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Work Package 1:	Consolidation of ex-ante analysis and preparation of implementation actions
Title:	D1.1 Consolidated analysis of educational/industrial needs on IoT in Argentina and Uruguay
Lead Organization:	UNI-KLU
Participating Organization:	UNI-KLU, UC3M, UNC, UNS, UNMDP, UdelaR, UCU, INCUTEX, ALASSIO, ALENET, TEAC, EYCON, ALLIANSYS SRL, Santex, TELECOM ARGENTINA S.A, CONTROLNET S. A., ABM ingeniería y sistemas S.R.L., UTE, CONAE.
Editors:	A. Tonello, N. Letizia, Juan Cousseau, M. Julia Fernández-Getino García
Contributors:	Juan Cousseau, M. Julia Fernández-Getino García, N. Letizia

Deliverable data	Work Package and Outcome ref.nr	WP1 D1.1
	Title	Consolidated analysis of educational/industrial needs on IoT in Argentina and Uruguay
	Type	☐Teaching material ☐Event ☐Learning material ☒Report ☐Training material ☐Service/Product
	Description	The document provides: i) an analysis, through an industry survey, of the existing situation related to IoT field, regarding trends, competences and skills needed, application areas, different domains of IoT, and cooperation between industries and universities ii) a snapshot of present situation about IoT in ICT studies in Argentinian and Uruguayan HEIs, identifying the potential courses to be updated with IoT contents iii) guidelines targeting the development of a professional profile with high competences in the field of IoT, leading to the modernization of curricula at Argentinian and Uruguayan universities
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Lead Organization	UNI-KLU	
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Task	T1.1 Survey and analysis of IoT courses in ICT study programmes in relation to modern society and industry needs in the IoT domain(Task leader: UNS). T1.2 Consolidate guidelines for curriculum modernization in cooperation with industry(Task leader: UC3M).	

Revision History				
Version	Date	Author(s)	Organization(s)	Brief description of change
1	14.3.2021	A. Tonello	UNI-KLU	Super draft
2	02.7.2021	M. Julia Fernández-Getino García	UC3M	Initial table of contents
3x	06.7.2021 – 13.7.2021	Juan Cousseau M. Julia Fernández-Getino García N. Letizia	UNS UC3M UNI-KLU	Drafts with partial contents of different sections and their revisions
4	14.7.2021	Juan Cousseau M. Julia Fernández-Getino García N. Letizia	UNS UC3M UNI-KLU	Complete draft of the document
5	13.09.2021	Vitali Korzhun	UNI-KLU	First review process for Quality Control (QC)
6	06.10.2021	Juan Cousseau M. Julia Fernández-Getino García N. Letizia	UNS UC3M UNI-KLU	Updated version of the document
7	14.10.2021	Vitali Korzhun	UNI-KLU	Second review process for Quality Control (QC)
8	19.10.2021	Juan Cousseau M. Julia Fernández-Getino García N. Letizia	UNS UC3M UNI-KLU	Final version of the document

Table of Contents

1. Introduction

IoT has become a key technology with multiple applications in several activities as, vehicular communications, smart cities, e-health, industry 4.0, sensors-based agriculture and acuiculture activities, civil security, emergency management,... During the last years an amazing growth of the industry activity in this field around the globe has happened, also in Argentina and Uruguay, where this project is focused. However, this new scenario, with a predominant role of IoT in many ICT applications, is not encompassed with a parallel transformation of the ICT study programs in these countries. The NEON project intends to overcome this situation.

This deliverable D1.1 titled “Consolidated analysis of educational/industrial needs on IoT in Argentina and Uruguay” reports the results of the activities carried out in tasks T1.1 and T1.2, within WP1 “Consolidation of ex-ante analysis and preparation of implementation actions” of the NEON project [1].

Regarding these tasks, their corresponding activities are provided next:

Task 1.1: Survey and analysis of IoT courses in ICT study programmes in relation to modern society and industry needs in the IoT domain (Task leader: UNS)

This task, whose duration ranges from M1 to M6, is basically intended to the development and analysis of both an industry survey and an academic survey. Then, a company-oriented survey, focused on the IoT field, has been prepared and distributed among numerous enterprises. It is meant to provide an understanding of whether companies are looking for IoT specialists, the more demanded areas of knowledge in the IoT field, the required skills, the need of training, in what fields the specialists are employed and many other perspectives from the industry side. Its analysis has provided relevant information to the project.

Additionally, an academic survey has been conducted. The responses have been analyzed to understand the status quo in IoT at the participating universities from Argentina and Uruguay. Also, information on course modalities, teaching methodologies and competences has been obtained.

Task 1.2: Consolidate guidelines for curriculum modernization in cooperation with industry (Task leader: UC3M)

This task has spanned from M1 to M6 too. From the joint analysis of industry and academic surveys, guidelines have been established. The guidelines will take a snapshot of the existing status in both academia and industry and present a set of common needs and objectives for the transformation of IoT studies. Guidelines have been prepared and conceived as a methodological tool, with the aim of modernizing the study programs with respect to IoT contents in cooperation with industry. These guidelines will orient the partners on the development phase of the modernized programs, labs, and teaching methodologies.

This document collects the outputs of these two tasks. In Section 2, the objectives of the deliverable are provided. All aspects related to the industry survey and its analysis to grasp the industry needs in the IoT domain are presented in Section 3. Then, in Section 4, the survey and analysis of IoT courses in ICT study programs in relation to modern society are addressed. Section 5 is focused on providing the consolidated guidelines for curriculum modernization in cooperation with industry. They are necessary to the following project activities which will address identified industry and academia needs. Finally, conclusions of this deliverable are given in Section 6, to serve as the basis for forthcoming activities in the NEON project.

2. Objectives of the deliverable

The main objective of deliverable D1.1 is to elaborate an initial analysis obtained from all HEIs and industry partners in Argentina and Uruguay and formulate a guideline document for the curriculum modernization in IoT that will guide the NEON project activities. In the framework of the project, a Network of Competence (NoC) will be developed. The accomplishment of the main objective includes several activities described in detail below.

Firstly, an industry survey has been carried out targeting companies related to the IoT field. Although the main scope was focused on enterprises located in Argentina and Uruguay, the survey was opened to neighbour countries as Brasil, Chile, Ecuador and others, to enrich the whole picture. The aim of this survey was to obtain detailed information on (but not limited to):

- the perception on IoT future and trends in companies;
- a connection between low IoT activity in Argentina and Uruguay and the lack of skills in this field;
- the demand for training courses or other activities;
- different domains where IoT skills are required;
- an opinion on the practical knowledge of recent graduate students;
- the impression on the level of cooperation between industries and universities.

The analysis of this valuable information will make it possible to grasp the industry needs in the IoT domain.

Secondly, representatives from HEIs have collected the information from the universities located in these countries through a survey. The goal is to acquire general knowledge on the ICT study programs to identify the current state of IoT studies in Argentina and Uruguay. The analysis of this gathered information will drive to work on a fourfold target:

- Location of current courses devoted to IoT, already available in these programmes;
- Identification of potential courses to be updated with IoT contents;
- Creation of new courses to fill the possible detected gaps on IoT training;
- Creation of new labs with IoT infrastructure.

In addition, a separate survey was conducted to obtain a general overview of the course modalities, teaching methodologies and competences used in HEIs participating in the NEON project. Analysis of this information is important for WP3, which is devoted to the modernization of teaching methodologies.

Thirdly, the guidelines have been designed based on an analysis of the current development of IoT in Argentina and Uruguay. The guidelines consider both educational and industrial inputs and aim to develop a professional profile with high competences in IoT. Moreover, a projection of its future needs, trends, and goals for the transformation of this field of studies will be addressed.

3. Analysis of industry survey to grasp the industry needs in the IoT domain

3.1. Methodology of the industry survey

An online survey was used to analyze the interest of the industry in Argentina and Uruguay in the Internet of Things (IoT). The survey was available for a period of approximately two months. The survey consisted of 27 questions, some of which were multiple.

A flow chart of the survey is shown in Figure 1. Survey questions can be grouped around a specific purpose and / or topic, as indicated by different colors in the flow chart. Below is a description of the objectives of each group of questions.

The first group of questions is of general purpose and is intended to obtain a classification of the respondents. The corresponding questions are as follows:

- **Q1**: What country do you work in?
- **Q2**: How many employees work in your organization?
- **Q3**: In which sector does your organization operate?
- **Q4**: What is your position?

The second group of questions is aimed at knowing the interest in the subject of IoT. The questions corresponding to this group are as follows:

- **Q5**: Are you interested in the Internet of Things for your organization?
- **Q6**: Are you familiar with the Internet of Things?
- **Q7a**: In which domain would you be interested in developing knowledge / skills about the Internet of Things? 1) Electronics, 2) Data analytics, 3) Management, 4) Device programming, 5) Back-end / front-end programming, 6) Security, 7) Other.

The third group of questions is aimed at knowing the interest in generic training needs in IoT. The questions for this group are as follows:

- **Q7b**: In your opinion: what best defines the Internet of Things? (choose up to 4 answers)? 1) Cloud computing, 2) Embedded systems, 3) Computer vision, 4) Data mining, data analytics, 5) Communication protocols, 6) Informatics security, 7) Machine learning, 8) Machine-machine communications, 9) Multiprocessing, 10) Networks, 11) Labeling of objects (RFID), 12) Robotic systems, 13) Sensor, actuators, 14) User services, 15) Sensor data collection, 16) Smart objects, 17) Other.
- **Q8**: Do you use / develop the Internet of Things in your organization?
- **Q9a**: What type of Internet of Things do you use / develop in your organization? 1) Embedded systems, 2) Sensor data collection, 3) Sensors, actuators, 4) User devices, 5) Labeling of objects (RFID), 6) Communication protocols, 7) Smart objects, 8) Robotic systems, 9) Other.
- **Q9b**: Why don't you use / develop the Internet of Things in your organization? 1) Lack of internet of things skills / competencies, 2) Financial reasons, 3) Using the internet of things is too complex, 4) Internet of things does not offer any benefit, 5) I am not aware of the benefits of the internet of things, 6) Informatics security concerns, 7) Other.

The following group of questions is aimed at knowing, given the interest in IoT, what type of related activities the respondent performs and what type of skills or competencies he considers necessary. The questions are as follows:

- **Q10**: What kind of activities / projects related to the Internet of Things are you involved in? 1) Manage / facilitate, 2) Create / develop, 3) Other.

- **Q11**: Do you think the following competencies are relevant when designing and implementing Internet of Things projects? (rate your needs from 0 to 4: 0 no need; 4 highly needy) Project management; innovation management; ability to anticipate future trends; creativity; ICT competence (digital); analytical thinking.
- **Q12**: What formation do you have to develop the following aspects of Internet of Things projects? (value your needs from 0 to 4: 0 no needs; 4 highly needy) ? Project management; innovation management; ability to anticipate future trends; creativity; ICT competence (digital); analytical thinking.
- **Q13**: How do you judge the Internet of Things according to the achievement of future results within your own organization? 1) I would like to learn about the Internet of Things for my organization, 2) I believe that the Internet of Things will have significant growth in the coming years, 3) I agree that organizations leading the Internet of Things will have a significant advantage.
- **Q14**: Are you willing to take advantage of training courses to manage Internet of Things projects? 1) Yes, 2) No, 3) Don't know.
- **Q15**: Do you have personal needs to improve skills or competencies to develop Internet of Things projects? (value your needs from 0 to 4: 0 no needs; 4 highly needy) Hardware (CPU, microcontrollers, etc); embedded systems; communication, networks and protocols; mobile computing: distributed architecture; data analytics; security.
- **Q16**: Would you be willing to take advantage of training courses and / or training activities to develop Internet of Things projects? 1) Yes, 2) No, 3) Don't know.
- **Q17a**: What specific training do you need in the "Hardware" domain? 1) System on Chip, 2) Signal processing, 3) Microcontrollers, 4) Energy consumption, 5) Sensors, 6) Circuit design, 7) Actuators, 8) Other.
- **Q17b**: What specific training do you need in the domain of "Operating Systems for Embedded Systems"? 1) General kernel programming (Linux), 2) Overview of embedded developments and operating systems, 3) Application development for embedded systems, 4) Processes and task planning, 5) Driver development, 6) Other, 7) Memory and file system manager.
- **Q17c**: What specific training do you need in the domain of "Communication, networks and protocols"? 1) Low-power, short-range wireless protocols (ZigBee, Bluetooth, ...), 2) Low-power large range wireless protocols (LoRa, SigFox, LTE-M, NB-IoT, ...), 3) Introduction to networks, 4) Web protocols (HTTP, UPnP, ...), 5) Other, 6) Time-constrained protocols.
- **Q17d**: What specific training do you need in the "Mobile Computing" domain? 1) IOS development, 2) Android development, 3) Universal Windows platform, 4) Multiplatform development, 5) Mobile app design / experiences, 6) Other.
- **Q17e**: What specific training do you need in the "Distributed Architecture" domain? 1) Introduction to Client / Server, 2) Web services architectures (REST, SOAP, ...), 3) Middleware for Internet of Things, 4) Data collection in the cloud, 5) Concurrent programming, 6) Other.
- **Q17f**: What specific training do you need in the domain of "Data Analytics"? 1) Data semantic and data labelling, 2) Machine learning and neural networks, 3) Artificial intelligence platforms, 4) Other.
- **Q17g**: What specific training do you need in the "Security" domain? 1) Security concepts, 2) Cryptography concepts, 3) Security algorithms and protocols on restricted devices, 4) Security in applications, 5) Communications security, 6) Other.
- **Q18**: Where do you see the main advantages of the Internet of Things within your organization? 1) Data and service analytics, 2) Customer engagement services, 3) Resource tracking and monitoring, 4) Automated manual processes, 5) Improved workflows and processes, 6) Other.
- **Q19**: Please list 1 or 2 business applications of Internet of Things related to your own organization. Use product names; Example: Analysis based on data production rules based on BOSCH embedded systems - IoT-Suite.
- **Q20**: The European Union encourages commercial adoption of the Internet of Things by various programs. Does your organization participate in any of these programs? 1) Yes, 2) No, 3) Don't know.

The last group of questions is aimed at employers and their interest in the training of specialists in ICT in general and in IoT in particular. The questions are as follows.

- **Q21**: Are you an employer (manager/director)?
- **Q22**: Indicate the sources for the recruitment of professionals used by your company? 1) National employment job matching services, 2) Private employment agencies, etc. 3) Announcement on the company's website, 4) Collaboration with secondary schools and universities, 5) Recruiting employees from other companies, 6) Word of mouth, 7) LinkedIn, 8) Open contest (research professor), 9) Researchers – students.
- **Q23**: Which professional skills are most important for your company in reference to the ICT specialists? 1) Software and Applications, 2) Hardware integration, 3) Firmware, 4) Hardware components, 5) Process Management, 6) Network and communication, 7) I don't know.
- **Q24**: Which professional skills does your company currently lack in reference to the ICT specialists? 1) Software and applications, 2) Hardware integration, 3) Firmware, 4) Hardware components, 5) I don't know.
- **Q25**: Do you believe that university graduate students have enough practical knowledge in the domain of IoT? 1) Yes, 2) No, 3) I never hired a graduate student, 4) I don't know.
- **Q26**: Do you implement internships and co-supervised thesis opportunities for students?
- **Q27**: How would you rate the cooperation between universities and industry in your country? (from 1, extremely bad cooperation to 5, total synergy)

To conduct the survey, regarding the adoption of Internet of Things usage and implementation in small and medium enterprises and necessary skills as well as competences for employees, Argentina and Uruguay were selected, according to NEON project participant's location. Due to different spoken languages, the initial English questionnaire version was translated in Spanish. In order to better facilitate and represent the results, the generalized data is indicated in charts and diagrams in English.

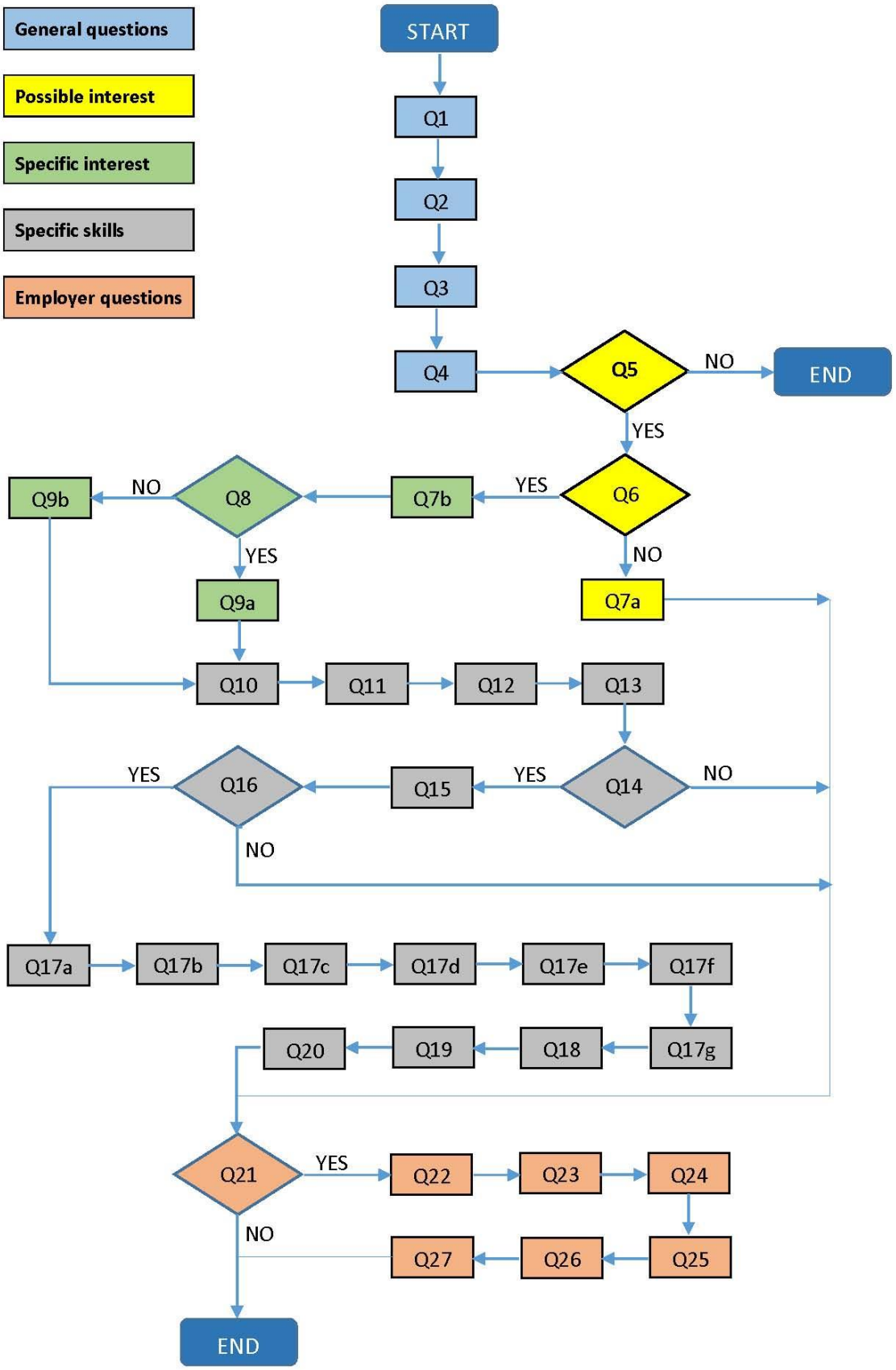
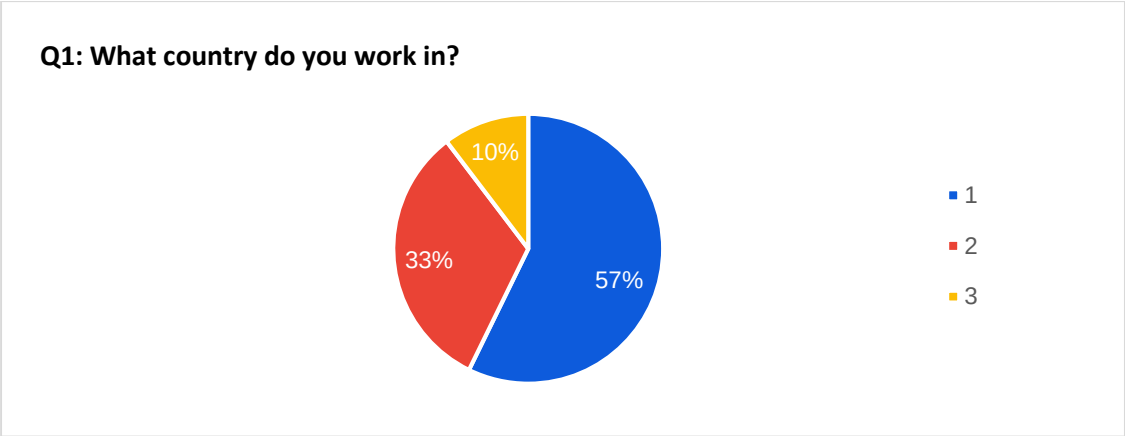


Figure 1. Flow chart of the industry survey.

