UNIVERSITÄT SIEGEN

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IoT Requirement and Market Needs Analysis Event

D1.3

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Disclaimer

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Table of Contents

Version History 2
Contributors 2
Disclaimer 2
Table of Contents 3
1 Introduction 4
1.1 Abstract 4
1.2 The scope of the document 4
1.3 Purpose of the document 4
1.4 Relation to other deliverables 4
1.5 Relation to workpackages 4
2 Analysis of D1.2 Outcome 5
2.1 The Stakeholders' Summary 6
2.2 The IoT Expertise Requirement Summary 7
2.2.1 Most Demanded Technical Skills 7
2.2.2 Technologies in Focus 8
2.2.3 Levels of Expertise 9
3 Market Player Presentations 10
3.1 KWPA Presentation 11
3.2 Faraz Presentation 11
3.3 Paanaak Presentation 11
4 Industry-Academia Discussion Panel 11

1 Introduction

1.1 Abstract

The IoTrain project is aimed at designing a master of engineering program in Internet of Things, to be offered in partner institutions in the partner countries of Iran and Iraq. Work package 1 (WP1) of the project, the preparation work package, is designed to provide an analytical study of the current status of IoT university education, IoT market needs, and the existing gap between the education system and the market/society. While D1.3 deliverable analysed the existing courses and resources, D1.2 surveyed the market needs for IoT related expertise. This deliverable, D1.3, is an event that is aimed at summarizing and concluding the results of the market needs survey conducted in D1.2. The event, which was held virtually on August 26, 2021 (organized by University of Tabriz and Shahid Chamran University of Ahvaz) included an analysis of the D1.2 results in addition to various industry presentations and discussion panels.

1.2 The scope of the document

The scope of this document is the status of IoT market and IoT expertise needs in partner countries.

1.3 Purpose of the document

This document is reporting on the D1.3 workshop event which was aimed at summarizing the market needs with respect to IoT education.

1.4 Relation to other deliverables

The aim of this event was to discuss, conclude and summarize the contents of D1.2 at the global level to come up with a global decision about the requirements of the target curriculum. As such, this deliverable uses the outcome of D1.2 (report) plus input from industrial and academic partners, to make a decision on IoT program requirements for market needs.

1.5 Relation to workpackages

This deliverable is part of WP1 and used services from WP4 (dissemination) and WP3 (Quality assurance).

2 Analysis of D1.2 Outcome

Following a relatively comprehensive survey conducted in deliverable D1.2 (Market needs analysis and goal definition), which covered a wide spectrum of market players with interviews and questionnaires, this section provides and analysis of the survey. This analysis is done by Shahid Chamran University of Ahvaz, which is the workpackage leader for WP1.

Figure 1- Market Sectors in Market Needs Analysis

The market sectors covered in this survey are depicted in Figure 1~~Figure 1~~. Figure 2~~Figure 2~~ presents the workflow of the market survey that was independently performed by a number of partner institutions in their local market.

