Modern Internet of Things as a Challenge for Higher Education

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Summary
This paper is designed to study the acceptance of the Internet of Things (IoT) in Industry (so-called Industry Internet of Things, shortly IIoT) and the necessities for higher education in the period of the fourth industrial revolt. The accumulation of the fourth letter, "P" in face of the "IoT" coins the name of the novel idea, "IIoT" in next of kin with another term, "Industry 4.0". Because these ideas have no specific and broadly conventional definitions, we offered some well thought-out significant by scientific literature. The paper also draws attention to the most significant similarities and differences between these ideas. PIoT is a very self-motivated idea and it will continually bring revolutionizes in digital technologies, necessities and markets, and will also renovate industries and Industry practices. According to various studies, presently, there is a proficiency gap which may amplify in the future if no stroke is taken. Higher education must approve the most recent associated technologies and must get used to to the novel ways in which people, machines, services and information can interrelate. As a result, employees, students, graduates, etc. have to be uniformly vibrant in learning and obtaining novel skills. The evolution from higher education to service is a challenge that could be further simply addressed during the hard work of all stakeholders, from individuals to organizations, and from industries to governments. As revolutionize in higher education take time, every stakeholders will now have to be active in getting ready for the Industry Internet of Things.

Key words:
Industry 4.0; Industry internet of things; internet of things; higher education; proficiency gap

1. Introduction

Industrial engineering is persistently bound to become familiar to the various happening changes, from growth in business models to the mainly sophisticated information and communications technologies; the idea is to enlarge the overall superiority of products and efficiency, and also to shrink overall costs. Presently, we are observing the increase of a innovative digital industrial wave, namely the fourth industrial revolution (IR 4.0 or FIR), made possible by the extensive exploitation of economical smart sensors, processors, wireless sensor networks, embedded systems, but also by the progressed in information storage, analytics, cloud communications, and so on. Different global surveys carried out in relative to the industry field expose that the major existing technical plan to put into operation this revolution is the Industrial Internet of Things (IIoT).

In a report [1], Accenture calculates approximately that the Industrial Internet of Things could append $14.2 trillion to the international market by 2030. The international Industrial Internet of Thing market is projected to get bigger at a CAGR of +24% through the 2018-2022 [2]. A McKinsey report [3] predicts that by 2025, the profit of industrial units implement IIoT will achieve 65%-90% in sophisticated economies and 50%-70% in rising economies.

Researchers guess that the IIoT development will beat different sectors, pressuring both the industry and the labor market, leading to the construct of fresh jobs, but also to the exclusion of several existing ones. Thus, a variety of studies on technology uptake carried out in different countries make public that the acceptance of innovative technologies is anticipated to have a important crash on the employment background. For instance, according to [4], ―in various industries and countries, the majority active employments or specialties did not continue living ten or yet five years previously, and the speed of revolutionize is set to go faster. The identical report guesses that ―65% of children ingoing primary school nowadays will eventually end up effective in totally novel job types that don't yet be present. This is also the crate of the Industrial Internet of Things. Assorted researches have alerted their concentration on this new idea; investigating, among others, both the various possible payback and challenges created by the application of this model across different economies. In calculation to the technological blockades, the extensive and accelerated acceptance of the Internet of Things (IoT) model in the industrial field is held back by the proficiency gap. According to multiple studies, presently, there is a proficiency gap which may broaden in the prospect if no achievement is taken. For instance, an investigation from Deloitte [5] discloses that in the subsequently decade, there will be 3.5 million job opportunities in modern, but only adequate capable labor to block less than half of them. And as IIoT development acquires hold, the call for capable staff will strengthen. One solution to decrease the proficiency gap rests in education, for example during efficient skills, re- and up-skilling programmes. IIoT is a especially dynamic idea and it will continuously transport changes in digital technologies, requirements and markets, and will also make over industries and business follow. As a result, employees, students, graduates, etc. have to be uniformly self-motivated in learning and attaining new proficiency.

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Higher education must accept the most recent associated technologies and must get used to \the novel ways in which people, machines, services and information can work together.
This paper is more focused exclusively with the significance of higher education in sustaining the development of the proficiency and competencies obligatory for the Industrial Internet of Things era. Presently, the pictures of Internet of Things, Industrial Internet of Things and Industry 4.0 are still relatively fuzzy. Even though IoT, IIoT and Industry 4.0 are very much associated ideas, they cannot be used interchangeably. So far, there is no usually acknowledged meaning for each of these terms and in a challenge to realize these ideas; this paper seeks to make clear them. The literature in the area recommends numerous definitions, some of them being offered in a section of this paper. Next section offers a short link of IIoT and IoT. The IIoT development is being facilitated by the enhanced accessibility and affordability of economical (smart) sensors, processors, embedded systems, etc., but also by the advances in data storage, analytics, cloud communications, and so on. Consistency plays a significance role for the additional development and extends of IIoT. In computation to record the significant IIoT enablers, we also emphasize the openings and challenges transports forth by IIoT. The subsequently section draws some achievable directions for concluding observations and the paper ends with some future research.

