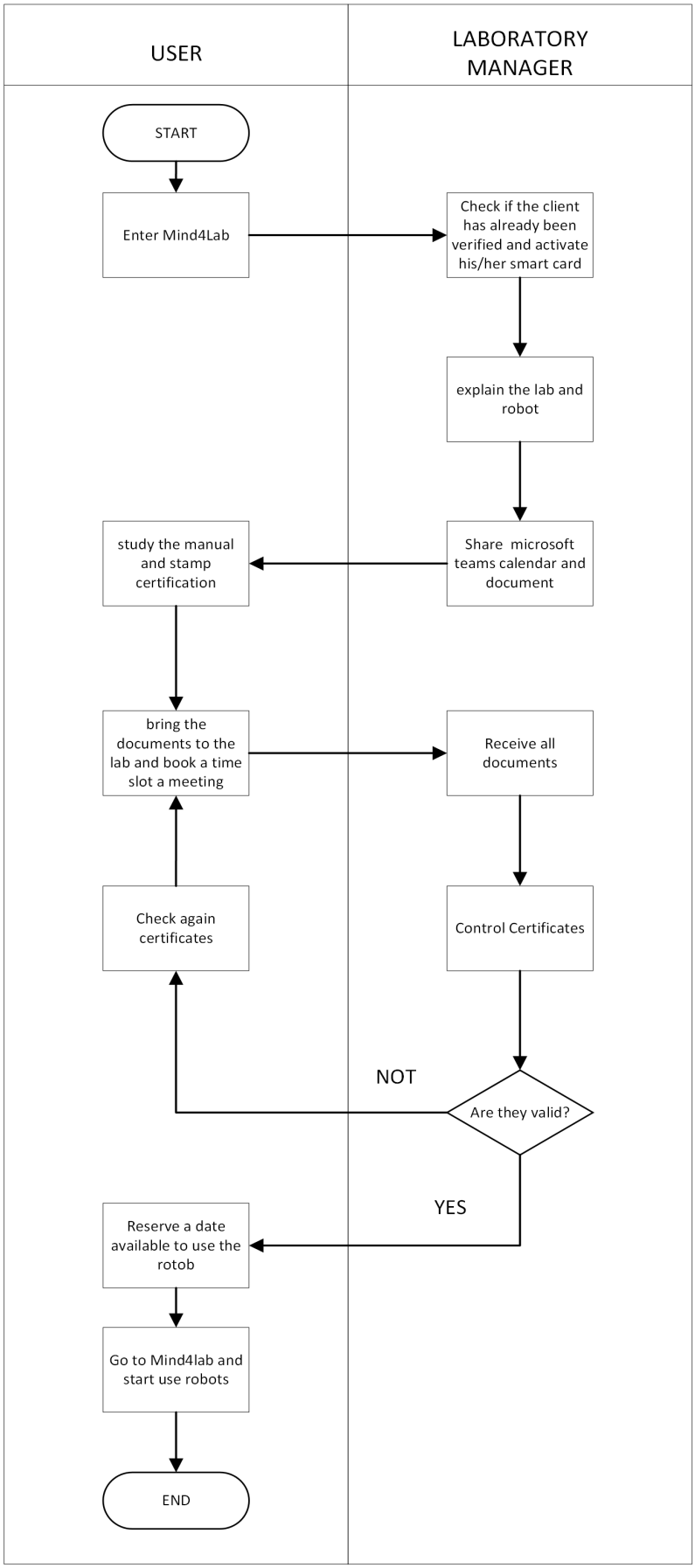


Figure 25 - Process Flow Chart of the previous management system.

The logic beyond the process

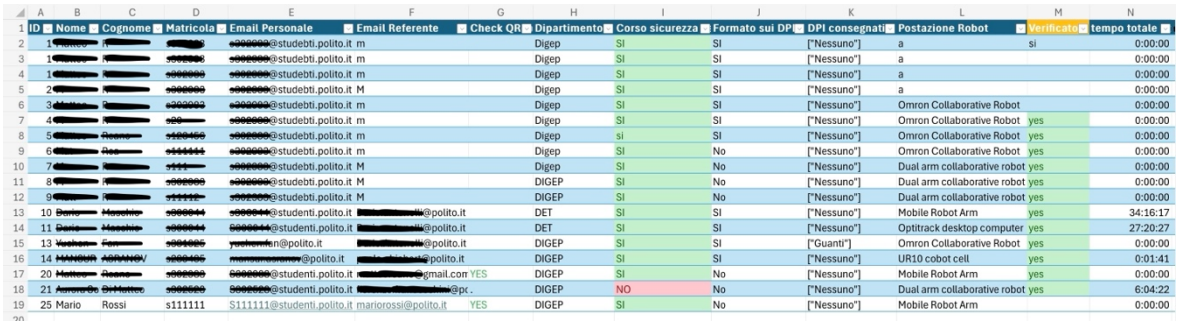
The process for entering the Mind4Lab laboratory has been streamlined using Power Automate, similar to the general entrance process.

This system integrates OneDrive, Microsoft Excel, Office365, Microsoft Forms, Outlook, and Microsoft Teams to create an efficient workflow.

Initially, a Microsoft Forms module was created to ask laboratory users a few key questions, such as the referent professor's email, department, confirmation of the safety course, use of any Personal Protective Equipment (DPI-PPE), and which robot will be used.

A screenshot of the module has been shown on the previous pages.

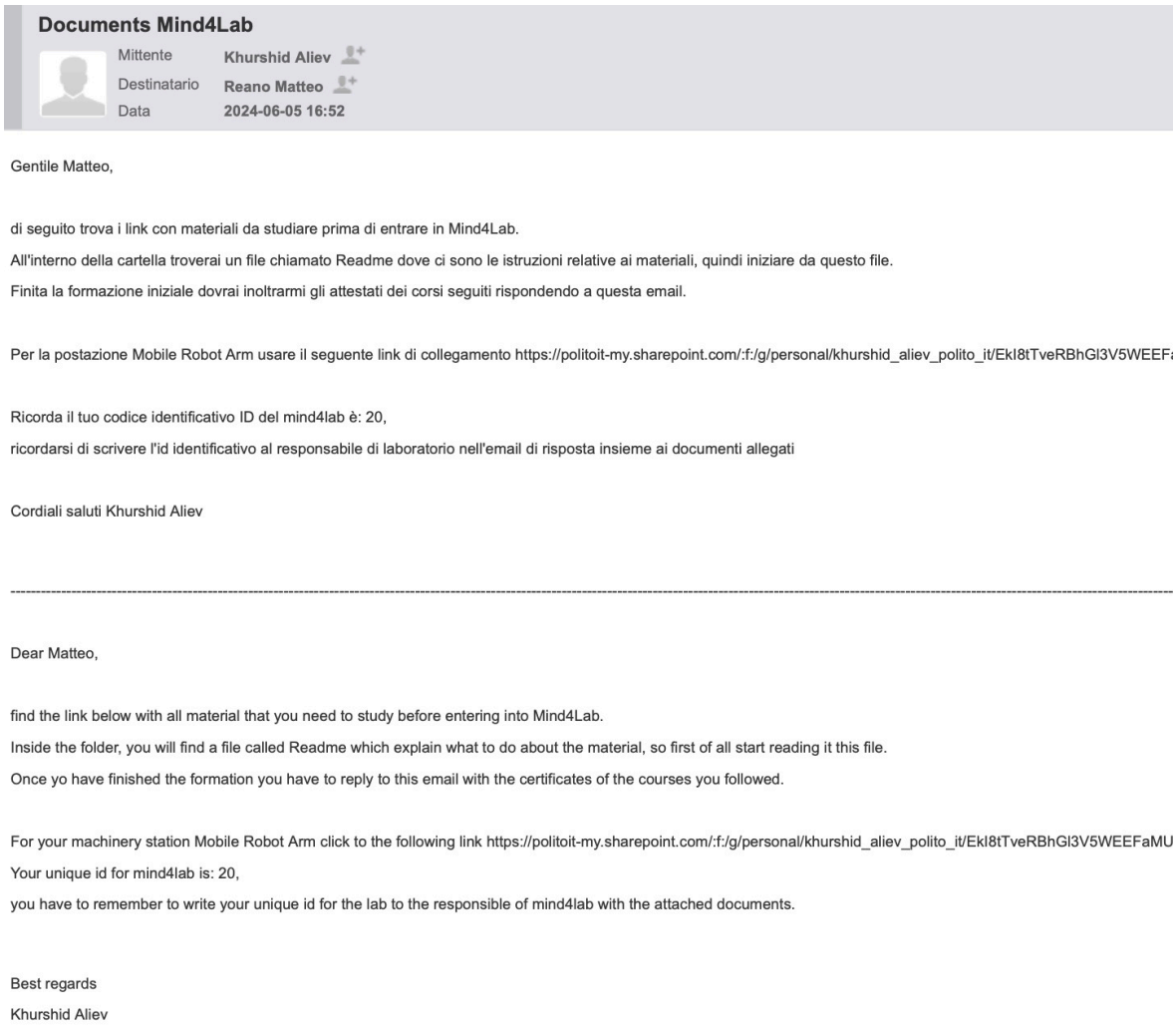
Once the user submits the form, Power Automate saves the data into an already created Excel file called "Mind4Lab laboratory" on OneDrive. The following screenshot illustrates the Excel file's layout. It is easy to understand, manage, and modify without any issues for the owner.



ID	Nome	Cognome	Matricola	Email Personale	Email Referente	Check QR	Dipartimento	Corso sicurezza	Formato sui DPI	DPI consegnati	Postazione Robot	Verificato	tempo totale
1	[redacted]			s[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	a	si	0:00:00
1	[redacted]			s[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	a		0:00:00
1	[redacted]			s[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	a		0:00:00
2	[redacted]			s[redacted]@studebti.polito.it	M		Digep	SI	SI	["Nessuno"]	a		0:00:00
3	[redacted]			s[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	Omron Collaborative Robot		0:00:00
4	[redacted]			s[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
5	[redacted]			s[redacted]@studebti.polito.it	m		Digep	si	SI	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
6	[redacted]			s[redacted]@studebti.polito.it	m		Digep	SI	No	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
7	[redacted]			s[redacted]@studebti.polito.it	M		Digep	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
8	[redacted]			s[redacted]@studebti.polito.it	M		DIGEP	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
9	[redacted]			s[redacted]@studebti.polito.it	M		DIGEP	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
10	Dario	Marchiò	s[redacted]	s[redacted]@studenti.polito.it	[redacted]@polito.it		DET	SI	SI	["Nessuno"]	Mobile Robot Arm	yes	34:16:17
11	Dario	Marchiò	s[redacted]	s[redacted]@studenti.polito.it	[redacted]@polito.it		DET	SI	SI	["Nessuno"]	Optitrack desktop computer	yes	27:20:27
13	[redacted]			[redacted]@polito.it	[redacted]@polito.it		DIGEP	SI	SI	["Guanti"]	Omron Collaborative Robot	yes	0:00:00
14	[redacted]			[redacted]@polito.it	[redacted]@polito.it		DIGEP	SI	SI	["Nessuno"]	UR10 cobot cell	yes	0:01:41
20	[redacted]			s[redacted]@studenti.polito.it	[redacted]@gmail.com	YES	DIGEP	SI	No	["Nessuno"]	Mobile Robot Arm	yes	0:00:00
21	[redacted]			s[redacted]@studenti.polito.it	[redacted]@pc.		DIGEP	NO	No	["Nessuno"]	Dual arm collaborative robot	yes	6:04:22
25	Mario	Rossi	s111111	S111111@studenti.polito.it	mariorossi@polito.it	YES	DIGEP	SI	No	["Nessuno"]	Mobile Robot Arm		0:00:00

Figure 26 - Excel file illustrating data saved from the Forms fig.16.

While the data is being written into the file, the user receives the following email explaining the steps he must follow in order to enter the lab.



Documents Mind4Lab

Mittente **Khurshid Aliev**
Destinatario **Reano Matteo**
Data **2024-06-05 16:52**

Gentile Matteo,

di seguito trova i link con materiali da studiare prima di entrare in Mind4Lab.
All'interno della cartella troverai un file chiamato Readme dove ci sono le istruzioni relative ai materiali, quindi iniziare da questo file.
Finita la formazione iniziale dovrai inoltrarmi gli attestati dei corsi seguiti rispondendo a questa email.

Per la postazione Mobile Robot Arm usare il seguente link di collegamento https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/EkI8tTveRBhGl3V5WEEF

Ricorda il tuo codice identificativo ID del mind4lab è: 20,
ricordarsi di scrivere l'id identificativo al responsabile di laboratorio nell'email di risposta insieme ai documenti allegati

Cordiali saluti Khurshid Aliev

Dear Matteo,

find the link below with all material that you need to study before entering into Mind4Lab.
Inside the folder, you will find a file called Readme which explain what to do about the material, so first of all start reading it this file.
Once yo have finished the formation you have to reply to this email with the certificates of the courses you followed.

For your machinery station Mobile Robot Arm click to the following link https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/EkI8tTveRBhGl3V5WEEFaMU
Your unique id for mind4lab is: 20,
you have to remember to write your unique id for the lab to the responsible of mind4lab with the attached documents.

Best regards
Khurshid Aliev

Figure 27 - E-mail received to the user after submission of QR Code fig.16.

The user needs to study the manuals in the folder shared via the email link and complete a certification that proves his studies. Inside the folder, there is a “Readme” document with instructions on how to navigate the folder, the order of manual, and other useful information. After studying manuals, the user must reply to the email with the certificates.

Once the Mind4Lab manager receives all the documents, he has to verify and confirm the validity using a specific QR Code, as shown in the previous pages.

After submission, the user receives the following email inviting him to join the Teams calendar group in order to book a time slot for the respective robot station.

link calendar
Mittente **Khurshid Aliev** Data **2024-05-27 14:37**

English below

Gentiale M ,

sei stato aggiunto nel team attraverso la tua mail personale dove potrai accedere al calendario teams microsoft.

Dovrai prenotarti nel calendario relativo al robot Omron Collaborative Robot che andrai ad utilizzare.

Saluti

KA

Dear M,

you have been added to the team with your personal email where you can access to calendar teams microsoft.

You have to book a time slot of your machinery station Omron Collaborative Robotthat you are going to use.

Best regards

KA

Figure 28 - E-mail received by the user after the confirm through QR code fig.18.

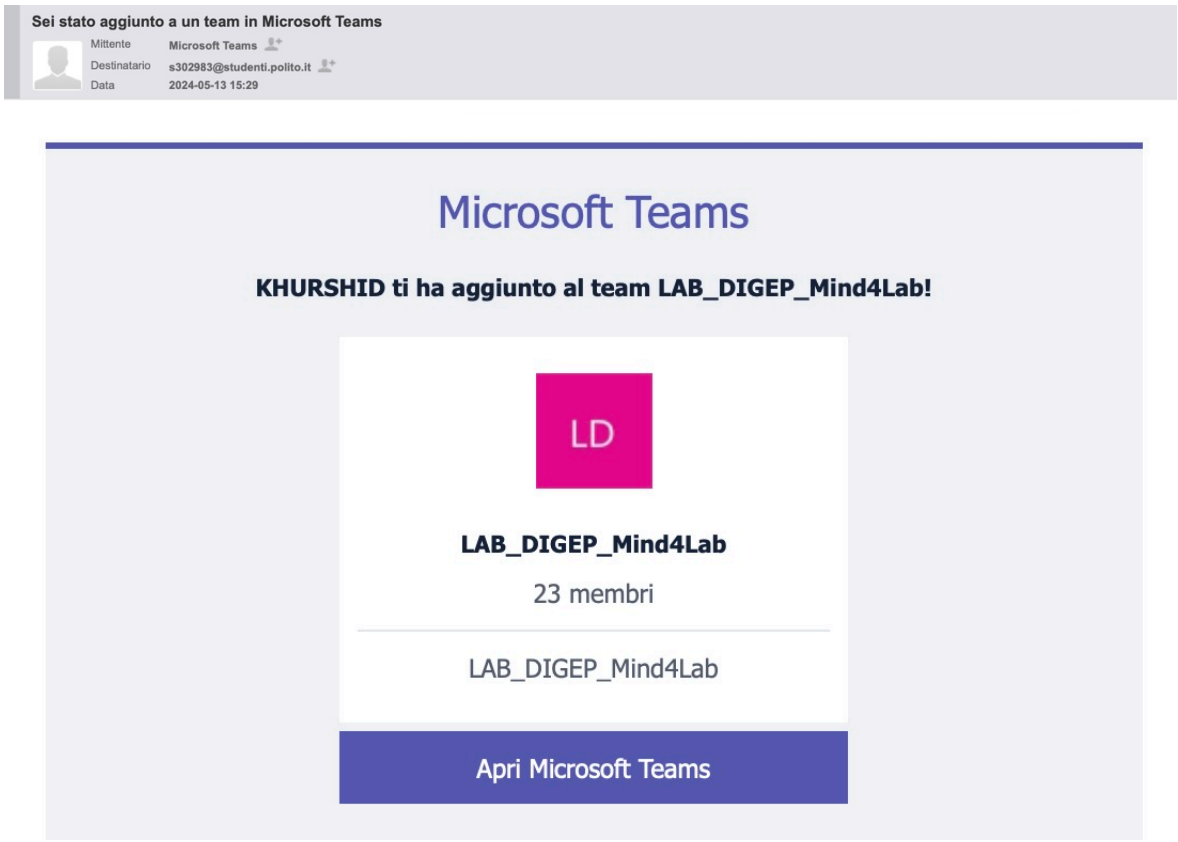


Figure 29 - E-mail received by the user in meanwhile of fig.28.

A screenshot of Teams calendar interface is provided once the user joins.

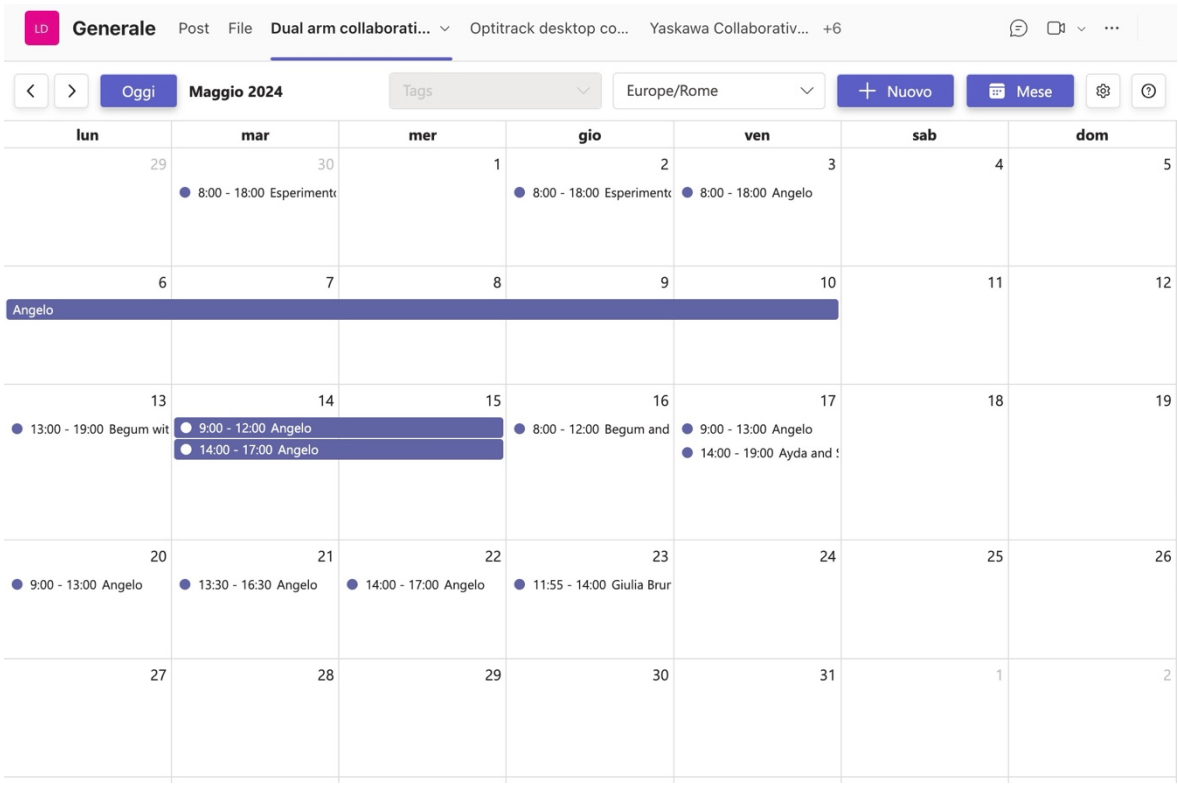
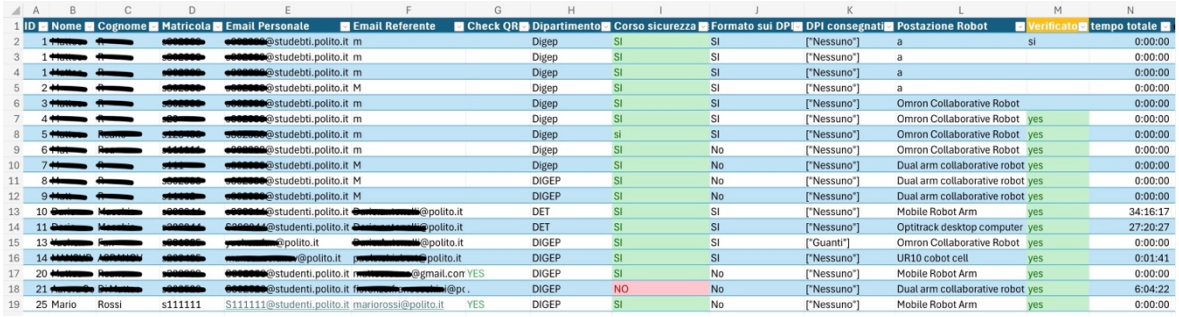


Figure 30 - Teams Calendar after joining through e-mail invitation fig.29.

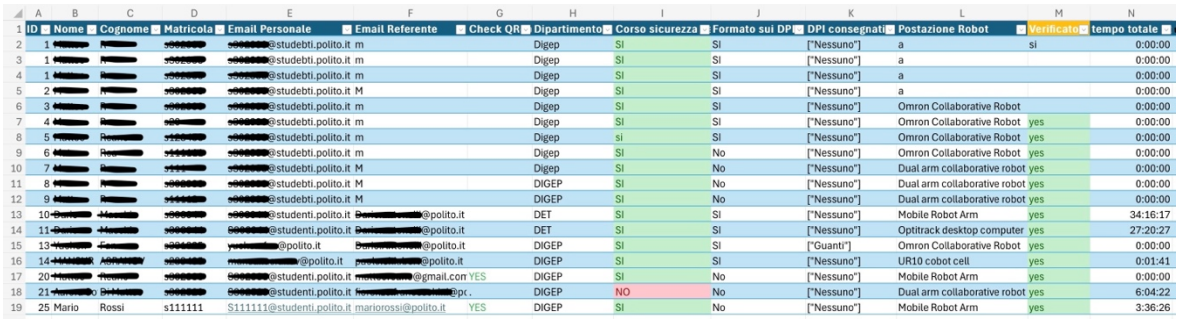
Meanwhile, the Excel file is updated in real-time to reflect the user's confirmation status, as shown in the following picture.