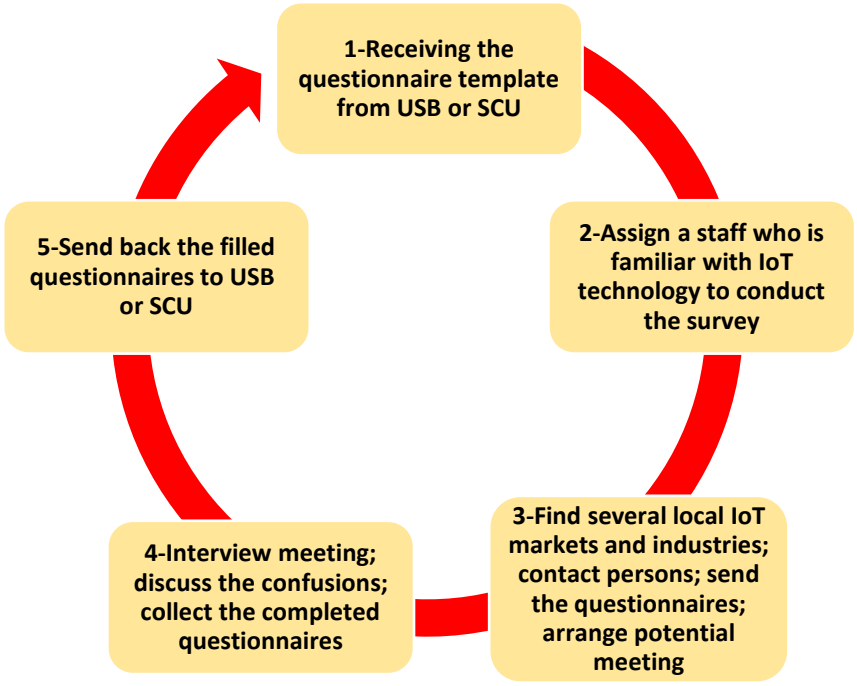

Figure 2- Market Survey Workflow

The questionnaire used in this survey was specially designed in D1.2 preparation phase (by USB and SCU research staff) to catch the following points from each participating stakeholder (i.e., the market players seeking IoT experts):

- General info and market sector
- Current practice and future plans for IoT technology
- IoT skills required by the organization (currently and in the next 5 years) – 21 technical skills surveyed
- Workforce expertise levels required in each skillset

2.1 The Stakeholders' Summary

Here is the summary of organizations interviewed:

- A total of 32 stakeholder institutions interviewed, covering 8 market sectors (out of 9 depicted in Figure 1~~Figure 1~~).
- The average confidence of the responders in their IoT expertise was 7.28 out of 10.
- Equally ranging between small to large workforce sizes (up to over 1000 employees)
- Nearly two-third are currently using IoT technologies

Figure 3 shows the geographical distribution of the stakeholder institutions

Location	Number of institutions
Ahvaz	13 (**40%**)
Tabriz	7 (**22%**)
Zanjan	7 (**22%**)
Bucharest	3 (**9%**)
Tehran	2 (**6%**)

Figure 3- Stakeholder Geographical distribution

2.2 The IoT Expertise Requirement Summary

A total of 21 technical topics where presented to the responders with questions such as:

- What is your institutions immediate and 5-year likelihood to need expertise in the topic?
- At what level(s) of expertise does your institution need the new employees to be?

Figure 4 depicts the aforementioned technical topics and number of courses at partner institutions that are currently being (fully or partially) covered. Based on D1.1 report, we see that most of these topics are somewhat covered in one or more of the existing courses at the partner institutions. What we need to do in D1.4 (Gap identification report) is to identify the gap between the market requirements of these topics and what is being covered in the courses.

Figure 4- IoT technical topics and course coverage

2.2.1 Most Demanded Technical Skills

A review of the responses to the above questions shows that on average, expertise in some topics is far more wanted than others. However, the demand for all of these topics, especially in the next 5 years is more or less high. Figure 5 shows the average immediate and 5-year demand for each expertise among the surveyed stakeholders, expressed in percentage (average probability of the organizations hiring graduates with each expertise).

Figure 6 lists the most demanded technical topics in the immediate and 5-year time frames. Clearly, software related topics are at the highest demand, followed by cloud, wireless technologies and HMI. This observation leads us to conclude that *most industries are interested in procuring (rather than developing) hardware solutions and platforms while directing their R&D and operational investments more towards IoT software operation and development expertise.*