2. IoT, IIoT, Industry 4.0

2.1 Iot, Iiot And Industry 4.0 Idea Disambiguation

The thoughts of Internet of Things, Industrial Internet of Things and Industry 4.0 do not have accurate and broadly acknowledged definitions. The literature in the field recommends numerous of them, some being offered in the subsequent sections.
Internet of Things:

- Is enabling highly developed services by communicating (physical and virtual) things based on obtainable and developing interoperable information and communication technologies [6].
- is not a particular technology; somewhat it is an agglomeration of different technologies that effort together in cycle [7].

The Industrial Internet of Things, view as an industrial alteration of the Internet of Things, has several identification dissimilarity, Industrial Internet as GE provisions it, Internet of all word expected by Cisco, Rockwell Automation's IoT Industrial Revolution, IBMs Smarter Planet or the European Industry 4.0 or Industrie 4.0 (original German term), correspondingly French ―Industrie du Futur (Industry of the Future). The word Industrial Internet of Things (truncated as IIoT, I-IoT, I2OT or I2oT) is second-hand to symbolize what is predictable to transform the industry, by amalgamation the digital and actual industry [8]. The Industrial Internet of Things is described as follows:

- a space of intellectual industrial products, developments and services that corresponds with each other and with public over a worldwide network [9].
- is a scattered network of elegant sensors that enables accurate organize and supervising of complex processes over subjective distances [10].Industry 4.0 or Industrie 4.0:
- Focuses on the end-to-end digitization of all physical resources and developments as well as amalgamation into digital ecological units with worth sequence associates [11].

According to [12], the Industrial Internet of Things is connected with Industry 4.0: ―each Internet of Things applications in Industry 4.0 are appearances of IIoT, but not all IIoT utilize cases are concerning the industries which are classified as Industry 4.0.
In numerous cases, the provisions Industry 4.0 and Industrial Internet of Things are utilized interchangeably [13], regardless of the dissimilarities between them. But, according to [14], ―Industrial IoT and Industry 4.0 fundamentally have a cause-and-effect connection i.e. the Industrial IoT is the foundation for, and will effect in, the fourth industrial revolt. Industry 4.0 or i-4.0 idea is paying attention particularly on the modern industry and making certain its competitiveness in a self-motivated worldwide market. The IIoT idea is ―further paying attention on allowing and speeding up the acceptance of Internet-connected technologies diagonally industries, both manufacturing and non-manufacturing [15]. Actually, IIoT is observed as a main enabler for the 4th industrial revolt (IR 4.0).
The word invented by the adding of the fourth letter, "I" in front of IoT explains the novel idea, IIoT. There are several ordinary points between these thoughts, IoT and IIoT, but there are also remarkable variations, some of which are being offered in the next section of this paper.

2.2 Industrial Internet of Things vs. Internet of Things

Even though the Industrial IoT pursues the identical core meaning of the IoT and distribute various common

characteristics (Table 1), these paradigms are also illustrious by dissimilar facial appearance (Table 2).

Table 1: IoT VS. IIoT - Similar Characteristics

Perspective	Internet of Things and Industrial Internet of Things
Accessibility of connected devices	accessibility of reasonably priced and smart devices; connectivity transports the accurate worth of IoT and IIoT, guarantee monitoring, control, etc.; even though they are used to achieve dissimilar goals
Structural design	[Collect | Store | Analyze | Share] architecture
Technologies concerned	communication technologies, cloud computing, (smart) sensors technologies, advanced analytics, big data, machine learning, etc.
Challenges	the mass of accessible standards and technologies, interoperability, security and privacy security, proficiency shift for users, need of knowledge and capability for developers, recognition, capital

Table 2: IoT VS. IIoT - Different Characteristics

Perspective	Internet of Things	Industrial Internet of Things
Linked things	consumer-level devices, typically less costly	serious machines, sensors, systems, typically with a high degree of difficulty
Service model	human-centric	machine-centric
Applications	consumer-oriented applications	industry-oriented applications
Communication transportation	basically wireless	Both wireless and wired
Communication competences	a small number of communication standards	a high number of connectivity standards and technologies
Quantity of data	Medium to high	High to very high
Criticality	Not severe	undertaking serious (timing, security, privacy reliability)
	typically no, industry with less time-sensitive systems	the majority often has a key role