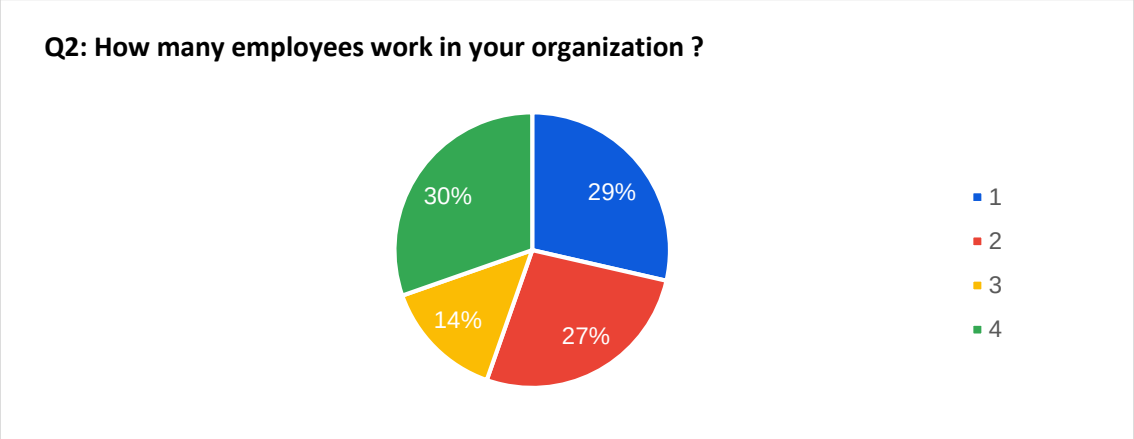
3.2. Analysis of the results

The first group of questions Q1-Q4 were addressed to have **general information** of the respondents.



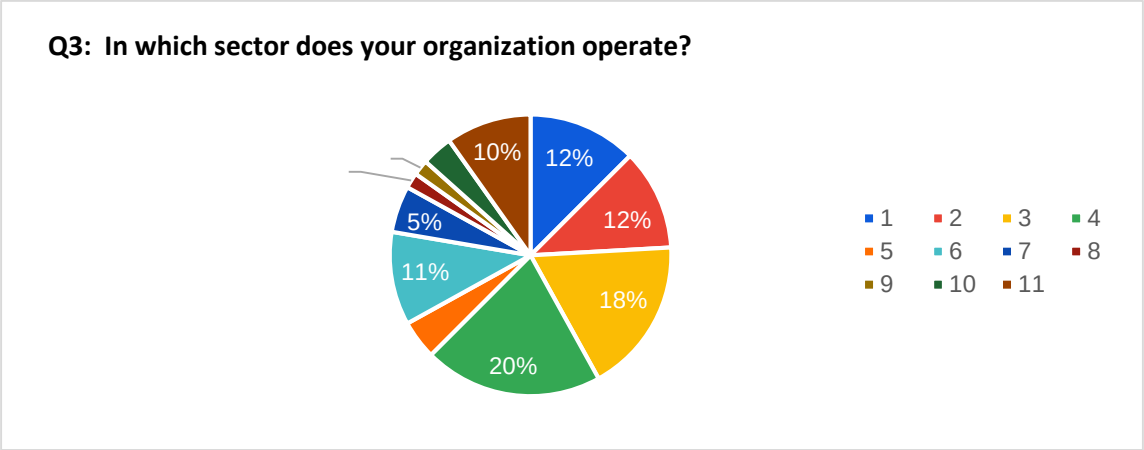
1) Argentina, 2) Uruguay, 3) Other.

The number of answers to Q1 the survey was 146, most of them from Argentina and Uruguay but also from other countries of the region (Brazil, Chile, etc.).



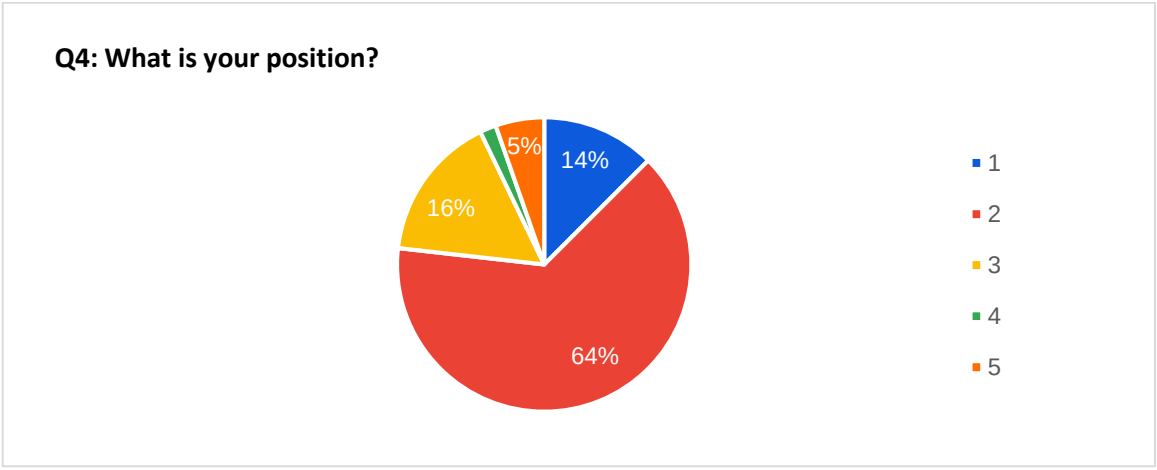
1) Less than 10, 2) Between 10 and 50, 3) Between 50 and 250, 4) More than 250.

Most of the answers to Q2 (70 %) are from small and medium enterprises, the main target group of NEON project.



1) Academy, 2) Industry, 3) Telecommunications, 4) ICTs, 5) Consulting, 6) Services, 7) Health, 8) Banks, 9) Transport, 10) Agriculture, 11) Other.

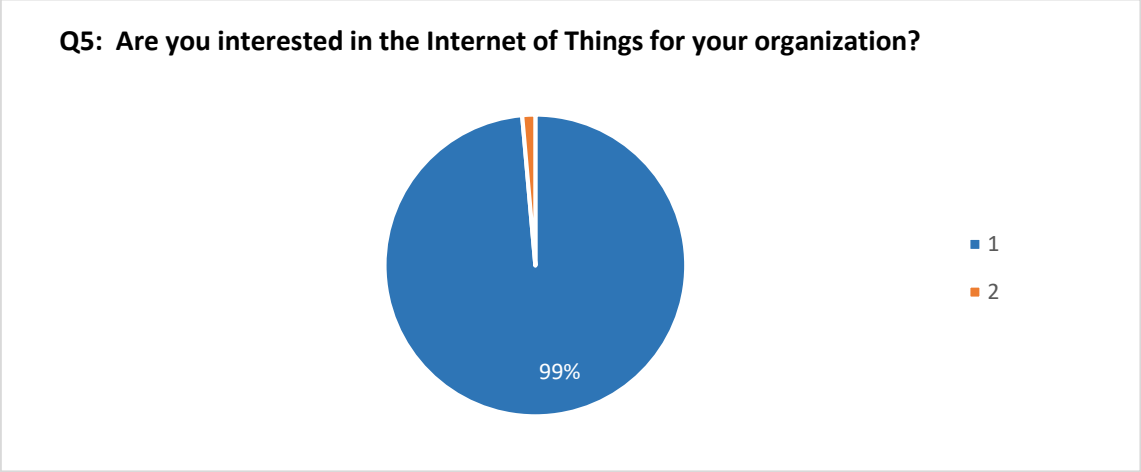
Despite being homogeneously distributed, the main answers to Q3 are: ICTs (20 %), telecommunications (18 %), academy (12 %), industry (12 %) and services (11 %). This allows to conclude that IoT interest is transversal to different business.



1) Professor - researcher, 2) Director / manager, 3) Technician or project manager, 4) Designer (industrial, product, service, user experience), 5) Other.

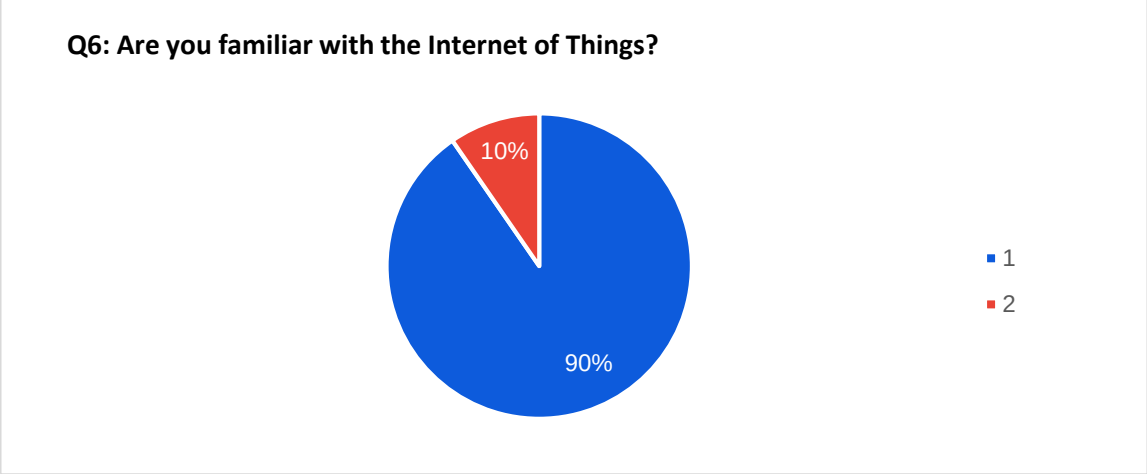
Most of the answers to Q4 came from the director / manager job role (64 %) who usually has a better understanding of the company needs. The technical position of the remaining answers (technician or project manager, professor and designer) are only 35 %. That means, curiously, that the respondents are more business-oriented.

The second group of questions (Q5, Q6 and Q7a) are associated with knowing the possible (general) interest in IoT.



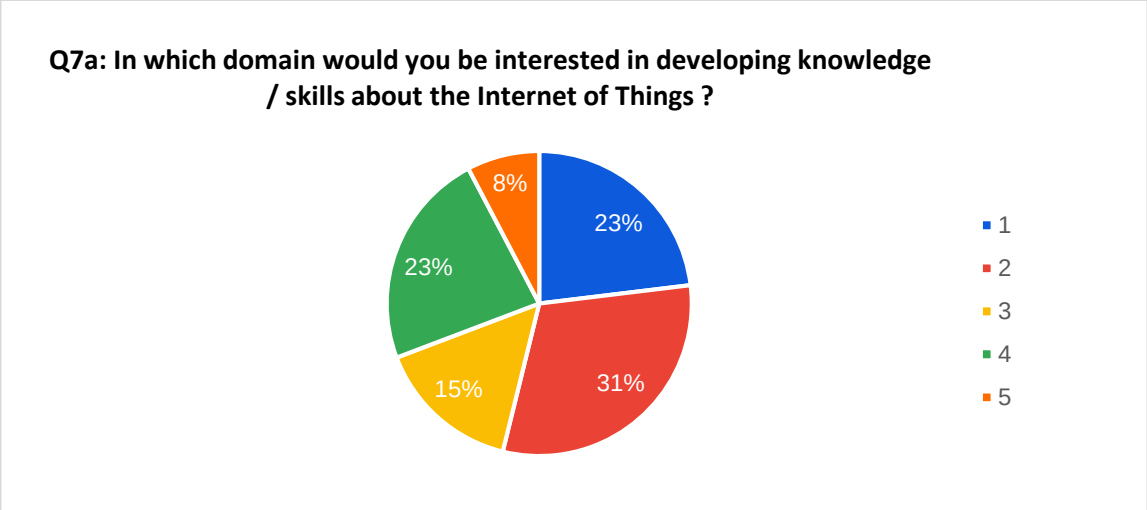
1) Yes, 2) No.

Most of the answers to Q5 were affirmative, that means high interest in the Internet of Things and therefore a potential broad impact of the IoT related results of the project.



1) Yes, 2) No.

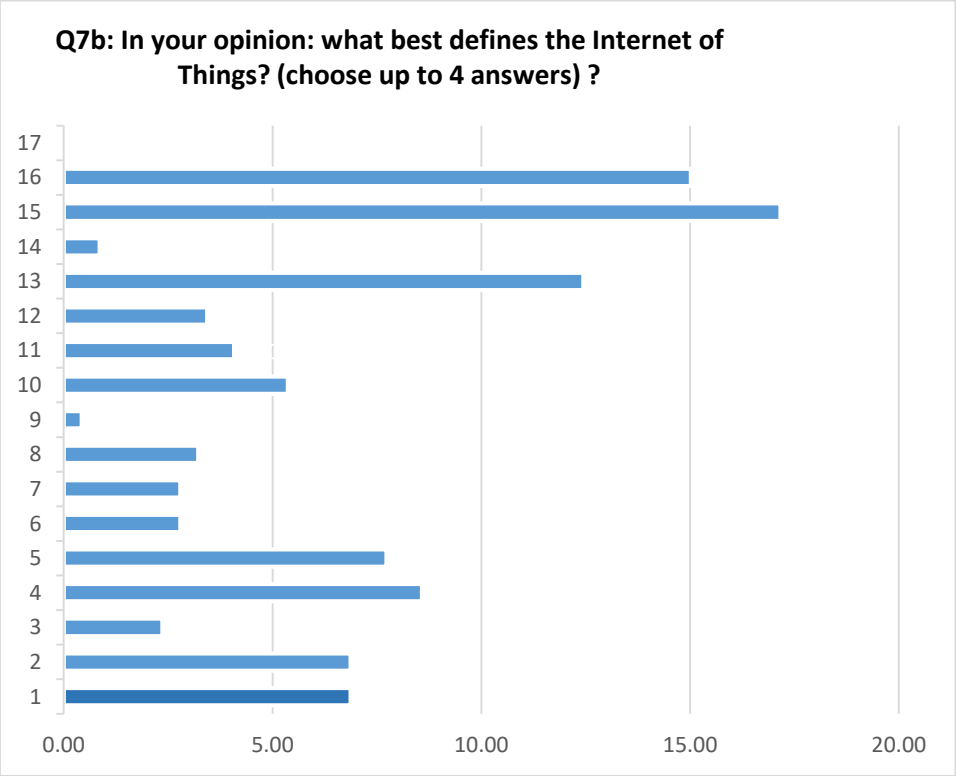
Most of the answers to Q6 also are positive when considering familiarity with the Internet of Things.



1) Electronics, 2) Data analytics, 3) Management, 4) Device programming, 5) Back-end / front-end programming, 6) Security, 7) Other.

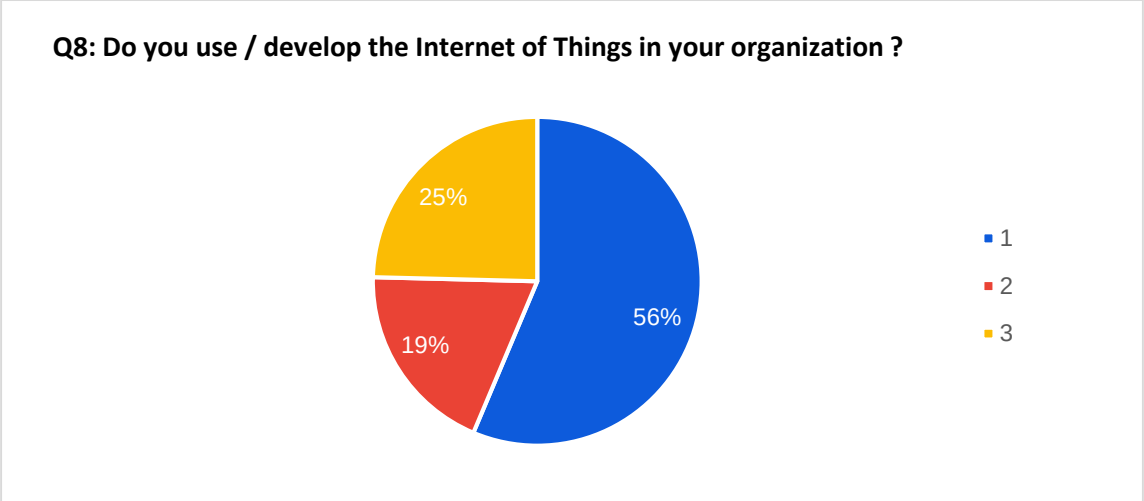
Again, the answers to Q7a are very homogeneous but it is possible to highlight: data analytics (31 %), electronics (23 %) and device programming (23 %). These answers are more oriented to technical skills about the Internet of Things.

The third group of questions (Q7b, Q8, Q9a and Q9b) are associated with knowing the specific interest in IoT and associated knowledge domains.



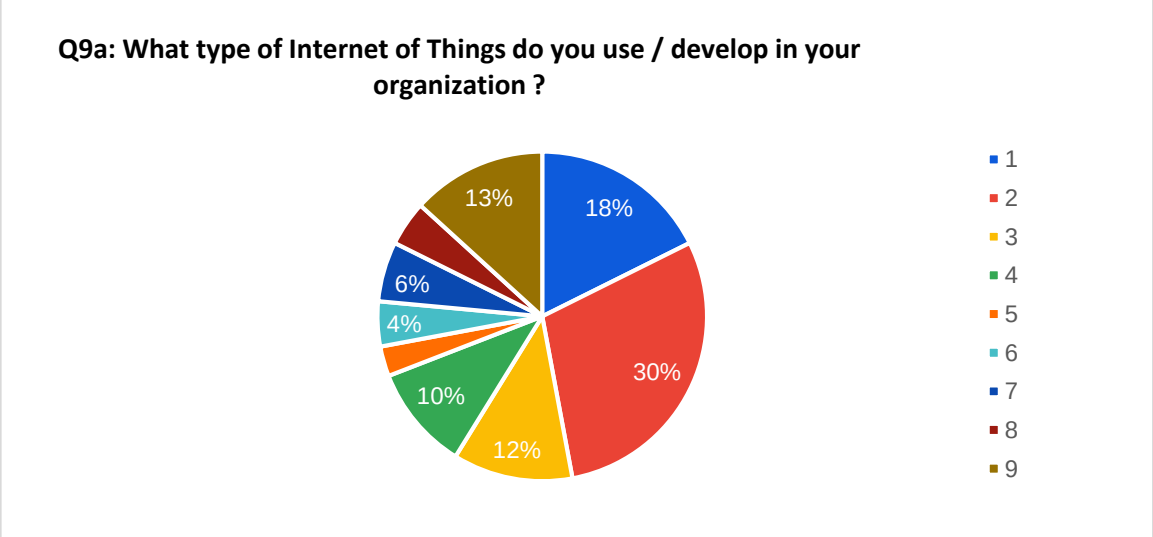
1) Cloud computing, 2) Embedded systems, 3) Computer vision, 4) Data mining, data analytics, 5) Communication protocols, 6) Informatics security, 7) Machine learning, 8) Machine-machine communications, 9) Multiprocessing, 10) Networks, 11) Labeling of objects (RFID), 12) Robotic systems, 13) Sensor, actuators, 14) User services, 15) Sensor data collection, 16) Smart objects, 17) Other.

According to the respondents to Q7b, sensors data collection (17 %), smart objects (15 %) and sensors and actuators (12.5 %) best defines Internet of Things. Moreover, respondents highly relate data mining, data analytics (8.5 %) and communications protocols (7.5 %) to the IoT. Approximately 7 % of respondents considers IoT as cloud computing and embedded systems and 5.5 % as networks.



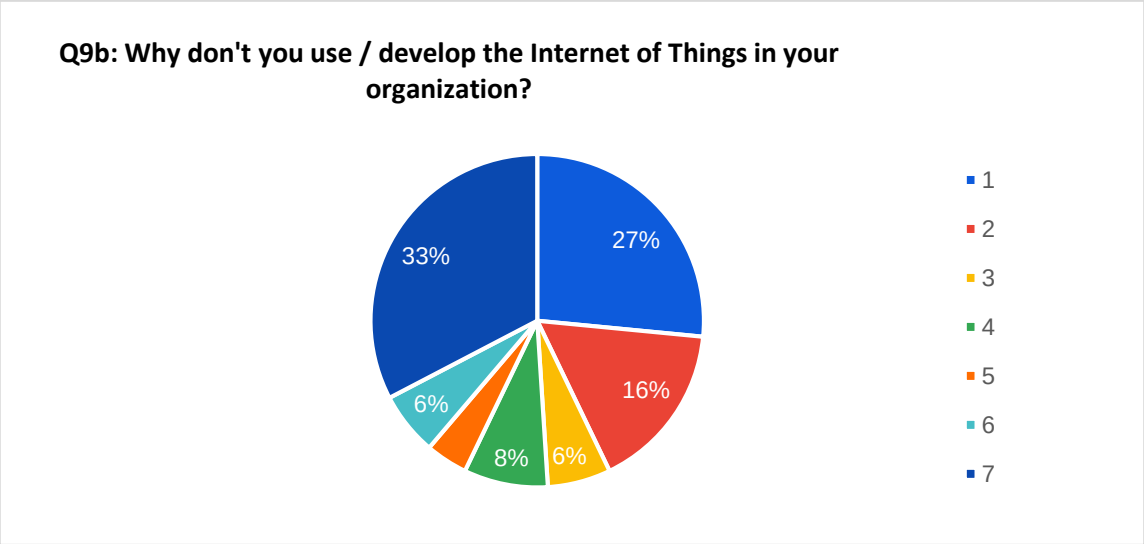
1) Yes, 2) No, 3) No, but in the future yes.

The majority of respondents to Q8 use / develop the Internet of Things (56%) or will do so in the future (19 %).