ID	Nome	Cognome	Matricola	Email Personale	Email Referente	Check QR	Dipartimento	Corso sicurezza	Formato sui DPI	DPI consegnati	Postazione Robot	Verificato	tempo totale
1	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	a	si	0:00:00
1	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	a		0:00:00
1	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	a		0:00:00
2	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	M		Digep	SI	SI	["Nessuno"]	a		0:00:00
3	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	Omron Collaborative Robot		0:00:00
4	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
5	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	si	SI	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
6	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	No	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
7	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	M		Digep	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
8	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	M		DIGEP	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
9	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	M		DIGEP	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
10	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it		DET	SI	SI	["Nessuno"]	Mobile Robot Arm	yes	34:16:17
11	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it		DET	SI	SI	["Nessuno"]	Optitrack desktop computer	yes	27:20:27
13	[redacted]	[redacted]	[redacted]	[redacted]@polito.it	[redacted]@polito.it		DIGEP	SI	SI	["Guanti"]	Omron Collaborative Robot	yes	0:00:00
14	[redacted]	[redacted]	[redacted]	[redacted]@polito.it	[redacted]polito.it		DIGEP	SI	SI	["Nessuno"]	UR10 cobot cell	yes	0:01:41
20	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@gmail.com	YES	DIGEP	SI	No	["Nessuno"]	Mobile Robot Arm	yes	0:00:00
21	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@pc.		DIGEP	NO	No	["Nessuno"]	Dual arm collaborative robot	yes	6:04:22
25	Mario	Rossi	s111111	S111111@studenti.polito.it	mariorossi@polito.it	YES	DIGEP	SI	No	["Nessuno"]	Mobile Robot Arm	yes	0:00:00

Figure 31 - Excel file updated after validation QR code fig.18.

As explained before, once the user is able to enter into Mind4Lab he can start using the robot station booked and the total time spent on that station is reported into the file excel as shown in the picture blow.



ID	Nome	Cognome	Matricola	Email Personale	Email Referente	Check QR	Dipartimento	Corso sicurezza	Formato sui DPI	DPI consegnati	Postazione Robot	Verificato	tempo totale
1	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	a	si	0:00:00
1	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	a		0:00:00
1	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	a		0:00:00
2	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	M		Digep	SI	SI	["Nessuno"]	a		0:00:00
3	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	Omron Collaborative Robot		0:00:00
4	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	SI	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
5	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	si	SI	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
6	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	m		Digep	SI	No	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
7	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	M		Digep	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
8	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	M		DIGEP	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
9	[redacted]	[redacted]	[redacted]	[redacted]@studebti.polito.it	M		DIGEP	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
10	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it		DET	SI	SI	["Nessuno"]	Mobile Robot Arm	yes	34:16:17
11	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it		DET	SI	SI	["Nessuno"]	Optitrack desktop computer	yes	27:20:27
13	[redacted]	[redacted]	[redacted]	[redacted]@polito.it	[redacted]@polito.it		DIGEP	SI	SI	["Guanti"]	Omron Collaborative Robot	yes	0:00:00
14	[redacted]	[redacted]	[redacted]	[redacted]@polito.it	[redacted]@polito.it		DIGEP	SI	SI	["Nessuno"]	UR10 cobot cell	yes	0:01:41
20	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@gmail.com	YES	DIGEP	SI	No	["Nessuno"]	Mobile Robot Arm	yes	0:00:00
21	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@pc.		DIGEP	NO	No	["Nessuno"]	Dual arm collaborative robot	yes	6:04:22
25	Mario	Rossi	s111111	S111111@studenti.polito.it	mariorossi@polito.it	YES	DIGEP	SI	No	["Nessuno"]	Mobile Robot Arm	yes	3:36:26

Figure 32 - Excel file updated after having user a robot station by the user, see column "Tempo totale".

A specific sheet that monitors all the robot station used has been created. There is illustrated for each ROBOT the number of people that used it, the number of times used, and the total time used.

While into the histogram graph has been reported the total time used for each robot. It is easier to have the whole picture of the time spent, it is possible to rank the robot from the most to the less used.

	A	B	C	D
1	ROBOT	number of people usin	Counting number used	total time used
2	ABB milling Robot cell	0	0	0:00:00
3	Automated Warehouse	0	0	0:00:00
4	Dual arm collaborative robot cell	4	3	6:04:22
5	Mobile Robot Arm	3	12	34:16:17
6	Omron Collaborative Robot	5	0	0:00:00
7	Optitrack desktop computer	1	10	27:20:27
8	UR10 cobot cell	1	1	0:01:41
9	Yaskawa Collaborative Robot (20 Kg)	0	0	0:00:00
10	Workstation ML and HoloLens	0	0	0:00:00

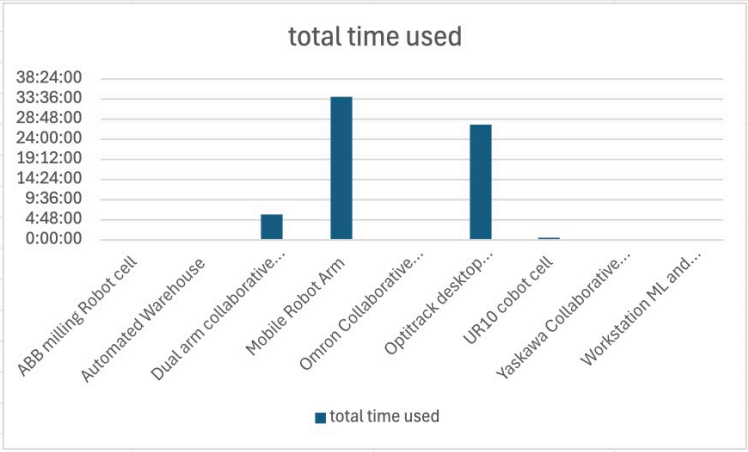


Figure 33 - Excel file sheet Robots illustrating the usage for each robot station.

This chapter demonstrates the overview of all saved data and processes. The file tracking the data is easy to understand and manage, and the owner can modify it like any normal Excel file. The only crucial data that should not be changed is the student's ID entrance, which is a progressive number indicating the response ID of the Forms module.

It is recommended to do not change, modify, columns of the Excel file since Power automate read the table.

Since all data are transferred using Power Automate, which generates the workflow, screenshots have been provided to illustrate the logic behind the process.

The first picture illustrates the flow connecting the initial QR code for entrance, the email system, and Excel file in order to keep track of users. It also connects to the general entrance Excel file to verify if the user has already been registered by the general entrance manager of DIGEP labs.

Currently, there are some issues with the process. Once the flow is generated, the general Excel file does not update for future entries. As a result, the Mind4Lab manager has to manually check new users comparing the two Excel files.

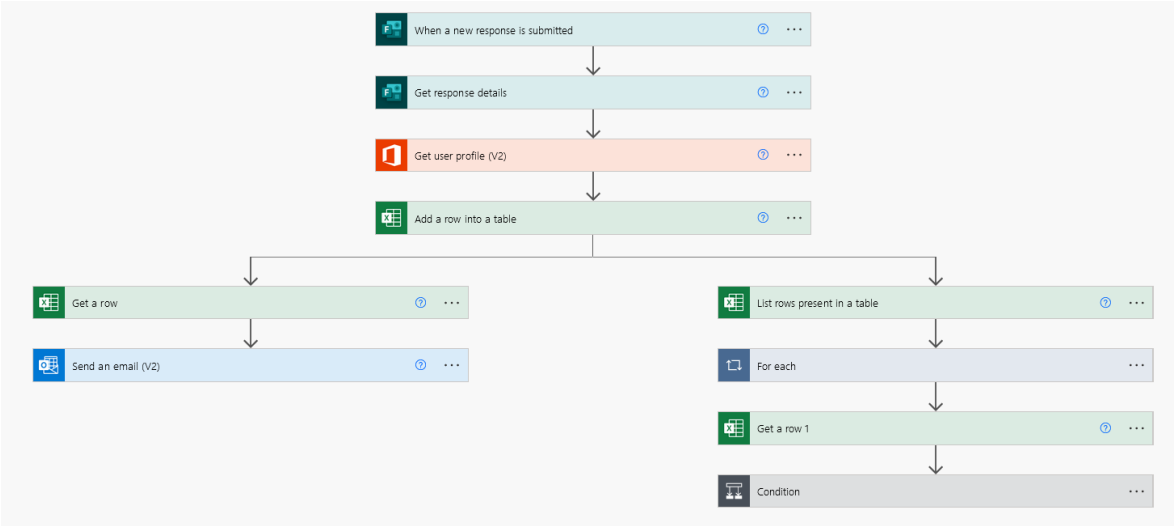


Figure 34 - Power Automate flow related to QR Code fig.16.

The picture below is an extract of the previous one. It represents the “Get a row 1” and “Condition” used to verify if the last user entered into the Lab was already verified by the general entrance DIGEP labs.

The actual flow is reported into the appendix.

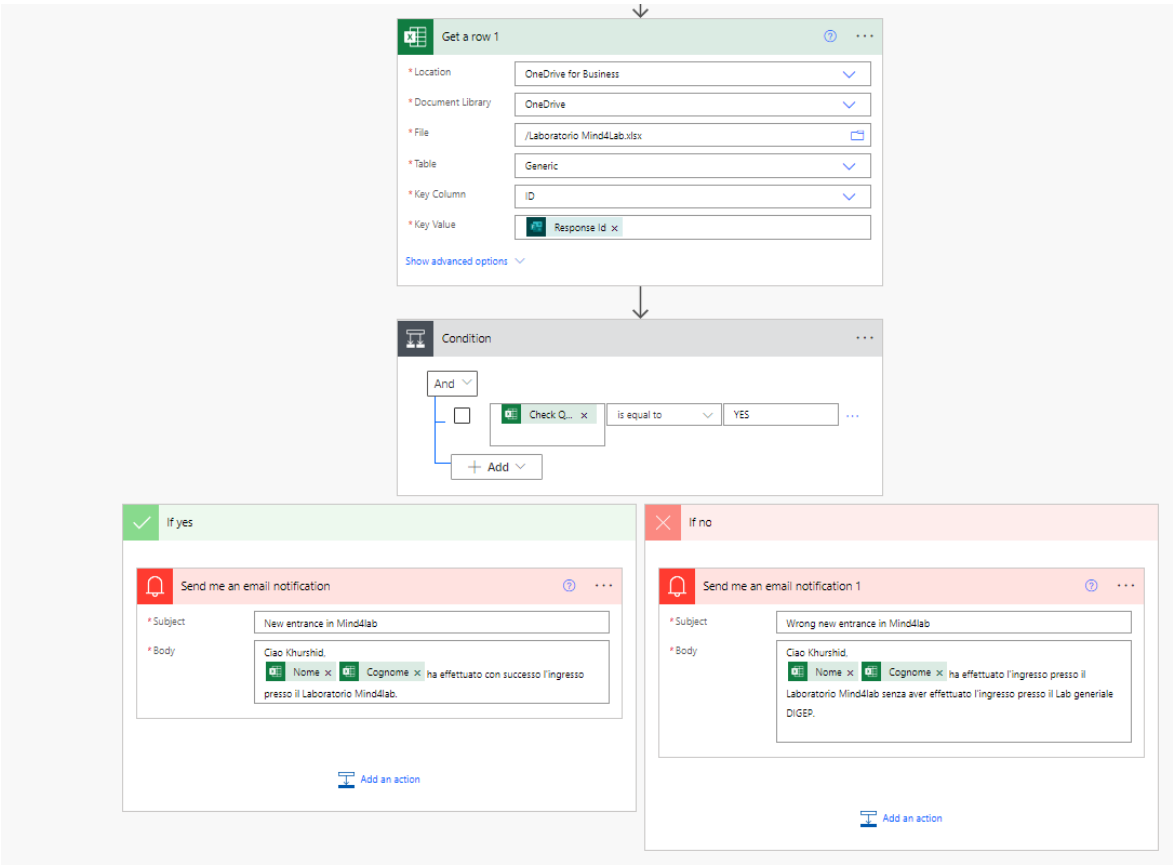


Figure 35 - Power Automate condition of the previous fig.34.

While the next picture explains the logic for the second QR code used to confirm the validity of documents and invite the user to join Microsoft Teams calendar.

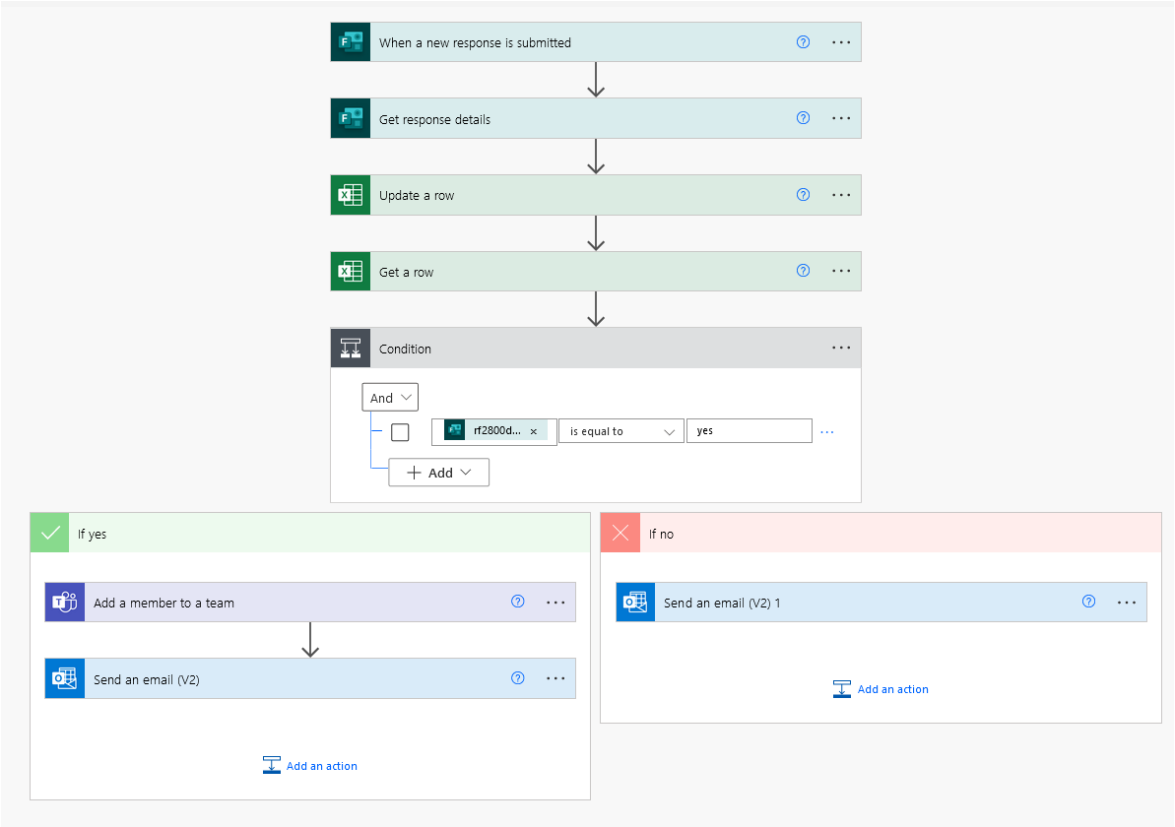


Figure 36 - Power Automate flow related to the QR Code fig.18.

The following two pictures illustrate the logic flow for tracking the use of each robot.

The first one represents the start of use, adding a new row into the Excel file.

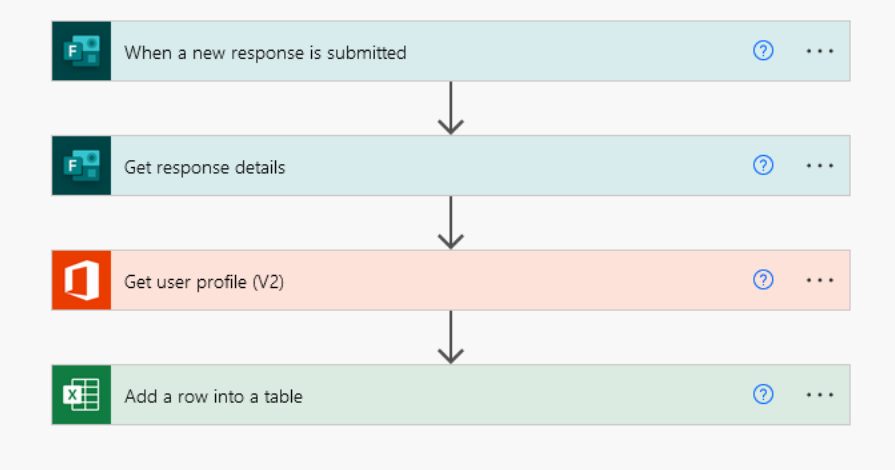


Figure 37 - Power Automate flow related to the QR code fig.20.

This second one illustrates the logic to update the specific user's row in the Excel file, recording the finish time to calculate the total time spent on that robot.

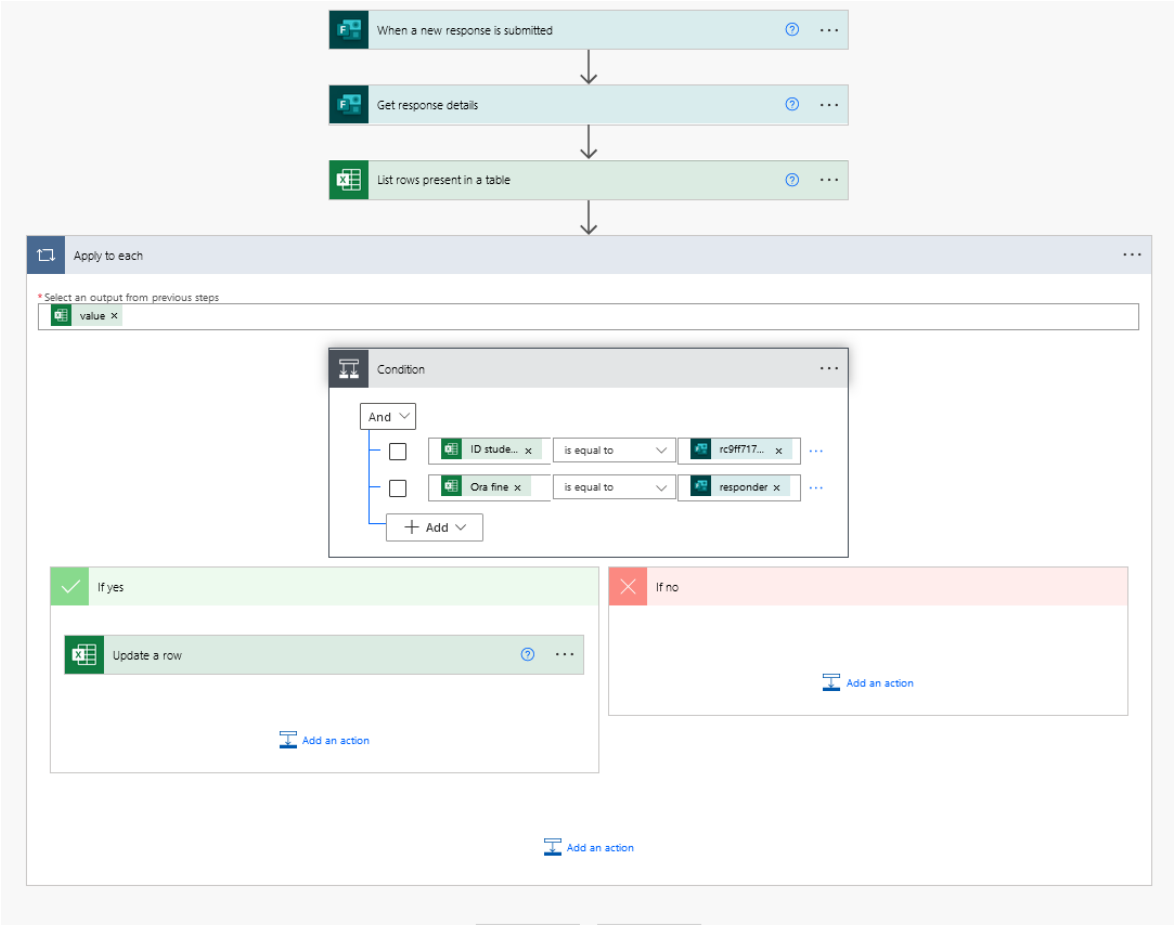


Figure 38 - Power Automate flow related to the QR code fig.22.

Improvement proposals

Afterwards developing the new management system, a critical analysis has been done. All systems can be always updated, optimized since the technology move forwards each year, even more quick.

I analyzed the process and I found critical aspect.

The first one is about the QR code Flow, and the other is an optimization of tracking the energy consumption and the usage of each machinery.

Flow QR-Code

The first crucial improvements are related to the security of the QR code Flow.

It is necessary to create a strictly flow of Form module, or other modules, that allow the use to scan a QR code only if he has already succeeded the previous one.

At the moment there are no limits on the Forms modules, everyone is allowed to scan all QR code, excepted the one to verify certifications that are restricted to the manager's email.

After the creation of a specific flow of QR codes, only a one-way flow, the consecutive improvement could be a creation of QR codes connected directly to the machinery. Once the user scan the Start use robot, the machinery will turn on automatically. The same for the end use of it.

This implementation is very important for the labs since it would consolidate the security of the usage of each robot and keeping track of the exact user of it.

Programmable Logic Controller – PLC

The second improvement proposal is related to the exact energy consumption of the machineries.

Programmable Logic Controller, known as PLC, is an industrial computer adapted for controlling and monitoring the manufacturing processes, they are used for automation control.

Since automation control refers also to industries 4.0, they are considered as a fundamental part for the transaction into next generation industries and the government allows the buyer to a discount of the product as a reduction of taxes spent at the end of the working year.

Nowadays there are such as variety of PLC that the user can choose the one that fits his interests. Each PLC has its own language to customize a software for specific needs.

The Programmable Logic Controller connects different types of sensors of machineries to a software that elaborates those input into output and it will send those data to a computer with a monitor that allows the user to understand the output, viewing data.

For example, if energy consumption sensors are connected to all machinery, then the plc will analyze the data received and once the user wants to read the output, the software will show the exact energy consumption for each machinery in the monitor.

This improvement allows managers to have the specific consumption for each machinery and save them into a server giving the possibility to make a quantitative analysis at the end of a period of interest.

