APPROACH TO TRAINING HUMAN RESOURCES FOR THE INDUSTRIAL INTERNET OF THINGS (IIOT) AT HANOI METROPOLITAN UNIVERSITY

Le Chi Chung[(*)]**, Nguyen Quoc Tuan, Hoang Thi Mai,**

Truong Duc Phuong, Luu Ngoc Sinh, Ngo Thuy Ngan

Hanoi Metropolitan University

Abstract: *According to a forecast by Cisco, by 2025, there will be more than 75 billion devices connected to the Internet of Things (IoT) [1]. This trend leads to an increase in the demand for human resources for the IoT industry. In Vietnam, there are several IoT training institutions with a limited number and still cannot meet the growth rate of the IoT market. In the context of the high-quality IoT field, the Faculty of Science and Technology – Hanoi Metropolitan University has taken a new approach with two-stage traning approach; orientation traning combining research and application to help the IT industry have more direction to transition to the IoT industry, increase more job opportunities for students upon graduation.*

Keyword: *Industrial Internet of Things, training human resource, jobs about IoT.*

1. INTRODUCTION

Internet Of Things (IoT) is no longer a trend. IoT applications are available thanks to new technology such as AI - artificial intelligence, Bigdata - big data, Blockchain, intelligence, healthcare, hi-tech agriculture, transportation. The rapid development of the IoT field has exploded the demand for high-quality human resources. Training institutions must change their programs to suit the new situation to meet the pressure on training in universities and colleges, especially in the IoT industry. Several institutions and universities such as Hanoi University of Science and Technology, FPT University, University of Electricity, Quy Nhon University, and Ho Chi Minh City University of Technology [4]... have introduced IoT training. Although the number of enrollments has increased gradually, it still cannot meet the market demand. Facing great opportunities and needs of society, the faculty of

Science and Technology has boldly changed the training program to help IT students access the necessary competencies to meet the requirements of the IoT industry.

1.1. What is IoT?

IoT is a network of physical devices embedded with sensors, software, and other technologies to connect and exchange information. Exchange data with other devices and systems over the internet. These devices range from everyday household objects to sophisticated industrial tools. For developing IoT products, it is necessary to invest in the following areas:

- Embedded programming for microchips placed in devices.
- Cloud Computing
- Artificial intelligence (AI)
- Big Data - Big data.
- High-speed internet.

With IoT, a lot of devices can connect and connect with people over the internet. From household appliances such as televisions, kitchens, bathrooms, air conditioners, cars to industrial tools in sophisticated assembly lines can connect with people for a seamless workflow.

IoT is considered one of the most critical components of the Industry 4.0 revolution. If AI and BigData act as data processing components, IoT will act as components to connect and control devices and robots to work tirelessly; collect information and data for AI, BigData.

Thus, when IoT is formed, it will bring countless benefits to life and other social activities, such as reducing human costs, increasing output or production quality, opening up new markets, new labor. There will be billions of devices connected and many more that need to be connected to the internet. According to Cisco forecast, by 2025, there will be more than 75 billion connected IoT devices in the world. [1]. With such a rapid growth rate, workforce would bethe problem to be solved.

In Vietnam, IoT is gradually becoming more feasible with the orientation and involvement of the Government to promote the development of 5G infrastructure[7] and supporting sciences. It leads to a shortage of human resources in the IoT industry for the new market. According to an assessment from the World Economic Forum in 2019, to promote the digital transformation process in Vietnam, it is necessary to improve the digital skills of the domestic workforce. Because otherwise, Vietnam will get little success from this process because the labor force that cannot meet the requirements will be replaced and cannot find jobs. [8]

1.2. Demand for human resources in the IoT industry

In the world market, IoT has a great attraction in terms of human demand. According to statistics from Forbes magazine, searching on the job network with the keyword; IoT

employments in the US alone gives more than 13,000 results [2]. IoT is still developing in Vietnam, building smart cities, smart factories, or intelligent devices. On the business side, only a few companies are participating in smart homes and intelligent agriculture, such as Bkav, Lumi [3]... On the training side, several schools have started to train human resources for IoT, such as Hanoi University of Science and Technology, FPT University, University of Electricity, Quy Nhon University, Ho Chi Minh City university of Science and Technology...[4]

The basic requirements for human resources for the IoT field are:
- Embedded programming skills (C language)
- Understanding of logic, electronics, peripheral connections
- Data structures and algorithms
- A mobile application programming such as Android, IOS, web programming
- Printed circuit design.