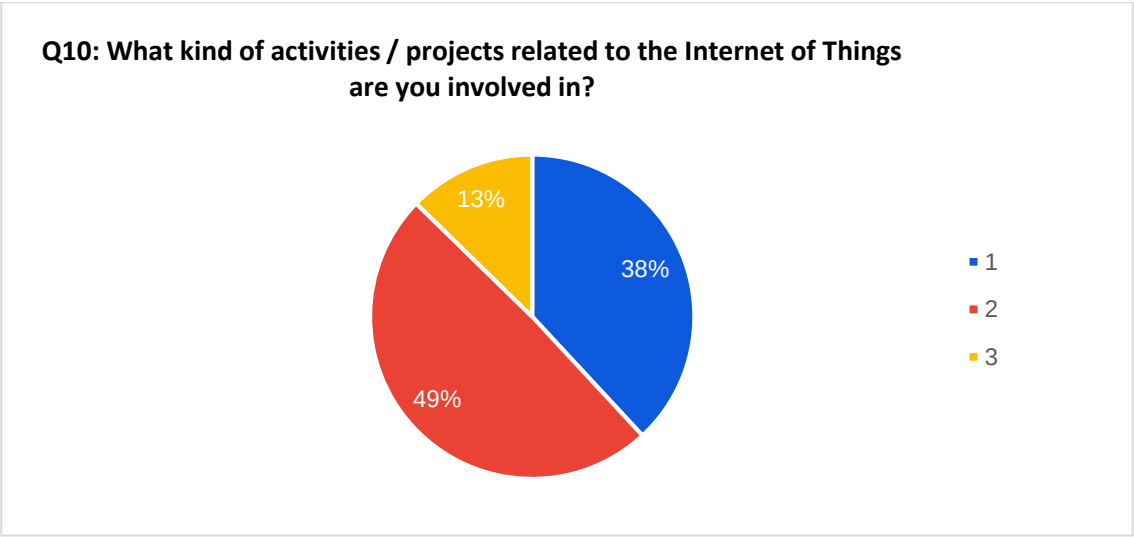
1) Embedded systems, 2) Sensor data collection, 3) Sensors, actuators, 4) User devices, 5) Labeling of objects (RFID), 6) Communication protocols, 7) Smart objects, 8) Robotic systems, 9) Other.

According to the answers to Q9a, the most significant type of use / development of the Internet of Thing is the sensor data collection.



1) Lack of internet of things skills / competencies, 2) Financial reasons, 3) Using the internet of things is too complex, 4) Internet of things does not offer any benefit, 5) I am not aware of the benefits of the internet of things, 6) Informatics security concerns, 7) Other.

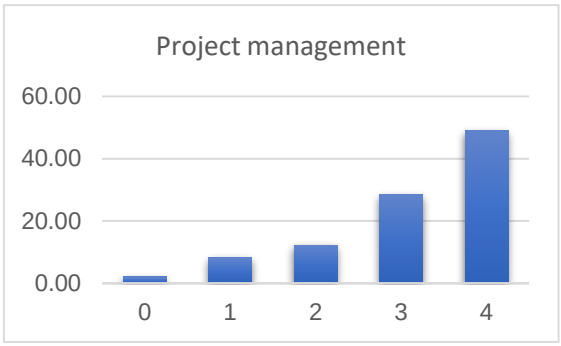
Despite the fact that 27% of the responses to Q9b report a lack of skills in the Internet of Things, it is possible to consider Others (33%, mostly blank comments but some related to business decisions) and financial reasons (16%) such as prevailing conclusion. That correlates with the profile of the people responding to the survey, as they are business-oriented.

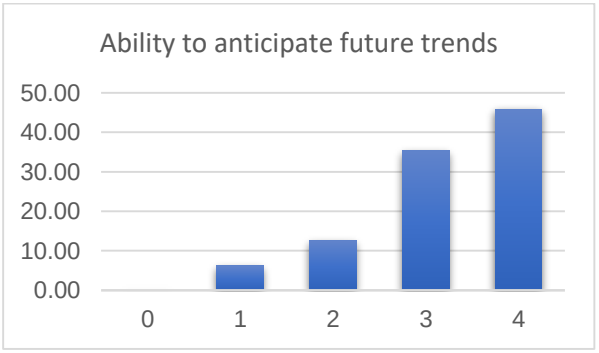


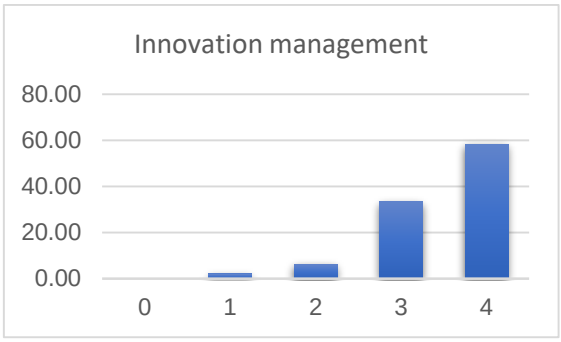
1) Manage / facilitate, 2) Create / develop, 3) Other.

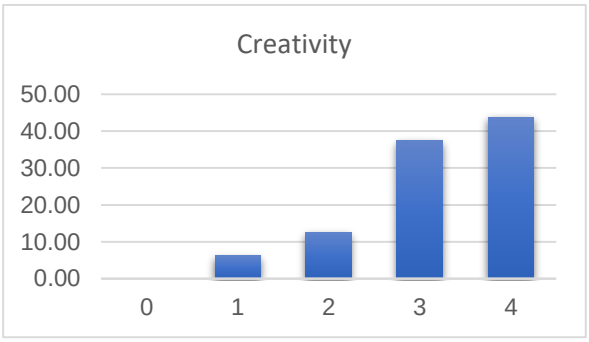
The answer to Q10 allows to profile the answer of the following three questions.

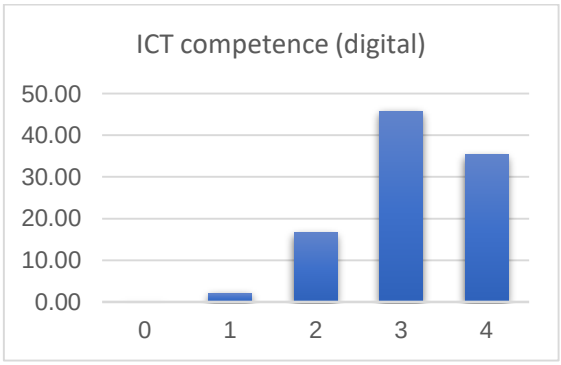
Q11: Do you think the following competences are relevant when designing and implementing Internet of Things projects? (rate your needs from 0 to 4: 0 no need; 4 highly needy)

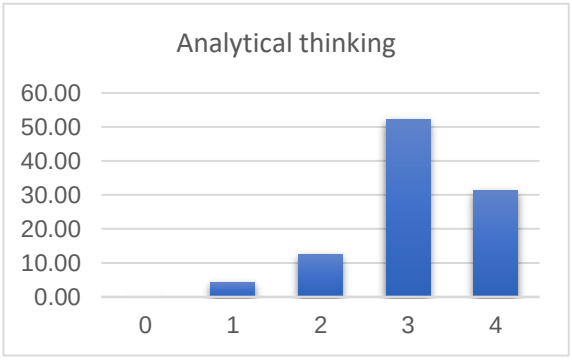








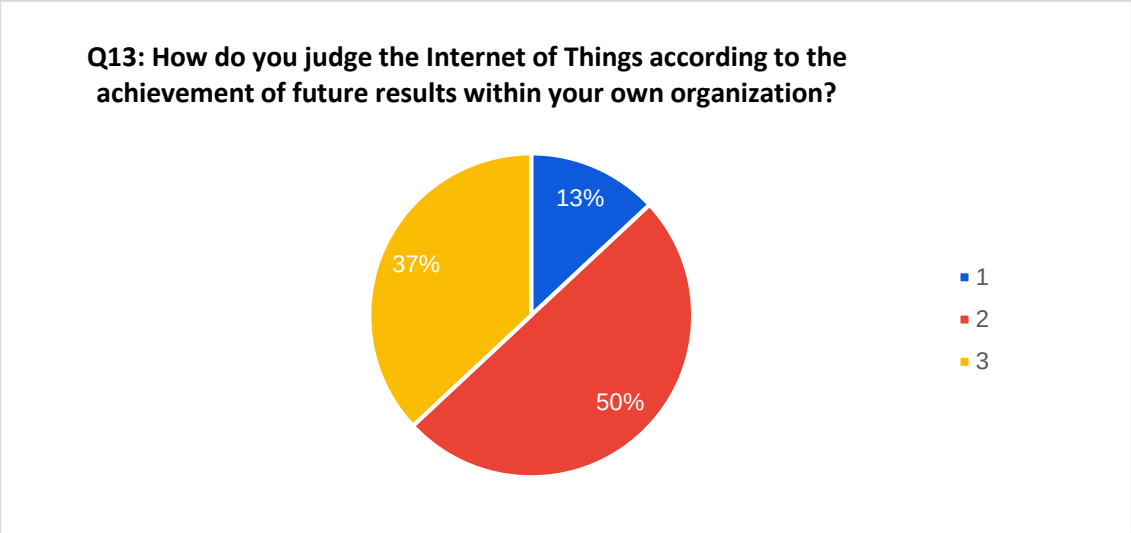




49 answers to Q11 were analyzed. Each bar graph illustrates the percentage number of responses for a score. To have a single comparison parameter, it is possible to weight the maximum score obtained (between 1 and 5 for simplicity) with the percentage of responses associated with that score, as illustrated by the bar graphs. Then, the most relevant competences when designing and implementing IoT projects are: innovation management (5 x 59 % = 2.95) and project management (2.5). Then, it follows: ability to anticipate future trends (2.25), creativity (2.2), analytical thinking (2.05) and ICT competence (digital) (4 x 51 % = 1.8).

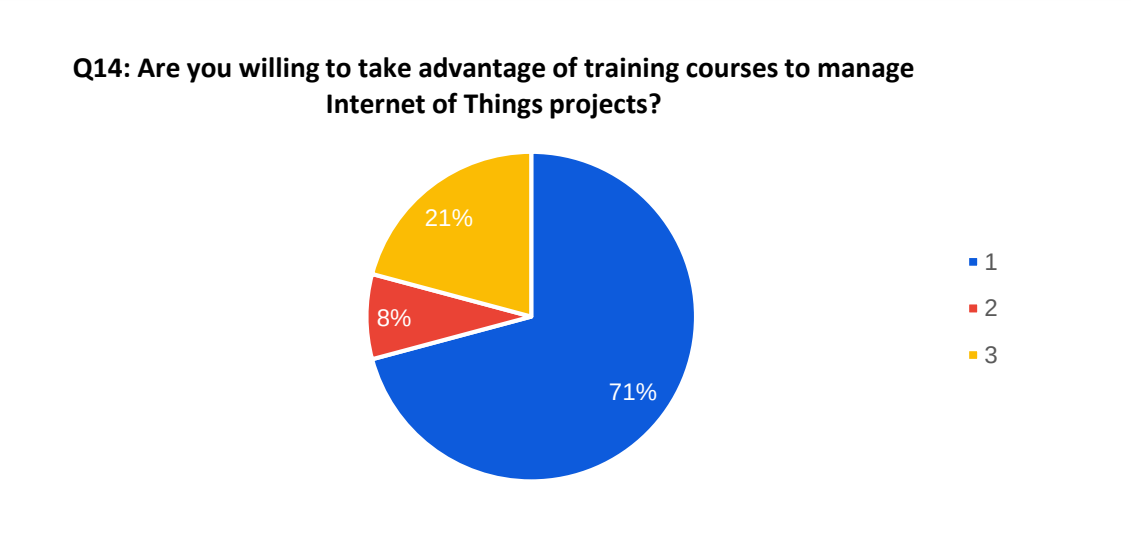
Q12: What formation needs do you have to develop the following aspects of Internet of Things projects? (rate your needs from 0 to 4: 0 no need; 4 highly needy)

In this case 48 answers to Q12 were analyzed. To have a single comparison parameter, and in a similar way that for question Q11, it is possible to weight the maximum score obtained with the percentage of responses associated with that score. According to the respondents the personal needs to develop in order to manage IoT-projects are: innovation management (5 x 41 % = 2.05), creativity (5 x 35 % = 1.75), project management (5 x 33 % = 1.65), ability to anticipate future trends (4 x 40 % = 1.6), analytical thinking (5 x 30 % = 1.5) and ICT competence (4 x 35 % = 1.4).



1) I would like to learn about the Internet of Things for my organization, 2) I believe that the Internet of Things will have significant growth in the coming years, 3) I agree that organizations leading the Internet of Things will have a significant advantage.

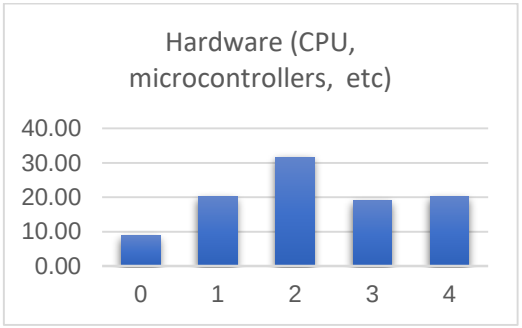
The answers to Q13 reflect a positive vision about the benefits of using IoT for competitiveness and productivity.

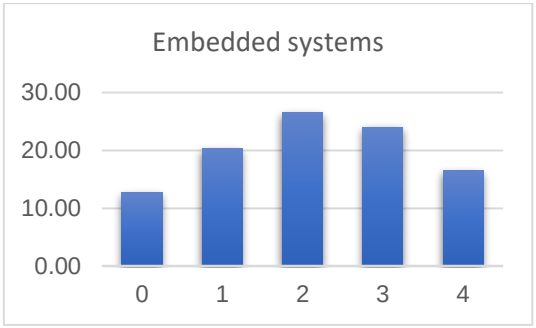


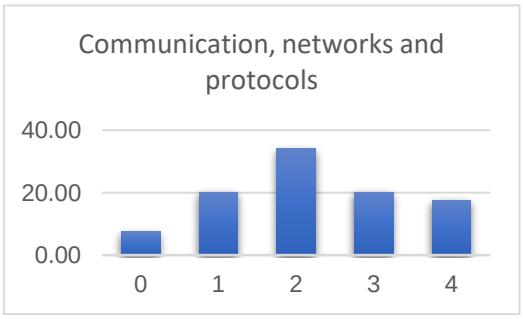
1) Yes, 2) No, 3) Don't know.

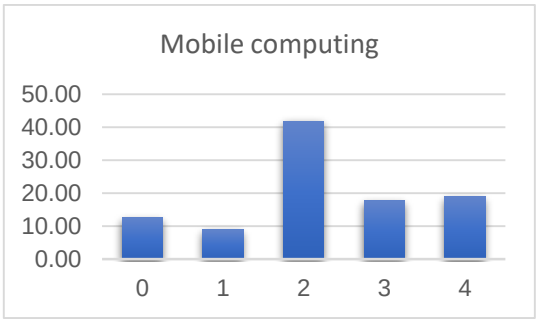
The answers to Q14 confirm the results in question Q13 about the need to benefit from training provisions in order to manage IoT projects and to increase the competitiveness and productivity of their organization.

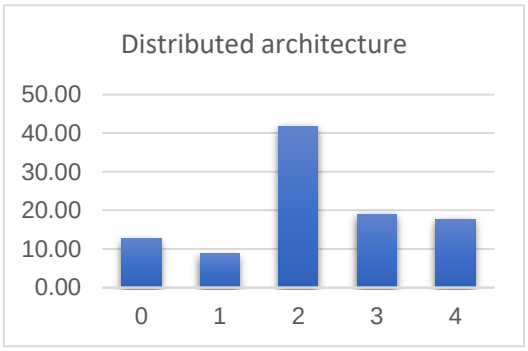
Q15: Do you have personal needs to improve skills or competencies to develop Internet of Things projects? (value your needs from 0 to 4: 0 no needs; 4 highly needy)

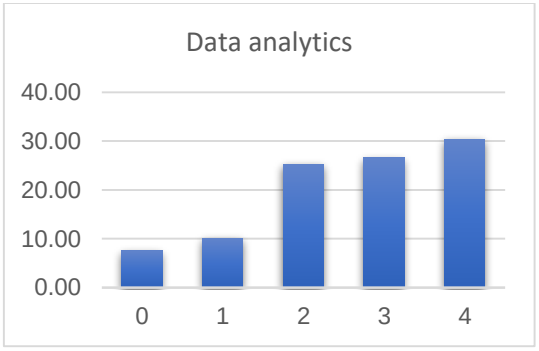


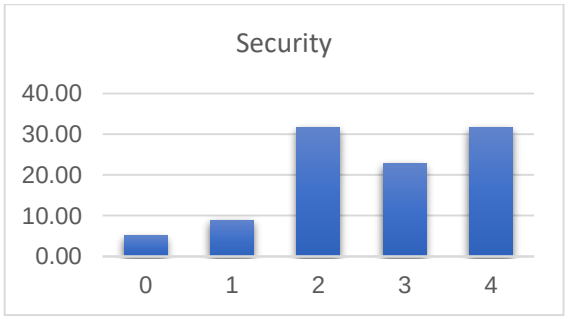




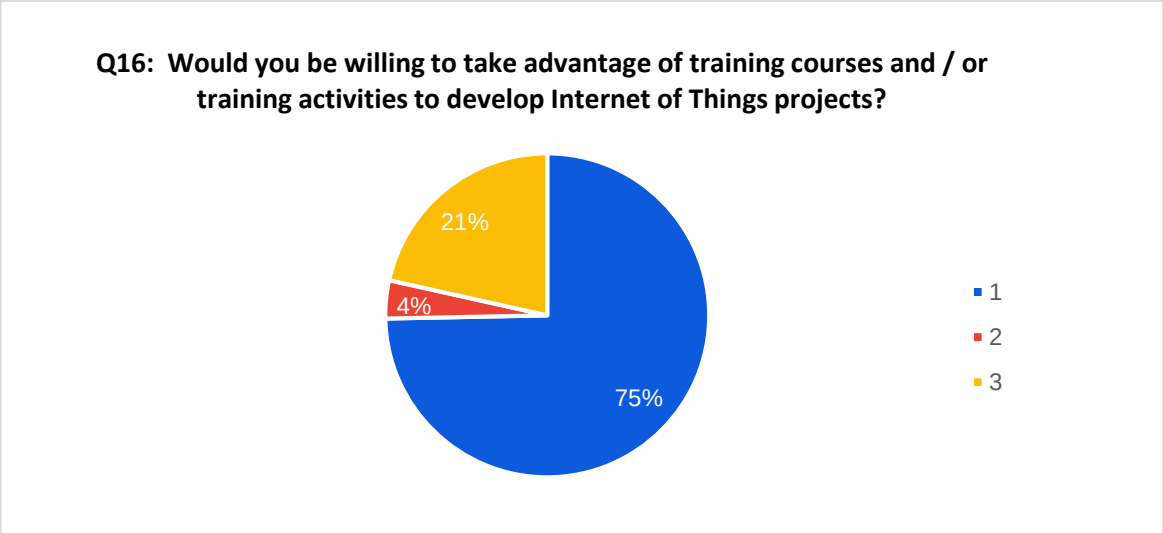






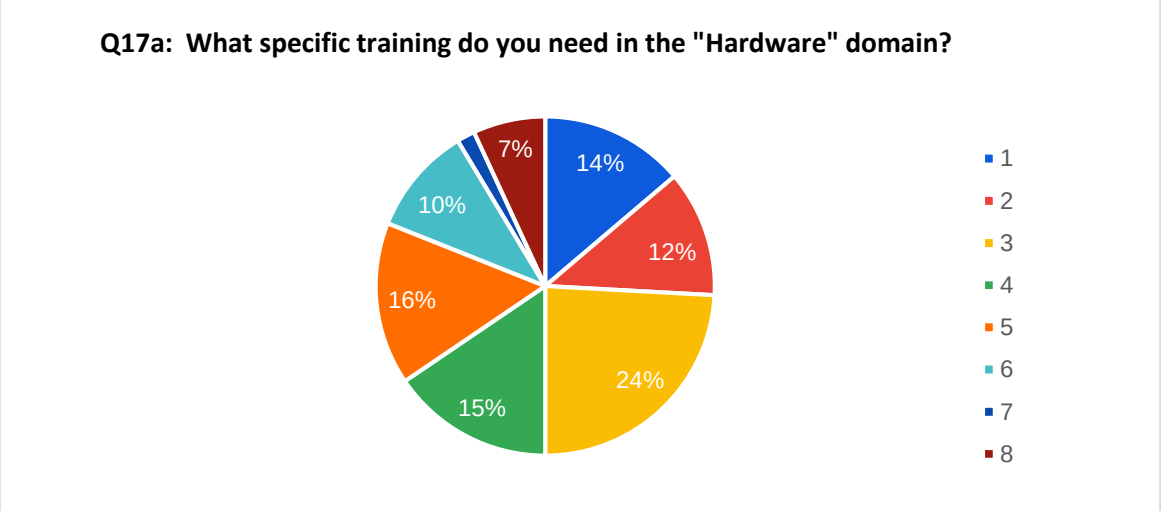


There were analyzed 79 answers to Q15. In a similar way that for question Q11 and Q12, it is possible to weight the maximum score obtained with the percentage of responses associated with that score. The personal needs to improve skills or competences in order to develop IoT-projects for IT or ICT staff are: security (5 x 33 % = 1.65), data analytics (5 x 30 % = 1.5), distributed architecture (3 x 41 % = 1.23), mobile computing (3 x 41 % = 1.23), communication, networks and protocols (3 x 35 % = 1.05), hardware (3 x 32 % = 0.96) and embedded systems (3 x 27 % = 0.81).