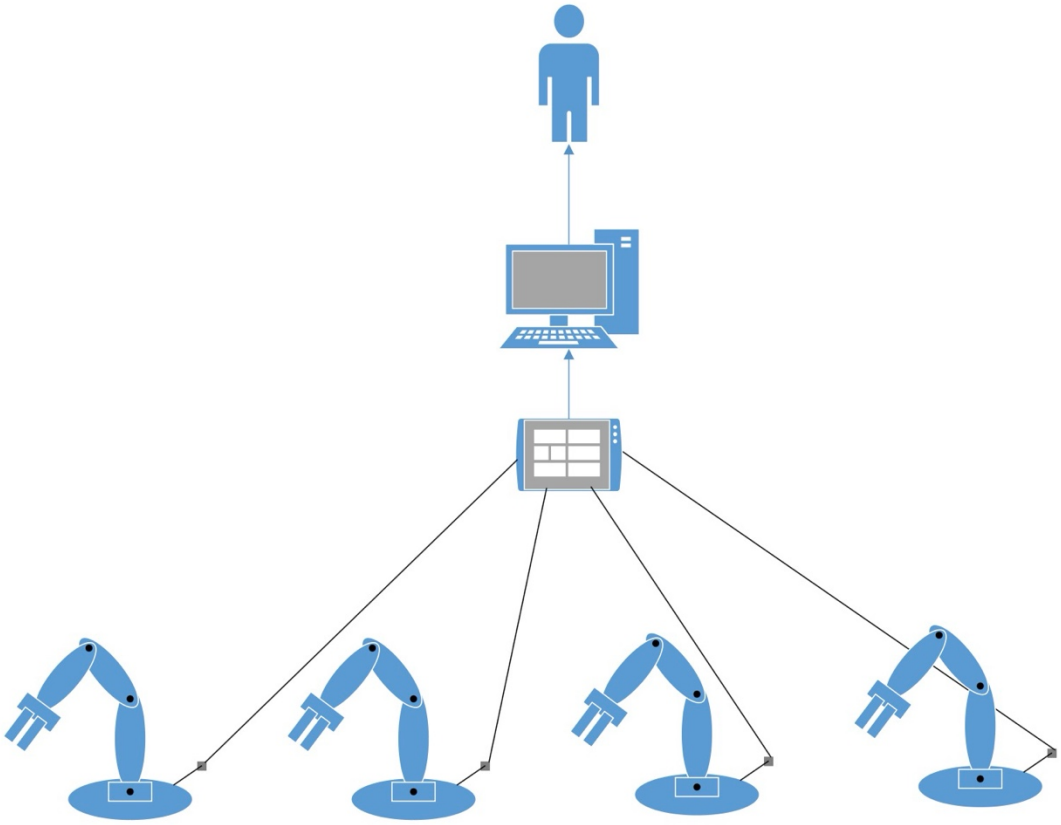


Figure 39 - Possible solutions using PLC connecting all robots and displaying data in the monitor.

The image above represents a possible solution using a Programmable Logic Controller. Each robot is connected to the PLC which elaborates the input received and it will send the data via wireless or cable. Those will be read by the final user through a monitor.

A possible electric scheme is reported in the following picture. Is a draft copy that illustrates the facility of connecting a robot to a PLC which displays the data output in a monitor.

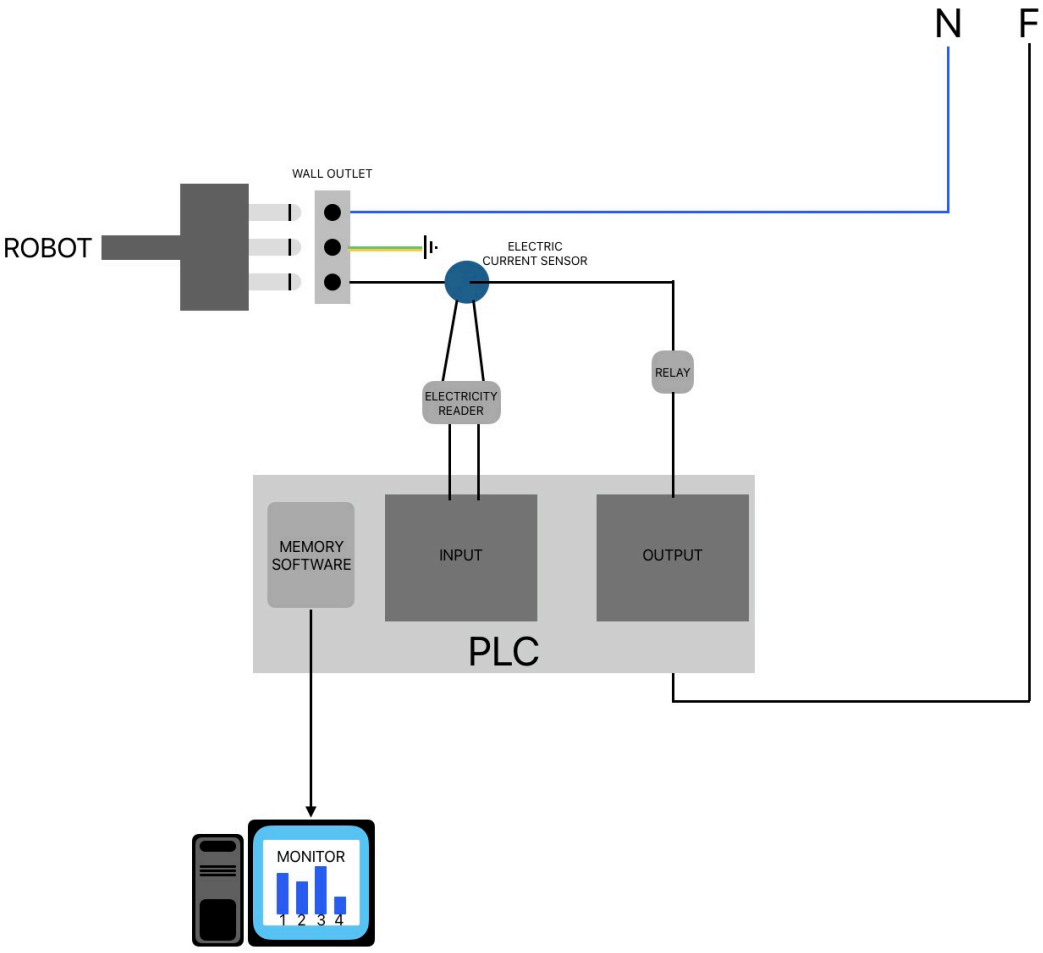


Figure 40 - Example of how to connect a PLC to the wall outlet of the robot.

Conclusions

I started my thesis by analyzing the existing process developed in the Workshop and with a deep focus on Lean Service, I optimized the flow process changing it and I extended it into Mind4Lab.

This laboratory was my focus because the manager requested a management system that satisfied all the requirements.

The thesis succeeded on it and at the end I found out some next solution for critical point analyzed.

While I was developing the process flow some professors and other laboratories managers were really interested on it, congratulating me and they asked me how it works. This feedback and the focus on Lean Service gave me the idea to develop standardized instructions creating a manual of the process.

This manual has the scope to help managers to extend my process to their own laboratory.

The process flow created optimize and track the user's data and reduce the wasting time for the managers.

Lean means effective and streamlined processes understanding which activities add values to for the customer, eliminating waste. This was the aim of the thesis.

Appendix

The following appendix provides manual instructions for laboratory managers to expand the new management system. Pay attention to the picture below to understand the management system developed for this thesis.

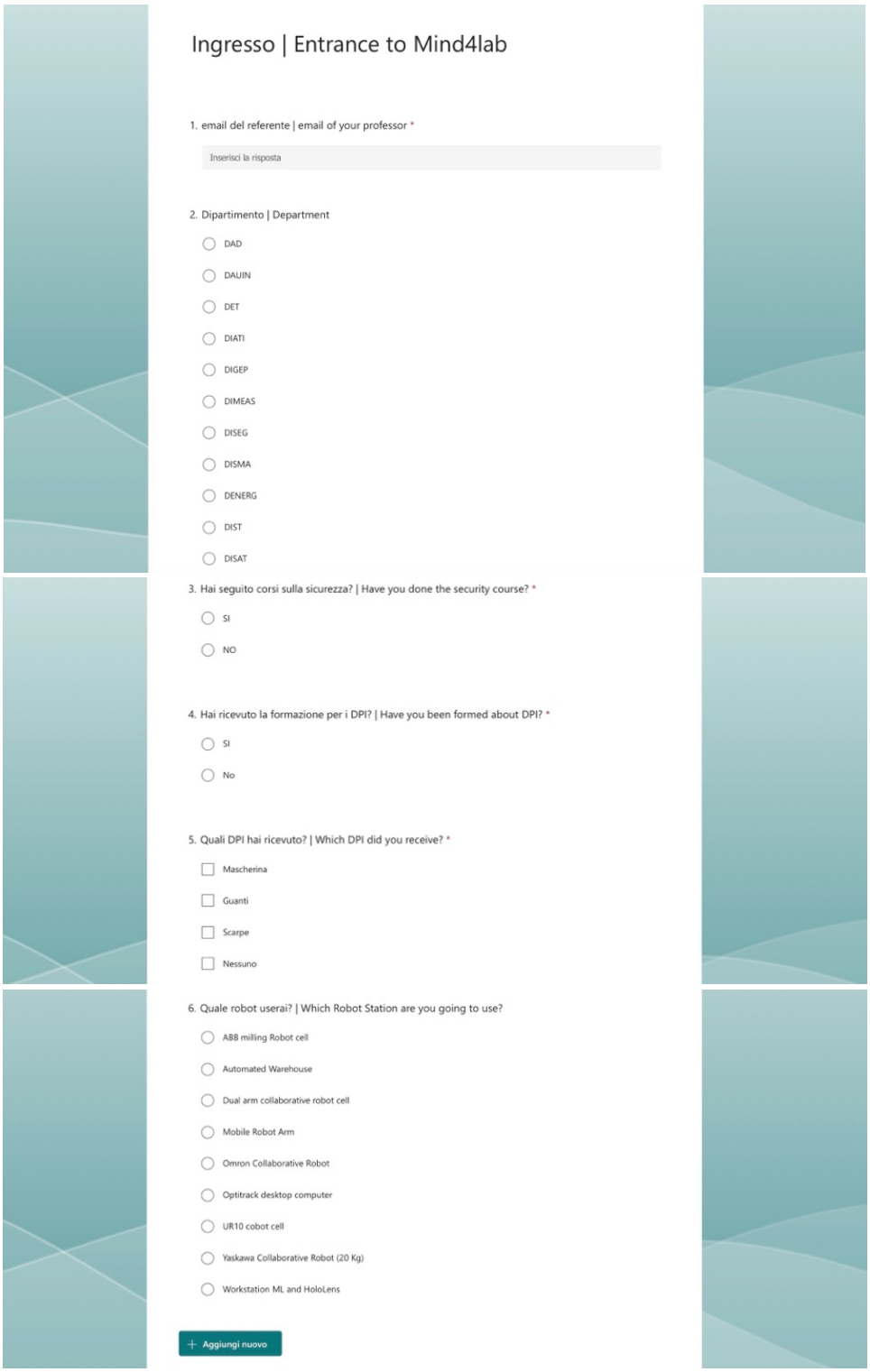
First, the managers need to create a Microsoft Office account with Politecnico credentials, if they haven't already done it.

After that, log in to OneDrive and create an Excel file. Insert a Table and add as many columns as needed, naming them with titles that represent the data. Then, go to "Table Design" and name the table as you prefer.

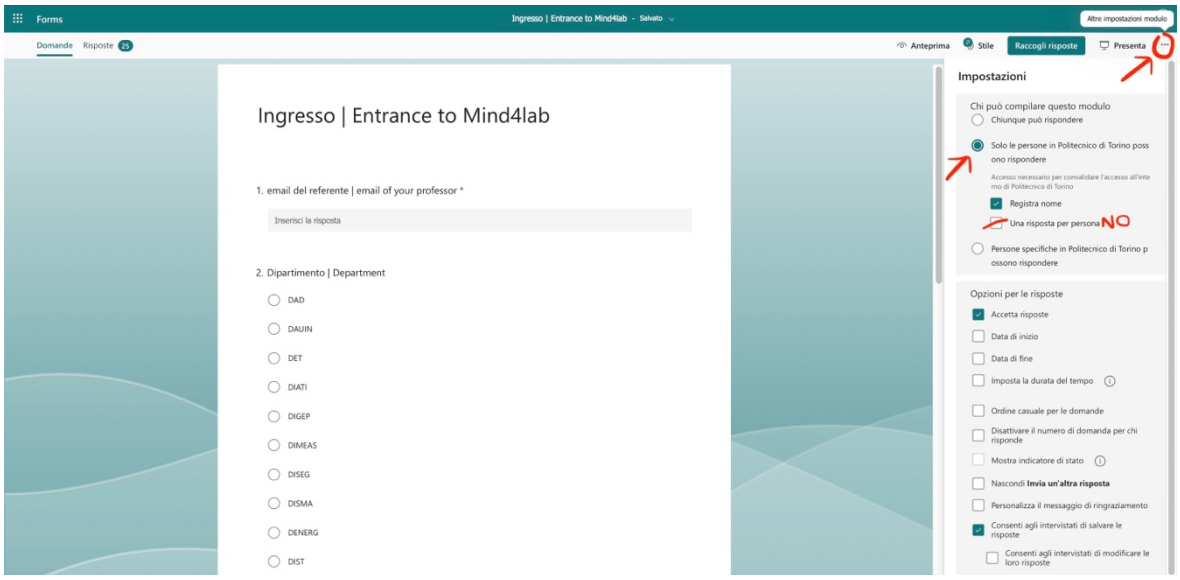
The Excel file, table name, and columns titles will be connected to Power Automate. After naming them, do not make any changes, as this will disrupt the automated flow.

The second step before opening Power automate is to create a Microsoft Forms with all questions required to collect data, which will be saved in each row of the Excel table, specifying the columns.

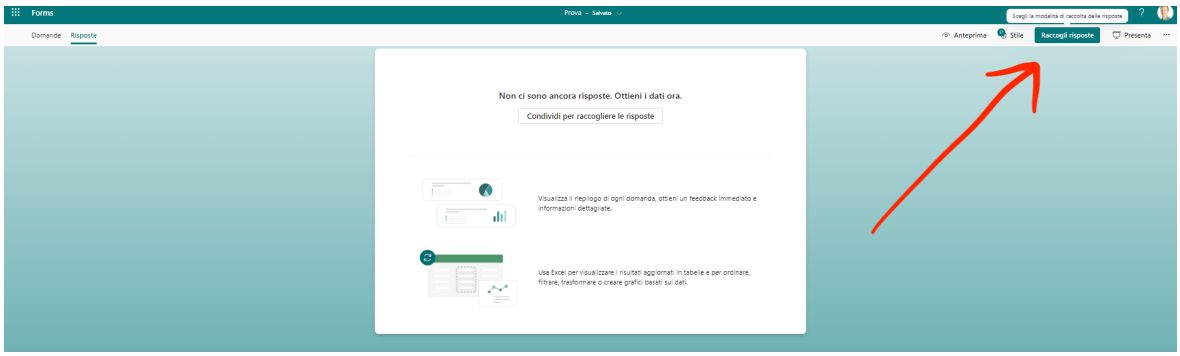
The following pictures illustrates the creation of a Form module related to the Entrance to Mind4Lab.



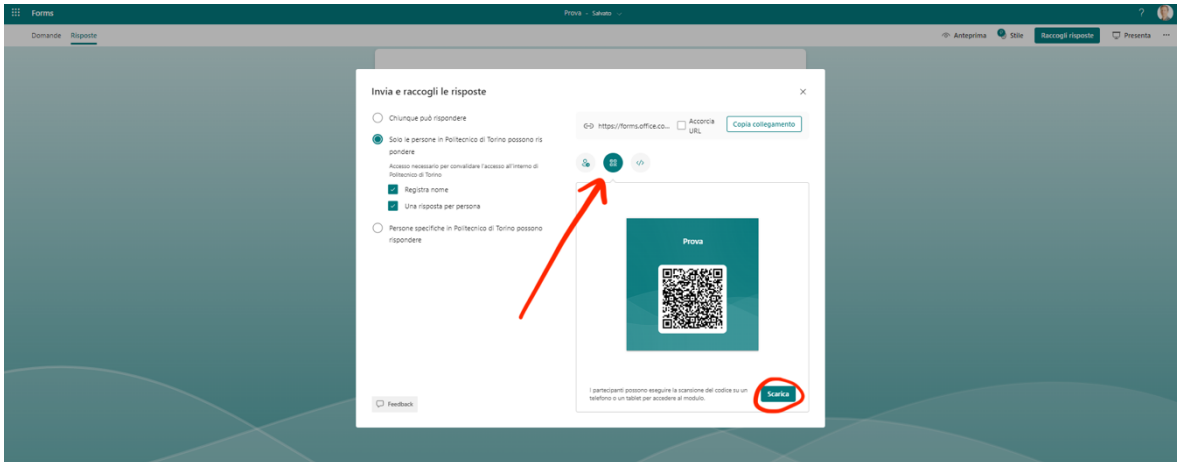
Before sharing, make sure that it will be available to Politecnico users. To limit access, click the three dots in the top right corner of the screen (as showed), and choose the option “only Politecnico users”. After that, click the “raccogli risposte” or “collect responses” button to share the module.



Do not select “una risposta per persona”.



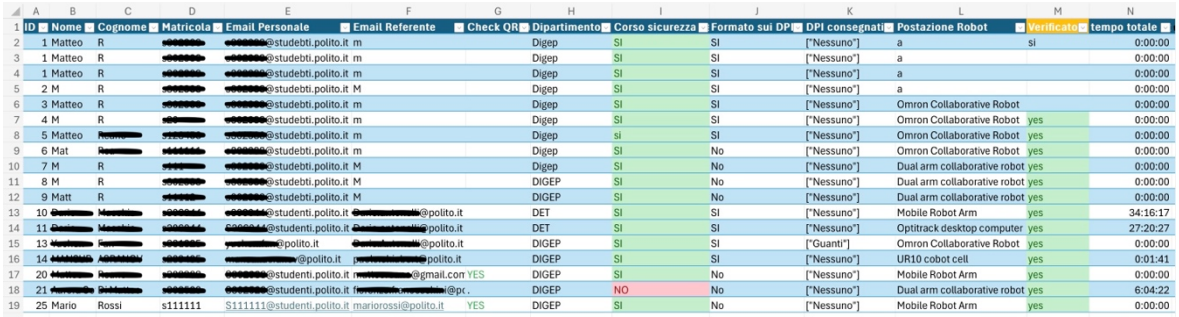
The share button will show you different option to share the module, the one I have used is QR Code.



Click the “scarica” or “download” button and print it, then display the QR code in the preferred location in the lab.

After creating a Microsoft Form and an Excel file, you can start using the Power Automate application.

The following pictures illustrate the different pages of excel file related to Mind4lab, each table and column has been named to be used by Power Automate.



ID	Nome	Cognome	Matricola	Email Personale	Email Referente	Check QR	Dipartimento	Corso sicurezza	Formato sui DPI	DPI consegnati	Postazione Robot	Verificato	tempo totale
1	Matteo	R	[redacted]	[redacted]@studenti.polito.it	m		Digep	SI	SI	["Nessuno"]	a	si	0:00:00
1	Matteo	R	[redacted]	[redacted]@studenti.polito.it	m		Digep	SI	SI	["Nessuno"]	a		0:00:00
1	Matteo	R	[redacted]	[redacted]@studenti.polito.it	m		Digep	SI	SI	["Nessuno"]	a		0:00:00
2	M	R	[redacted]	[redacted]@studenti.polito.it	M		Digep	SI	SI	["Nessuno"]	a		0:00:00
3	Matteo	R	[redacted]	[redacted]@studenti.polito.it	m		Digep	SI	SI	["Nessuno"]	Omron Collaborative Robot		0:00:00
4	M	R	[redacted]	[redacted]@studenti.polito.it	m		Digep	SI	SI	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
5	Matteo	[redacted]	[redacted]	[redacted]@studenti.polito.it	m		Digep	si	SI	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
6	Mat	[redacted]	[redacted]	[redacted]@studenti.polito.it	m		Digep	SI	No	["Nessuno"]	Omron Collaborative Robot	yes	0:00:00
7	M	R	[redacted]	[redacted]@studenti.polito.it	M		Digep	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
8	M	R	[redacted]	[redacted]@studenti.polito.it	M		DIGEP	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
9	Matt	R	[redacted]	[redacted]@studenti.polito.it	M		DIGEP	SI	No	["Nessuno"]	Dual arm collaborative robot	yes	0:00:00
10	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it		DET	SI	SI	["Nessuno"]	Mobile Robot Arm	yes	34:16:17
11	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@polito.it		DET	SI	SI	["Nessuno"]	Optitrack desktop computer	yes	27:20:27
13	[redacted]	[redacted]	[redacted]	[redacted]@polito.it	[redacted]@polito.it		DIGEP	SI	SI	["Guanti"]	Omron Collaborative Robot	yes	0:00:00
14	[redacted]	[redacted]	[redacted]	[redacted]@polito.it	[redacted]polito.it		DIGEP	SI	SI	["Nessuno"]	UR10 cobot cell	yes	0:01:41
20	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@gmail.com	YES	DIGEP	SI	No	["Nessuno"]	Mobile Robot Arm	yes	0:00:00
21	[redacted]	[redacted]	[redacted]	[redacted]@studenti.polito.it	[redacted]@pc.		DIGEP	NO	No	["Nessuno"]	Dual arm collaborative robot	yes	6:04:22
25	Mario	Rossi	s111111	S111111@studenti.polito.it	mariorossi@polito.it	YES	DIGEP	SI	No	["Nessuno"]	Mobile Robot Arm	yes	0:00:00

This is the general sheet named generic and the table is named “Generic”. Remember the table name.

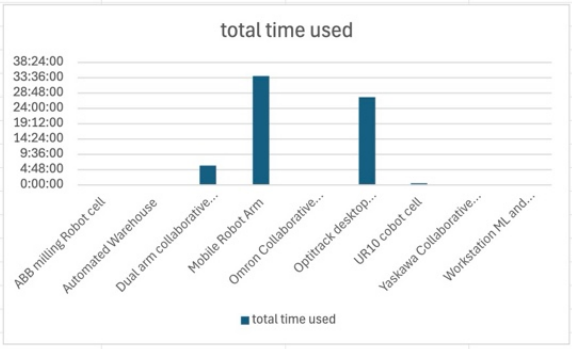
ID studente	Matricola	Giorno	Ora inizio	Ora fine	tempo totale
10	[redacted]	5/30/2024	10:03:05	11:19:48	1:16:43
10	[redacted]	5/30/2024	11:55:03	14:19:37	2:24:34
10	[redacted]	5/31/2024	7:33:10	13:15:58	5:42:48
10	[redacted]	6/3/2024	7:53:40	10:48:24	2:54:44
10	[redacted]	6/3/2024	12:50:29	13:47:01	0:56:32
10	[redacted]	6/4/2024	7:47:10	10:21:37	2:34:27
10	[redacted]	6/4/2024	10:54:57	13:47:48	2:52:51
10	[redacted]	6/5/2024	10:08:49	11:06:34	0:57:45
10	[redacted]	6/5/2024	12:22:47	14:28:55	2:06:08
10	[redacted]	6/6/2024	7:47:08	10:38:33	2:51:25
10	[redacted]	6/12/2024	8:36:13	14:38:07	6:01:54
10	[redacted]	6/13/2024	10:55:22	14:31:48	3:36:26
10	[redacted]	6/18/2024	11:54:15	14:28:29	2:34:14
10	[redacted]	6/19/2024	9:24:49	15:40:16	6:15:27
10	[redacted]	6/20/2024	8:24:46	14:48:56	6:24:10
10	[redacted]	6/21/2024	6:15:29	9:25:32	3:10:03
10	[redacted]	6/25/2024	7:06:37	14:57:39	7:51:02

This is the sheet related to the specific robot station Dual Arm, and the table name is “MobileRobotArm”. In the table records the laboratory students’IDs and their personal ID, tracking the start and end time and calculating the total time in the last column.