For human resources to meet such requirements, each school or institute has its advantages in training. But looking at the requirements, we can see that an engineer working for the IoT industry needs skills and knowledge in many technical areas. Not to mention that IoT applications require developers also to understand the field in which IoT devices are being applied.

The difficulty of the IT industry at Hanoi Metropolitan University is the lack of facilities for teaching and practical experiments. The teaching staff is still small. When there is no change, the university training program in IT is still oriented to provide students with the skills of Information Systems and Computer Science.

To meet the high requirements of training human resources, to catch up with the trend of digital transformation in various fields, the Faculty of Science and Technology staff and lecturers have promptly made two changes in operation. *Firstly,* change the university training program right from the first enrollment in 2017 [5]. The program is designed to provide an approach for IT students who do not understand electronics and embedded programming but can still add knowledge and skills to meet the requirements of working in the IoT industry. *Secondly,* the faculty's change in the orientation of science and technology development is a training goal that cannot be separated from application and research. The research and experience in building applications will be fed back to the training process to raise the level and level of product perfection to new heights.

2. CONTENT

2.1. Two-stage training approach

For IoT, the IT lecturers of the Faculty of Science and Technology see this as an opportunity to increase the advantage of job search for students upon graduation and catch up with the digital transformation trend in Vietnam. Because of the long tradition of training, the IT training program has helped students have in-depth skills and knowledge in the fields

needed in the information processing process. What is lacking for students is the skills in embedded programming and connecting peripherals. The advent of open-source implanted microchips allowed us to make up for that shortfall. Because embedded microchips are manufactured at a low cost, easy to communicate and connect, helping programmers no longer have difficulties building IoT devices. From popular kits such as Arduino, Intel Galileo, Raspberry Pi, ESP….as the center of information processing of the device, to sensors manufactured in a modular form that are easy to connect and program to be used to collect information from the environment. These components are widely produced at a very suitable price for students' learning and scientific research activities in general. We changed the program with two changes corresponding to the two stages of training the skills and knowledge needed for the IoT industry. The training program has obtained encouraging results from the very first course in 2017.

2.1.1. Changes in training

Stage one: students are introduced to programming on Arduino through the hands-on content of the Digital module. Due to the nature of a simple programming language, like the C programming language, students have been trained in the basics, so students quickly master embedded programming techniques.

The goals of stage one are:

- Know the essential components of an embedded system
- Understand how to design an embedded system, build and assemble parts.
- Learn how to program and load programs for embedded systems
- Reviewing Results

Stage Two: Students who have mastered programming techniques on Arduino will begin to develop their creativity and self-study by completing an application project. The implemented course is Embedded Programming. In this stage, students can freely choose any circuit board circulating on the market to develop application ideas in automation, communication, control.

The goals of stagetwo are:

- Master the process of designing an embedded system.
- Place the embedded system in a specific application context.
- Orientation for the application of embedded systems in studies of Internet Of Things.

With the above training program implemented for two years, students have achieved encouraging results:

- 100% of students meet training requirements
- The topics developed by students are applicable in a narrow range, but the stability of the design is increasing.

-       The student-organized embedded programming club led by faculty members also has an annual award-winning product from the Ministry of Education and Training. [6]

2.1.2. Development costs

With the limited funding, the process of implementing the program in two years. Training costs come entirely from the regular training budget in the school.

-       The training program is integrated or replaced in the sector training framework program.

-       Experimental equipment was added from two sources: one was from the professional fund of the IT faculty, and the students themselves invested in their projects.

2.2. Orientation training combining research and application

The goal of training is not separate from the purpose of application or study. In the early stages of development in embedded programming, we aim to research specific products that can be directly applied to various production and life activities. Thereby removing barriers for entering a new field such as:

-       Embedded programming techniques with several different ICS
-       Data transmission and processing solutions for IoT
-       How to use sensors, relays, resistors
-       Study welding, printed circuit, machine building, distributing power techniques in equipment.