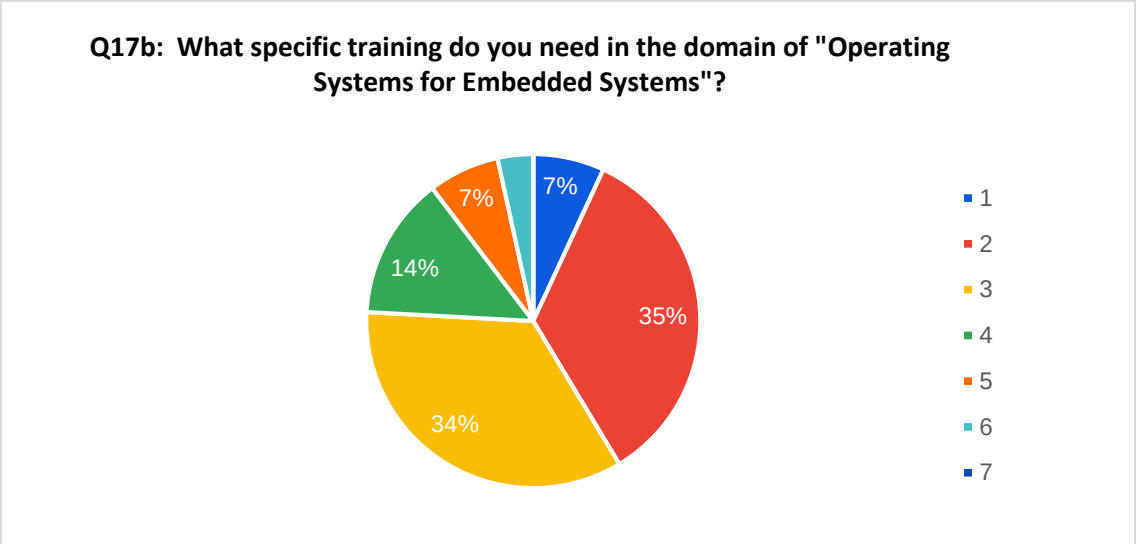
1) Yes, 2) No, 3) Don't know.

75% of respondents to Q16 are willing to benefit from training provisions in order to develop IoT projects, while 21% of respondents don't know.



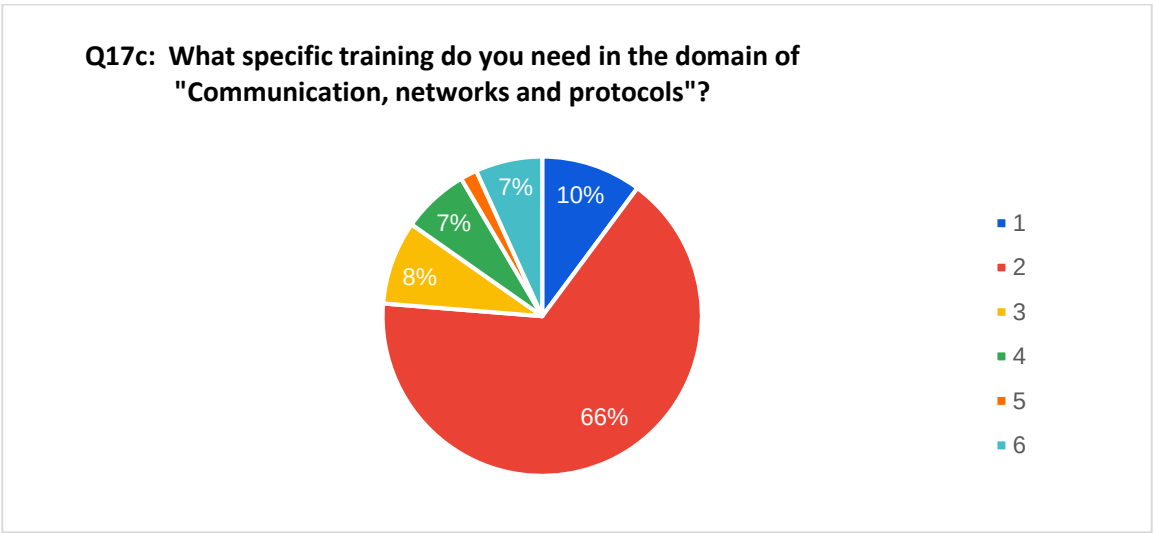
1) System on Chip, 2) Signal processing, 3) Microcontrollers, 4) Energy consumption, 5) Sensors, 6) Circuit design, 7) Actuators, 8) Other.

Based on 47 answers to Q17a, the most specific trainings needed in the Hardware domain are about: microcontrollers (24 %), sensors (16 %), energy consumption (15 %), actuators (14 %). Although the number of responses may not be high, the clear training needs on the "Hardware" domain must be considered.



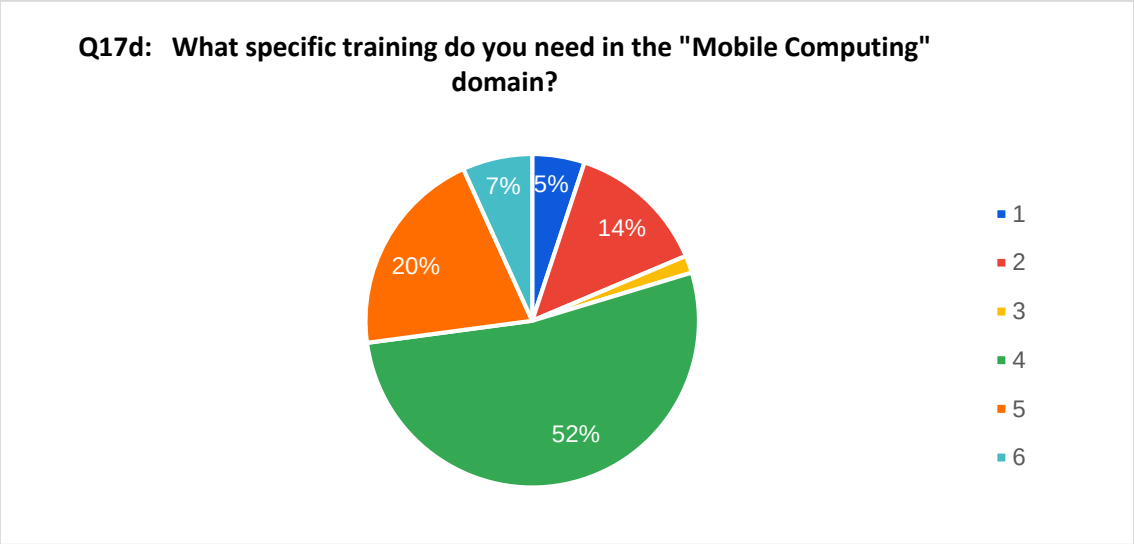
1) General kernel programming (Linux), 2) Overview of embedded developments and operating systems, 3) Application development for embedded systems, 4) Processes and task planning, 5) Driver development, 6) Other, 7) Memory and file system manager.

Based on 58 answers to Q17b, the most specific trainings needed in the Operating Systems for Embedded Systems domain are about: overview of embedded developments and operating systems (35 %), application development for embedded systems (34 %) and processes and task planning (14 %). Clear needs in training provisions about Operating Systems for Embedded Systems domain nonetheless arouse.



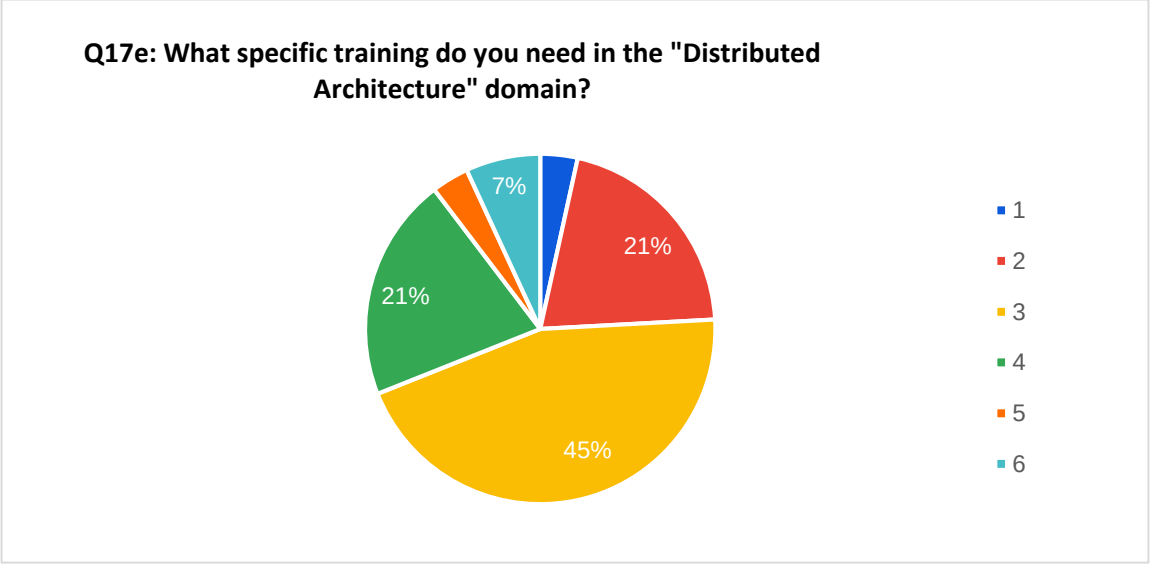
1) Low-power, short-range wireless protocols (ZigBee, Bluetooth, ...), 2) Low-power large range wireless protocols (LoRa, SigFox, LTE-M, NB-IoT, ...), 3) Introduction to networks, 4) Web protocols (HTTP, UPnP, ...), 5) Other, 6) Time-constrained protocols.

Based on 58 answers to Q17c, the most specific trainings needed in the Communication, networks and protocols domain is mainly Low-power large range wireless protocols (LoRa, Sigfox, LTE-M, NB-IoT) (66 %) with needs in the other aspects lower than 10 %. It can be concluded that training is required in Communication, networks and protocols domain.



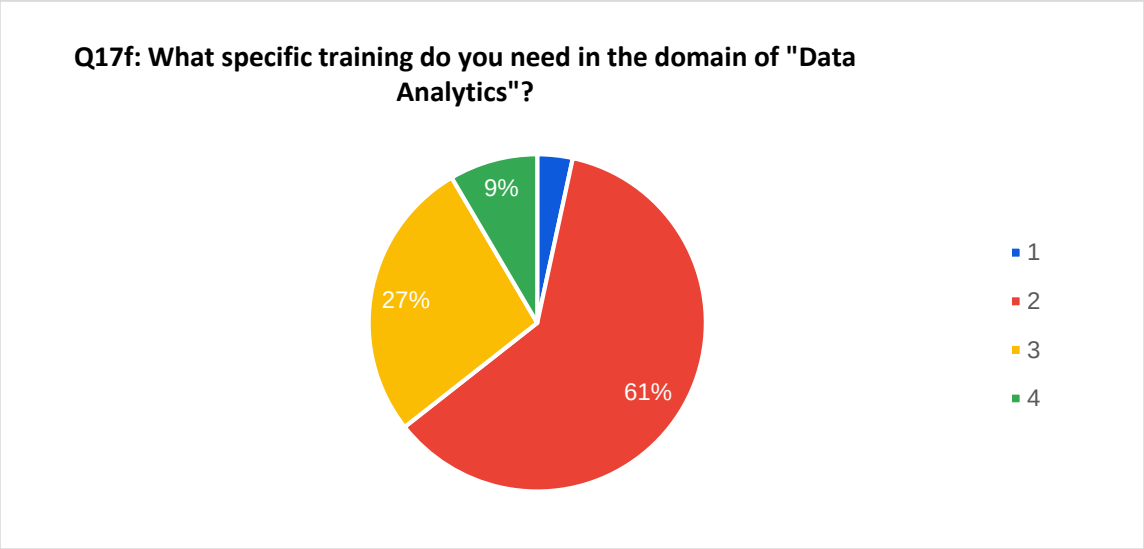
1) IOS development, 2) Android development, 3) Universal Windows platform, 4) Multiplatform development, 5) Mobile app design / experiences, 6) Other.

Based on 59 answers to Q17d, the most specific trainings needed in the Mobile Computing domain is mainly Multiplatform development (52 %), adding also Mobile app design / experience (20 %) and Universal Windows platform (14 %). In this case, it is possible to infer specific training needs in the domain of Mobile Computing.



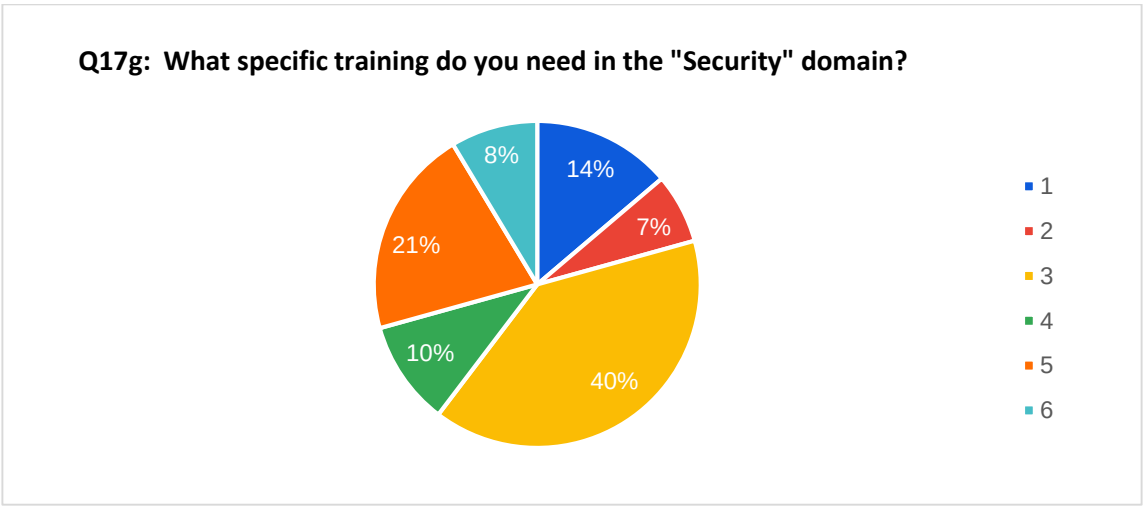
1) Introduction to Client / Server, 2) Web services architectures (REST, SOAP, ...), 3) Middleware for Internet of Things, 4) Data collection in the cloud, 5) Concurrent programming, 6) Other.

Based on 58 answers to Q17e, the most specific trainings needed in the Distributed Architecture domain is mainly Middleware for IoT (45 %), adding also Web services architectures (21 %), Data collection in the cloud (21 %). It can be concluded general needs for training provisions about Distributed Architecture domain arouse.



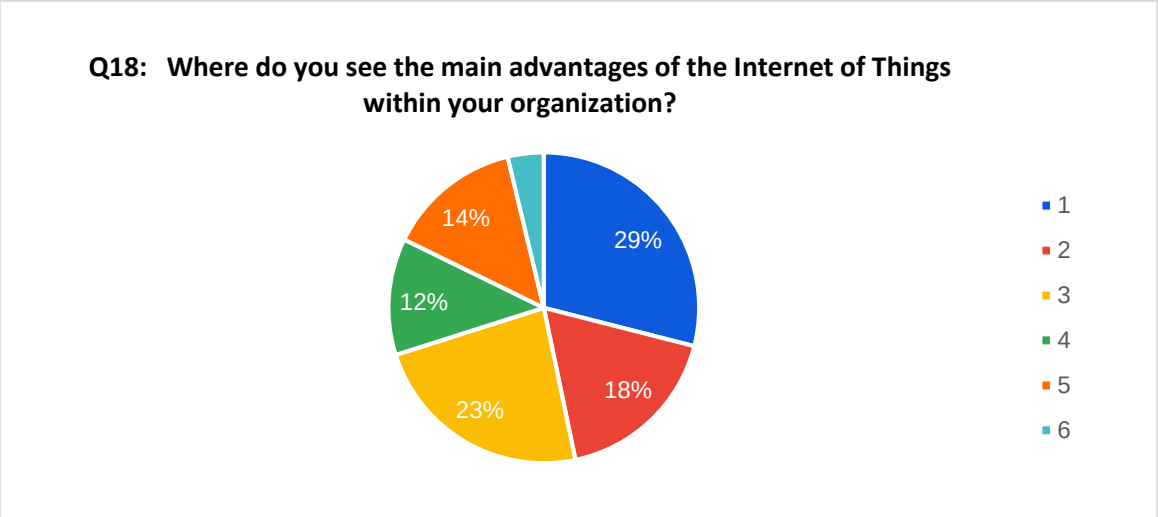
1) Data semantic and data labelling, 2) Machine learning and neural networks, 3) Artificial intelligence platforms, 4) Other.

Based on 59 answers to Q17f, the most specific trainings needed in the Data Analytics domain is mainly Machine learning and neural networks (61 %), with minor in Artificial intelligence platforms (27 %) and Other (9 %). The dominant need for training in the Data Analytics domain is Machine learning and neural networks.



1) Security concepts, 2) Cryptography concepts, 3) Security algorithms and protocols on restricted devices, 4) Security in applications, 5) Communications security, 6) Other.

Based on 58 answers to Q17g, the most specific trainings needed in the Security domain is mainly Security algorithms and protocols on restricted devices (40 %), adding also Communications security (21 %) and Cryptographic concepts (14 %). In this case, the most important training need is Security algorithms and protocols on restricted services.



1) Data and service analytics, 2) Customer engagement services, 3) Resource tracking and monitoring, 4) Automated manual processes, 5) Improved workflows and processes, 6) Other.

According to the 107 answers obtained from Q18, the biggest advantages to leveraging the IoT within their organization is: Data analytics an services (29%), Resource tracking and monitoring (23 %), Customer services (18 %), Improving workflows and processes (14 %) and Automated manual process (12 %).

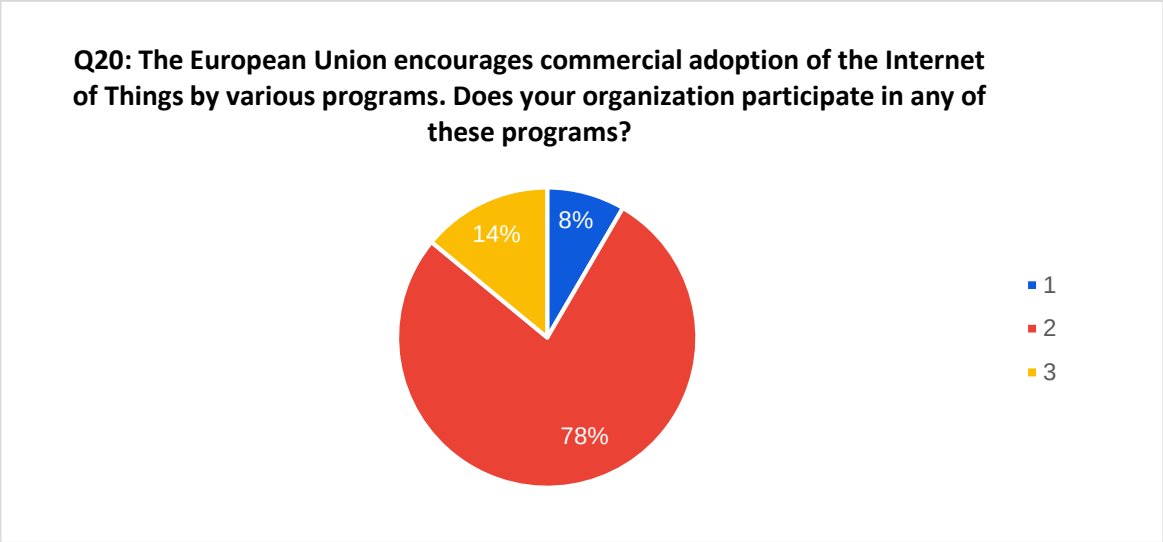
Q19: Please list 1 or 2 business applications of Internet of Things related to your own organization. Use product names; Example: Analysis based on data production rules based on BOSCH embedded systems - IoT-Suite

IoT for Smart Buildings.
Remote measurement of corrosion potential in pipelines
Wireless communicator for alarm panels, smart energy meters.
PIMS smart safe deposit box monitoring, control and management system - miniBANK Asset, consumption and energy efficiency monitoring system – Bowi.
Remote recollection of water consumption using NB-IoT
RFID based track and tracing
IoT Platform
IoT Kit development.
For our clients: Robotics systems integration with Firmware IoT platform, Hardware-Bluetooth integrations with apps.
tracking and cattle management.
Collect data from different sensor in order to measure different companies' assets such a silo, tanks, processes, etc. In our company, it is very important to start collecting data from different processes such as weld time, cut time, manufacturing time to make better decisions.
Data collection, Smart advanced measurement.
I don't know.
At the moment, we do not have any application.
Extract and data analytics from car electronic brain.
Is the Provider of the service.
IoT Platforms like Thingworx implementations and edge computing.
Analysis based on data production.
Autonomous agricultural monitoring kit based on LoRaWAN technology that simplifies the installation and configuration of various sensors for smart agriculture.
Tank telemetry in gas tanks - PAD Project.
Home security and entertainment.
Industrial process overview and analysis based on sensor data (eg. energy consumption vs. production indicators).

Power energy telemetric. Water consumption metrics.
Communications and ES.
Data analytics of sensor data using IBM Watson.
Smart Waste Management.
Remote Cold Storage Monitoring. Monitoring of cooling and heating systems.
Domotic.
Asset management, process optimization.
Smart home and industry.
Analysis and monitoring of cryogenic storage systems using Nettra Telemetry solutions.
Sim 5320 hardware.
Measurement of audience.
Security and logistics services for vehicles in client fleets.
Stock management for big warehouses: 1- Analysis of data generated by a non-invasive glucometer. 2- Compliance of rules to fulfil EMC aspects in an environment with several IoT networks.
Edge computing development and applications.
Get sensor's data with a cheap communication system.
Atheling IoT framework for Precision Livestock farming.
Smart Metering.
We can mention EdgeX Foundry Platform, ThingsBoard, OpenIot, among other.
KERLINK.
Production data (production cycles) in machinery.
Rockwell IoT Platform: Thingworx.
Own systems for Smart Cities.
IoT in access controls.
Middleware between GPS devices and SAP Leonardo / Proxy IOT to intercept communications between IOT devices and vertical systems, to capture information from sensors and redirect to other business or data logging systems.
Hydrological Flood Early Warning System (INSUS SAT), Soil moisture measurement and monitoring system for agriculture, Civil structures monitoring system, Industry 4.0 productivity measurement system, Precision Beekeeping monitoring system.
Telemetry of electrical meters for decision making.
Automation - Intelligent Systems.
Telemetering.
Our goal is to install an IoT Laboratory for educational purposes and services to industry and government institutions.
Octave by Sierra Wireless Multiplatform Edge-To-Cloud Solution.
I don't know.
Temperature and humidity control in ultrafreezer, greenhouses and livestock.
Analysis of production processes for lead-free tin solders.
Energy efficiency analysis based on Microcontrollers and Arduino.
Temperature and Humidity Monitoring for industries. Current consumption monitoring.
Telemetry for automated management of equipment shutdown events for industries. Thermographic measurements of equipment for pattern identification, panel generation and failure prediction.