Postazione Robot	link collegamento
ABB milling Robot cell	https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/EpxtxdMuNY5Jlfz-1p7vBt4BBvN-U9TDChP4i--AGn03VA?e=Nvv9dP
Automated Warehouse	https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/EsGP5-a6N_tDhFPHnZTgazkBt95qnmIUjSgtTIXANTtQHA?e=SrUhVn
Dual arm collaborative robot cell	https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/Eq0BltUv-llAmHMary9n1s8B9i5VP-VzWEJrXi118EKxJA?e=A7c57A
Mobile Robot Arm	https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/Ekl8tTveRBhGl3V5WEEFaMUB_tGskvdlgfdBIsH-QGrPbw?e=Ra89AH
Omron Collaborative Robot	https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/Ep2qghvtdcpAmprSXBtBZPQBAQdFFDDoQkwR9fhnYmKfkw?e=dLJdbF
Optitrack desktop computer	https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/Eo_9tGNmqbVCqZ0xeX4T-xwBtn0IpLtEyhDQJI3EY4Ak7A?e=Tf1P1f
UR10 cobot cell	https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/EvM2FT_gg3FGihVCNRU-NGkBQvGwzix74XzqHDAvhuTYOQ?e=UVQaHi
Yaskawa Collaborative Robot (20 Kg)	https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/ElBdDx84kPtKrq_45ibETK4BZKjXg1JKvUvPKqGlv6QTdA?e=KiHr9t
Workstation ML and HoloLens	https://politoit-my.sharepoint.com/:f:/g/personal/khurshid_aliev_polito_it/ElxG65TwMT9EkJLUQgj9n5ABErHk6aR2FCWGf1sRm7JesA?e=rXvxSG

The picture above illustrates the table named “Postazioni”, which contains, for each robot station, the specific folder link in OneDrive.

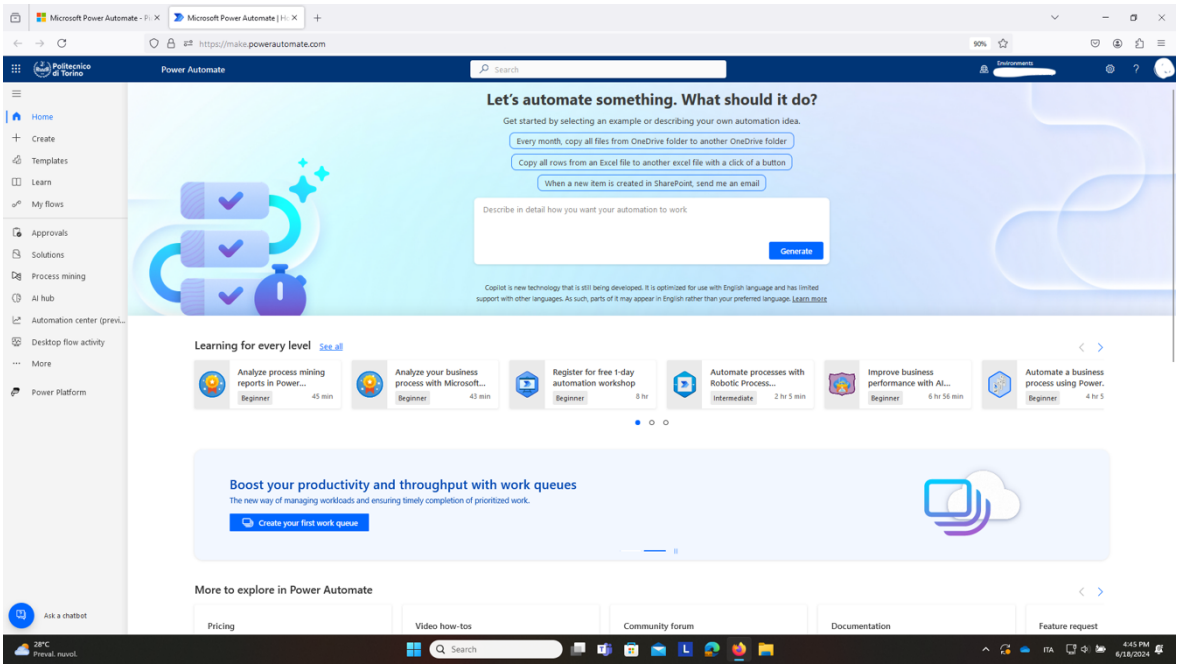
ROBOT	number of people usin	Counting number used	total time used
ABB milling Robot cell	0	0	0:00:00
Automated Warehouse	0	0	0:00:00
Dual arm collaborative robot cell	4	3	6:04:22
Mobile Robot Arm	3	12	34:16:17
Omron Collaborative Robot	5	0	0:00:00
Optitrack desktop computer	1	10	27:20:27
UR10 cobot cell	1	1	0:01:41
Yaskawa Collaborative Robot (20 Kg)	0	0	0:00:00
Workstation ML and HoloLens	0	0	0:00:00



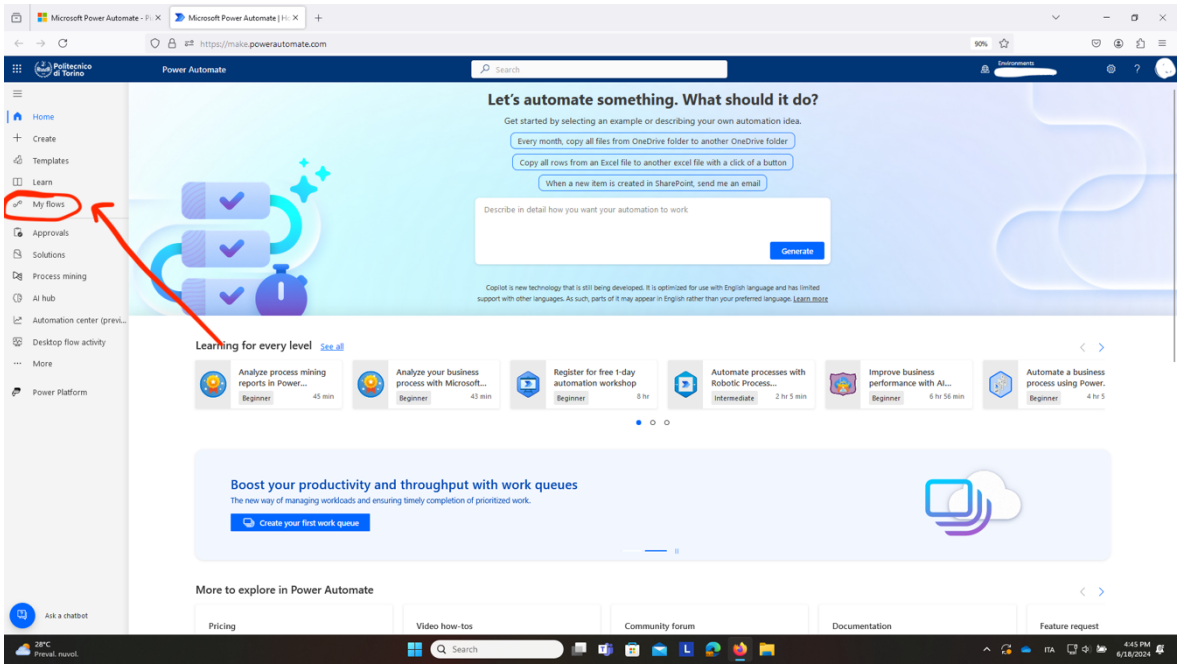
As explained in the previous chapter, this table has been created to calculate the total time used for each robot station, and the results are extrapolated into the histogram chart.

Now it is possible to start using Power automate. Go to the website www.powerautomate.com and log in with your Politecnico Microsoft credentials.

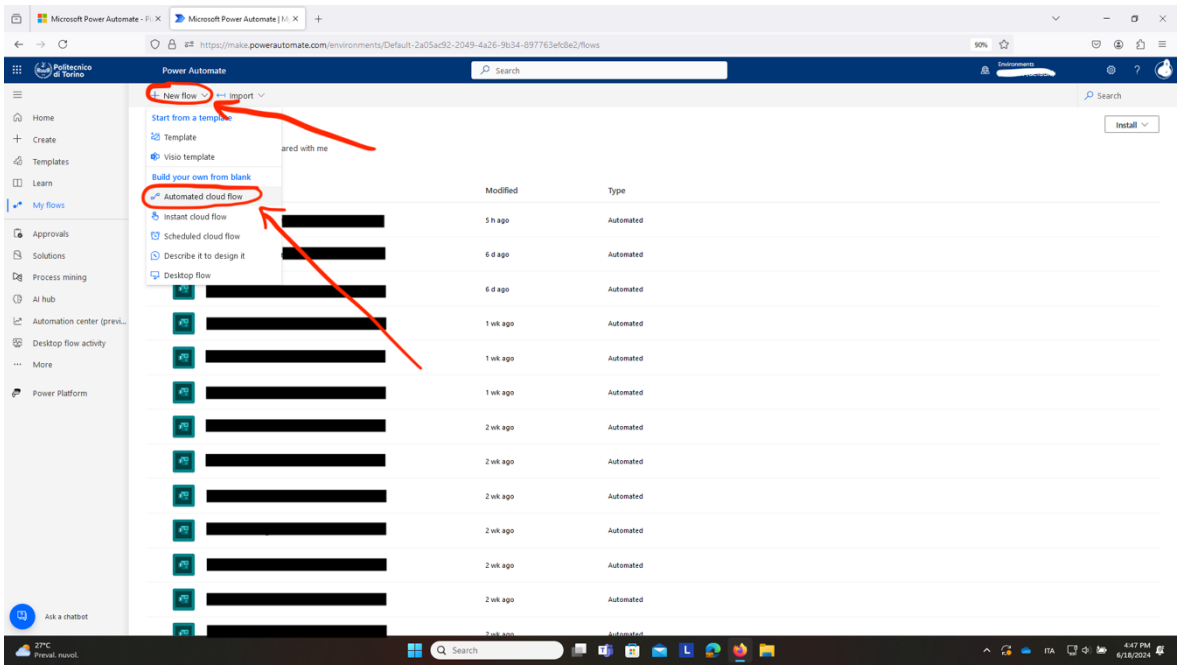
The following picture illustrates the home page.



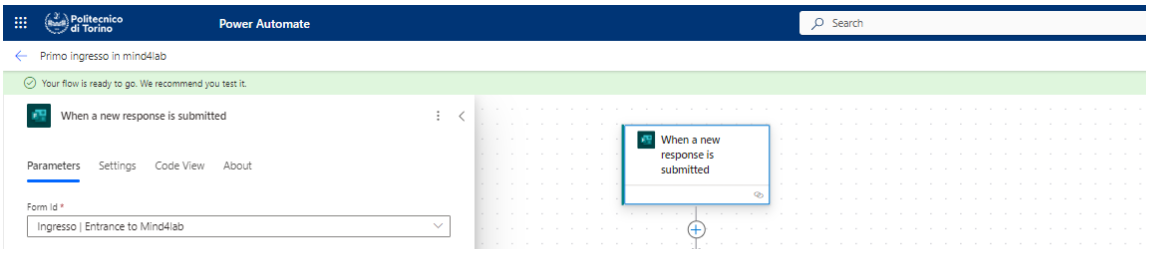
To start creating a new flow, click the “My Flows” button as shown below.



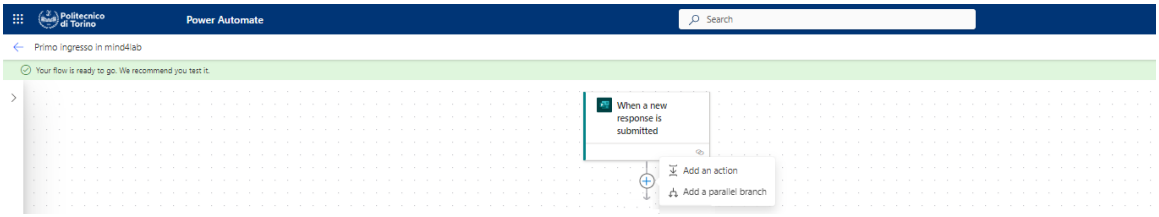
On this page, you can see your current flows and create a new one. Click the “New Flow” button, then select “Automated cloud flow”, as illustrated in the following picture.



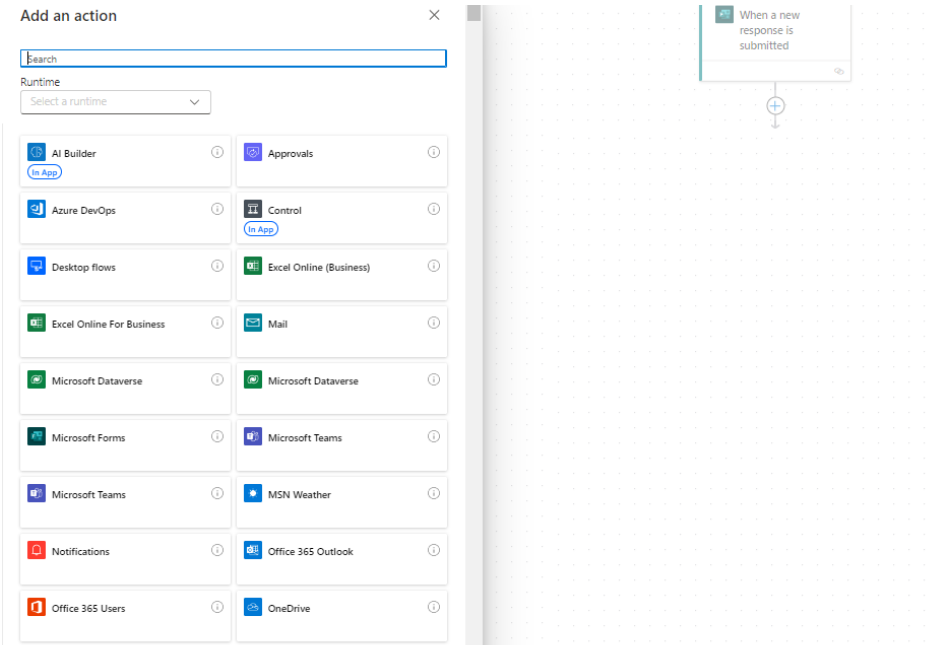
After that, a script will appear. Name the flow as you prefer and select the trigger option “When a new response is submitted” from Microsoft Forms. Then, start creating the actual flow.



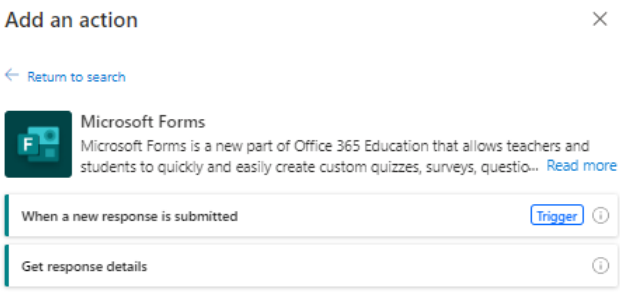
Select the form from which you want to collect data from the drop-down menu.



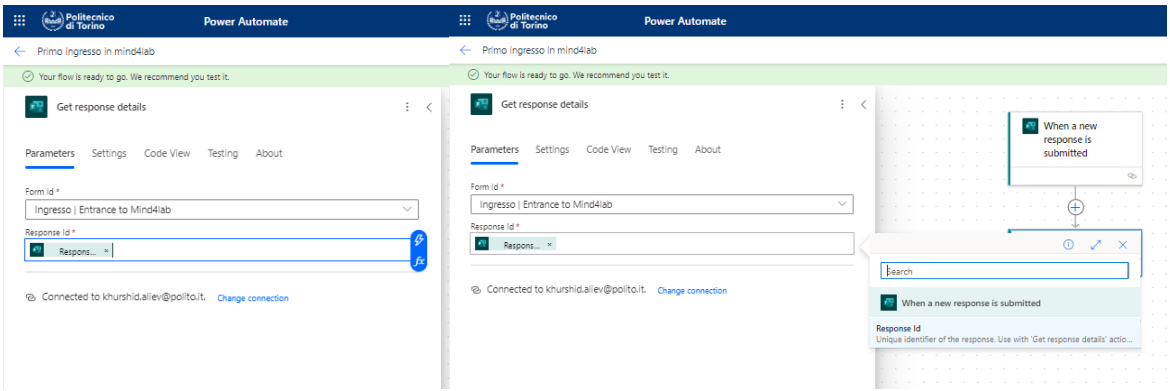
Click the "+" symbol and choose "Add an Action".



Different applications will appear on the left, and you have to choose the application that you want to use in your logic idea for the creating flow. In our case, select Microsoft Forms since we need to extract data from the module.

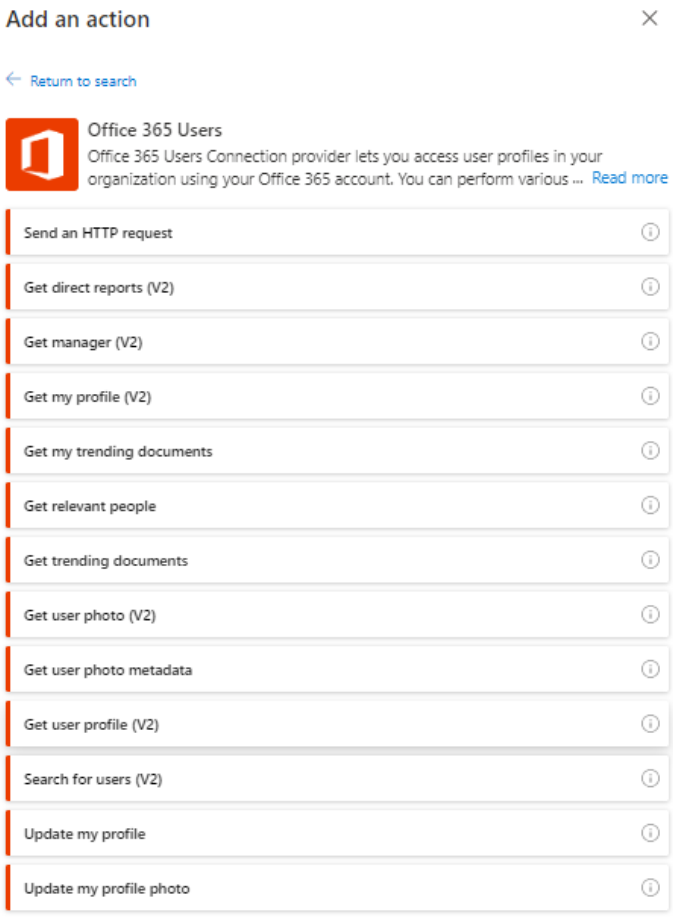


Click the "Get response details" button.

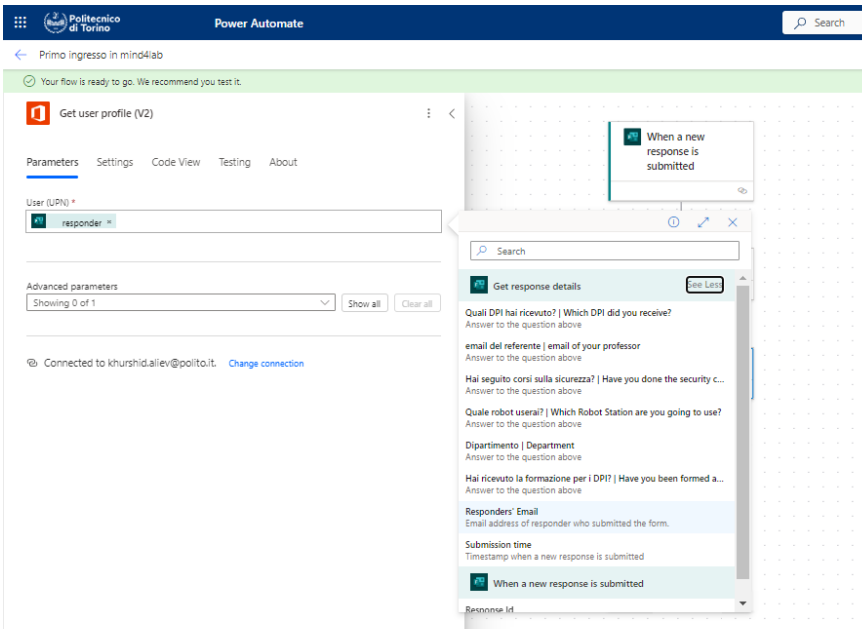


Select the form from which you want to collect data from the drop-down menu. Click on the field labeled “Response id”, and a blue lightning will appear. Click on it to open a drop-down menu and select the option “Response id”.

Again, press the “+” symbol to add a new action and select the Office365.

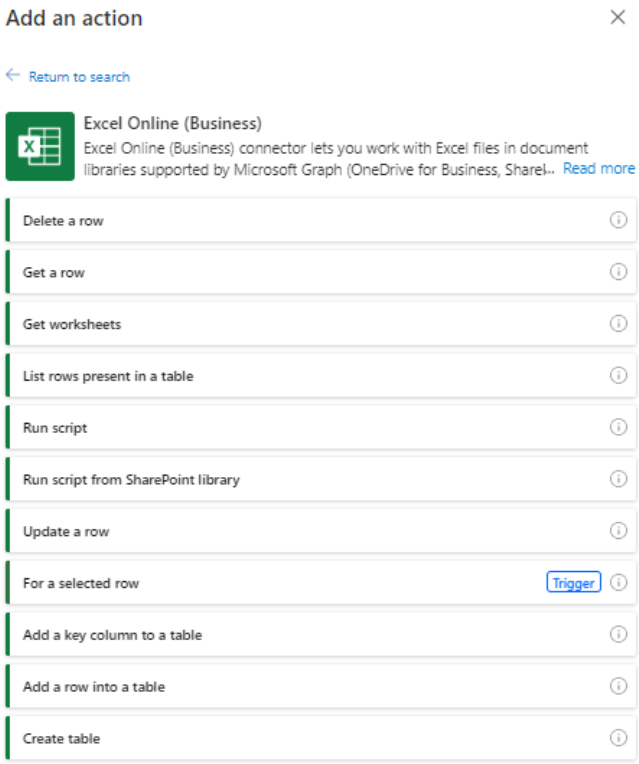


Click on “Get user profile (V2).

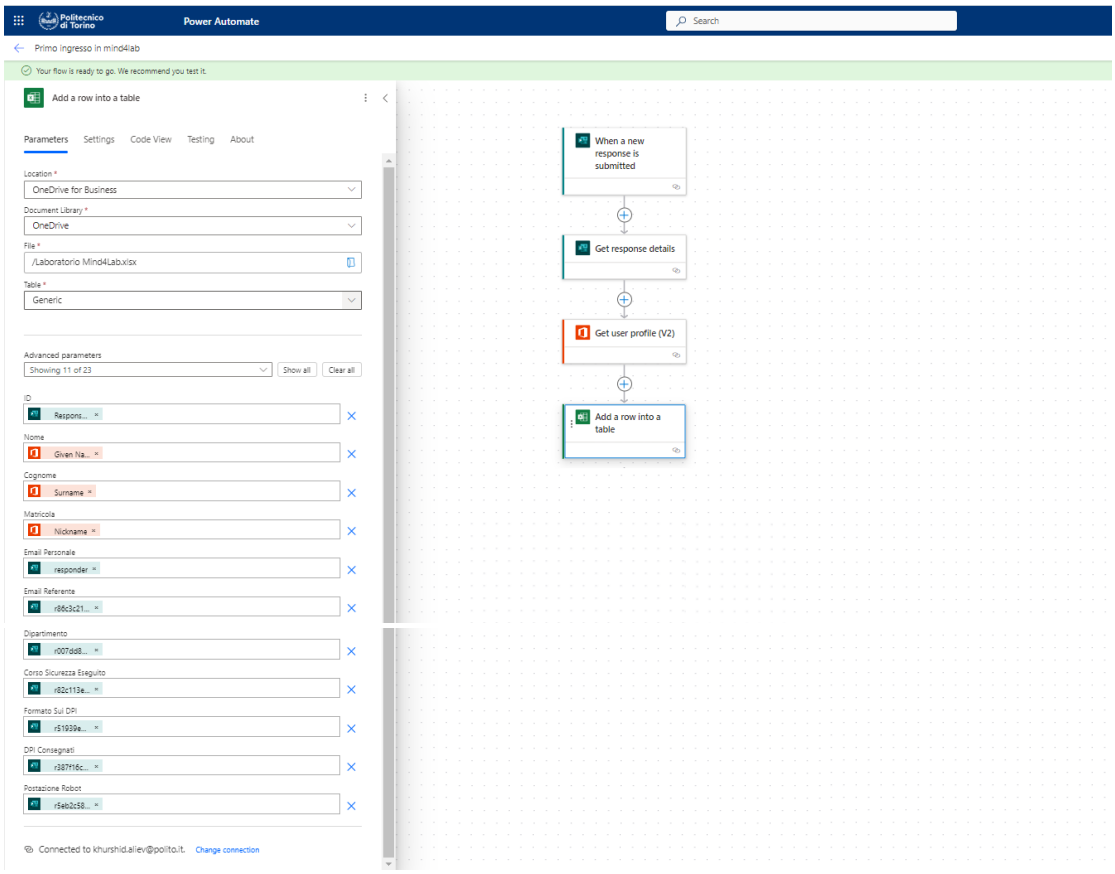


Click on the field labeled “User (UPN)”, and a blue lightning icon will appear. Click on it to open a drop-down menu and select the option “Responders’ Email”. This application extracts some personal information using the responders’ email, as all Politecnico users have an office365 account. This action allows for the removal of personal data questions from the module.