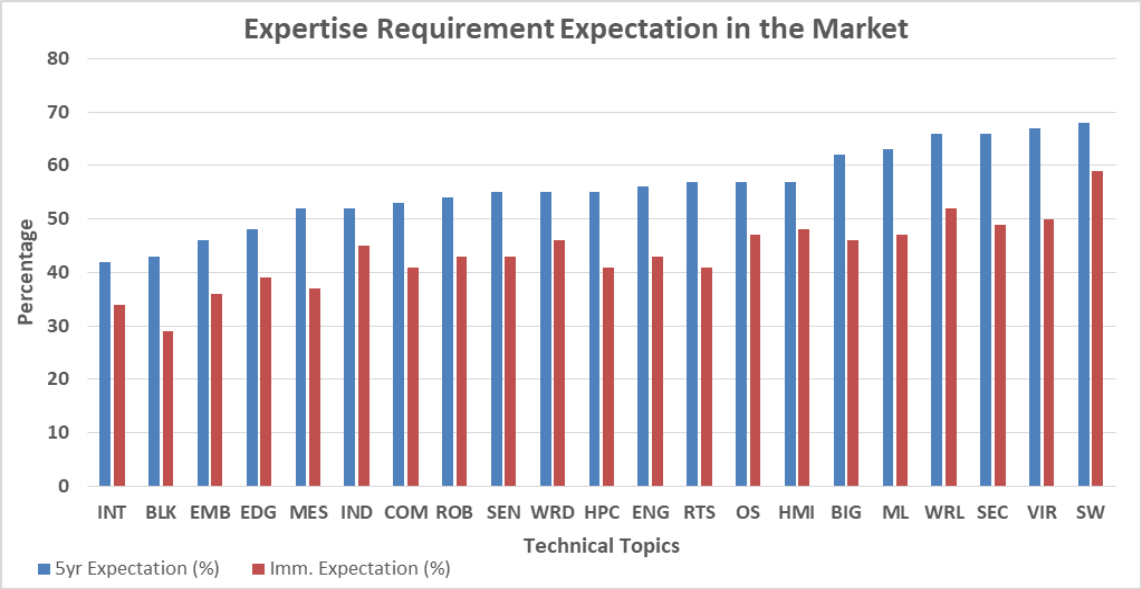

Figure 5- IoT topic requirement in the market

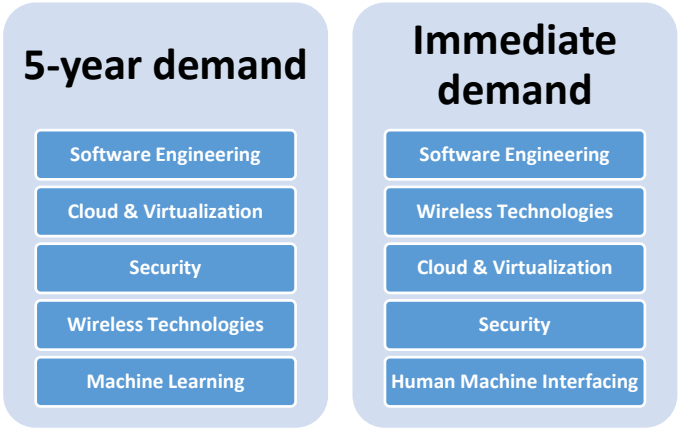

Figure 6-Most demanded technical topics

2.2.2 Technologies in Focus

In order to grab an idea of technologies, technical brands and buzz words that are most wanted by the stakeholders, For each technical topic, Figure 7 summarizes the most wanted technologies / brands mentioned during the survey. This figure can help curriculum and laboratory designers identify technologies and skills that the IoT graduates need the most to increase their employability in the market.

Sensors and Actuators	•RFID
Robotics & Control Theory	•Siemens
Measurement Technologies	•Schneider Electric
Embedded Systems	•Raspberry pi
Interfacing circuits and standards	•Schneider Electric
Energy Efficiency & Energy sources	•Low energy protocols
Wired Networks & Standards	•Ethernet
Wireless Networks & Standards	•WiFi
Real-time systems	•RTOS
Operating Systems	•Android
High performance computing	•Scientific simulation
Cloud, Virtualization and Serverless	•Virtualization
Edge and Fog computing	•OpenFog
Communication and Queuing	•TCP/IP
Big Data	•SQL/NOSQL
Machine Learning	•Python
Security and Privacy	•WPA/WPA2
Blockchain Technologies	•Cryptocurrency
Industrial / Production Engineering	•SCADA
Human-machine interaction	•Rugged HMI
Software Engineering	•Python