These are also the main barriers for students or researchers to master the field of IoT. Because of the specificity of IT training, there is a lack of knowledge and experience in electricity and electronics.

Although there are many obstacles for students to overcome, the attraction of practical applications will be an inspiration to overcome. Practical applications require students to be able to put their learning products into practice. Because through experiments, it will prove that theoretical problems can be implemented or not. Students now, in addition to evaluating the effectiveness of using the device, will face issues such as:

-       The application product deployment environment is not like the test.
-       Sensor stability.
-       Product energy consumption
-       Material durability.
-       The appearance of products.
-       Product maintenance
-       Assess the impact on the environment after the equipment has been used.

Just one of these contents, after being researched and used in a product, the training process also accomplishes the goal. Training at this time is the process of replicating the results of applied research. By increasing the number of products, there will be initiatives to improve and improve the quality of the products. Application is the process of testing and

re-evaluating the effect in practice. The experiences learned from the application will be brought back to the training process, the problems to be solved will become the contents to be studied. This cyclical process is one of the essential strategies for developing and improving the quality of the team, thereby affecting the quality of training.

2.3. Results of applied research in the period 2018-2020

From a training-oriented perspective that combines application and research, our team has achieved some initial results.

On the part of the faculty, they opened up research in applied IoT with two university-level scientific research projects in the academic years 2018-2019 and 2020-2021. The two topics are respectively:

The product " IoT system for device in Office"implemented in 2018-2019 with the goal of initial research on the structure of an IoT system and direct application to electrical devices in the office. The product comes complete with a set of IoT devices and a control website for standard electrical appliances in the office, such as lights, fans, water heaters, etc.
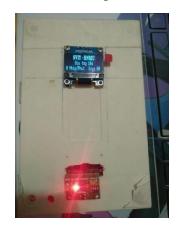

Picture 1. Device to control lamps and fans in Office

A successful product with high stability and superior features compared to similar products is regular operation even when the Internet connection is lost. Currently, the product is still used in the office of the Faculty of Science and Technology.

The product "Intelligent humidification IoT system applied to high-tech mushroom growing process"; implemented in the school year 2020-2021 to master signal transmission and processing techniques for an IoT system and apply products to high-tech agriculture. One of the leading products obtained from the project's success is a combination of IoT devices and software to control and monitor the humidification process applied to mushroom growing technology. The success of the project is also a testament to the right direction of the staff. Therefore, lecturers of the Faculty of Science and Technology in doing research must be associated with the practice. The research direction of the topic is also consistent with the general trend of the scientific community as interdisciplinary research.

The product: "Heart rate measuring device for the elderly" consisted of science research students of the D2017 IT course conducted research and design in 2018-2019 [6]. The product is a machine applied in the medical field. The device accurately measures heart rate but can be operated by battery or by direct power, making it easy for users to carry it anywhere, anytime. It is considered a potential product in that the average age is increasing.

The rate of people suffering from cardiovascular diseases increases due to the negative influence of everyday life habits. In the next upgraded design, the device can be changed into an IoT device with unchanged functionality to help doctors remotely monitor the patient's heart rate. As a result, the machine promptly issues warnings via the internet to the doctor if there is a problem so that each doctor can monitor and save more patients.

Product: "Gas detection device"; a group of science research students of the D2018 IT course conducted research and design in the 2019-2020 school year. The product is an application in evaluating gas appliances in daily life. In addition to being compact and easy to assemble, the device also has the advantage of detecting other gases that are harmful to humans. These gases are emitted from gas stoves and industrial refrigeration equipment or cracks and holes in sewage disposal pits. Thanks to the equipment, people's lives are improved, ensuring fire safety or health problems caused by inhalation of toxic gases.

Picture 2. Heart rate measuring device for the elderly

In addition to the above results, there are many other products of the team of researchers and students in the Faculty of Science and Technology, researched and manufactured over the years. These results are evidence showing positive signals from the fundamental changes in training orientation associated with research and application of the Faculty of Science and Technology.