Again, press the “+” symbol to add a new action and select the Excel for Business app.



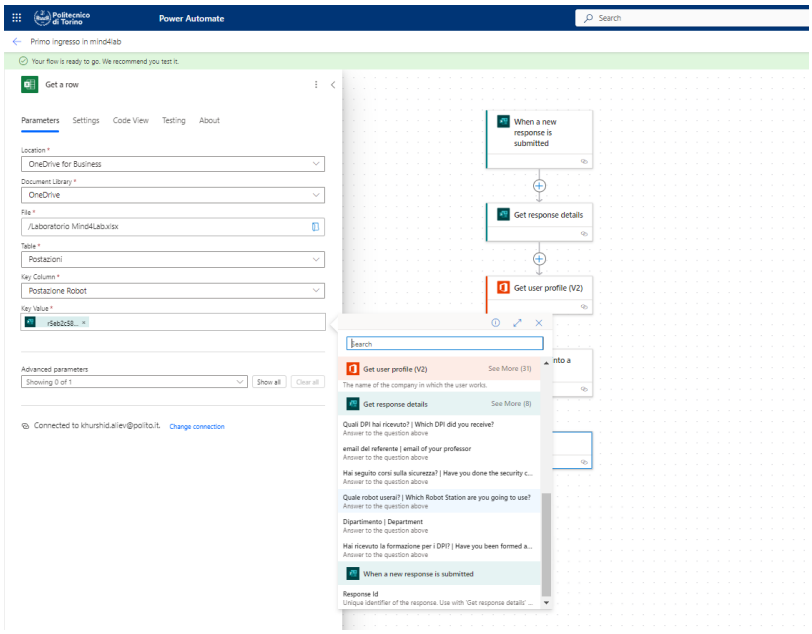
Choose the option “Add a row into a table”.



Complete all the field labels. The first three labels are always “OneDrive for Business”, “OneDrive”, and the file name “LabortorioMind4Lab”, which is our file created at the beginning. For the Table field, you need to select the table that pertains to this specific flow; in this case, it is “Generic” table.

Then click the “Show all” button, which will display all the columns of the table. Now, you are going to fill each of them using the blue lightning icon that simplifies the data selection. For the columns related to the forms’ answers, the selection is straightforward. Regarding the personal data extracted by Office365, choose “Given Name” for the name, “Surname” for the last name and “Nickname” for StudentID-matricola.

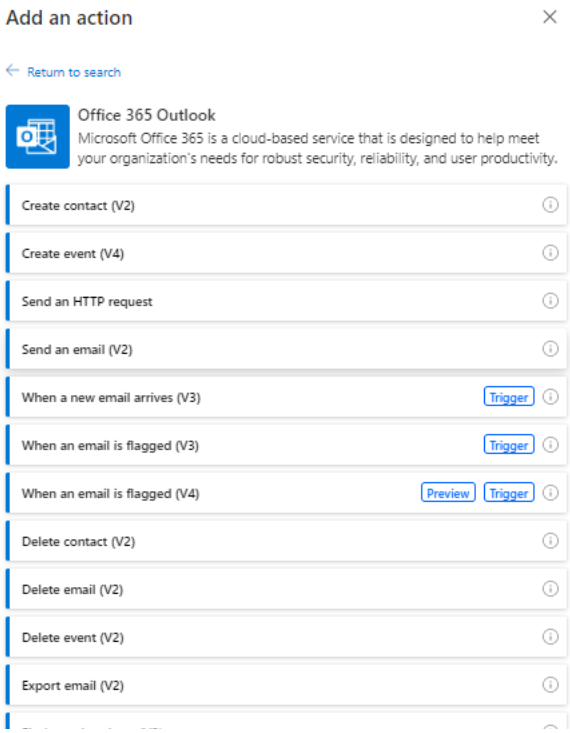
Again, press the “+” symbol to add a new action, select the Excel for Business app and choose the option “Get a row”.

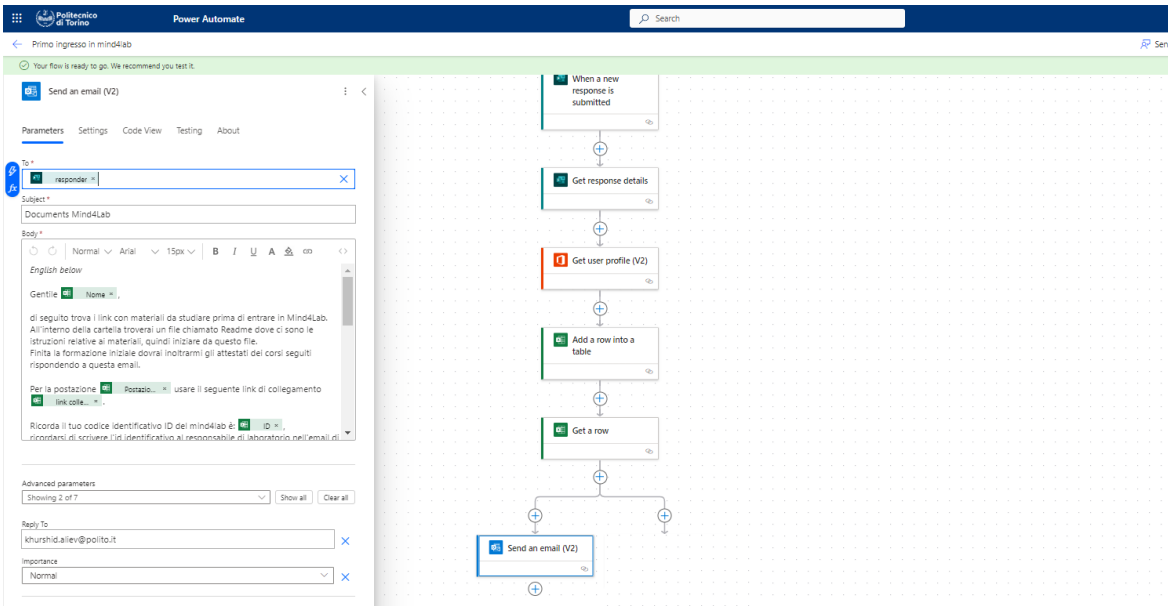


Fill in the first three labels as before, then select “Postazioni” for Table, “Postazione Robot” for Key columns, and “Quale robot userai? | Which robot station are you going to use?” for Key value.

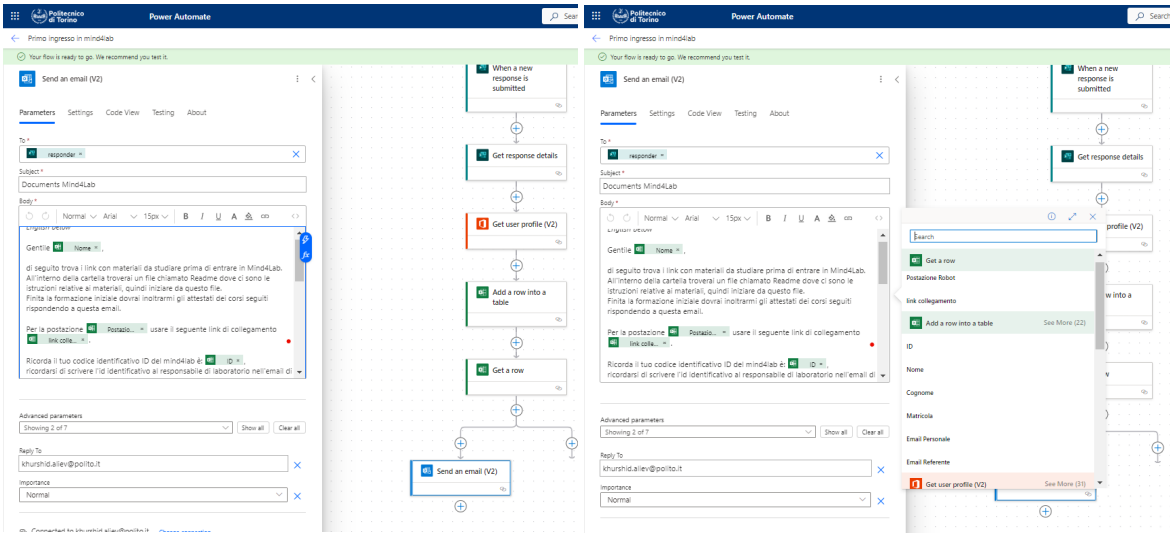
This action searches through the column “Postazione Robot” in the table “Postazioni” for the specific robot station answered by the user. In this table, there are two columns: one related to the robot station and the second one filled with OneDrive folder links.

Again, press the “+” symbol to add a new parallel action, select the Office 365 Outlook app and choose the option “Send an email (V2)”.



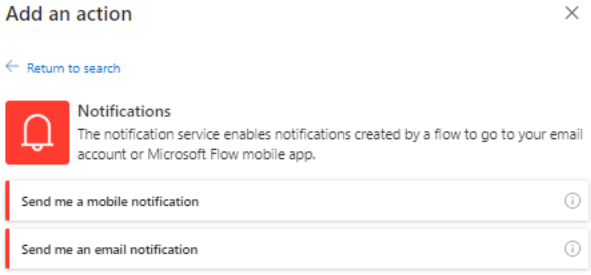


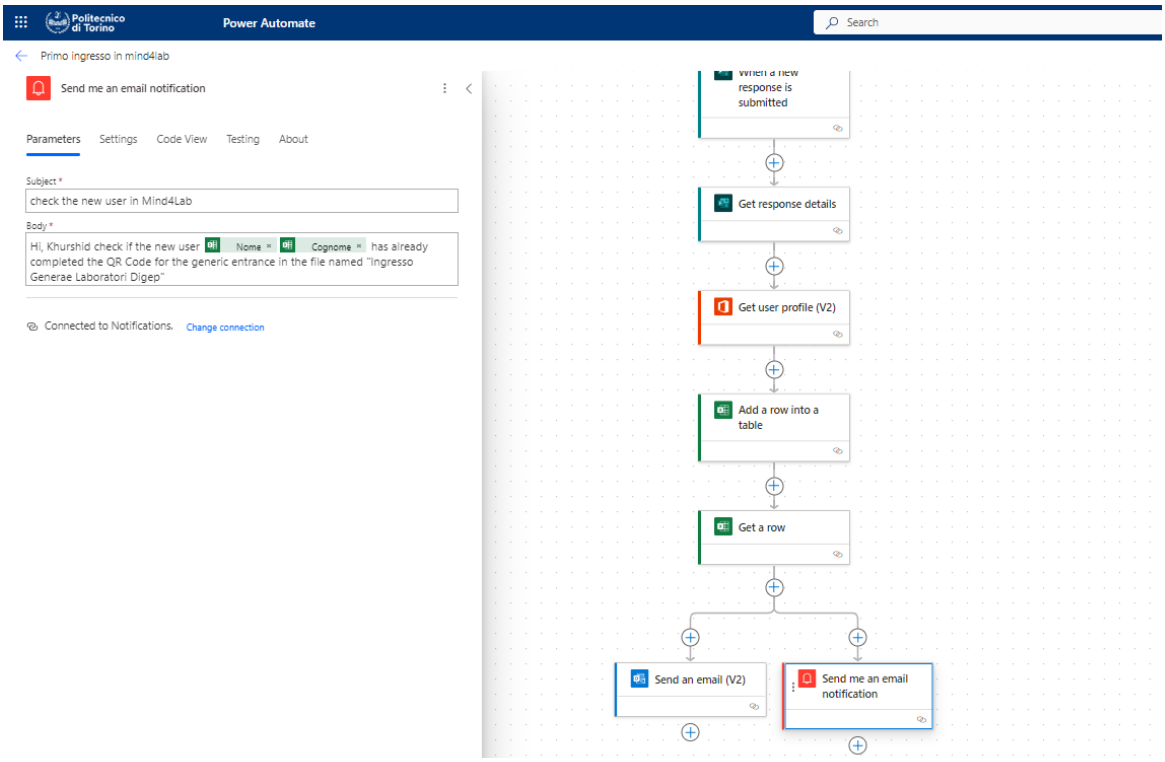
Fill the first label using the lightning icon and select the option “Responders’ email” since it is the email address to which the email will be sent. Then name the Subject as you prefer and write the email that will be received by the users.



You can customize the email body by using the lightning icon and selecting the data collected in the previous steps.

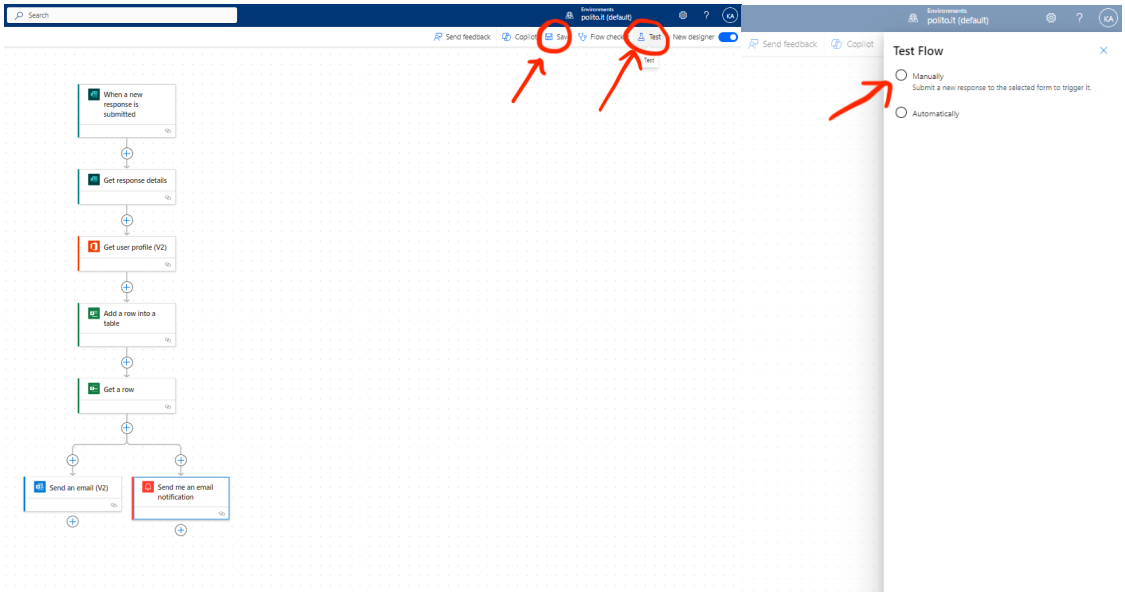
Again, press the “+” symbol to add a new action, select the Notifications app and choose the option “Send me an email notification”.





Fill the labels as you prefer and customize the Body as you did for the email body illustrated in the previous step.

Once you have finished creating the flow, save it and run the test.

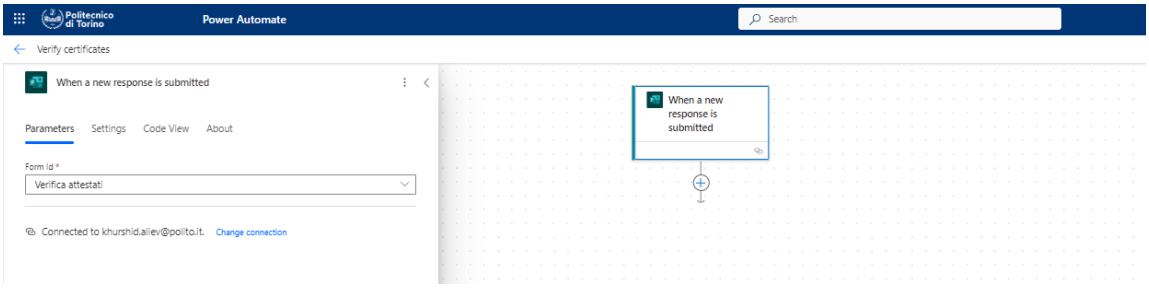


Then click on the “Manually” button to test the flow by scanning the QR code.

The Entrance to Mind4Lab flow has been created successfully.

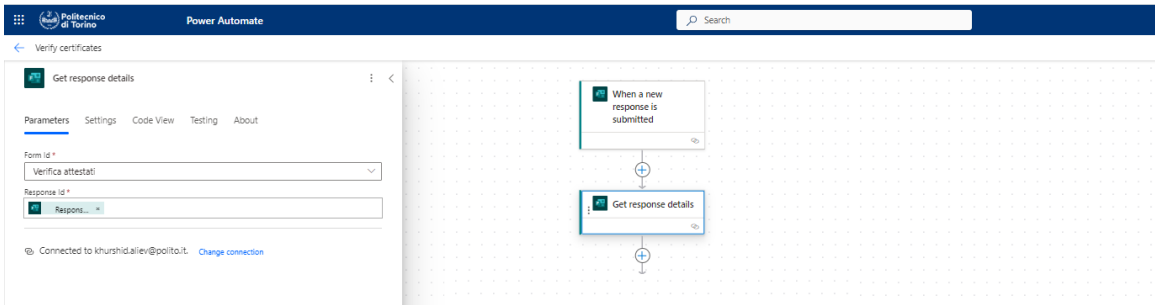
Now you need to create the second flow related to the verification of the documents after the user enters the lab.

Repeat the first passage of the flow, create a new flow and choose the trigger option “When a new response is submitted” from Microsoft Forms.



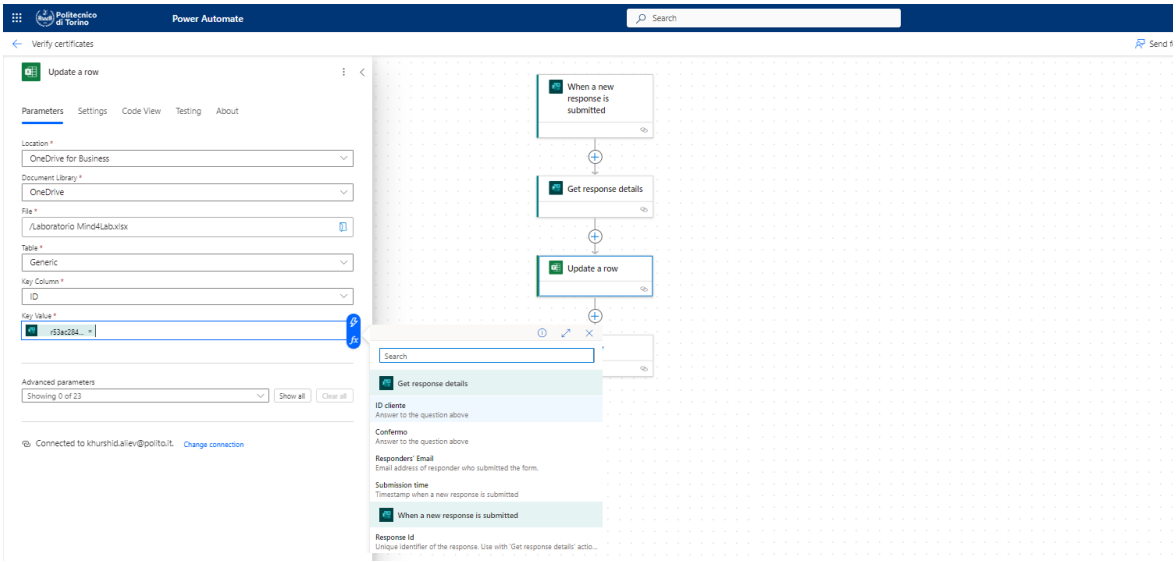
Select the form from which you want to collect data from the drop-down menu.

Click the “+” symbol and choose “Add an Action”. Click on Microsoft Forms app then “Get response details” button.



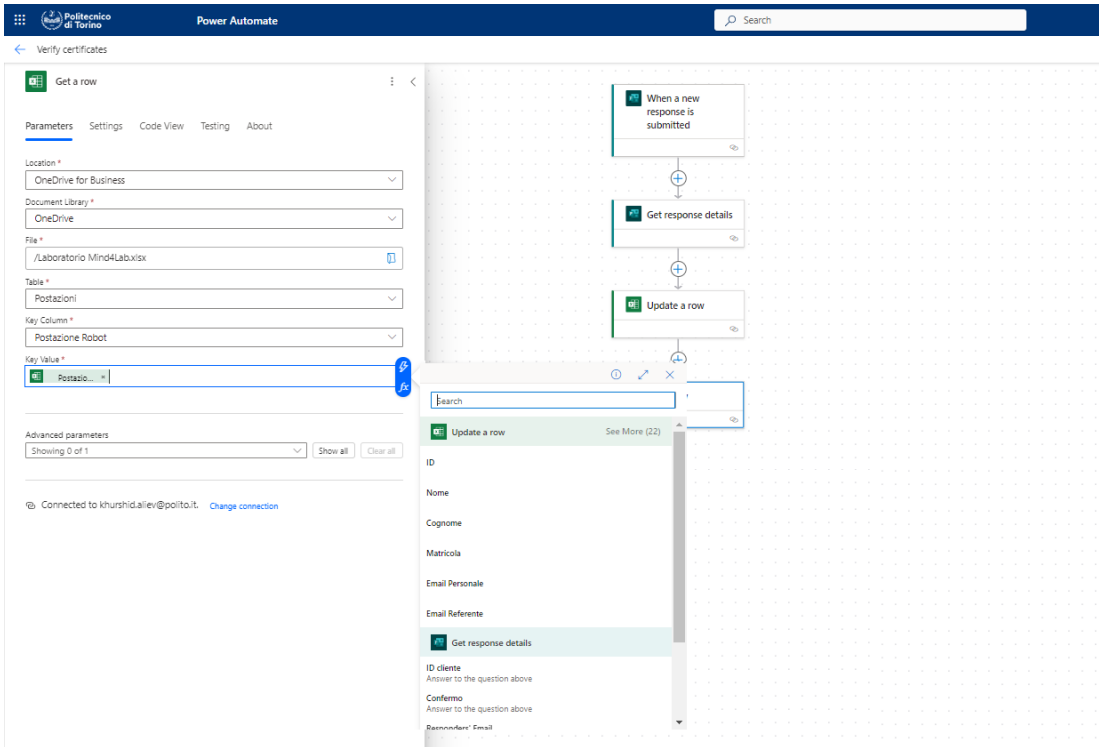
Select the form from which you want to collect data from the drop-down menu. Click on the field labeled “Response id”, and a blue lightning will appear. Click on it to open a drop-down menu and select the option “Response id”.