Answers: 59

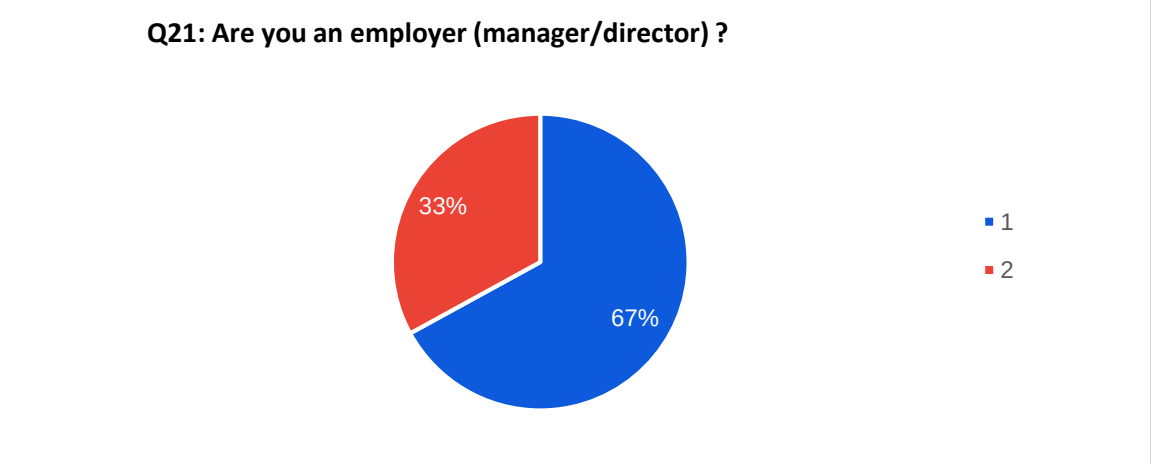
From the application examples obtained in response to Q19, its diversity and heterogeneity can be concluded, both in the field of application and in the business model.



1) Yes, 2) No, 3) Don't know.

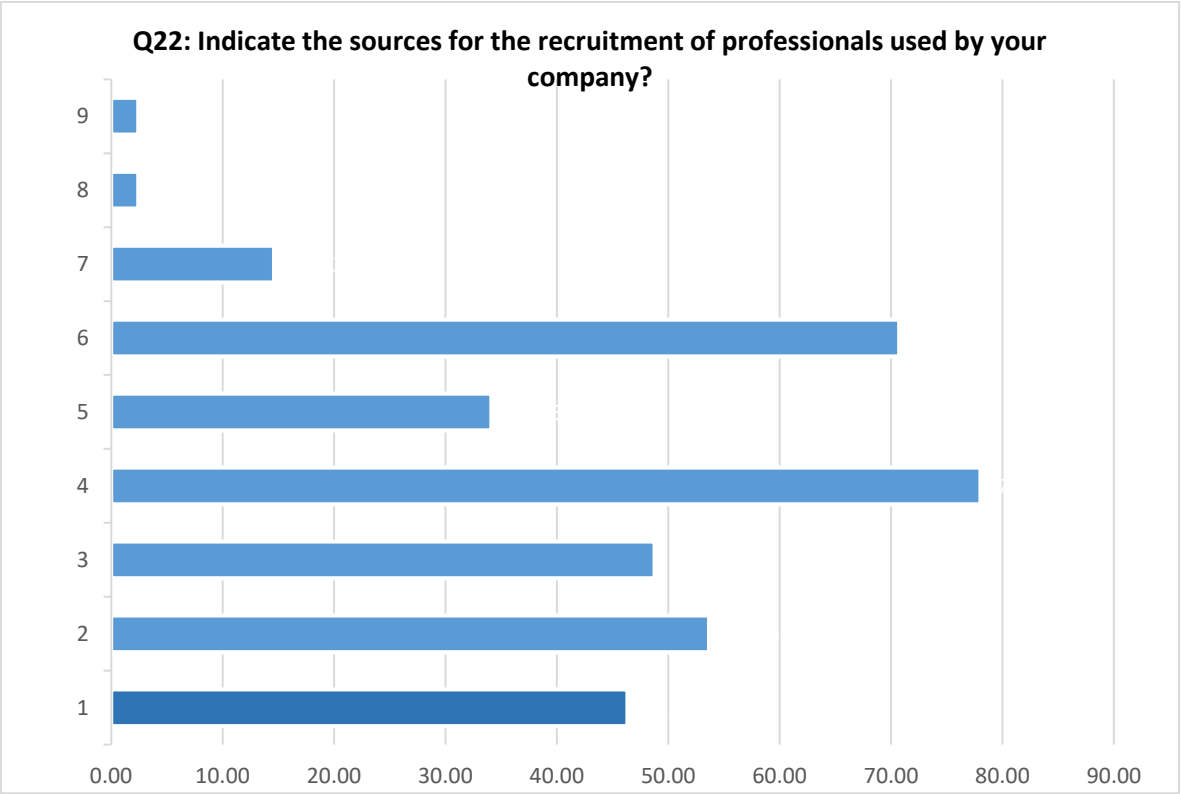
78% of respondents to Q20 claimed that their organization have not participated in any program supported by European Union, and 14% of respondents have no information or are not familiar with existing programs for support of IoT adoption.

The last group of questions is geared towards employers.



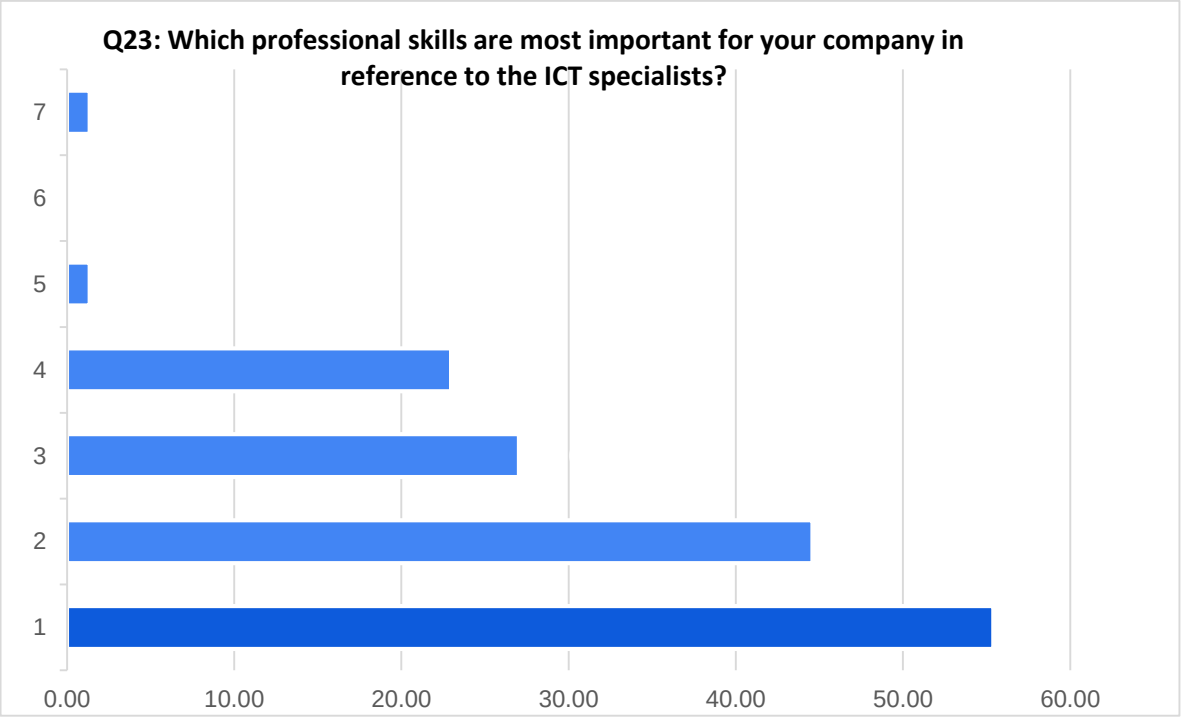
1) Yes, 2) No.

Most of the respondents to Q21 (94 in total) are employers.



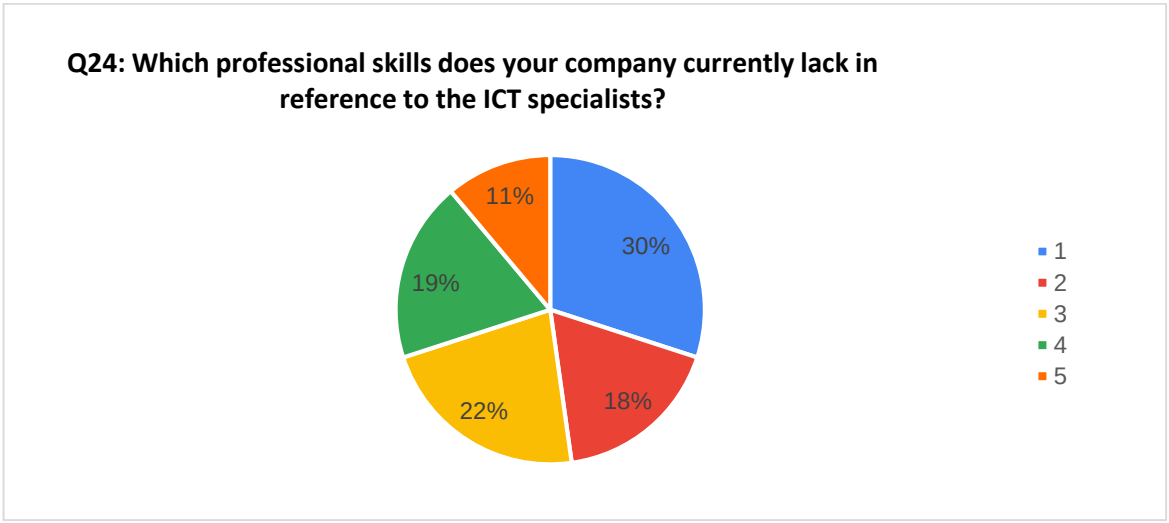
1) National employment job matching services, 2) Private employment agencies, etc. 3) Announcement on the company's website, 4) Collaboration with secondary schools and universities, 5) Recruiting employees from other companies, 6) Word of mouth, 7) LinkedIn, 8) Open contest (research professor), 9) Researchers – students.

According to the answers to Q22, the main sources of recruitment of professionals used are (multiple choice question): Collaboration with secondary schools and universities (78 %), Word of mouth (70 %), Private employment agencies (53 %), Announcement on the company's website (48 %) and National employment job matching services (46 %).



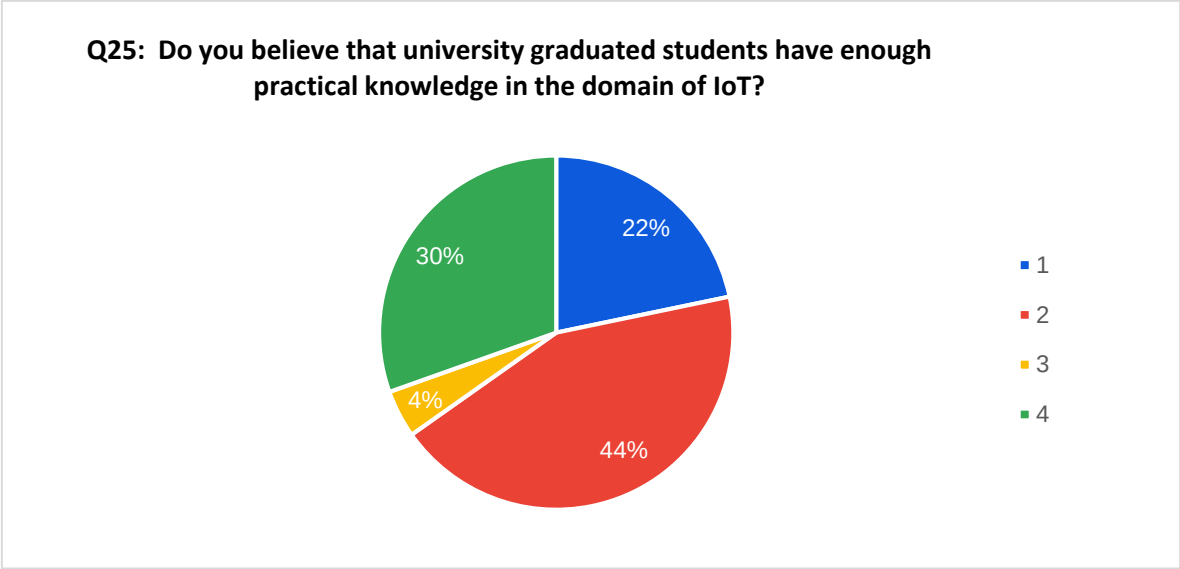
1) Software and Applications, 2) Hardware integration, 3) Firmware, 4) Hardware components, 5) Process Management, 6) Network and communication, 7) I don't know.

Following the answers to Q23, the most important professional skills in reference to the ICT specialists for the companies are (multiple choice question): Software and applications (55 %), Hardware integration (44 %), Firmware (27 %) and Hardware components (23 %).



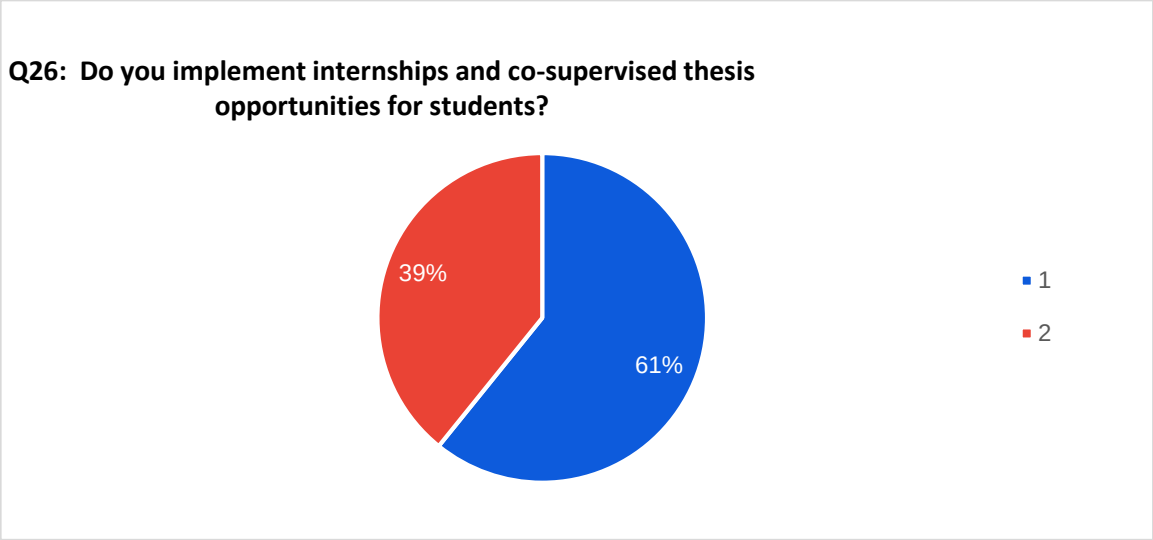
1) Software and applications, 2) Hardware integration, 3) Firmware, 4) Hardware components, 5) I don’t know.

Considering the answers to Q24, the most important professional skills that companies lack in reference to the ICT specialists are: Software and applications (30 %), Firmware (22 %), Hardware components (19 %) and Hardware integration (18 %).



1) Yes, 2) No, 3) I never hired a graduate student, 4) I don't know.

Based on 69 answers to Q25, the opinions related to enough practical knowledge of university graduate students are: negative (44 %), positive (22 %) and does not know (30 %).



1) Yes, 2) No.

Most of the answers to Q26 (61 %) indicate that there is an implementation of internships and co-supervised thesis, however almost half of companies (50%) does not implement any internship activity.

Based on the obtained percentage of answers to Q27, most of the opinion (43 %) rate the cooperation and industry at the target countries as average (not bad but also not total synergy).

3.3. Identification of key aspects that represent a gap to be filled by NEON

There are several results of the industry survey that allow to show where the NEON project can contribute and have impact by achieving the objectives of adopting technologies in the Internet of Things in the region.

Some general conclusions can be drawn from the following questions:

Q3: In which sector does your organization operate? The responses covered practically all the options in similar quantities, which highlights the transversality of the Internet of Things theme for all the areas considered.

Q4: What is your position? Most of the answers correspond to people with a profile oriented to Director - manager, that is, business-oriented. This highlights the interest in the internet of things not only from a technical perspective but also from a business decision perspective.

Q9a: What type of Internet of Things do you use / develop in your organization? From a technological use / development perspective, the most widely used type is the collection of sensor data. This allows us to understand what kind of competences are involved in those who responded to the survey.

On the other hand, from a more specific perspective, some of the needs that the NEON project can help solving are related to the following questions:

Q9b: Why don't you use / develop the Internet of Things in your organization? A considerable portion of responses (27%) associates not using / developing the Internet of Things due to lack of skills and training or other associated reasons (33%). This indicates that IoT training is a crucial need that can be engaged in the NEON project.

Q13: How do you judge the Internet of Things according to the achievement of future results within your own organization? 50% of the people surveyed respond with a positive view regarding the significant growth of IoT in the coming years. This allows us to conclude, both from the technological perspective and from the business perspective, that they hope to adopt this technology, which is one of NEON's objectives.

Q16: Would you be willing to take advantage of training courses and / or training activities to develop Internet of Things projects? The vast majority of responses (75%) are positive regarding the desire to take training courses and / or associated activities. Such positive response may be extremely useful for the objectives of WP2.

Q17x: What specific training do you need in the seven IoT selected domains? Most of the responses associated with these seven questions are positive in requiring training for the selected domain.

Q25: Do you believe that university graduate students have enough practical knowledge in the domain of IoT? A significant number of responses (44%) consider that recent graduates do not have adequate practical training in the domains of IoT. This allows us to conclude that developing facilities and practical instrumentation (laboratories), one of the objectives of the NEON project, is of extreme importance for the region's IoT eco-system.

Q26: Do you implement internships and co-supervised thesis opportunities for students?
Despite the majority of companies (61%) does implement internships and co-supervised thesis opportunities for students, one of the objective of the project is also to improve this percentage in the near future.

Q27: How would you rate the cooperation between universities and industry in your country?
Taking into account the responses obtained, the cooperation between industry and academia can be greatly improved. This also projects on NEON's objectives, both in relation to specific training to be developed and in ways to improve the training of students on the subject of IoT.

3.4. Key knowledge domains as observed by the industry

Taking into account the answers to the Q17x questions (training required in seven specific domains of IoT), it is possible to conclude that there are considerable knowledge needs in some key domains.

The case of "Hardware" domain is perhaps the most homogeneous in terms of the selection of training alternatives, the most prominent being **System on chip**.

Two options prevail in the "Operating systems for embedded systems" domain: **Overview of embedded developments and operating systems** and **Application development for embedded systems**. This indicates the need for general training in this domain.

In the domain "Communication, networks and protocols" the dominant training sought is in **Low-power large range wireless protocols** (LoRa, Sigfox, LTE-M, NB-IoT, etc.). This indicates a specific type of applications associated with the responses obtained.
Considering the domain of "Mobile computing", the prevailing training is mostly associated with **Multiplatform development**. This indicates the need for general training in this domain.

Regarding the domain "Distributed architecture", a dominant need is also shown in the responses obtained. In this domain it is associated with **Middleware for IoT**.

In the case of the "Data analytics" domain there is also a dominant training need. The need for this domain is **Machine learning and neural networks**.

Finally, for the "Security" domain, the prevailing training is **Security algorithms and protocols on restricted devices**.

3.5. Overall analysis of status quo

From a general perspective, and taking into account the profile and the number of respondents, it is possible to conclude that it has aroused considerable interest from people in the industry who make decisions about business and product development based on IoT.

There is a positive expectation regarding the adoption and growth of IoT technology, although it is also evident that there is a lack of training of human resources in general and the need for specific training in various aspects of the IoT domains.

Moreover, although there is some interaction - cooperation between the industry and the university on the subject of IoT, there is the expectation that it can be improved.

In conclusion, it is possible to summarize as a list the status quo and the **major outcomes from the industry survey** analysis as follows:

- Trasversality of Internet of Things is widely recognized in the surveyed companies. The majority of them believes that a growth of the topic is expected and the trend will follow in the upcoming years;
- Sensors and data collection is one of the major IoT aspects for the companies in the Argentina and Uruguay regions;
- A lack of skills and training on IoT was highlighted and consequently companies showed a significant interest in training opportunities for their employees;
- A detailed analysis on the IoT areas to further explore and adopt them for companies was conducted and it includes both software and hardware applications;
- Companies highlighted the lack of practical knowledge in the IoT domain of the university graduates. Therefore, modernized graduate courses with focus on practical concepts are needed to fill the gap.
- There is a necessity to improve the cooperation between academia and industry. The options can be increasing the number of internships and co-supervision of students' theses.