Figure 7- Most wanted technology / product in each technical topic

2.2.3 Levels of Expertise

Finally, the stakeholders were asked about the level of expertise they need the prospective employees in each technical skill. We categorized the expertise in four levels:

- *R&D experts* are those capable of managing and advancing organization's product/service research and are usually PhD or MSc graduates with proven track record in research. These experts will probably benefit the most from industrial internships in R&D offices of stakeholder organizations during their course of study.
- *Senior Engineers* are engineers with design, analysis, and supervisory skills in any technical aspect of IoT
- *Junior Engineers* (who are usually fresh graduates) are engineers that usually manage and implement sub-tasks in and IoT related project, assigned by senior engineers.
- *Technicians* usually at the bottom of the engineering pyramid usually involved in the most practical and technical actions required to implement a particular design, operate a specific system/machine, or undertake a manual task supervised by engineers.

Looking at Figure 8, we can see the most demanded technical skills in various expertise levels.

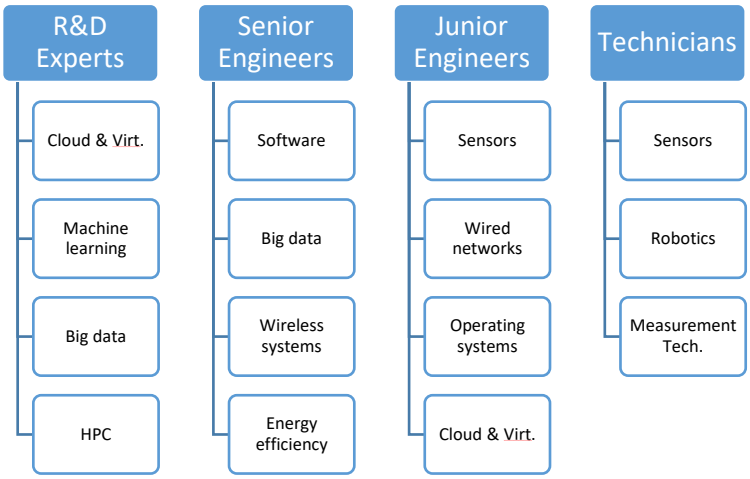

Figure 8- Most demanded technical skills at various expertise levels

This outcome indicates that *in some technical topics such as robotics or measurement technologies, experimental and hands-on skills are more important*, while in topics such as *machine learning, research and analysis capabilities of the are much more important* for the market players.

3 Market Player Presentations

In the second part of the workshop, three market players from different market sectors (Figure 1~~Figure 1~~), experience, and business models presented their IoT related work and their expectation from university graduates whom they may hire in this field.

1. *Khuzestan Water and Power Authority* is the largest water resource management organization, located in the southwest region of Iran. KWPA studies and manages surface and underground water resources and related utilities in the region. It belongs to the *government industry* sector of the market and is considered a *large enterprise*.
2. *Faraz Novin* is a well-established engineering and manufacturing company in the Oil and Gas production market of Iran, providing technologies, solutions, and services for enhancing oil well production. It belongs to the *Oil and Gas* market sector and is considered an *SME*[1].
3. *Paanaak IoT Solutions* is a startup company providing IoT solutions in various application fields including smart building and smart farming. Paanaak directly operates in the IoT field by manufacturing devices and software solutions for smart monitoring. It belongs to the *IoT industry* market sector and is considered a *startup*.

Table 1~~Table 1~~ summarizes the presenter market players that introduced their vision and expertise need in the field of IoT.

Table 1-Presenter stakeholders

Organization	Location	Market sector	Org. Size
KWPA	Iran	Government and public services	Large enterprise
Faraz Novin	Iran	Oil and Gas	SME
Paanaak	Iran	IoT industry	Startup

[1] Small and Medium Size Enterprise

3.1 KWPA Presentation

Generally, according to KWPA, the IoT ecosystem includes three major role sets, including product designer/manufacturers, integrators, and end users. Depending on the application and the role, different skill sets are required.