Again, press the “+” symbol to add a new action, select the Excel for Business app and choose the option “Update a row”.



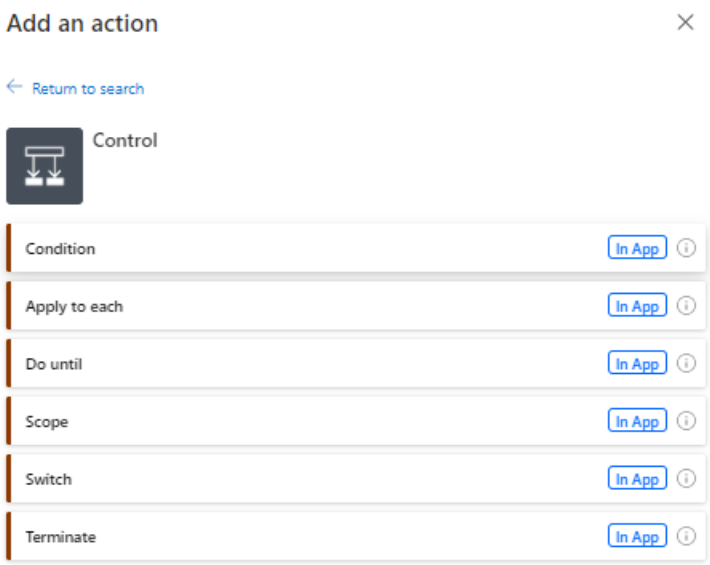
Fill all the labels, and for the Key value use the blue lightning icon, which guides you on what to insert. For this example, choose “ID Cliente”.

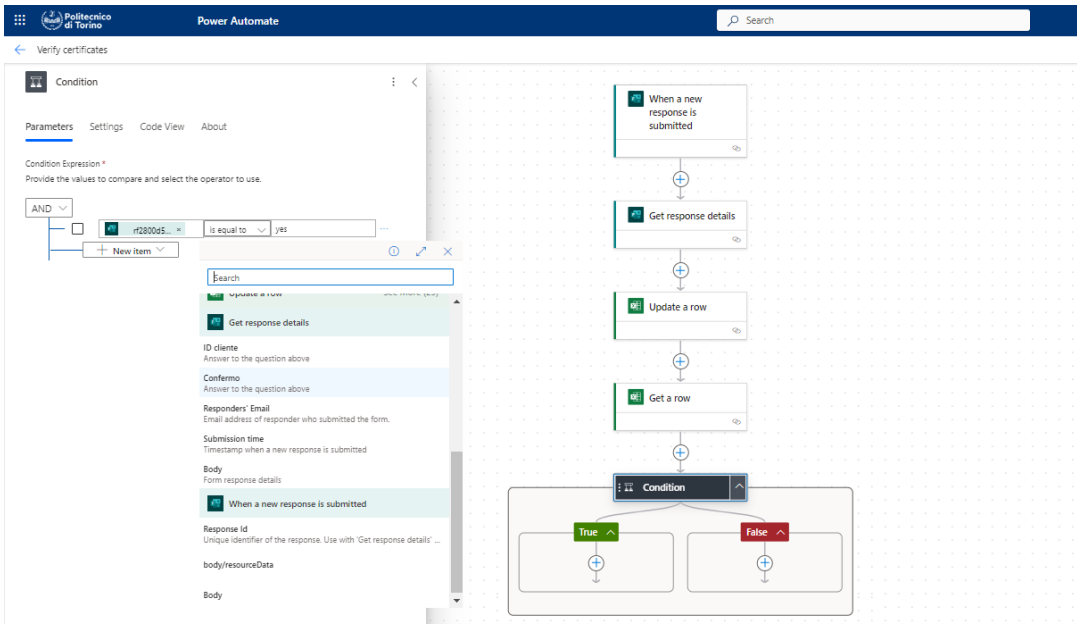
Again, press the “+” symbol to add a new action, select the Excel for Business app and choose the option “Get a row”.



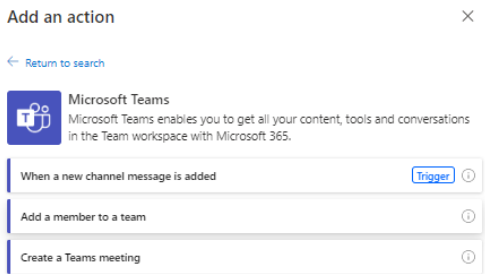
Fill in all labels. For this example, under the Key Column label, it should say “Postazione Robot”, and under the Key Value label, it should say “Postazione robot”.

Click the “+” symbol and choose “Add an Action”. Click on Control app then “Condition” button.

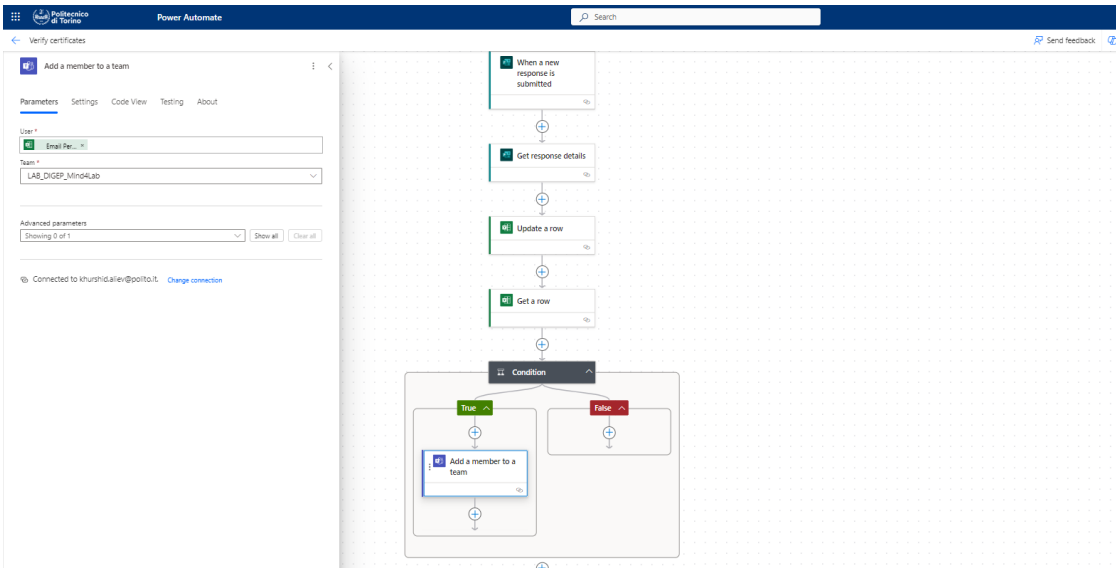




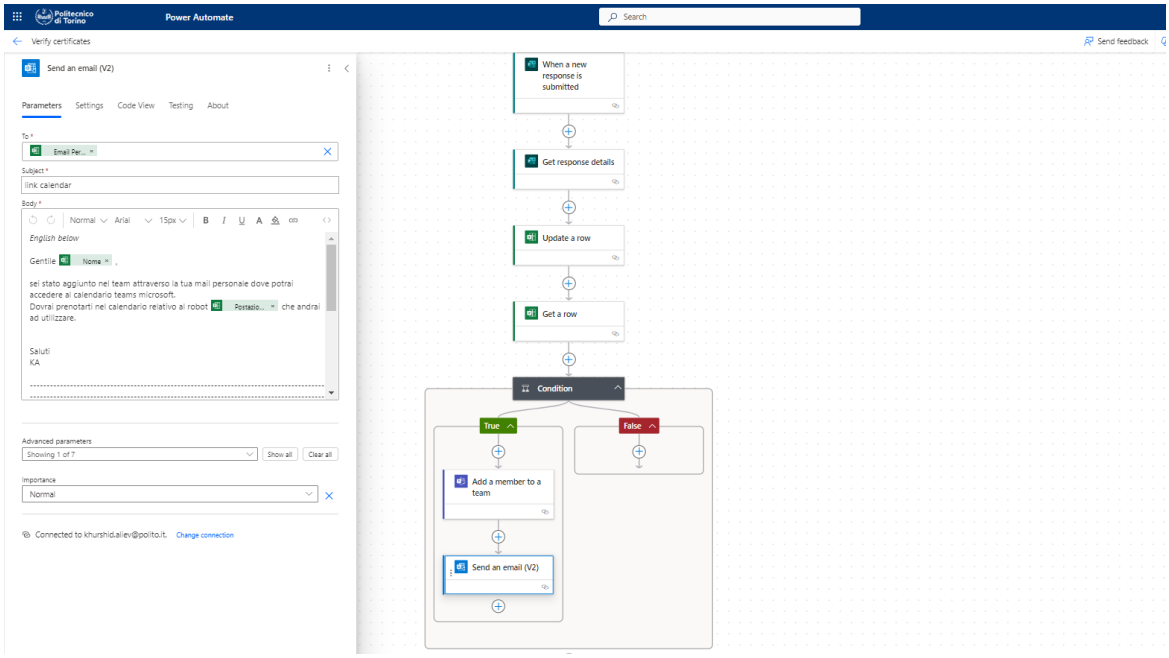
For the condition, select the operator “AND” and in the new item, choose “Confermo” using the blue lightning icon. Then, select “is equal to” and type “YES” in the last label, as shown in the picture.



Under the True condition, add an action and choose Microsoft Teams app. Then select the option “Add a member to a team”. Fill in the labels as shown in the following picture: choose “Email personale” for User and choose the teams LAB_MIND4LAB from the drop-down menu.

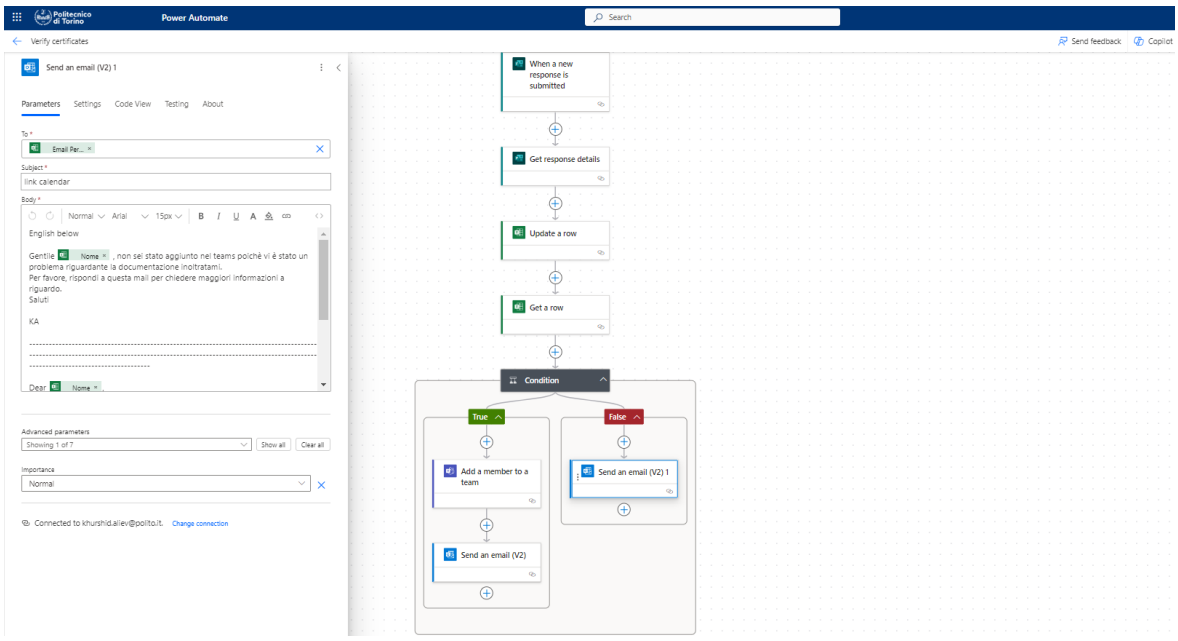


Add another action below the previous one and select the Office 365 Outlook app, choosing the option “Send an email (V2)”.



Fill in all labels as you have done in the previous flow.

Then, under the False condition, add an action by selecting the Office 365 Outlook app, and then choose the option “Send an email (V2)”.



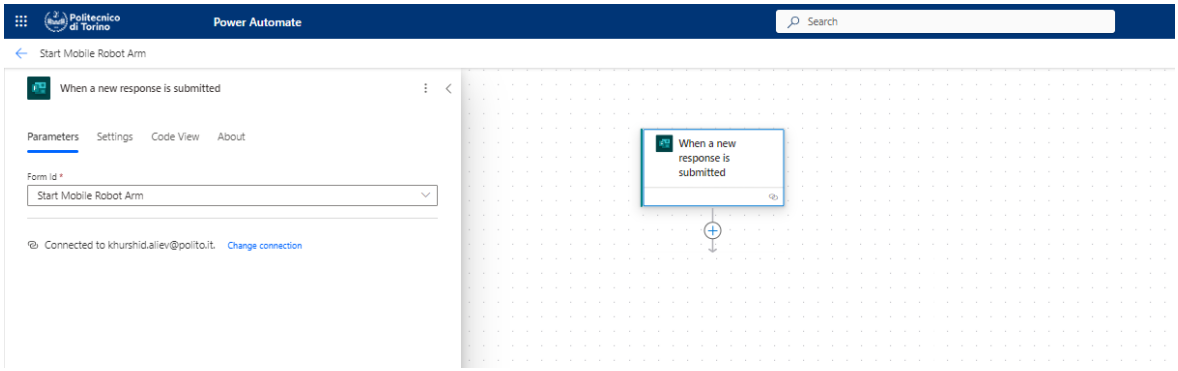
Compile the email as the previous flow.

Once you have finished, remember to save the flow and test it.

After this flow, the user is able to come to Mind4Lab and start using the booked robot station.

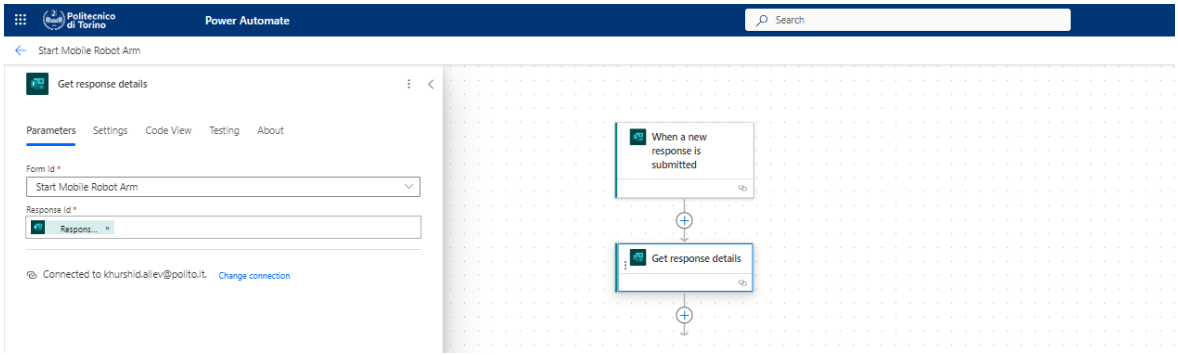
Now you need to create a new flow that keeps track of the usage of the robot station.

Again, repeat the first passage of the flow, create a new flow and choose the trigger option “When a new response is submitted” from Microsoft Forms.



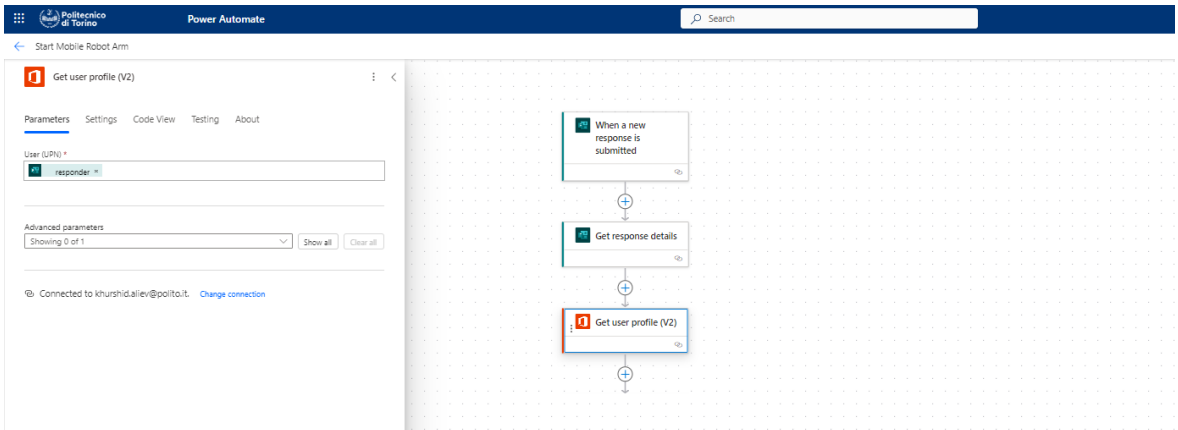
Select the form from which you want to collect data from the drop-down menu, in this case the one related to the start usage of Dual Arm Robot station.

Click the “+” symbol and choose “Add an Action”. Click on Microsoft Forms app then “Get response details” button.



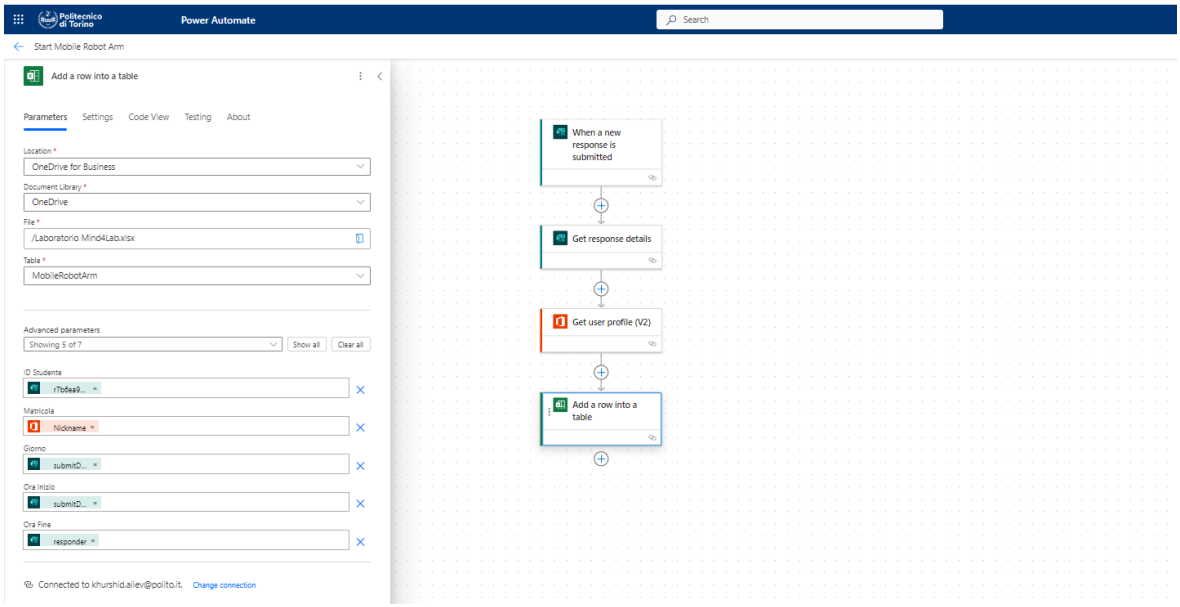
Select the same form from which you want to collect data from the drop-down menu. Click on the field labeled “Response id”, and a blue lightning will appear. Click on it to open a drop-down menu and select the option “Response id”.

Again, press the “+” symbol to add a new action, select the Office 365 app and choose the option “Get user profile (V2)”.



Fill in the label User using the blue lightning icon and selecting responder's email from Microsoft Forms.

Add the next action selecting Excel for Business and choose the option "Add a row into a table".



Complete the labels as in the previous flow and select the table named "MobileRobotArm" related to the specific robot station.

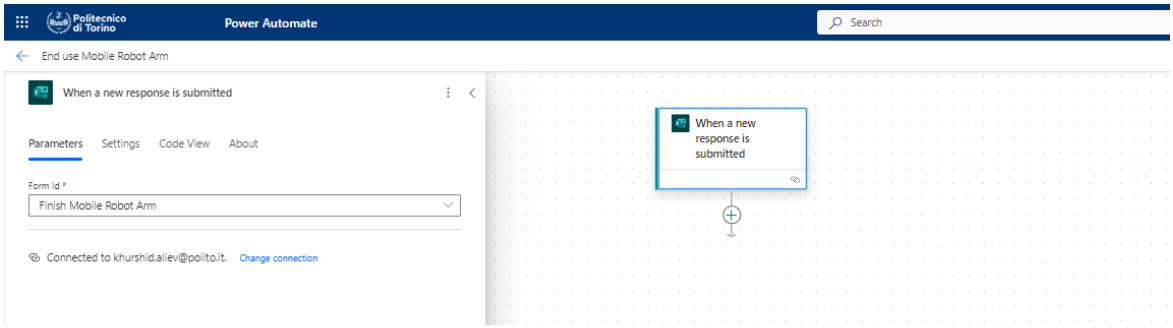
For the other fields, remember to use the blue lightning icon to facilitate the compilation.

At the end of the flow, save it and run a manual test.

The flow just created saves the user and the starting time, which is equal to the submission time of the module, into the table of the specific robot.

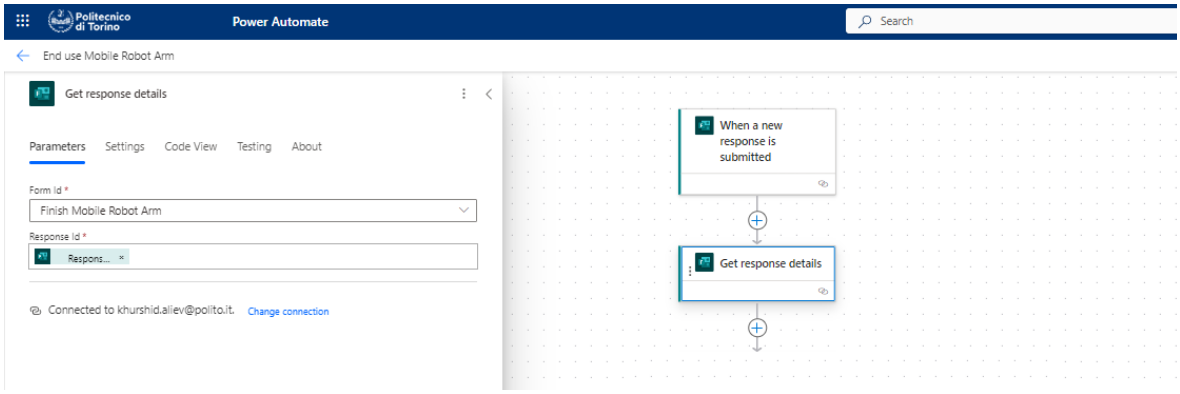
Now, you have to create the flow that keeps track of the end time of the robot usage.

Repeat the first passage of the flow, create a new flow and choose the trigger option "When a new response is submitted" from Microsoft Forms.