4. Survey and analysis of IoT courses in ICT study program in relation to modern society

4.1. Methodology of the academic survey

The academic information collection methodology was aimed at collecting information by institution rather than conducting a generic survey. The partners participating in the project and other entities close to the regions of interest were included.

We obtained information on degree programs that have educational content related to the Internet of Things and can be enhanced with such content.

In the case of information obtained from specific IoT courses or compatible with an improvement based on IoT content, the following aspects are considered (see Annex 8: Academic survey):

- **University (Country)**
- **Study Program (years); Course name; Year** located; **Duration** (ECTS or hours)
- **Type**: **BC**: Basic Core; **C**: Compulsory; **E**: Elective
- **Modality**: **I**: in person; **H**: hybrid; **O**: online
- **Teaching methodologies**: **T**: Theory class; **P**: Practical class (practical cases and problems); **L**: Laboratory Practical Sessions; **TU**: Tutoring sessions (individual or in-group attendance).
- **General competences**
    - **C1**: **know** the principles and contemporary issues of the field.
    - **C2**: **analyse** in order to indentify, formulate and solve problems in the field.
    - **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints.
    - **C4**: design and conduct innovative **research experiments** and analyze and interpret data.
    - **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice.

It must be pointed out that the competences C1-C5 are based on international accreditation criteria. In particular, guidelines from ABET [2], Accreditation Board for Engineering and Technology, and EUR-ACE label [3], awarded by the European Network for Accreditation of Engineering Education (ENAEE), have been considered.

It must be noticed that soft skills have not been included in the defined competences. For example, competences such as team-working, communication skills to effectively communicate with a range of audiences, lifelong learning, being aware of ethical issues and making judgements are not considered. The decision of obviating them was intentional, since the focus was on the acquisition of competences related to IoT contents. Nevertheless, when implementing the updates on the courses, these competences can be taken into account, since they could be acquired in parallel to the other ones already specified C1-C5.

4.2. Legislation in higher education

The legislation in higher education is dependent on the country. The regulations in Argentina and Uruguay significantly differ and will be described separately for each country.

4.2.1 Legislation in HEI of Argentina

With the approval in 1995 of the Higher Education Law [4], the National Commission for University Evaluation and Accreditation (Comisión Nacional de Evaluación y Acreditación Universitaria, CONEAU) was created in Argentina. According to this law, the obligation to accredit those university degrees that were declared of public interest was imposed. All engineering majors were declared of public interest.

The novelty of this law was to generate an instrument to guarantee quality in training, within the framework of a system of continuous improvement. To this end, minimum standards were set. It should be taken into account that in Argentina associate degrees are qualifying for professional practice and graduates will be able to access said exercise only if they graduate from accredited study programs. An accredited degree is understood to be one that comes from universities that have successfully passed the evaluation process, meeting the qualification standards.

The accreditation procedure is associated with the designated public interest majors, regardless of whether it is a public or private university. The main information required by CONEAU includes: insertion and institutional framework of the career, study plan, academic body, research and transfer activities, and laboratory infrastructure and equipment. It also includes a self-assessment associated with the above information. After the information is presented, an evaluation is carried out by a committee of specialists. This evaluation includes technical visits and interviews with the teaching and technical staff. The result of the evaluation can be accreditation for a full period (6 years), accreditation with observations (3 years) or no accreditation.

Current engineering study programs in Argentina are not based on competencies but simply planned by the professional incumbency of interest. Only recently, the Ministry of Education of the Argentina approved (May 2021) the new standards for the accreditation of engineering study programs in the country. These new standards are geared towards Competency - Based Teaching [5].

New technologies play an essential role on two levels: the training of teachers and access to the technologies by students during their journey within the academy. This is contemplated in the new routes under two items: curricular conditions and conditions for teaching activity.

Among the titles that must change their teaching, those related to engineering are identified: electronics, telecommunications, computing, informatics and biomedical, without prejudice to specific applications in other disciplines.

This constitutes an opportunity for the objectives of the NEON project, since a menu of options in training, internships, etc., can be provided to adapt the learning levels to those required by the new standards. The tools that result from the program will be of fundamental importance so that, once implemented, they support the accreditation process in Argentine universities.

4.2.2 Legislation in HEI of Uruguay

Although Uruguay does not have an accreditation agency that promotes evaluations of university programs, there is an Ad Hoc Accreditation Commission in the Ministry of Education and Culture of

Uruguay. This commission is the way to participate in the Regional Accreditation of University Careers of the Southern Common Market (Acreditación Regional de Carreras Universitarias del Mercado Común del Sur, ARCU-SUR) [6]. This institution has allowed several study programs from various Uruguayan universities to accredit different degrees in the region.

Then, for the universities in Uruguay, ARCU-SUR evaluates the study programs voluntarily submitted to the accreditation procedure. The procedure is similar to that of CONEAU: it is addressed to an specific study program and university of the Southern Common Market (Mercado Común del Sur, MERCOSUR) countries. Through this procedure, compliance with the quality requirements previously established at the regional level is evaluated and verified. The degrees that can be submitted to the accreditation calls are defined by agreement of the MERCOSUR Ministries of Education. This agreement also allows automatic recognition of accredited study programs in MERCOSUR countries.

4.3. Analysis of academic survey and description of study programs

In the analysis of the academic survey and the offer of specific IoT content, it is possible to take into account several aspects, such as: duration and type of study programs, content organization, professional Practices, relations with the industry.

In relation to the duration of study programs, in almost all cases it is 5 years. The degree leads to the title of engineer, and in the topics of interest it would be:

- Telecommunications Engineer
- Electronic Engineer
- Computer Engineer

However, other degrees of interest are

- Communication Systems Engineer
- Informatics Engineer
- Biomedical Engineer
- Computer Systems Engineer

Both in the first group and in the second group of study programs, the organization of the contents contemplates: a set of courses in basic sciences, a set of courses in basic technologies, a set of courses in applied technologies and another set of complementary training courses.

From the information obtained from the academic survey, it is possible to conclude that there are almost no specific IoT courses. The exception is the one associated with the Catholic University of Uruguay, which includes the courses: “Design of IoT and embedded systems” and “IoT in agribussiness” in the study programs of Electronic Engineering.

Despite the lack of specific courses, there are several related content courses where it is possible to include and improve existing content. These courses have been identified in the study programs analyzed and will be described in section 4.4.

In these courses the idea is to include concepts of IoT or its domains of interest: systems integration, connectivity, data analytics, security and applications.

To illustrate, an example is provided from an EU country. In particular, there is an elective course devoted to IoT offered at Carlos III University of Madrid, Spain, in the study programme of Bachelor

Degree in Telecommunication Technologies Engineering. In this 4-years degree, there is an elective course completely devoted to IoT and titled “Internet of Things”, located at the 2nd semester of the 4th year with a duration of 3 ECTS, which corresponds to half-semester. More information can be found in the link:

https://aplicaciones.uc3m.es/cpa/generaFicha?est=252&anio=2021&plan=445&asig=18478&idioma=2

Moreover, there are some study programs, Master level, that are focused on IoT. From these programmes, some suggestions can be taken in the process of creation of new courses with IoT full contents. Some examples follow with their corresponding links. First, at Carlos III University of Madrid, Spain, the one-year “Master in Internet of Things: Applied Technologies” is offered. More information in this link:

https://www.uc3m.es/master/iot

Second, at Polytechnic University of Catalonia, Spain, the one-year “Master’s degree in Internet of Things (IoT)” is offered. More information in this link:

https://www.talent.upc.edu/ing/estudis/formacio/curs/200100/master-degree-internet-iot/

In particular, the study programs of interest in engineering in Argentina (electronics, telecommunications, computer, etc.), as required by CONEAU, have the following structure:

- **Basic sciences** (3 semesters): The basic sciences (mathematics, physics, chemistry) encompass the knowledge common to all engineering careers, ensuring a solid conceptual formation to support the specific disciplines and the permanent evolution of its contents based on scientific and technological advances.
- **Basic technologies** (3 semesters): The basic technologies must aim at the creative application of knowledge and the solution of engineering problems based on Basic Sciences. The fundamental principles of the different disciplines must be treated with the appropriate depth for their clear identification and subsequent application in the resolution of such problems.
- **Applied Technologies** (3 semesters): The application processes of Basic Sciences and Basic Technologies should be considered to project and design systems, components or procedures that satisfy pre-established needs and goals. From the formulation of the basic problems of engineering, the fundamental elements of design must be included, covering aspects such as the development of creativity, solving engineering problems, design methodology, feasibility analysis, analysis of alternatives, economic, environmental and safety factors, aesthetics and social impact.
- **Complementary** (1 semester): As an integral part of an Engineering program and in order to train engineers aware of social responsibilities and capable of relating various factors in the decision-making process, they must train competencies in Economics, Legislation, Industrial Organization, Environmental Management, Project Formulation and Evaluation, and Work and Environmental Safety.

In addition, during the last semester it is necessary to do a final degree project (thesis). In addition, there is a mandatory internship of at least 3 months called Supervised Professional Practice (Práctica Profesional Supervisada, PPS).

It is important to bear in mind that, at least in Argentina, this structure is not a requirement for private institutions.

Note that similar academic programs at any of the universities in Argentina have the same (compulsory) courses except for the electives. The creation of elective courses with specific or related IoT contents appears as an interesting alternative.

In Uruguay, study programs are structured in terms of contents in a very similar way to those in Argentina (basic sciences, basic technologies, applied technologies, and complementary sciences). However, for example, the University of the Republic of Uruguay has a common core of Electrical Engineering or Communication Systems Engineering. In Electrical Engineering it is possible to follow any of the following branches (profiles): Electronics, Biomedical, Power, Signal Processing and Machine Learning and Telecommunications. In Communication Systems Engineering the branches are: Electronics for communications, Signal processing for communications, Communications applications and services and Telecommunications networks.

4.4. Identification of potential courses on IoT

As identified by the academic survey carried out in section 4.1, the study programs analyzed have courses that could potentially introduce IoT concepts. This can be carried out through content in Applied Technologies set courses and / or associated elective courses.

The information obtained from the academic survey in relation to possible courses to update with some specific IoT content is provided in Table 4.1.

Table 4.1 Potential courses to be updated with IoT contents

COUNTRY	UNIVERSITY	STUDY PROGRAM	POTENTIAL COURSES TO BE UPDATED WITH IOT CONTENTS
Uruguay	**Universidad de la República**	**Electronic Engineering**	Antennas and propagation
			Wireless sensor networks
			Real time embedded systems
			IoT communication technologies
		Communication Systems Engineering	Antennas and propagation
			Advanced topics in wireless systems
			Complement of advanced topics in wireless systems
			Wireless sensor networks
		Master in Electrical Engineering	Low power digital design
			Advanced topics in wireless systems
			Complement of advanced topics in wireless systems
			Wireless sensor networks
	Universidad Católica de Uruguay	**Electronic Engineering**	IoT design and Embedded Systems
			Wireless Communications
			Communication Systems
			IoT on agribusiness
			Development of Electronic Products
			Project in embedded systems

Table 4.1 (cont.) Potential courses to be updated with IoT contents

COUNTRY	UNIVERSITY	STUDY PROGRAM	POTENTIAL COURSES TO BE UPDATED WITH IOT CONTENTS
Argentina	**Universidad Nacional de Córdoba**	**Computer Engineering**	Programming Digital
			Digital electronics 3
			Digital signal processing
			Digital communications
			Cognitive and software defined radios
			Data communications
			Artificial intelligence
		Electronic Engineering	Programming Digital
			Digital electronics 3
			Digital signal processing
			Digital communications
			Cognitive and software defined radios
			Data communications
			Artificial intelligence
		Biomedical Engineer	Programming Digital
			Digital electronics 3
			Digital signal processing
	Universidad Nacional de Mar del Plata	**Computer Engineering**	Modeling and Prediction with Emerging Technologies
			Data transmission networks
			Fundamentals of digital communications
			Embedded systems
			Computer networks security
			Computational intelligence
			Virtual instrumentation
			Introduction to image processing
		Electronic Engineering	Modeling and Prediction with Emerging Technologies
			Electronic measurements
			Digital communications
			Data networks
			Virtual instrumentation
			Introduction to image processing
		Informatics Engineering	Modeling and Prediction with Emerging Technologies
			Computer networks
			Distributed systems
			Artificial intelligence
			Virtual instrumentation
			Introduction to image processing
	Universidad Nacional del Sur	**Electronic Engineering**	Fundamentals of communication systems
			Telecommunication systems and services
			Wireless communications and antennas
			Radiofrequency circuits design
			Special Topics in Electronic Engineering
		Telecommunications Engineering	Radiofrequency circuits design
			Cellular communications
			Introduction to digital communications
			Wireless communications and antennas
			Radio-localization and radar
			Special Topics in Telecommunications Engineering
	Universidad Nacional del Centro de la Provincia de Buenos Aires (not NEON)	**Computation System Engineering**	Neural networks and deep learning
			Distributed and parallel computation
			Communications I & II
			Artificial Intelligence
			Data Science
			Business intelligence and smart cities
	Universidad de la Cámara Argentina de Comercio y Servicios (not NEON)	**Computation Systems Engineering**	Intelligent systems
			Teleinformatics & networks I
			Teleinformatics & networks II
	Universidad de la Fraternidad de Agrupaciones Santo Tomás de Aquino (not NEON)	**Informatics Engineering**	Decision Support Systems
			Distributed systems
			Computational intelligence
			Teleinformatics & networks
			Informatics security

To complete the academic survey, additional study programs from institutions that are not NEON partners but are interested in being part of the updates are also included in Table 4.1. These institutions are: the Universidad Nacional del Centro de la Provincia de Buenos Aires (UNICEN, Tandil, Argentina), the Universidad de la Cámara Argentina de Comercio y Servicios (CAECE, Argentina) and the Universidad de la Fraternidad de Agrupaciones Santo Tomás de Aquino (FASTA, Argentina).

In general, taking into account study programs and the courses offered, it is possible to conclude that those where there is greater flexibility are more likely to offer more specialized courses, and in particular specific to some of the most important domains of IoT.

It is important to consider more flexibility in the first semesters of study programs (ie, basic science and basic technology courses). In this way, there will be the opportunity to include courses and / or content associated with the domains of interest in IoT: systems integration, connectivity (communications), data analysis and processing, security and applications.

4.5. Current status of the teaching methodologies and course modalities

Taking into account the methodologies associated to the survey of courses where IoT content can be included, a characterization of them is as follows:

- Most of the courses (except for the current conditions in July 2021) are in person or face-to-face.

- The characterization of the teaching methodology and the general competencies of these courses can be synthesized as follows, organized by the type of courses:
  - Basic core courses: T (theory class), P (practical cases and problems), L (laboratory practical sessions) - C1 (know the principles and contemporary issues of the field), C2 (analyze in order to identify, formulate and solve problems in the field), C3 (design a system, component or process to meet identified needs in the project with realistic constraints).
  - Compulsory courses: T (theory class), P (practical cases and problems), L (laboratory practical sessions) - C1 (know the principles and contemporary issues of the field), C2 (analyze in order to identify, formulate and solve problems in the field), C4 (design and conduct innovative research experiments and interpret data).
  - Elective courses: T (theory class), P (practical cases and problems), L (laboratory practical sessions), TU Tutoring sessions (individual or in-group attendance) - C1 (know the principles and contemporary issues of the field), C3 (design a system, component or process to meet identified needs in the project with realistic constraints), C4 (design and conduct innovative research experiments and interpret data), C5 (apply in practice the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice).

Currently, the teaching methodologies employed in the potential courses to be updated are mainly based on classical teaching techniques. However, in recent years, many new approaches have appeared with the aim of improving the teaching-learning process [7], [8]. The objectives of these novel methodologies are focused on reinforcing the learning process. Some of these new teaching methodologies are commented next:

- **Flipped classroom**: the class is inverted in the sense that it is not used by the professor to provide the contents to the students [9]. The professor will create materials with these contents and they will be made available to the students in advance, prior to the class. Later, in the class the professor will answer questions, carry out problems and go further in the learning process. The interactive learning process is improved.
- **Gamification**: some activities are proposed to the students like a game experience [10]. In these actions, students significantly increase the interest and concentration on the contents. Learning becomes a funny activity so the learning process is benefited. Gaming is a useful tool to involve students in the course and their motivation experiences a great positive change.
- **Learning-Service:** the learning process is based on a service that is given to the society. In this case, students contribute to improve the society what makes that their motivation abruptly increases. Indeed, the help to the community inspires their work and the learning process experiences an improvement. In the evaluation process, it can be considered how useful that product has been to the society, i.e. the quality of service, with respect to the collaborating entity. The engagement between academia and the professional practice in external entities is strengthened.
- **Company challenge**: a company provides a problem to the professor, in fact a challenge since it will be a broad question, to be solved by the students during the course. Typically, the professor will teach, during the initial classes of the course, the essentials contents. Then, they start this challenge, where the first classes are used to partition it into several subproblems. Also groups are created and they are assigned to the different subproblems according to their preferences. At the end, in the evaluation process when they present their results, somebody from the company will be present, jointly with the professor. Finally, the students visit the headquarters of the company. This methodology reinforces the engagement between industry and academia. Also, students benefit from collaborative learning, increase their abilities for the future professional practice of engineering, and their motivation is greatly increased.

With regard to competencies in IoT, C1 is generally taken into account at the different levels of courses; C2 is focused on basic core and compulsory courses; C4 logically does not appear in the basic core courses but in the electives, since they allow greater flexibility. In particular, in the field of IoT, C5 frequently appears in electives when it should appear in mandatory. The latter suggests the need to adapt the contents of this type of courses.

4.6. Overall analysis of status quo

One of the objectives of the NEON project takes into account the incorporation of IoT courses and content in the study programs surveyed and in associated careers in Argentina and Uruguay. Also among the objectives of the NEON project is the updating of the study programs associated with the IoT, or its domains of interest, in Argentina and Uruguay.

To include IoT content in the study programs of Argentina and Uruguay, taking into account current legislation, it is possible to emphasize the following aspects of the status quo:

- Competency training, necessary for the new accreditations of engineering study programs in Argentina and Uruguay, favor the inclusion of IoT content.

- Currently, there are very few specific IoT courses. In the survey, only the UCU in Uruguay has 2 courses.

- Currently, there are numerous potential courses in different universities where it is possible to include IoT contents. In particular, 18 courses in Uruguay and 62 in Argentina. Also, these courses are distributed among the different partner universities in each country.

- The teaching methodologies used, both in Argentina and Uruguay, are classic. This allows to conclude that there is considerable space to include IoT concepts using new teaching methodologies.

Finally, it is necessary to consider some flexibility in the study programs of Argentina and Uruguay that allows including training in some of the IoT domains of interest. In this sense, the commitment of NEON university participants will be extremely useful.

5. Consolidated guidelines for curriculum modernization in cooperation with industry

5.1. Introduction

After addressing the industry and academic surveys and their analysis in previous sections, the consolidated guidelines have been established in Task 1.2 and they will be presented in this section. As previously stated, the objective is the curriculum modernization in IoT field in Argentina and Uruguay with the cooperation of industry. The motivation of these consolidated guidelines is to guide the project activities and these guidelines are intended for the partners of the NEON project, although they could serve in the future as a basis for any other similar initiative. This section is organized as follows.

Firstly, in subsection 5.2, a joint analysis of the industry and academic surveys is provided. General view of the existing status in both academia and industry justifies the need of NEON activities. It has been found that cooperation between both academia and industry is required and the resultant action is the proposal of these guidelines.

Secondly in subsection 5.3, the modernization of curricula is tackled, where a set of common needs and objectives for the transformation of IoT-related studies are presented. This modernization is addressed through a methodological tool, with a steps-based approach. In many cases, this modernization may imply the creation of completely novel labs and the adoption of new teaching methodologies, and this has been separately considered in subsection 5.4.

Later, subsection 5.5 deals with the training and internship activities. They will be key elements for the joint feedback among all the institutions. The exchange of knowledge, experiences on different methodologies, access to different points of view, etc will definitely enrich all the partners. Some other initiatives that may arise will be commented in subsection 5.6.

The intention is to continue in the future, beyond the NEON project, with the collaboration between industry and academia, to preserve the benefits of this project. This issue is addressed in subsection 5.7.

Finally, in subsection 5.8, the general proposed structure to carry out this modernization is presented. Guidelines have been prepared and conceived as a tool to guide the partners on the development phase of the modernized programs, labs, and teaching methodologies.

5.2. The need of reinforcing the cooperation between industry and HEI`s in Argentina and Uruguay

Upon the review of the results obtained from the academic and industry surveys, the situation confirms the necessity of the NEON project.
Regarding the **industry survey**, it is worthy to highlight that:

- **About the relevance of IoT**: 50% of the industries consider that organizations leading the Internet of Things will have a significant advantage (see Q13)

- **About the skills on IoT, do the companies require them?**: 33% of the companies reflect that they do not use or develop IoT in their organizations because they have lack of internet of things skills / competences (see Q9b). Also, 75% of the companies would be willing to take advantage of training courses and/or training activities to develop IoT projects (see Q16)
- **IoT domains, which are the areas where training and skills are more desirable?**: the range covers all domains (hardware; operating systems for embedded systems; communication, networks and protocols; mobile computing; distributed architecture; data analytics; security) and within each domain a broad specialization is required (see Q17). Moreover, there is almost a uniform distribution among the areas (software, hardware,..) regarding which professional skills the companies currently lack in reference to the ICT specialists (see Q24).
- **Opinion on recent graduate students and academia**: 44% of the companies believe that university graduate students do not have enough practical knowledge on IoT domain (see Q25). Furthermore, the cooperation between universities and industry was rated mostly acceptable (3/5) or poor (2/5), with a wide margin of improvement to reinforce it (see Q27).