Specifically, KWPA presented a case study of their use of IoT technologies in monitoring water distribution canals for irrigation and agriculture system of the Khuzestan province. KWPA believes that mechanical, electronic, computer, control, and instrumentation engineers are the most needed in their IoT projects. As a large government-based enterprise, they need experts in machine learning and AI, JS/Python, sensors, UI / HMI, Node.js, big data, security, GPS/GIS, cloud, and mobile HW systems, among others.

3.2 Faraz Presentation

This talk was focused on the role of IoT in artificial lift, which offers a bag of technologies for enhancing oil well production in wells where the natural reservoir drive energy cannot push the oil to the surface. In this field, IoT can be helpful in R&D, QC, manufacturing, monitoring, and maintenance. Most needed skills are industrial engineering, software engineering, HMI, HPC, and wireless systems.

3.3 Paanaak Presentation

Paanaak presentation identified the IoT platforms, standards, business flows and application segments It further analysed the main roles required in IoT production business as the following:

- WEB and Network Developer
- REST/MQTT/Socket developers
- Mobile Developer
- Electronic Circuit Designer
- CAD Designers
- Product Manager
- Machine learning and AI engineers

According to the mentioned roles that are deemed essential for an IoT startup to progress and succeed, Paanaak believes that web and hardware developers in addition to 3D CAD designers (for box design) are the main expertise areas required for IoT platform development.

4 Industry-Academia Discussion Panel

At the last part of the event, a discussion panel was held between the participants who were from both industry and academia. The purpose of the discussion panel was to take experts' opinion on the requirements of an IoT program. The panel raised three main questions for debate:

1. **Is a specific IoT degree really required?**

   This is fundamental question that was deliberately devised to not only motivate every panelist to ponder on the importance of IoT education, but also to provide an opportunity for discussing the quality of such education.

   Given the scope of IoT applications, and the existing gaps between various engineering curricula and what is expected from IoT engineers, the necessity of an IoT-specific degree was emphasized by most of the panelists. However, their expectations from an IoT graduate was diverse; while some panelists expect the program to prepare IoT project managers who understand project

requirements and can oversee engineers from various other disciplines, others emphasized on a practice-oriented approach, where frequent internships mixed with various lecture-lab courses boost practical skills of the students. Other suggestions such as sub-disciplines, and increased number of courses from various disciplines (with less lecture hours) also show that most of the panelists believed that the interdisciplinary nature of the IoT needs to be preserved in the education system.

2. What is the trade-off between practical and theoretical capabilities required from IoT M.Eng. graduates?

Since the main motivation behind this project has been training engineers with high employability, the practical and lab-oriented part of the curriculum is indispensable. However, the main question is trade-off between theoretical/technical lectures that are critical for elevating the students' technical knowledge, and laboratory/internship training that are aimed at strengthening their practical skills.

This part of the discussion induced extremely diverse opinions. While some panelists from academia stressed on a theoretical/research oriented curriculum, others took a more moderate approach. For example, one opinion was to train IoT managers with more theoretical material, while beefing up laboratory and trainings and internships for production engineers.

A couple of questions that were not really concluded or well answered were:

- How do we include laboratory material in the curriculum? As separate courses or as parts of lecture courses?
- Do we need to keep a thesis for IoT MEng students in the curriculum (hence a research based program)?

3. Which background is preferred for IoT MEng. students at the admission time?

Given the interdisciplinary nature of IoT, this is a valid question that is very important in designing the curriculum. While most panelists agreed that admissions can be made from any engineering discipline, a number of them emphasize on computer engineering, electrical engineering, and mechatronics engineering as the most relevant disciplines to IoT.

One major solution that can handle the potentially diverse background of admitted students is to design a broad curriculum with multiple sub-disciplines geared towards any of the relevant backgrounds. It will be up to the implementing body (i.e., the university) to cover any or all of these sub-disciplines.