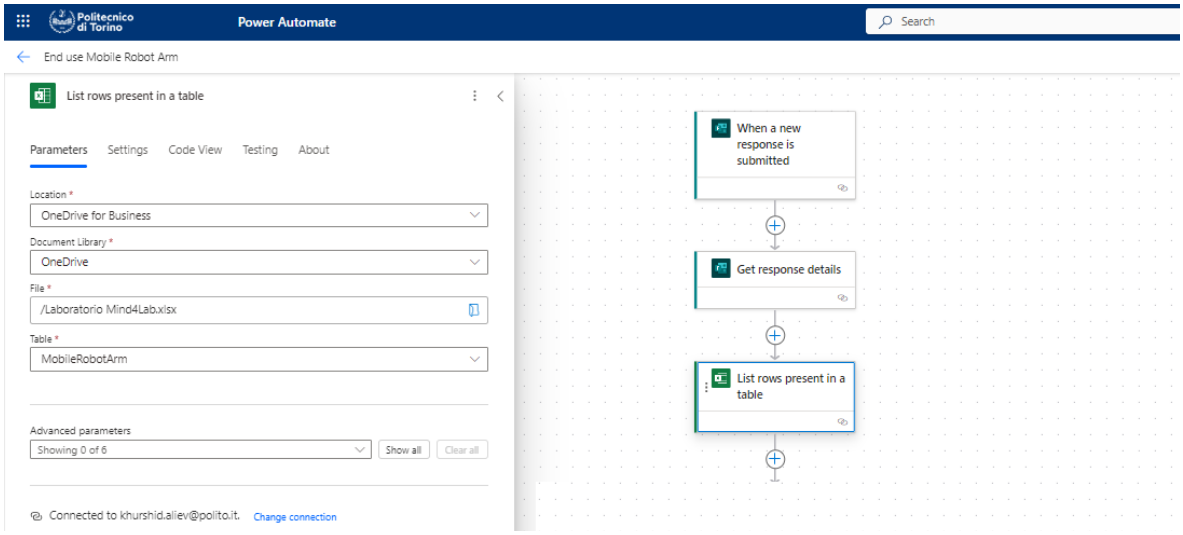
Select the form from which you want to collect data from the drop-down menu, in this case the one related to the start usage of Dual Arm Robot station.

Click the “+” symbol and choose “Add an Action”. Click on Microsoft Forms app then “Get response details” button.



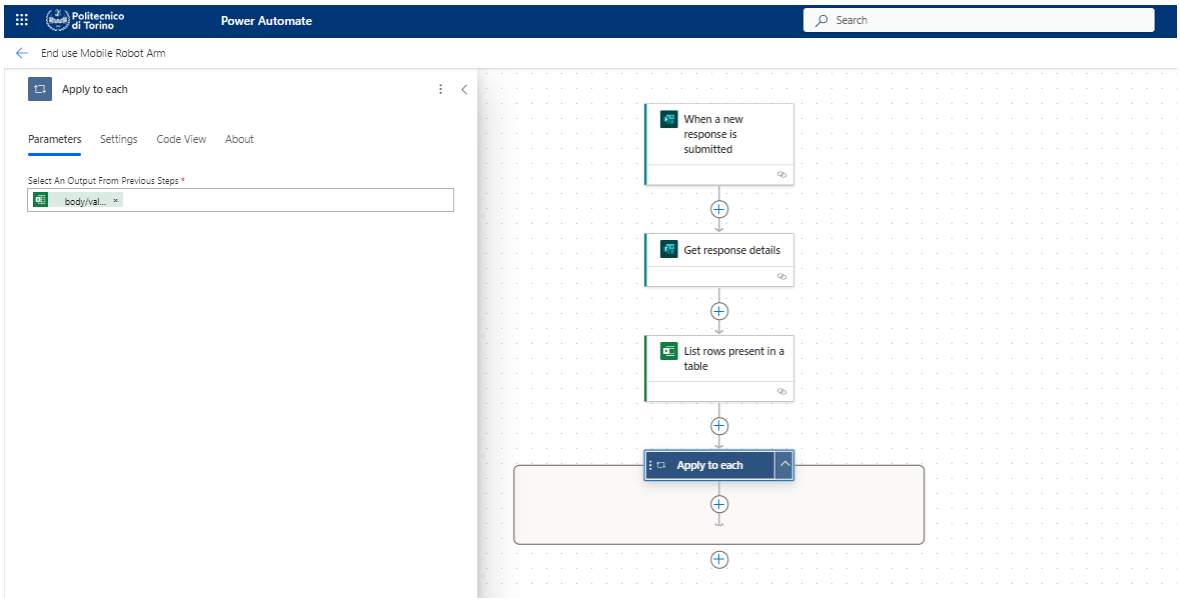
Select the same form from which you want to collect data from the drop-down menu. Click on the field labeled “Response id”, and a blue lightning will appear. Click on it to open a drop-down menu and select the option “Response id”.

Again, press the “+” symbol to add a new action, select the Excel for Business app and choose the option “List rows present in a table”.



Fill the labels and select the table related to the robot station, which is the “MobileRobotArm” table.

Click the “+” symbol and choose “Add an Action”. Click on Control app then “Apply to each” button.

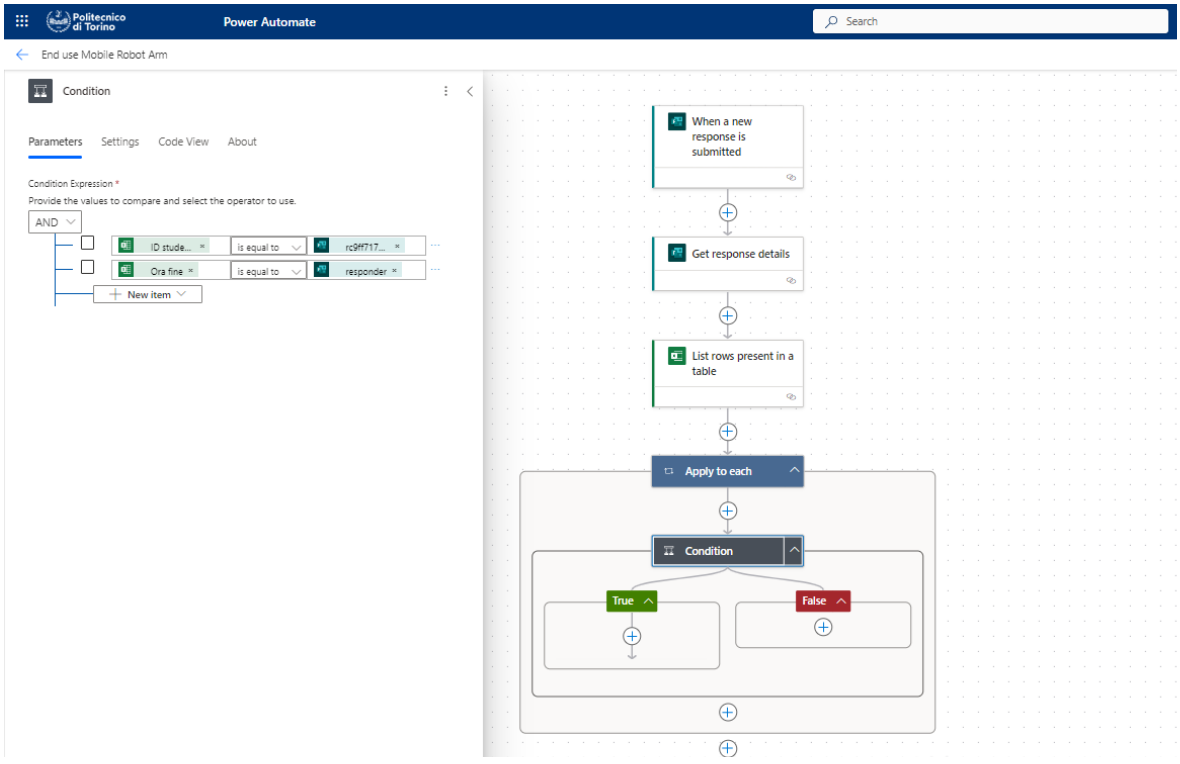


Complete the label by selecting the body value using the blue lightening icon.

Again, press the “+” symbol to add a new action, select the Control app and choose the option “Condition”.

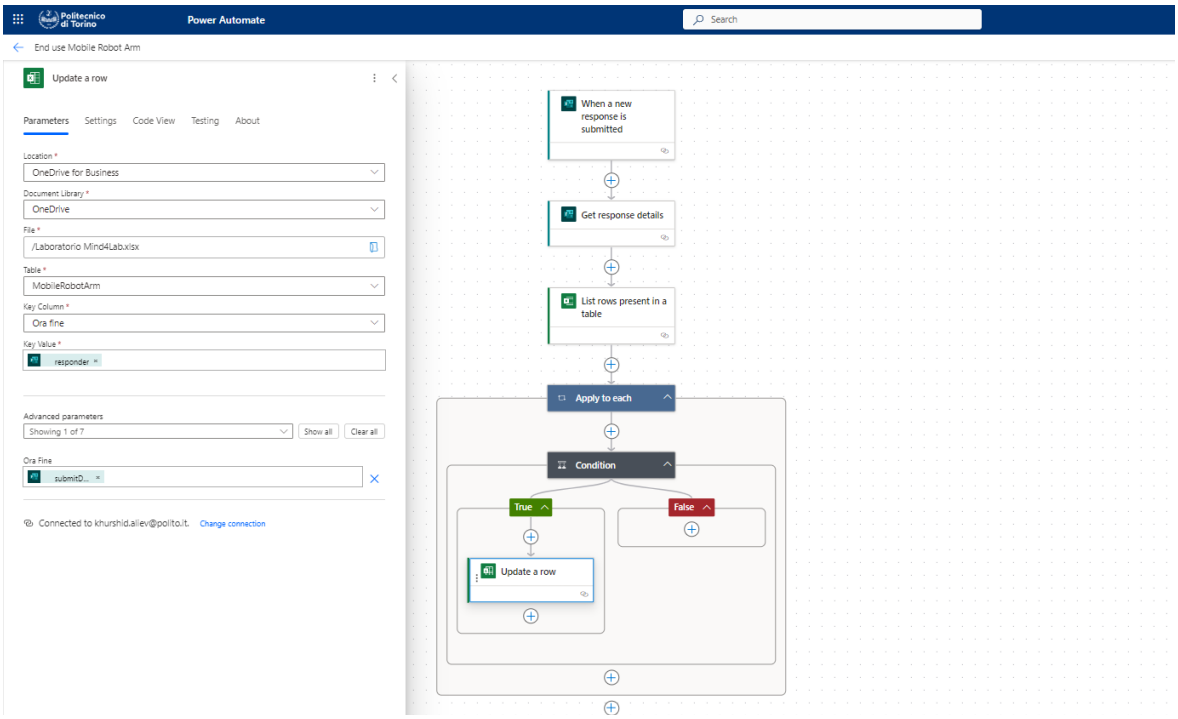
For the condition, select the operator “AND” and in the new item, choose “ID student” using the blue lightning icon. Select “is equal to” and then choose the “ID mind4lab student” option from the Forms responses, see the picture below.

Therefore, create a second item and choose “Ora fine” selecting then is equal to and choose the option “Responder’s email”. This last option is the one that you have used to fill the Excel file in the previous flow when the user starts using the Robot.



Under the True condition, add an action and choose Excel for Business. Then select the option “Update a row”. Fill in the labels as shown in the following picture: type “Ora fine” for Key Column and choose “Responder’s email” for Key value.

In the advance parameters select Ora fine and choose “Submission time” using the blue lightning icon.



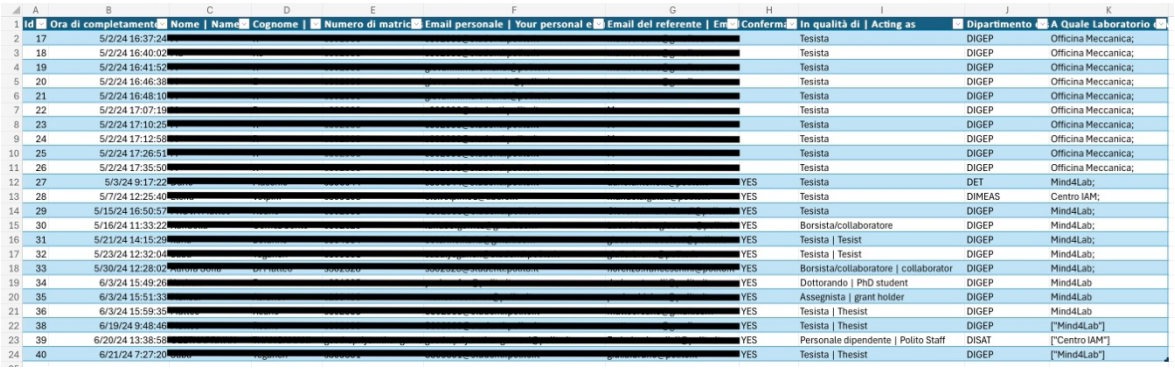
Remember to save and run a manual test.

The flow related to Mind4Lab has finished successfully.

Now, let’s look at the management system used for the general entrance to Digep Labs.

For the new system flow, the computer of the responsible person for the general entrance of the DIGEP lab was used.

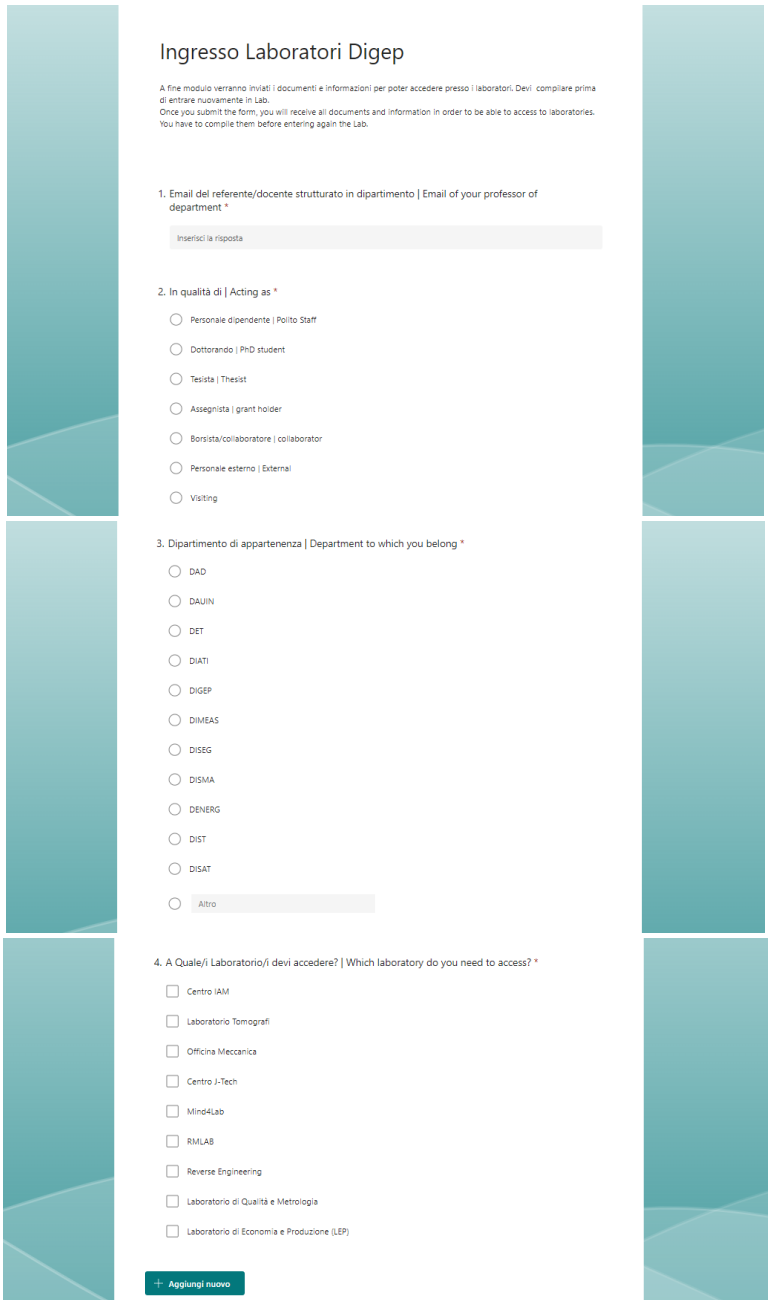
First of all, the responsible manager has to create an Excel file on OneDrive as the one illustrated below.



Id	Ora di completamento	Nome | Name	Cognome |	Numero di matric	Email personale | Your personal e	Email del referente | Em	Conferma	In qualità di | Acting as	Dipartimento	A Quale Laboratorio
17	5/2/24 16:37:24	[redacted]						Tesista	DIGEP	Officina Meccanica;
18	5/2/24 16:40:02							Tesista	DIGEP	Officina Meccanica;
19	5/2/24 16:41:52							Tesista	DIGEP	Officina Meccanica;
20	5/2/24 16:46:38							Tesista	DIGEP	Officina Meccanica;
21	5/2/24 16:48:10							Tesista	DIGEP	Officina Meccanica;
22	5/2/24 17:07:19							Tesista	DIGEP	Officina Meccanica;
23	5/2/24 17:10:25							Tesista	DIGEP	Officina Meccanica;
24	5/2/24 17:12:58							Tesista	DIGEP	Officina Meccanica;
25	5/2/24 17:26:51							Tesista	DIGEP	Officina Meccanica;
26	5/2/24 17:35:50							Tesista	DIGEP	Officina Meccanica;
27	5/3/24 9:17:22						YES	Tesista	DET	Mind4Lab;
28	5/7/24 12:25:40						YES	Tesista	DIMEAS	Centro IAM;
29	5/15/24 16:50:57						YES	Tesista	DIGEP	Mind4Lab;
30	5/16/24 11:33:22						YES	Borsista/collaboratore	DIGEP	Mind4Lab;
31	5/21/24 14:15:29						YES	Tesista | Tesist	DIGEP	Mind4Lab;
32	5/23/24 12:32:04						YES	Tesista | Tesist	DIGEP	Mind4Lab;
33	5/30/24 12:28:02						YES	Borsista/collaboratore | collaborator	DIGEP	Mind4Lab;
34	6/3/24 15:49:26						YES	Dottorando | PhD student	DIGEP	Mind4Lab
35	6/3/24 15:51:33						YES	Assegnista | grant holder	DIGEP	Mind4Lab
36	6/3/24 15:59:35						YES	Tesista | Thesist	DIGEP	Mind4Lab
38	6/19/24 9:48:46						YES	Tesista | Thesist	DIGEP	["Mind4Lab"]
39	6/20/24 13:38:58						YES	Personale dipendente | Polito Staff	DISAT	["Centro IAM"]
40	6/21/24 7:27:20						YES	Tesista | Thesist	DIGEP	["Mind4Lab"]

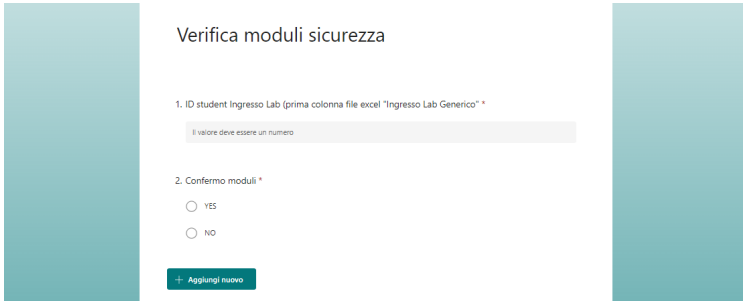
You need to name all columns to properly save the data you want to track during the flow.

After that, the manager has to create a Microsoft Forms module which will be used to collect data. The one used for this system is illustrated below.



This Forms is used by the users who will come to one of the proposed laboratories.

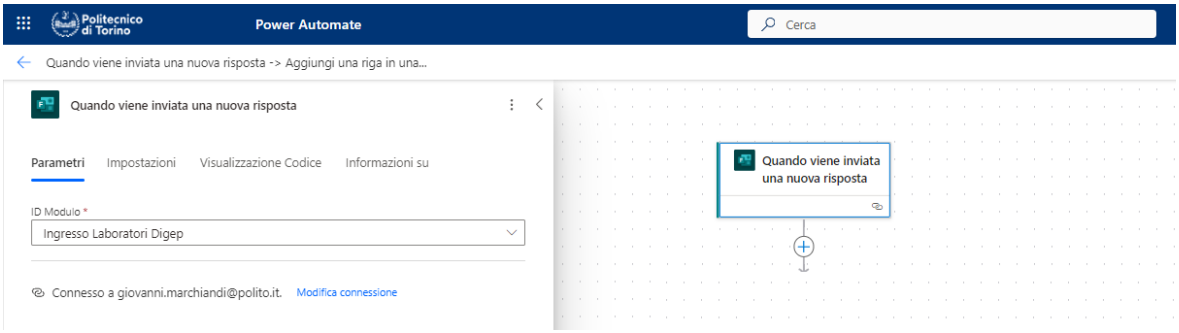
The following module is used by the manager to confirm the documents received.



As with the form created for Mind4Lab, remember to limit access to Politecnico users only.

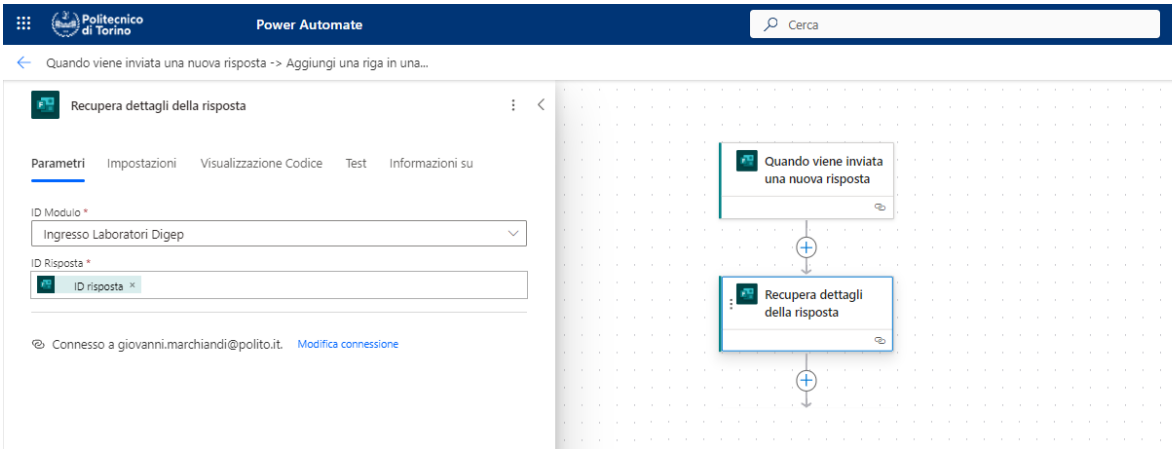
Now the manager is ready to start creating the flow using Power Automate. Follow the steps from the previous flow.

Again, start by creating a new flow and choose the trigger option “When a new response is submitted” from Microsoft Forms.