In summary, the industry considers these four points: 1) IoT is a relevant field, 2) they require more skills on IoT, 3) they consider that training is required in every domain and with a broad distribution among the topics within the domains, and they have identified lack of skills in every area, 4) the graduate students exhibit lack of practical knowledge on IoT and the cooperation industry-academia must be strengthened.

Regarding the **academic survey**, it must be pointed out that in partner universities in Argentina and Uruguay:

- **Current courses devoted to IoT**: rarely available at present study programs. Just at UCU, in the "Electronic Engineering" programme two courses named "IoT design and embedded systems" and "IoT on agribusiness" are found.
- **Potential courses to be updated with IoT contents**: several courses at each institution have been identified where some partial IoT contents may be included. These updates will cover courses on the different domains implied in IoT.
- **Creation of new courses on IoT**: to fill the detected gaps on IoT training: the possibility of creating new courses completely dedicated to IoT will be explored. However, this may face the difficulties inherent to the academic development of programs in HEI's in Argentina and Uruguay, taking into account their particular legislations.
- **Creation of new labs with IoT infrastructure**: new labs can be created to support the practical training of the students, since, in general, there is no a laboratory infrastructure specific for IoT in most of the institutions.

Putting both results together, from industry and academia, it can be observed the necessity to update courses with IoT content to fill the gap. However, this modernization must be carried out taking into acccount the industry for several reasons:

- involving companies will provide a perspective on IoT required skills that will be very valuable for the modernization; indeed, they will add value to the modernization
- if they are not involved, universities could provide contents that are not well aligned with practical application of engineering in the field of IoT
- companies identified a lack of collaboration with the universities and the industry is aware of the active role they should play in the transmission to HEIs of the contents and skills that they require in IoT.

Therefore, it is considered of great importance this cooperation, and this leads to the need of reinforcing the cooperation between industry and HEIs in Argentina and Uruguay. This cooperation

will be materialized through the development of a NoC. This analysis of the current situation leads to the conclusion of the necessity of modernizing the ICT study programs in the field of IoT, considering the feedback from the industry. Indeed, several initiatives about introducing IoT courses on curriculum have already been reported [11], [12].

5.3. Modernization of curricula and creation of new labs

The modernization of curricula addressed in this section will focus on three cases, that will be the pillars of this process:

- **Pillar 1: Potential courses to be updated with IoT contents**
- **Pillar 2: Creation of new courses on IoT**
- **Pillar 3: Creation of new labs with IoT infrastructure**

Next, the methodology to consider the modernization in these cases is addressed separately. It is presented in a steps-based form, in order to guide the institutions in its implementation.

Pillar 1: Potential courses to be updated with IoT contents

This case refers to the courses which are included in study programs and cover topics relevant to the IoT. In this case, some classes could be updated to include a referral to IoT concepts. The guidelines to be followed in this update (U), are specified in these steps (S), to ensure that the process is performed successfully:

U-S1 **Identification**: identify the study programme and its duration, the course and the year where it is located and the duration of the course, either in credits (ECTS) or teaching hours. Specify also the type of course: basic core, compulsory or elective.

U-S2 **Justification of the domain**: justify how adequate this course is to include IoT contents, expressing the domain of IoT where it is involved.

U-S3 **Duration**: specify how many classes or hours will be updated and when they are located within the course duration

U-S4 **Contents**: compare the IoT content with the content being eliminated. Some justification that this adaptation will not cause a loss of essential contents in the course would be desirable.

U-S5 **Features**: provide information on how these contents will be introduced in terms of: modality, teaching methodologies and general competences that will be covered.

U-S6 **Scope**: analyse the impact on the industry, i.e. think about the benefit for the graduate students regarding their theoretical/practical training, the professional impact regarding their acquired skills, how beneficial these updates will be for the companies working on IoT,..

U-S7 **Revision**: check the proposal with both academia and industry, before final implementation of the update. The idea is to consult with industry if they consider the proposal meets their expectations on that IoT domain. Simultaneously, a final analysis in the academia should be carried out to ensure that the course maintains its essentials contents and that the update provides a clear benefit for the students in the IoT field. This double-check will be a good practice.

U-S8 **Approval**: obtain the approval of university administration and any required accreditation for the updated course.

U-S9 **Implementation**: proceed with the final implementation of the updates in the course.

U-S10 **Feedback**: collect feedback during the first year of the updated course to allow a subsequent evaluation. The feedback should be gathered from students and professors involved in the coordination/teaching process. An assessment method should be designed to test if learning outcomes have been achieved. Information on the real learning outcomes will be very useful.

U-S11 **Evaluation**: evaluate the results after the first year of introduction of the updated course. The conclusions obtained will be useful to track these updates and carry out adjustments to these updates if necessary.

It is considered that this Pillar 1 will be the main tool considered by HEIs to provide IoT contents in their study programs. To summarize the process of this pillar, the steps are provided in next Table 5.1.

Pillar 1: Potential courses to be updated (U) with IoT contents	
Step Code	**Description**
U-S1	Identification
U-S2	Justification of the domain
U-S3	Duration
U-S4	Contents
U-S5	Features
U-S6	Scope
U-S7	Revision
U-S8	Approval
U-S9	Implementation
U-S10	Feedback
U-S11	Evaluation

Table 5.1: Summary of the methodology, with a steps-based approach, for the update with IoT contents of selected potential courses.

Pillar 2: Creation of new courses on IoT

This case refers to courses that are not currently present in study programs. The idea of their creation is to cover contents on IoT domains with an in-depth approach, rather than including an update on current courses, already addressed in Pillar 1 (U). In this case, a new (N) course is created in the study programme, although this process may be complicated. The guidelines to be followed in this creation are specified in these steps (S), to ensure that the process is performed successfully:

N-S1 **Identification**: identify the study programme and its duration, the year where you intend to locate the course and its duration, either in credits (ECTS) or teaching hours. Specify also the type of course: basic core, compulsory or elective.

N-S2 **Justification of the domain**: justify how necessary this course is to include IoT contents, expressing the domain of IoT that will be covered and that these contents were missing in the current study programme.

N-S3 **Feasibility**: state the possibility of modifying the study programme to introduce this new course, according to the regulations and legislation that may apply. Some information on the process to be followed should be provided.

N-S4 **Contents**: detail the contents you will introduce in this new course.

N-S5 **Interactions**: analyse how this course would interact with other surrounding courses, either previous or subsequent ones. An adequate sequence of knowledge acquisition among the different courses should be ensured.

N-S6 **Features**: provide information on how the contents of this course will be introduced in terms of: modality, teaching methodologies and general competences that will be covered.

N-S7 **Scope**: analyse the impact on the industry, i.e. think about the benefit for the graduate students regarding their theoretical/practical training, the professional impact regarding their acquired skills, how beneficial these updates wil be for the companies working on IoT,..

N-S8 **Revision**: check the proposal with both academia and industry, before final implementation of the new course. The idea is to consult with industry if they consider the proposal complies with their expectations on that IoT domain. Simultaneously, a final analysis in the academia should be carried out to ensure that the course will provide adequate contents, providing a clear benefit for the students in the IoT field. This double-check wil be a good practice.

N-S9 **Approval**: obtain the approval of university administration and any required accreditation for the new course.

N-S10 **Implementation**: proceed with the final implementation of this new course.

N-S11 **Feedback**: collect feedback during the first year of the new course to allow a subsequent evaluation. The feedback should be gathered from students and professors involved in the coordination/teaching process. An assessment method should be designed to test if learning outcomes have been achieved. Information on the real learning outcomes will be very useful.

N-S12 **Evaluation**: evaluate the results after the first year of introduction of the new course. The conclusions obtained will be useful to track its performance and carry out adjustments if necessary.

To summarize the process of this pillar, the steps are provided in next Table 5.2. As it can be observed, the steps are very similar to the case of Pillar 1, but S3 is modified and a new step appears in S5 what drives to more steps in this case.

Pillar 2: Creation of new (N) courses on IoT	
Step Code	**Description**
N-S1	Identification
N-S2	Justification of the domain
N-S3	Feasibility
N-S4	Contents
N-S5	Interactions
N-S6	Features
N-S7	Scope

N-S8	Revision
N-S9	Approval
N-S10	Implementation
N-S11	Feedback
N-S12	Evaluation

Table 5.2: Methodology, with a steps-based approach, for the creation of new courses on IoT.

It is considered that this Pillar 2 may not be the main tool considered by HEIs to provide IoT contents in their study programs. The reason behind is the difficulties that may arise to modify the study programs, because of the legislation for university studies. Nevertheless, the possibility of creating an elective course, which in general is more flexible, could be a choice.

Pillar 3: Creation of new labs with IoT infrastructure

This action, that will constitute the Pillar 3 of the guidelines, refers to the creation of new labs (L) to support the practical training of the students, since, in general, there is no a laboratory infrastructure specific for IoT in most of the institutions. Also, it could be possible the development of novel thematic joint industry-academia labs. Several IoT-based labs have been designed in the recent years in different HEIs and these experiences can serve as an initial research [13], [14], [15].

The guidelines to be followed in this creation are specified in these steps (S), to ensure that the process is performed successfully. It must be noted that the labs to be created were initially described in the project proposal [1]. Therefore, the steps labelled as L-S1 and L-S2 could be obviated. However, during the development of the project, some adjustments might be required or more adequate equipment could be considered in the implementation phase. In view of these situations, both steps have been maintained to provide general guidelines that would allow possible future updates in the creation of labs.

L-S1 **Identification**: identify the needs on hardware/software equipment on the IoT field. Define the IoT domains that could be covered with that infrastructure to be acquired. It could include a variety of elements such as sensors / actuators /computers / servers for data processing / communications devices /…

L-S2: **Budget**: define what you need, compute its cost, and then check whether cost is within the budget or additional funding schemes are required. It is important to adjust the amount of lab equipment to be acquired, according to the budget available. Funding for this purpose will be provided from the project to the HEIs, but any other sources of support could enrich the scope of the lab.

L-S3: **Courses**: identify the courses and study programs in which these lab facilities can be used. It may probably happen that the same lab could be used for different courses that contain IoT concepts. Also, it would be possible that courses that are just specifically lab courses are entirely taught in the lab.

L-S4: **Acquisition**: creation of bill of material and acquisition of the lab equipment. It must be noted that the acquisition may occur at different stages: 1) initial; 2) additional after material development but before class offering; 3) additional if required after evaluation. This may involve budget reconsideration.

L-S5: **Installation**: install the labs equipment and its initial setting and testing.

L-S6: **Certification**: obtain the accreditation and certifications required by the labs. At this stage, safety guides and instructions must be written.

L-S7: **Preparation**: design the lab practices to be developed by the students. The lab scripts should be formative and also, some tutorials would be helpful.

L-S8: **Curriculum**: include the labs in the curriculum, then promote them and offer them to the students.

L-S9 **Feedback**: collect feedback during the first year of the new lab to allow a subsequent evaluation. The feedback should be gathered from students and professors involved in the coordination/teaching process. Information on the real learning outcomes will be very useful.

L-S10 **Evaluation**: evaluate the results after the first year of operation of the lab. The conclusions obtained will be useful to track its benefits to the training of students and carry out the required adjustments.

It is considered that this Pillar 3 will be essential for HEIs to develop a professional profile with high competences in the field of IoT. Also, the study programs will be significantly enriched with these new labs. To summarize the process of this pillar, the steps are provided in next Table 5.3.

Pillar 3: Creation of new labs (L) with IoT infrastructure	
Step Code	**Description**
L-S1	Identification
L-S2	Budget
L-S3	Courses
L-S4	Acquisition
L-S5	Installation
L-S6	Certification
L-S7	Preparation
L-S8	Curriculum
L-S9	Feedback
L-S10	Evaluation

Table 5.3: Summary of the methodology, with a steps-based approach, for the creation of new labs with IoT infrastructure.

Definitely, the modernization of the curricula, based on any of the Pillars, will add value to the academic programs.

5.4. Adoption of new teaching methodologies

The modernization of curricula will be also determined by other pillar, that completes the previous ones introduced in prior section, that will be addressed in this section:

- **Pillar 4: Adoption of new teaching methodologies**

Next, the methodology to consider the modernization in this sense is addressed.

Pillar 4: Adoption of new teaching methodologies

This transversal action that will constitute the Pillar 4 of the guidelines, can be applied to the other three pillars. The adoption of new teaching methodologies can be considered when: updating an existing course (Pillar 1); in the creation of a new course (Pillar 2); and in the creation of a new lab when designing the teaching methodology in that lab (Pillar 3). Additionally it could be also applied to the couple of existing courses that are currently offering full-contents on IoT.

All new teaching methodologies described in Section 4 could be applied in the IoT field, as well as many others that are available. In general, it is important to pay attention to the active learning concept, to ensure that the students are not merely receiving contents from the professor, with a passive teaching methodology. A way of improving this active attitude is through the use of labs, that simultaneously improve their practical skills and reinforce relevant competences as C5, that regards to the application in practice of engineering knowledge.

The NEON project vision is to engage industry-faculty-students in this network of competence. The adoption of new teaching methodologies will also require considering an improvement on the competences of the professors. The term competences here is referred to three aspects:

- knowledge competences: focused on IoT contents, and being aware of skills for pratical applications in labs;
- technological competences: mainly digital competences, to handle new tools that can enrich the teaching-learning process, as Wooclap, Kahoot, Kaltura, Jupyter Notebook, Google Colaboratory;
- pedagogical competences: to have a criterion to determine the best teaching methodologies for each specific course. The intention is to answer the question: how to teach better?

All these competences target the development of a high-level professional profile with high competences in the field of IoT, ensuring the projection of its future needs.

Definitely, the adoption of new teaching methodologies should be inspired by several concepts that has arisen above: engagement, motivation, service to society, active learning, collaborative learning, practical skills, challenge, … These terms will lead to better outcomes and will optimize the student success. To graphically present these concepts that should guide the adoption of new teaching methodologies, a sketch is presented in Fig. 5.1. Our actions in this sense will be inspired by: *"Tell me and I forget, Teach me and I remember, Involve me and I learn", Benjamin Franklin*.

Figure 5.1: Concepts that should guide the adoption of new teaching methodologies

5.5. Training and internship activities

Apart from the four pillars that will be the basis for the transformation of the curricula with respect to the IoT field, other two initiatives will be considered in this network of competence:

- training activities
- internship activities.

These two activities are intended to provide a better engagement between industry-academia and to reinforce the links among all the institutions. Also, students and graduate students may benefit from them.

Training activities

There will be three different types of training activities, depending on who the recipients are. Specifically, these types are categorized as:

- **1. Training activities for faculty members**: these activities will be oriented to teaching staff. The mission of this training is to upgrade the competences of the professors that will take care of courses with IoT contents.
- **2. Training activities for students**: training will be conceived for students, either current students or graduate students, who want to extend their knowledge in the IoT field.
- **3. Training activities for industry**: activities to reinforce the training in the industry will be planned. The objective will be to broaden their knowledge and skills in the IoT field.

Next, each of them will be described in more detail. Regarding the first type, the **training activities for faculty** will be oriented in different lines:

- **training on advances in the IoT field**: focused on IoT knowledge, with special attention to recent advances on the state-of-the-art, cutting-edge proposals, innovative research contributions in the field, … This knowledge may be used by the professors to update certain courses of the study programme.
- **training on applications of IoT**: focused on the practical implementation of solutions to particular problems of the society (smart cities, vehicular communications, e-health, agriculture,…). Here, the interest is on the design of deployments, paying attention to the specific hardware/software components employed, the practical requirements, the system restrictions, the attained results, drawbacks of the implemented system, recommendations for similar deployments,..In this case, the main objective is to get benefit from the previous experience of other experts of a particular area of application of IoT. This knowledge on practical applications could be incorporated by the professors to certain courses of the study programme.
- **training on innovative teaching methodologies**: focused on providing information on innovative teaching methodologies available in the education community, analysing their applicability to courses on IoT field, sharing feedback of new methodologies already implemented at any of the institutions, proposing new initiatives to improve teaching, getting the perspective from the industry regarding teaching methods,…

In the second type, **training activities for students** will be oriented in two lines, although both lines could be combined:

- **training on general IoT contents**: focused on general IoT knowledge, with a more theoretical approach. One or several knowledge domains, related to IoT, could be addressed. The objective is the specialization of the students on the IoT field.
- **training on applications of IoT**: focused on the practical implementation of solutions to particular problems of the society, analogous to the similar courses intended for the faculty. They are more centered on the professional activity of IoT, with a close connection to the companies interests.

Finally, for the third type, **training activities for industry** will be focused in two lines. although as in above cases, they could be combined:

- **training on IoT contents**: focused on IoT knowledge, either general or more centered on the recent advances. One or several knowledge domains, related to IoT, could be addressed. The objective is the transfer of knowledge in the IoT field from the university to the industry. Therefore, the knowledge accumulated in the academia will be transferred to the society.
- **training on applications of IoT**: focused on the practical implementation of solutions in specific areas of application of IoT. The area could be the current area of specialization of that company, in order to enhance its expertise. However, it could be focused on a different area, where the company plans to extend its activity. This training may have some similarities with the analogous proposals for the faculty and students

Althoug training activities for the three types will be initially centered on these lines, any other kinds of training may be later proposed in the context of the project.

Internship activities

This activity will be essential for the joint development of the network among all the institutions. It will allow the exchange of knowledge and different experiences, making easier the access to different points of view.

These internship activities will be organized considering the particularities and needs of each institution. In general, short-term stays will be advisable, to maintain a flexible and fluid exchange of people among the partners. However, in some cases long-term internships will be recommendable to ensure an adequate use of this resource. It will be particularly interesting the possibility of sending students abroad for one semester to partner universities in the framework of the NEON project. Besides, student internships in companies would be of high interest.

The definition of an internship should be clearly stated in advance. Next features should be specified prior to the activity:

- destination
- duration
- supervisors
- objective of the internship
- work plan
- expected results

5.6. Other activities

In the framework of the NEON project, many other activities could be performed in order to reinforce its goals. Next, some examples are presented, although many other possibilities could be proposed:

- **Hackathon**: a challenge on any domain of IoT could be launched. This kind of competition is usually very attractive for the students. Their participation can reinforce their interest about IoT issues.
- **Student award sponsored by a company**: an open problem could be proposed by a company, or alternatively, a kind of contest to propose novel solutions can be laid out. Those students who present a better solution or idea to solve the problem could have the recognition of winning an award. The students would be engaged to IoT related technologies. The benefits for the company would be twofold. The company can collect innovative ideas from the students and it also gets promotion and visibility.
- **Bachelor/Master Thesis with joint supervision university-industry**: either Bachelor or Master Thesis can be proposed where there is a joint supervision from the university and the industry. A tutor from the university will take care of the academic part, supervising that the scope of the document fits with the university requirements, but, at the same time, a director from a company will be responsible for the development of the work. This is an opportunity to put in contact to the students with the industry in the IoT field. Also, the interaction between faculty and industry will be very beneficial for both sides.
- **Visits to industry facilities**: one-day visits of groups of students coordinated by a professor to the facilities of IoT companies would be very interesting. The students can learn at first hand the activities on IoT being developed in the companies. This can be an activity that could be integrated in a particular course or just organized independently of any course.
- **Technical talks**: employees of specific IoT companies can be invited to the universities to give technical talks on the activities of the company. They can provide general knowledge on IoT but also practical hints on IoT applications, deployments, etc. These talks, typically one or two hours duration, can be offered apart from the courses of the study programme, as a separate activity. If possible, the students could even obtain additional elective credits for attending and participating in several talks along the academic year.
- **Seminars and webinars**: they can be proposed in order to disseminate different issues related to IoT field. A variety of formats and programs would be possible, depending on the specific objective and the organizing entity.
- **Workshops**: they are a very useful tool to make possible the exchange among different partners, industry, universities, local or regional administration, government, students, society,… The structure or focus of a workshop must be clearly determined to ensure its success.
- **Establishment of double degrees with other HEIs**: this possibility will be explored. A double degree implies a synergy between different institutions and it constitutes a milestone in the joint collaboration. These programs are usually very attractive for the students since they usually provide a wider perspective. However, it may be difficult to be implemented since different regulations and procedures should be harmonized.

5.7. How to continue with the collaboration industry-academia in the future

It is recommended that each academic institution establishes a future plan, beyond NEON project duration, to ensure that the cooperation between industry and academia will be maintained. It is considered that a mechanism should be stated to ensure an adequate tracking on both sides.

This collaboration can be set up in many different ways. One choice could be establishing a "**Focus group**", which implies an annual meeting between industry and academia. In this meeting, several representatives from the IoT companies would join the professors in charge of the IoT courses. On the one hand, the companies can provide feedback on some aspects as:

- skills of the graduate students: so the academia can re-adapt the programs of the courses in case a lack of skills were detected and, consequently, some competences should have to be reinforced.
- hot topics on IoT in the industry: relevant information can be provided to the academia regarding the trends in the industry related to IoT and expected evolution in the near future. This can help to slightly update the courses according to the future needs.
- opportunities for career development on IoT: some hints on the professional profiles requested by the industry will help the academia to strengthen the associated learning outcomes more closely related to those profiles.
- any other information that could add value to the collaboration between industry-academia

On the other hand, the faculty can provide information on:

- the activities currently developed in the courses: explanations on the contents, teaching methodologies, practical exercises, etc would provide relevant information to the industry to know the competences of their future employees.
- labs description: information on the IoT infrastructure at the university, so the industry can know the facilities where the students are trained.
- any other information that could be valuable for the industry to understand the level of IoT competences provided by the academia.