3. CONCLUSION

IoT is a potential market; according to Forbes Vietnam forecast, the IoT market is forecasted to grow by 35% per year and may reach a value of VND 8,300 billion by 2023[8]. The technologies and techniques that support IoT are already in place. In terms of institutions, the Government of Vietnam makes urgent requirements to accelerate the digital transformation process [9]. It is an excellent pressure on universities and colleges to train high-quality human resources to take advantage of the fourth revolution's opportunities. Human resources for IoT are incredibly diverse to meet many stages in the production process of products, including design, construction, installation, and operation engineers and data analysis personnel.

So, by approaching a radical change from training programs to industry development strategies associated with training with research and application, the Faculty of Science and Technology has gradually moved from creating a favorable environment for scientific research to orienting application for research products, put research results into training. As a result, the team of researchers has achieved encouraging results in the Internet of Things. At the same time, with the results achieved in training, we have helped students increase job

opportunities by anticipating the trend of IoT applications in Vietnam. With these initial positive results, it is vital and feasible to train human resources for the embedded system market and the IoT industry in particular. We need more significant investment for this training program to produce high-quality human resources to supply the demand.

In the process of further development of the research team to further improve the quality of training and continue to pursue the training orientation associated with research and application, the team will perfect the change of the training program; create IT industry; invest in more equipments for practical experiments; encourage scientific research movement among students and faculty to improve the quality of research products; actively exchange expertise with other scientific disciplines to open up interdisciplinary research; associate with businesses in the field of IoT to help students practice and improve skills, increase practical experience and increase job opportunities for students upon graduation.

REFERENCES

1. Bạch Tân Sinh, Đặng Thị Hoa (2019), "IoT ở Việt Nam: Thực trạng và giải pháp phát triển", *Tạp chí Khoa học & Công nghệ Việt Nam*, Số 1+2 (2019).
2. Vân Anh (2019), "Ngành IoT đang "khát" nhân lực: Học ở đâu, thu nhập ra sao?", *Tạp chí ICTNews,* Số ra ngày 12/04/2019.
3. Trường Đại học Thủ đô Hà Nội, Chương trình đào tạo đại học chính quy ngành Công nghệ thông tin khóa D2017, D2018.
4. Giải khuyến khích NCKH sinh viên các trường Đại học – Bộ Giáo dục và Đào tạo – năm 2019 – Đề tài: "Thiết bị đo nhịp tim dành cho người già" – Chủ đề ứng dụng IoT trong lĩnh vực y tế
5. Thanh Hà, Đức Thiện (2020), "Mạng 5G 'Make in Vietnam' đã sẵn sàng", *Tạp chí Công nghệ Tuổi trẻ*, số ra ngày 03/9/2020, truy cập ngày 11/10/2020.
6. JACQUES MORISSET (2021), "Chuyển đổi số ở Việt Nam: không kỹ năng, không thành công", *Tạp chí WorldBank*, số ra 08 tháng 10 năm 2021.
7. Nghị quyết số 52-NQ/TW ngày 27/9/2019 về một số chủ trương, chính sách chủ động tham gia cuộc Cách mạng công nghiệp lần thứ Tư.

CÁCH TIẾP CẬN ĐÀO TẠO NGUỒN NHÂN LỰC CHO NGÀNH IoT Ở TRƯỜNG ĐẠI HỌC THỦ ĐÔ HÀ NỘI

Tóm tắt: Theo dự báo của tập đoàn Cisco, tới năm 2025 sẽ có hơn 75 tỷ thiết bị được kết nối Internet Of Things (IoT) [1]. Điều này kéo theo nhu cầu nhân lực cho ngành IoT cũng tăng lên. Ở Việt Nam hiện có một số cơ sở đào tạo ngành IoT với số lượng hạn chế và vẫn chưa thể đáp ứng được tốc độ tăng trưởng của thị trường IoT. Trong bối cảnh ấy, với mục tiêu đáp ứng nhu cầu nhân lực cho lĩnh vực IoT chất lượng cao, khoa KHTN&CN – trường Đại học Thủ đô đã có cách tiếp cận mới với hai giai đoạn; định hướng đào tạo kết hợp nghiên cứu và ứng dụng để giúp ngành CNTT có thêm hướng chuyển đổi sang ngành IoT, tăng thêm cơ hội việc làm cho sinh viên khi tốt nghiệp.

Từ khoá: Ngành IoT, đào tạo nguồn nhân lực, nghề nghiệp IoT.