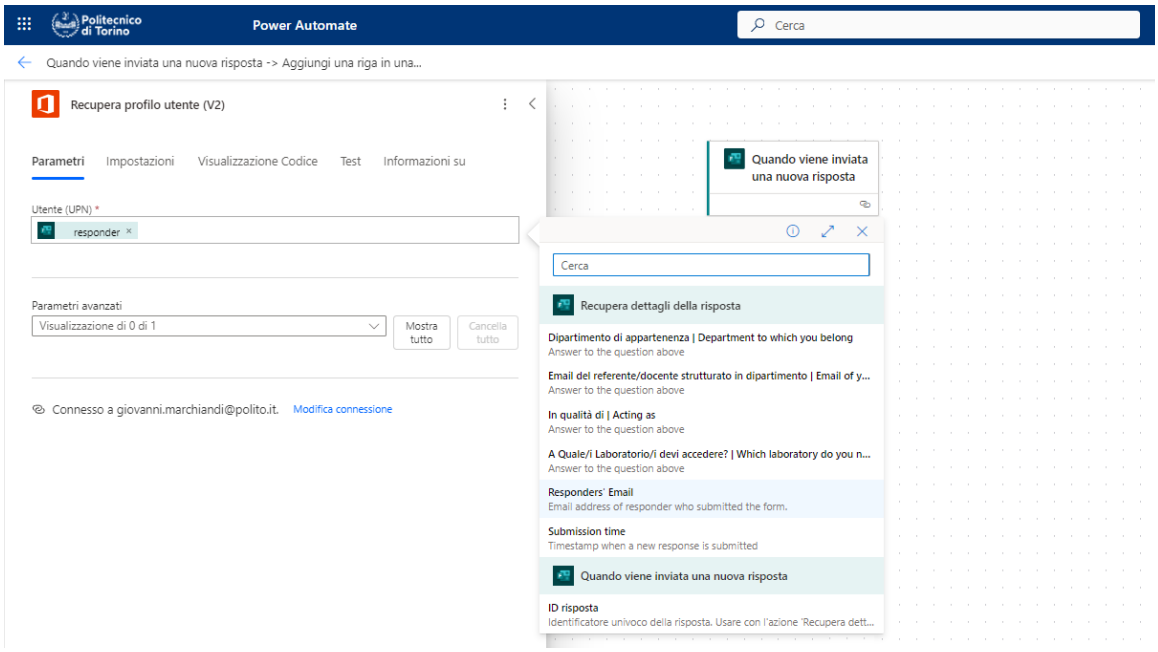
Select the form from which you want to collect data from the drop-down menu, in this case it is called “Ingresso Laboratori Digep”.

Click the “+” symbol and choose “Add an Action”. Click on Microsoft Forms app then “Get response details” button.



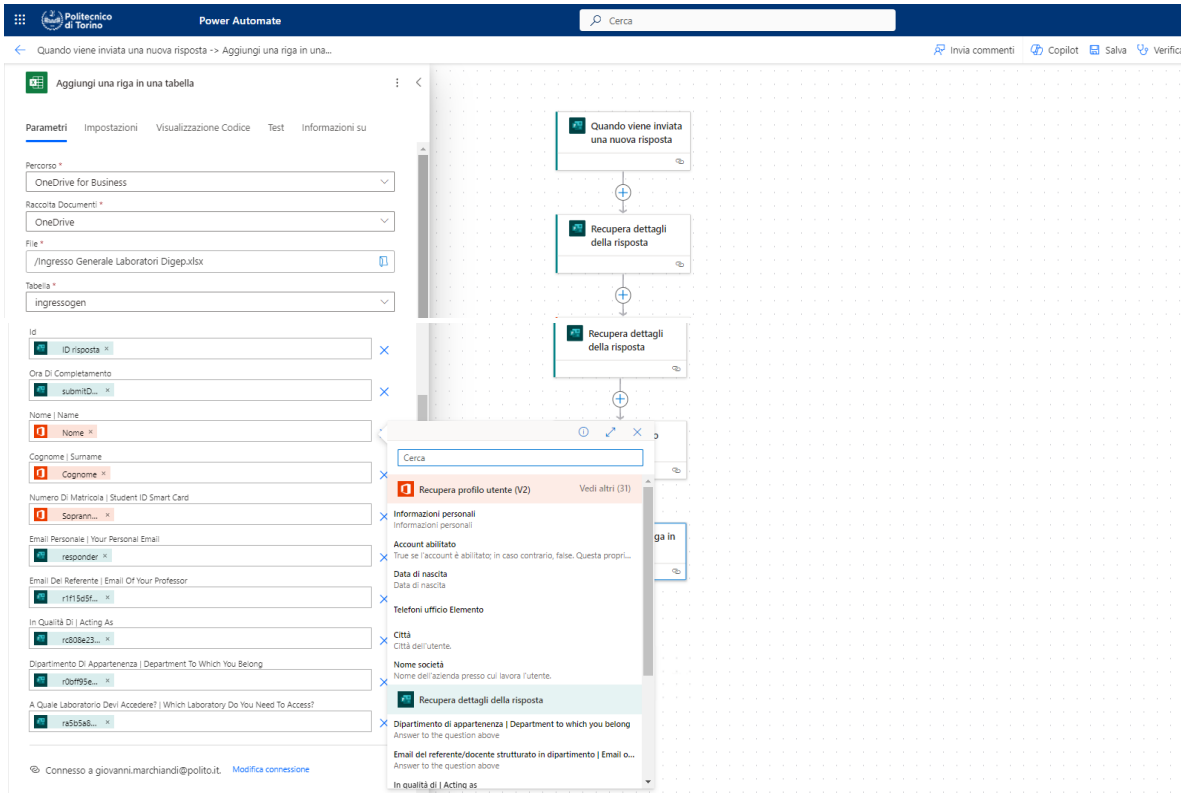
Select the same form from which you want to collect data from the drop-down menu. Click on the field labeled “Response id”, and a blue lightning will appear. Click on it to open a drop-down menu and select the option “Response id”.

Again, press the “+” symbol to add a new action, select the Office 365 app and choose the option “Recupera profile utente (V2)”.



Select “Responder’s email” for Utente (UPN).

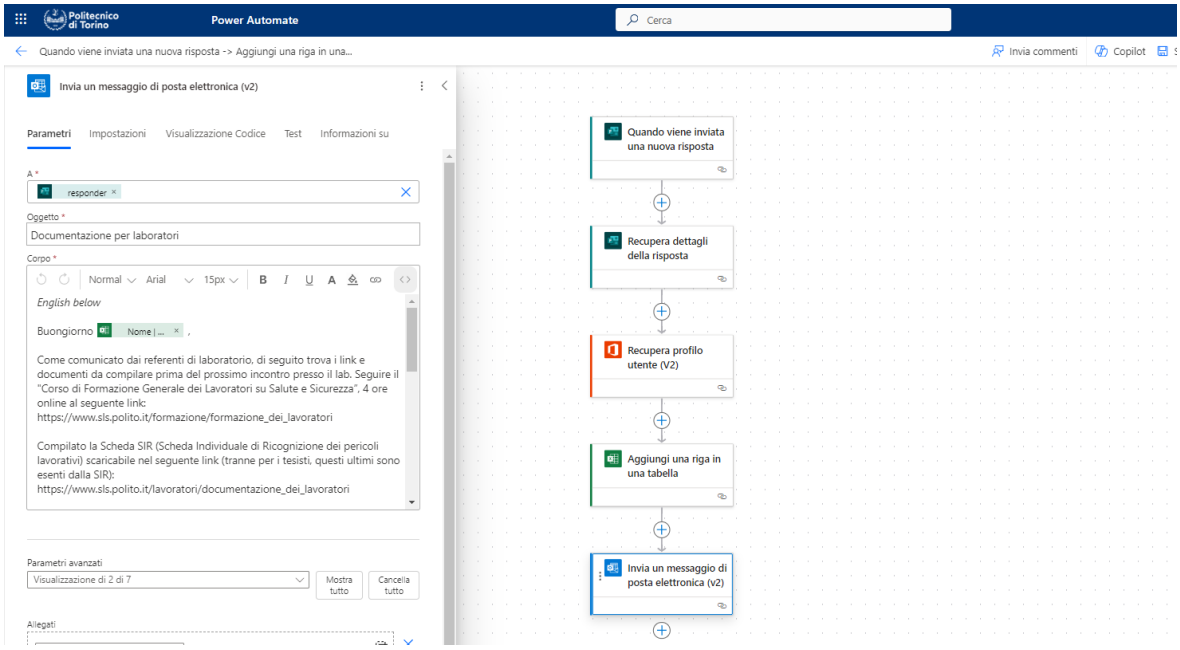
Click the “+” symbol and choose “Add an Action”. Click on Excel for Business app then “Aggiungi una riga in una tabella” button.



Fill all the labels as shown in the picture above. Remember to use the blue lightning icon, which facilitates completion of each field.

Select the Excel file created earlier and the correct table; in this example, they are the “Ingresso Generale Laboratori Digep” file and the “Ingressogen” table.

Again, press the “+” symbol to add a new action, select the Outlook email app and choose the option “Invia un messaggio di posta elettronica (V2)”.

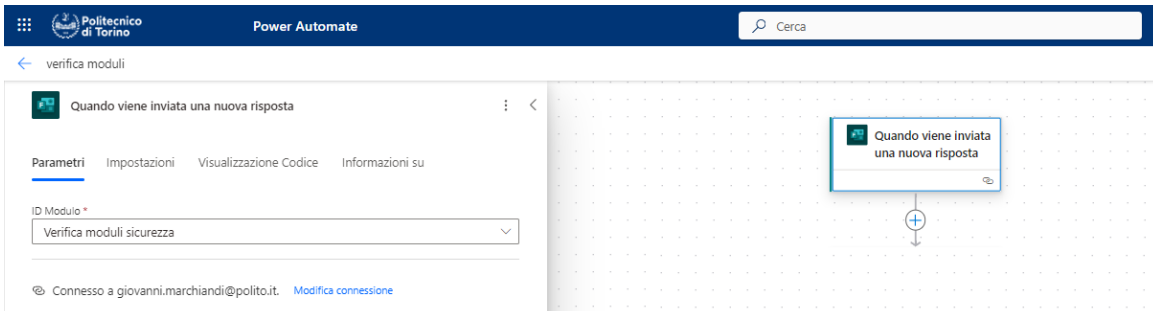


Fill all fields as in the previous flow and customize the email body as desired.

Once you have finished setting up the flow, save it and perform a manual test.

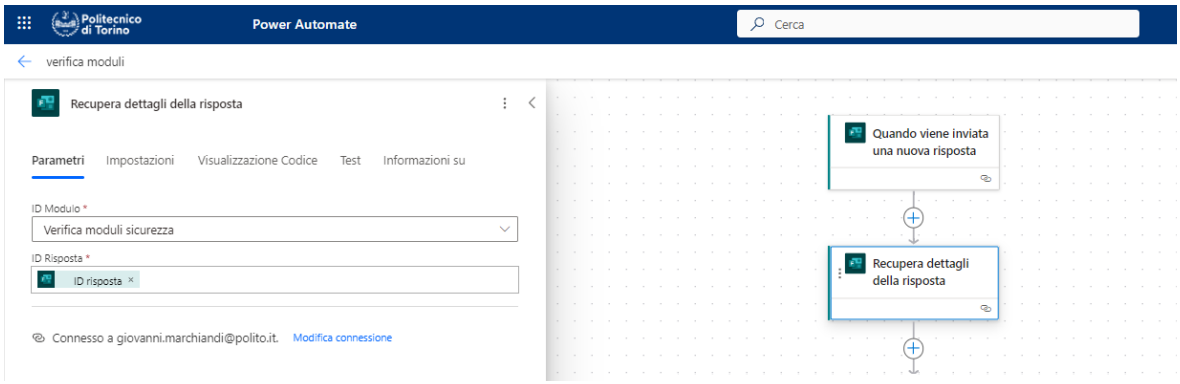
Now, the final flow remains related to the manager confirming receipt of the documents.

Again, start by creating a new flow and choose the trigger option “When a new response is submitted” from Microsoft Forms.



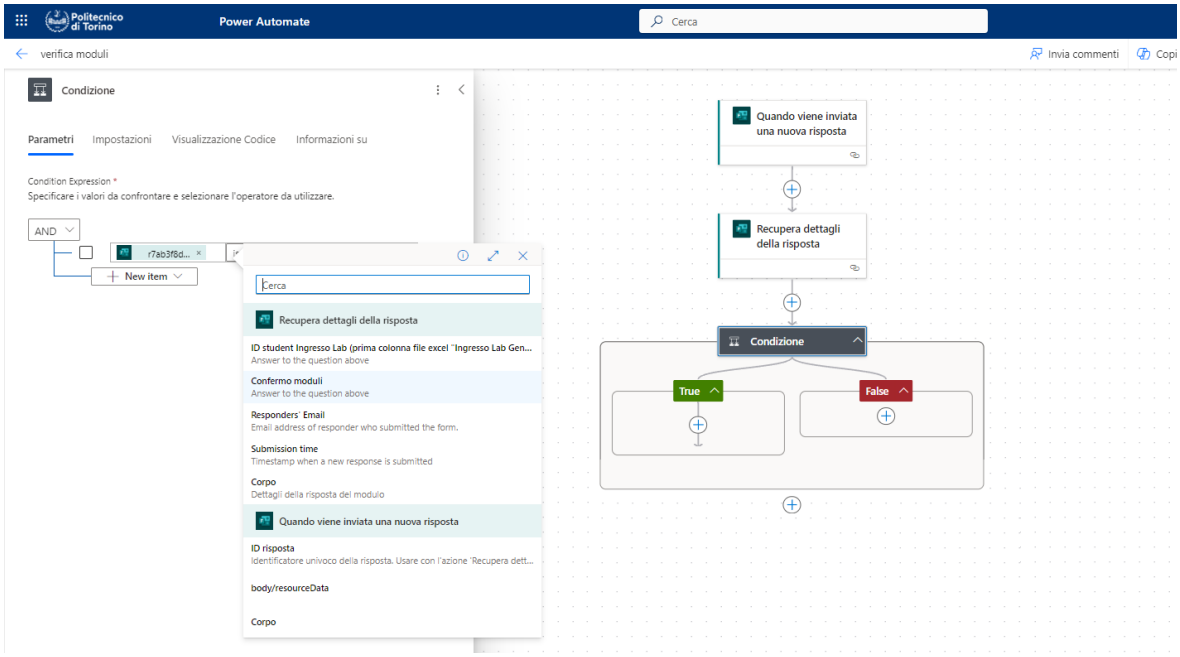
Select the form from which you want to collect data from the drop-down menu, in this case it is called “Verifica moduli sicurezza”.

Click the “+” symbol and choose “Add an Action”. Click on Microsoft Forms app then “Get response details” button.



Select the same form from which you want to collect data from the drop-down menu. Click on the field labeled “Response id”, and a blue lightning will appear. Click on it to open a drop-down menu and select the option “Response id”.

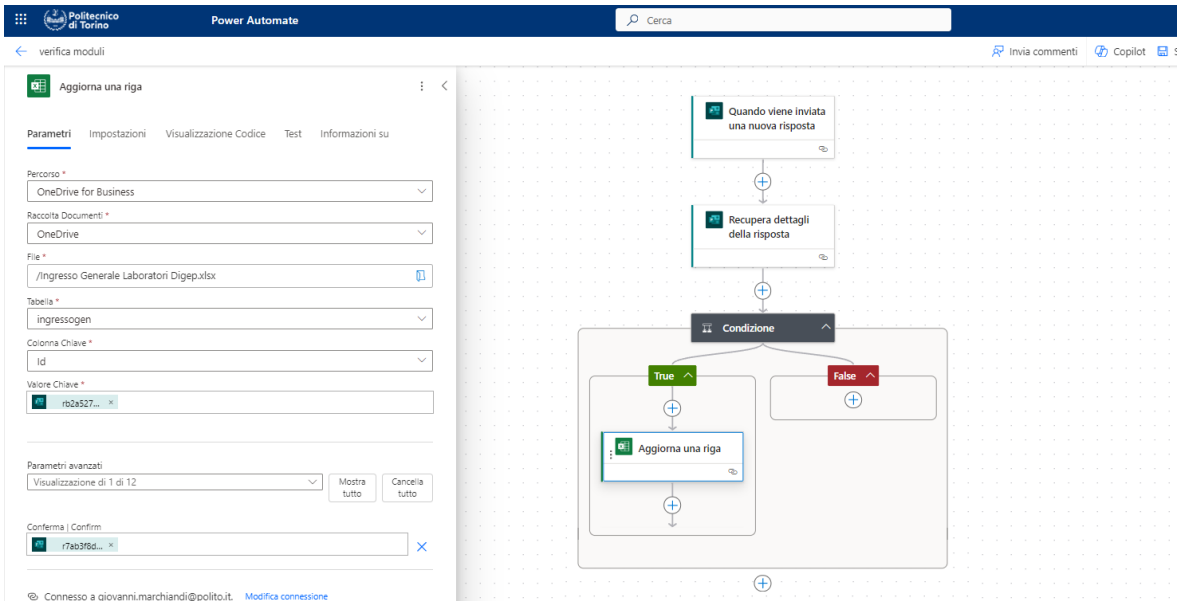
Again, press the “+” symbol to add a new action, select the Control app and choose the option “Condition”.



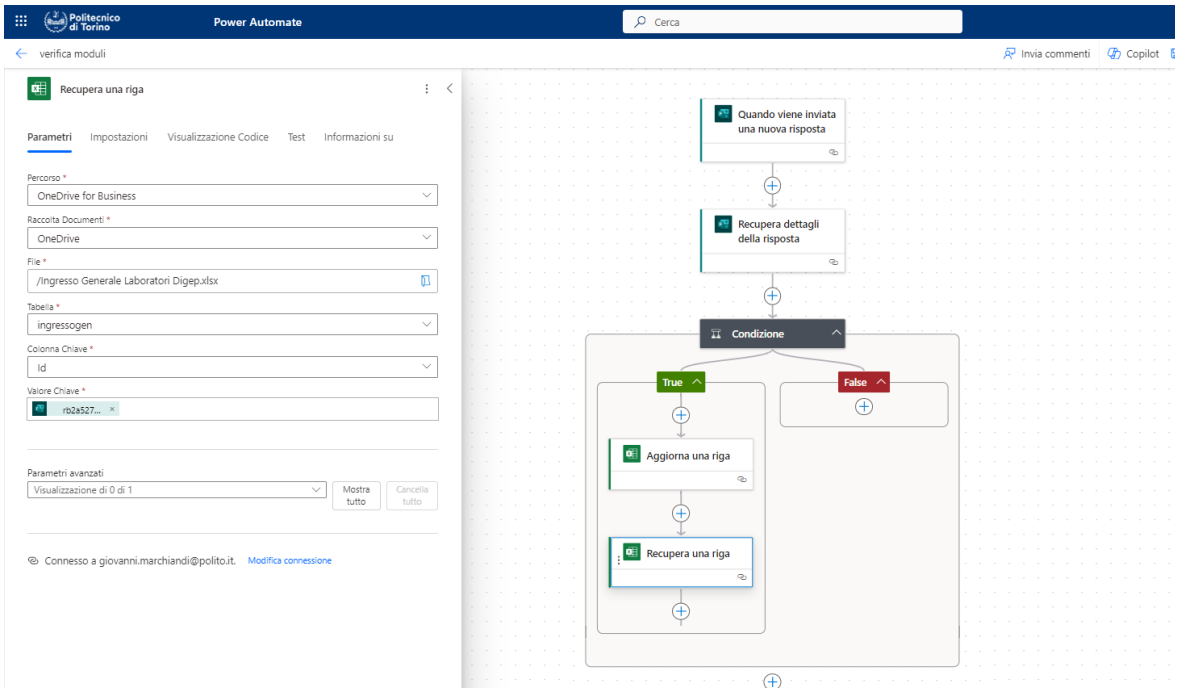
For the condition, select the operator “AND” and in the new item, choose “Confermo moduli” using the blue lightning icon. Then, select “is equal to” and type “YES” in the last label, as shown in the picture.

Under the True condition, add an action and choose Excel for Business. Then select the option “Aggiungi una riga”. Fill in the labels as shown in the following picture: type “Id” for Key Column and choose “Id student entrance” for Key value.

In the advance parameters select Confermo/Confirm and choose “Confermo” by Microsoft Forms using the blue lightning icon, as show in the picture below.



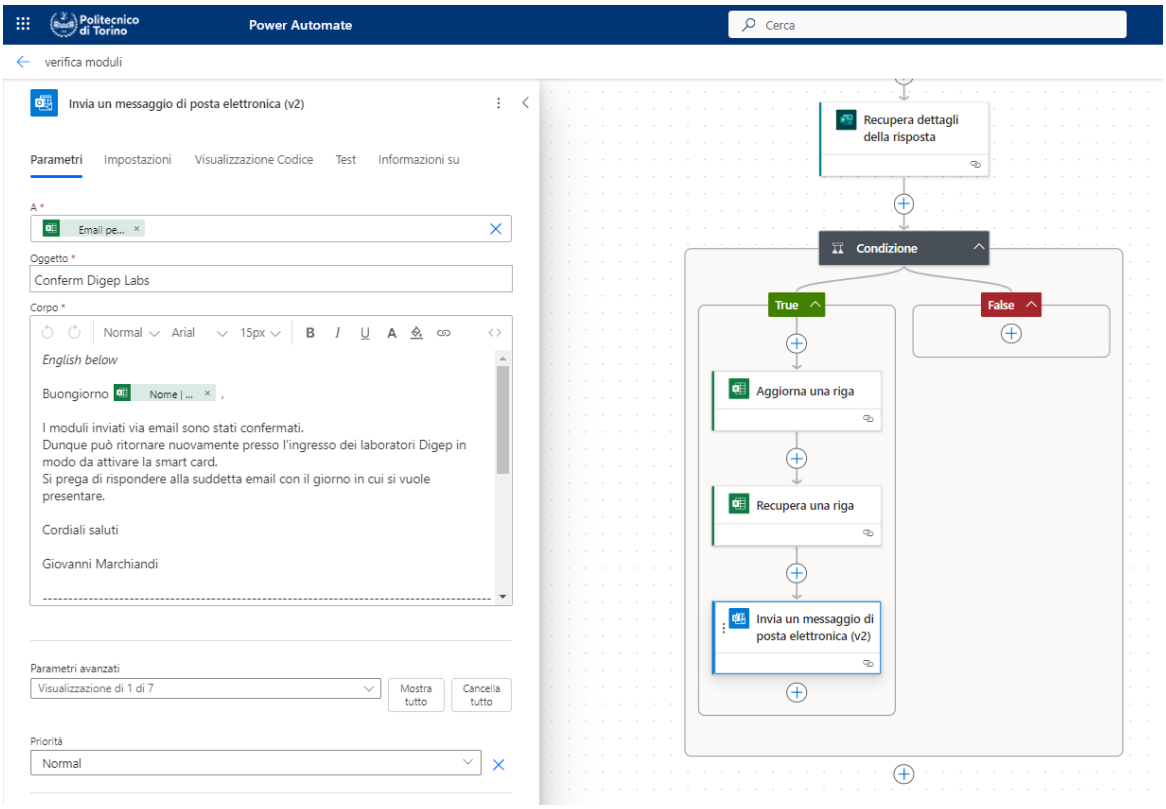
Click the “+” symbol and choose “Add an Action”. Click on Excel for Business app then “Recupera una riga” button.



Fill all labels as you in the picture.

Choose “Id” for Key columns and “Id student entrance” for key value.

Click again the “+” symbol and choose “Add an Action”. Click on Outlook e-mail app then “Invia un messaggio di posta elettronica (V2)” button.



Fill all fields as in the previous flow and customize the email body as desired.

Once you have finished setting up the flow, save it and perform a manual test.

The management system used for this thesis has been successfully completed.

Bibliography and Website

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