The goal of the Focus Group is to initiate and maintain collaboration of academia and industry. The idea is to ensure a continuity on sensing its future needs, to react accordingly in the academia to maintain the alignment between industry and HEIs. The universities must have the tools to be able to detect and address any future changes.

5.8. Proposed procedure

Each HEI must revise in detail its situation and, according to the **four pillars** identified in these guidelines, it should define the actions on each pillar where it will base its modernization. Then, the procedure would be stating a proposal, where it is specified the actions to be taken per pillar. To clarify, the process to be taken by the HEIs in Argentina and Uruguay would be: 1) analyse its situation with respect to the 4 pillars; 2) propose actions on each pillar, following the guidelines stated in this document for each of them; 3) implement the actions; 4) evaluate the impact of these actions. It must be noted that, for each pillar, a clear methodology is proposed in these guidelines, with a steps-based approach.

In parallel, **three layers of activities** can be developed, namely, training activities, internship activities and other activities. Again, each HEI must propose the different actions to be carried out in the framework of these activities. In this case, the procedure would be very similar to the pillar's process: 1) identify activities of interest for that HEI or the whole network; 2) state a proposal for that activity; 3) carry out the activity; 4) evaluate the advantages that it has reported.

To summarize, the structure of the actions to be carried out within the NEON project is graphically presented in Fig. 5.2. It illustrates that the aim of modernizing the study programs with respect to IoT contents in cooperation with industry will be supported by the four pillars. Concurrently, there will be three layers of activities that will allow to build the network successfully, providing competences for the programs and for the continuous training.

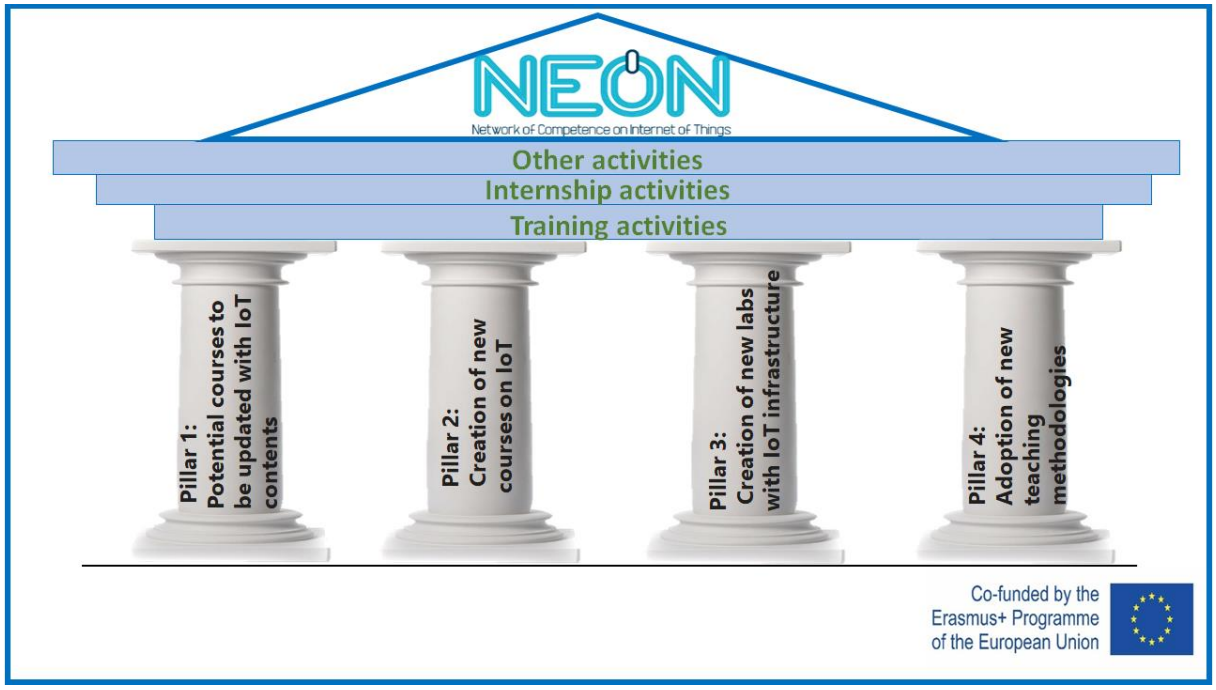


Figure 5.2: Structure of the actions that are integrated in the NEON project, consisting of 4 pillars to modernize curricula and 3 layers of activities.

6. Conclusions

Nowadays, IoT is a field with a remarkable industry activity although IoT topics are not well covered in the ICT study programs in Argentina and Uruguay. In the analysis provided in this deliverable D1.1, we have made two main conclusions.

Firstly, industry considers that IoT field is very relevant now and it will experience a significant growth in the future. However, companies have highlighted a lack of skills in employees and graduate students who do not show enough practical training. Consequently, more IoT-focused training would be desirable from this perspective. In summary, the industry surveys provide evidence of necessity to proceed with the project activities.

Secondly, universities have stated that HEIs are not currently offering, in general, specific content on IoT, although they recognize the requirements from the companies. In this deliverable, the particular situation of each institution has been explored, considering the regulations and country legislation. Again, in summary, the academic survey results show the importance of the NEON project activities.

To offer more IoT-related content for students at HEIs, either new courses are needed, or the modernization of available classes is required. Moreover, the implementation of IoT labs in universities is desirable to improve practical training of students. The development and implementation of laboratories will be tackled in WP4.

The aim of **NEON project** could be summarized as: "**aligning both industry and academia in IoT field**" by creating a "**network of competence**". With this objective in mind, consolidated guidelines for curriculum modernization in cooperation with industry have been proposed, in a steps-based methodology to ease its application. They intend to provide a clear guide with a proposed structure for implementation. These guidelines are based on 4 main pillars, as previously detailed. The NoC will be the framework to improve cooperation between companies and universities and its development will be addressed in WP2.

Moreover, this curriculum modernization should be carried out taking into account an innovative approach to modalities and teaching methodologies. The project vision will try to go beyond IoT-contents, since it will also try to incorporate modern learning approaches. They could add additional value to the study programs, rather than just IoT-contents. Indeed, it is intended that the teaching methodologies are inspired by several modern concepts to improve the teaching-learning process, to be considered in WP3.

Furthermore, a variety of activities will be incorporated to attain the goals of the network. Training, internships and many other activities may be launched to reinforce the acquisition of IoT competences. The training and internship implementation will be addressed in WP5.

To conclude, it is envisaged that the benefits of the project will be multiple to industry, academia and also society. This document constitutes the foundations for the development of the future actions of the NEON project.

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8. Annex:

Academic survey – Teaching methodologies and course modalities

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Nacional de Córdoba (Argentina) – Bachelor Degree in Biomedical Engineering**

	University (Country): Universidad Nacional de Córdoba (Argentina)		
	Study Program (years): Bachelor Degree in Biomedical Engineering (5 years)		
	Course 1: Programming	**Course 2: Digital Electronics 3**	**Course3: Digital Signal Processing**
Year located	1	4	5
Duration (ECTS or hours)	130 hs	180 hs	90 hs
BC: Basic Core	B	C	
I: in person	I	I	I
T: Theory Class	T, P	T,P,L,TU	T,P,L
General competences: **C1: know the principles and contemporary issues of the field** **C2: analyse in order to indentify, formulate and solve problems in the field** **C3: design a system, component or process to meet identified needs in the project with realistic constraints** **C4: design and conduct innovative research experiments and analyze and interpret data** **C5: apply in practice the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice**	C1, C2	C1,C2,C3	C1,C2,C3

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Nacional de Córdoba – Bachelor Degree in Computer Engineering**

	University (Country): Universidad Nacional de Córdoba (Argentina)						
	Study Program (years): Bachelor Degree in Computer Engineering (5 years)						
	Course 1: Programming	**Course 2: Digital Electronics 3**	**Course3: Digital Signal Processing**	**Course 4: Digital Communications**	**Course 5: Cognitive and Software Defined Radios**	**Course 6: Data Communications**	**Course 7: Artificial Intelligence**
Year located	1	4	5	4	5	5	5
Duration (ECTS or hours)	130 hs	180 hs	90 hs	130 hs	72	180 hs	72 hs
BC: Basic Core	B	C		C	C	E	E
I: in person	I	I	I	I	I	I	I
T: Theory Class	T, P	T,P,L,TU	T,P,L	T,P,L	T,P,L	T,P,L	T,P,L
General competences: **C1: know the principles and contemporary issues of the field.** **C2: analyse in order to indentify, formulate and solve problems in the field.** **C3: design a system, component or process to meet identified needs in the project with realistic constraints.** **C4: design and conduct innovative research experiments and analyze and interpret data.** **C5: apply in practice the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice.**	C1, C2	C1,C2,C3	C1,C2,C3	C1, C2, C3, C5	C1, C2, C3, C5	C2,C3,,C5	C1,C2, C3,C5

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Nacional de Córdoba – Bachelor Degree in Electronic Engineering**

	University (Country): Universidad Nacional de Córdoba (Argentina)						
	Study Program (years): Bachelor Degree in Electronic Engineering (5 years)						
	Course 1: Programming	Course 2: Digital Electronics 3	Course3: Digital Signal Processing	Course 4: Digital Communications	Course 5: Cognitive and Software Defined Radios	Course 6: Data Communications	Course 7: Artificial Intelligence
Year located	1	4	5	4	5	5	5
Duration (ECTS or hours)	130 hs	180 hs	90 hs	130 hs	72	180 hs	72 hs
BC: Basic Core	B	C		C	C	E	E
I: in person	I	I	I	I	I	I	I
T: Theory Class	T, P	T,P,L,TU	T,P,L	T,P,L	T,P,L	T,P,L	T,P,L
General competences: C1: know the principles and contemporary issues of the field C2: analyse in order to indentify, formulate and solve problems in the field C3: design a system, component or process to meet identified needs in the project with realistic constraints C4: design and conduct innovative research experiments and analyze and interpret data C5: apply in practice the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2	C1,C2,C3	C1,C2,C3	C1, C2, C3, C5	C1, C2, C3, C5	C2,C3,,C5	C1,C2, C3,C5

Co-funded by the Erasmus+ Programme of the European Union

Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Nacional de Mar del Plata (Argentina) – Bachelor Degree in Computer Engineering**

	University (Country): UNMDP (Argentina)							
	Study Program (years): Computer Engineering (5 years)							
	Course 1: Modeling & Prediction with Emerging Technologies	**Course 2**: Embedded systems	**Course 3**: Fundamentals on Digital communications	**Course 4**: Data transmission networks	**Course 5**: Introduction to Image Processing	**Course 6**: Virtual Instrumentation	**Course 7**: Computer networks security	**Course 8**: Computational Intelligence
Year located	5	4	4	5	5	5	5	5
Duration (ECTS or hours)	6 ECTS	7	6	5	6	6	4	5
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	E	C	C	C	E	E	C	C
Modality: **I**: in person **H**: hybrid **O**: online	I	I	I	I	I	I	I	I
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T,P,L,TU	T,P,L,TU	T, P, TU	T,P,L, TU	T,P,L, TU	T,P,L, TU	T,P,L, TU	T,P,L, TU
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to indentify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C3, C4, C5	C1, C2, C5	C1, C2, C3	C1, C2, C3, C5	C1, C2, C3, C4, C5	C1, C2, C3, C4, C5	C1, C2, C3, C5	C1, C2, C3, C5

Co-funded by the Erasmus+ Programme of the European Union

Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Nacional de Mar del Plata (Argentina) – Bachelor Degree in Electronic Engineering**

	University (Country): UNMDP (Argentina)					
	Study Program (years): Electronic Engineer (5 years)					
	Course 1: Modeling and Prediction with Emerging Technologies	**Course 2**: Electronic measurements	**Course 3**: Digital communications	**Course 4**: Data networks	**Course 5**: Introduction to Image Processing	**Course 6**: Virtual Instrumentation
Year located	5	5	4	5	5	5
Duration (ECTS or hours)	6 ECTS	7	6	5	6	6
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	E	C	C	C	E	E
Modality: **I**: in person **H**: hybrid **O**: online	I	I	I	I	I	I
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T,P,L,TU	T,P,L,TU	T, P, TU	T,P,L,TU	T,P,L,TU	T,P,L,TU
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to indentify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C3, C4, C5	C1, C2, C5	C1, C2, C3	C1, C2, C3, C5	C1, C2, C3, C4, C5	C1, C2, C3, C4, C5

Co-funded by the Erasmus+ Programme of the European Union

Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Nacional de Mar del Plata (Argentina) – Bachelor Degree in Informatics Engineering**

	University (Country): UNMDP (Argentina)					
	Study Program (years): Informatics Engineering (5 years)					
	Course 1: Modeling & Prediction with Emerging Technologies	**Course 2**: Distributed systems	**Course 3**: Artificial Intelligence	**Course 4**: Computer networks	**Course 5**: Introduction to Image Processing	**Course 6**: Virtual Instrumentation
Year located	5	4	4	5	5	5
Duration (ECTS or hours)	6 ECTS	6	6	6	6	6
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	E	C	C	C	E	E
Modality: **I**: in person **H**: hybrid **O**: online	I	I	I	I	I	I
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T,P,L,TU	T,P,L,TU	T, P, TU	T,P,L,TU	T,P,L,TU	T,P,L,TU
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to indentify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C3, C4, C5	C1, C2, C3, C5	C1, C2, C3, C5	C1, C2, C3, C5	C1, C2, C3, C4, C5	C1, C2, C3, C4, C5

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Católica del Uruguay (Uruguay) – Bachelor Degree in Telecommunications Engineering**

	University (Country): Universidad Católica del Uruguay (Uruguay)					
	Study Program (years): Electronic Engineering (5 years), Telecommunications Engineering (5 years).					
	Course 1: IoT Design and Embedded Systems	**Course 2**: Wireless Communica-tions	**Course 3**: Communica-tion Systems	**Course 4**: IoT on Agribusiness	**Course 5:** Develop-ment of Electronic Products	**Course 6:** Project in Embedded Systems
Year located	3	4	3	5	4	5
Duration (ECTS or hours)	12 ECTS	8 ECTS	12 ECTS	6 ECTS	12 ECTS	6 ECTS
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	BC	C	C	E	C	E
Modality: **I**: in person **H**: hybrid **O**: online	I	I	I	H	I	I
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T,P,L	T,P,L	T,P,L	T,P,TU	T,P,TU	TU
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to identify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C3	C1,C2,C3,C5	C1,C2	C1,C2,C5	C1,C2,C5	C5

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad de la República (Uruguay) – Bachelor Degree in Electrical Engineering**

	University (Country): Universidad de la República (Uruguay)			
	Study Program (years): Electrical Engineering (5 years)			
	Course 1: Antennas and Propagation	**Course 2**: Wireless sensor networks	**Course 3**: Real time embedded systems	**Course 4**: IoT communication Technologies (TIoT)
Year located	4	5	4	5
Duration (ECTS or hours)	5 ECTS	4 ECTS	5 ECTS	4 ECTS
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	C in Telecom profile. E in other profiles.	E	C in Electronic profile. E in other profiles.	E
Modality: **I**: in person **H**: hybrid **O**: online	I (due to Covid today is online)	I (due to Covid today is online)	I (due to Covid today is online)	I (due to Covid today is online)
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T,P,L	T, P, L, TU (in-group final course project)	T, P, L, TU (in-group final course project)	T, P, L, TU (in-group final course project)
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to indentify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C5	C1, C3, C5	C1, C2, C3, C5	C1, C2, C3, C5

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad de la República (Uruguay) – Bachelor Degree in Communication Systems Engineering**

	University (Country): Universidad de la República (Uruguay)			
	Study Program (years): Communication Systems Engineering (5 years)			
	Course 1: Antennas and Propagation	**Course 2**: Advanced Topics in Wireless System	**Course 3**: Complement of Advanced Topics in Wireless Systems	**Course 4**: Wireless sensor networks
Year located	3	5	5	5
Duration (ECTS or hours)	5 ECTS	3 ECTS	2 ECTS	4 ECTS
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	C	E	E	E
Modality: **I**: in person **H**: hybrid **O**: online	I (due to Covid today is online)	I (due to Covid today is online)	I (due to Covid today is online)	I (due to Covid today is online)
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T,P,L	T,TU	T,TU	T, P, L, TU (in-group final course project)
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to indentify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C5	C1, C3, C4	C1, C3, C4	C1, C3, C5

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Nacional del Sur (Argentina) – Bachelor Degree in Electronic Engineering**

	University (Country): Universidad Nacional del Sur (Argentina)			
	Study Program (years): Electronic Engineering (5 years)			
	Course 1: Fundamentals of communication systems	**Course 2**: Radio frequency Circuits design	**Course 3**: Wireless communications and antennas	**Course 4**: Telecommunication systems & services
Year located	4	5	5	5
Duration (ECTS or hours)	6 ECTS			
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	C	E	E	E
Modality: **I**: in person **H**: hybrid **O**: online	I	I	I	I
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T, P, L	T, P, L, TU	T, P, TU	T, P
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to indentify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C5	C1, C3, C5	C1, C3, C5	C1, C3, C5

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Nacional del Sur (Argentina) – Bachelor Degree in Telecommunications Engineering**

	University (Country): Universidad Nacional del Sur (Argentina)					
	Study Programme (years): Telecommunications Engineering (5 years)					
	Course 1: Introduction to digital communications	**Course 2**: Radio frequency Circuits design	**Course 3**: Wireless communic. and antennas	**Course 4**: Cellular communic.	**Course 5:** Radio-localization and radar	**Course 6:** Special topics in Telecom. Eng.
Year located	4	5	5	5	5	5
Duration (hours)	8	6	6	6	6	6
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	C	C	E	C	E	E
Modality: **I**: in person **H**: hybrid **O**: online	I	I	I	I	I	I
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T, P, L, TU	T, P, L, TU	T, P, L, TU	T, P, TU	T,P,TU	T,P,L,TU
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to indentify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C5	C1, C3, C5	C1, C3, C5	C1, C2, C5	C1, C2, C4, C5	C1, C2, C4, C5

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Argentina de Comercio y Servicios (Argentina) – Bachelor Degree in Computation Systems Engineering**

	University (Country): UNIVERSIDAD CAECE MDP (Argentina)		
	Study Program (years): Computation Systems Engineering (5 years)		
	Course 1: Intelligent systems	**Course 2**: Teleinformatics & networks I	**Course 3**: Teleinformatics & networks II
Year located	4	4	E
Duration (ECTS or hours)	4	4	4
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	C	C	E
Modality: **I**: in person **H**: hybrid **O**: online	I	I	I
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T,P,L,TU	T,P,L,TU	T, P, TU
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to indentify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C3, C5	C1, C2, C3, C5	C1, C2, C3, C5

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents **Universidad Fraternidad de Agrupaciones Santo Tomás de Aquino (Argentina) – Bachelor Degree in Informatics Engineering**

	University (Country): Universidad Fraternidad de Agrupaciones Santo Tomás de Aquino (Argentina) – Bachelor Degree in Informatics Engineering				
	Study Program (years): Informatics Engineering (5 years)				
	Course 1: Decision Support Systems	**Course 2**: Distributed systems	**Course 3**: Computational Intelligence	**Course 4**: Teleinformatics & networks	**Course 5**: Informatics Security
Year located	5	5	4	3	5
Duration (ECTS or hours)	4	4	4	4	4
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	C	C	C	C	E
Modality: **I**: in person **H**: hybrid **O**: online	I	I	I	I	I
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T,P,L,TU	T,P,L,TU	T, P, TU	T,P,L,TU	T,P,L,TU
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to indentify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C3, C5	C1, C2, C3, C5	C1, C2, C3, C5	C1, C2, C3, C5	C1, C2, C3, C5

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Project: Network of Competence on Internet of Things [NEON]

Project ID: 618942-EPP-1-2020-1-AT-EPPKA2-CBHE-JP

Work Package 1: Consolidation of ex-ante analysis and preparation of implementation actions

Title: Table of potential courses to be updated with some specific IoT contents of **Universidad Nacional del Centro de la Provincia de Buenos Aires (Argentina) – Bachelor Degree in Computation Systems Engineering**

	University (Country): Universidad Nacional del Centro de la Provincia de Buenos Aires (Argentina)					
	Study Program (years): Computation Systems Engineering (5 years)					
	Course 1: Neural Networks and Deep Learning	**Course 2**: Distributed and Parallel Computation	**Course 3**: Artificial Intelligence	**Course 4**: Data Communications I & II	**Course 5**: Data Science	**Course 6**: Business intelligence and smart cities
Year located	5	4	5	3, 4	5	5
Duration (ECTS or hours)	4	4	4	6, 5	4	4
Type: **BC**: Basic Core **C**: Compulsory **E**: Elective	E	E	E	C, C	E	E
Modality: **I**: in person **H**: hybrid **O**: online	I	I	I	I, I	I	I
Teaching methodologies: **T**: Theory Class **P**: Practical Class (practical cases and problems) **L**: Laboratory Practical Sessions **TU**: Tutoring Sessions (individual or in-group attendance)	T,P,L,TU	T,P,L,TU	T, P, TU	T,P,L,TU; T,P,L,TU	T,P,L,TU	T,P,L,TU
General competences: **C1**: **know** the principles and contemporary issues of the field **C2**: **analyse** in order to indentify, formulate and solve problems in the field **C3**: **design** a system, component or process to meet identified needs in the project with realistic constraints **C4**: design and conduct innovative **research experiments** and analyze and interpret data **C5**: **apply in practice** the techniques, skills and engineering tools of the field, taking into account the limitations and implications of this practice	C1, C2, C3, C4, C5	C1, C2, C3, C4, C5	C1, C2, C3, C5	C1, C2, C3, C5; C1, C2, C3, C5	C1, C2, C3, C4, C5	C1, C2, C3, C4, C5