2.3 Industrial Internet of Things Allowable, Payback and Confronts

There are a variety of IIoT enablers, software and hardware knowledge, production association and society, equivalence, public policy; experienced human resources, exhaustive in Fig. 1. Thus, for instance, in order to put into action elastic, customizable, and well-organized industrial systems, entirely associated with the IIoT thoughts, all linked enabling skills (industrial networks, big data, cloud computing, , data analytics, artificial intelligence, blockchain, etc.) and hardware system (embedded systems, developed robots, etc.) must be uniformly urbanized for being incorporated into IIoT systems [16]. IIoT platforms have participated and will participate a significant role in sustaining the growth and execution of IIoT applications, by dropping the difficulty of different stages of the application lifecycle similar to, for instance, development, deployment, etc. Presently, there are additional IIoT platforms obtainable [17]. As IIoT turn into better definite and keep on to develop and to be additional developed, more impactful and influential IIoT applications can and will be shaped and deployed; expansion of these applications may or may not utilize an IIoT platform.

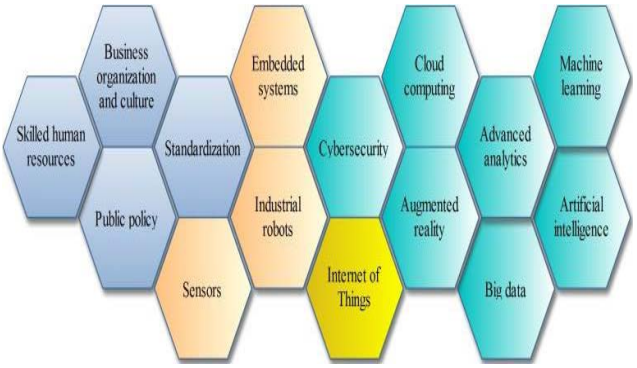

Fig. 1 IIoT Enablers

IIoT could fetch a variety of benefits in an industrial perspective, some of the key ones being the following: observing creation flow and record; pretty automation, yield, industrial security, effectiveness, safety and quality control; enabling simple maintenance, supply management, yield tracking and tracing, development of novel industry models, services and/or products; optimization of covering, logistics and deliver chain; decline of human mistakes and manual labor, and of costs (both in stipulations of time and funds), etc. Besides all the payback, the important employment of IIoT is overwhelmed with different challenges. The main challenges -branch from the necessities in energy-efficient process, real-time performance in dynamic environments, the need for coexistence and interoperability, and sustaining the security of the applications and users “privacy [18], launching connectivity, short of consistency, etc. Besides technological challenges, there are wider social, financial and supporting enabling parameters that have to be conquered. Thus, the acceptance of the Internet of Things pattern in the industrial field is postponed by the so-called proficiency gap. The literature reports that presently, Industrial Internet of Things stands for a keystone of many companies’ production strategies. Also, various agreed that quickly developing IIoT will have important and broad effects on the industrialized and market sectors, renovating and redefining practically all markets and industries; the possessions will also create changes in other sectors, such as education.

3. IIoT Higher Education

In classify to talk to higher education in the environment of the Industrial Internet of Things; we have in vision a holistic vision of all IIoT-related higher education perceptions from:

- A scientific perception – universities are performing research both in the IIoT sector and the IIoT-related area, thus causative to the growth of knowledge perspective;
- An educational perception - during their teaching, universities vigorously sustain the distribution of IIoT knowledge amongst students and graduates, thus civilizing the stock of trained human capital;
- A technological perception - universities hold the relocate of their knowledge to industry, by targeting on technology reassign.

Next, we are making effort to show a few features of IIoT higher education, by captivating into account the above mentioned proportions.

3.1 The Scientific Viewpoint

In modern years, there has been a increasing concern in Industrial Internet of Things and IIoT, as Google development shows (Fig. 2). We can imagine the virtual fame of these keywords between 2008 and 2018.

Furthermore, the number of articles that speaks to Industrial Internet of Things is rapidly growing. Some of these publications show the result of the research conceded in universities. In order to review the existing status of scientific publications on the exploit of IoT in industries, the author of this paper perform a wide literature review by investigative key articles from six important academic databases (Web of Science, IEEE Xplore, ScienceDirect, SpringerLink, Scopus, ACM digital library). As a consequence, we found a big number of journal publications and conference papers, books and book chapters linked to the offered IIoT research.

For instance, we found 453 IIoT-related scientific publications and books/chapters available from 2011 to 2018 just by thorough the Web of Knowledge database. We also acknowledged the articles where at least one creator has an educational affiliation. Fig. 3 shows the number of scientific publications accumulates in the aforesaid databases, by attractive into thought two categories for author‘s affiliation: educational and non-educational. The figure shows the evidently growing inclination of IIoT research in the current years and as well as the significant responsibility played by academic authors.

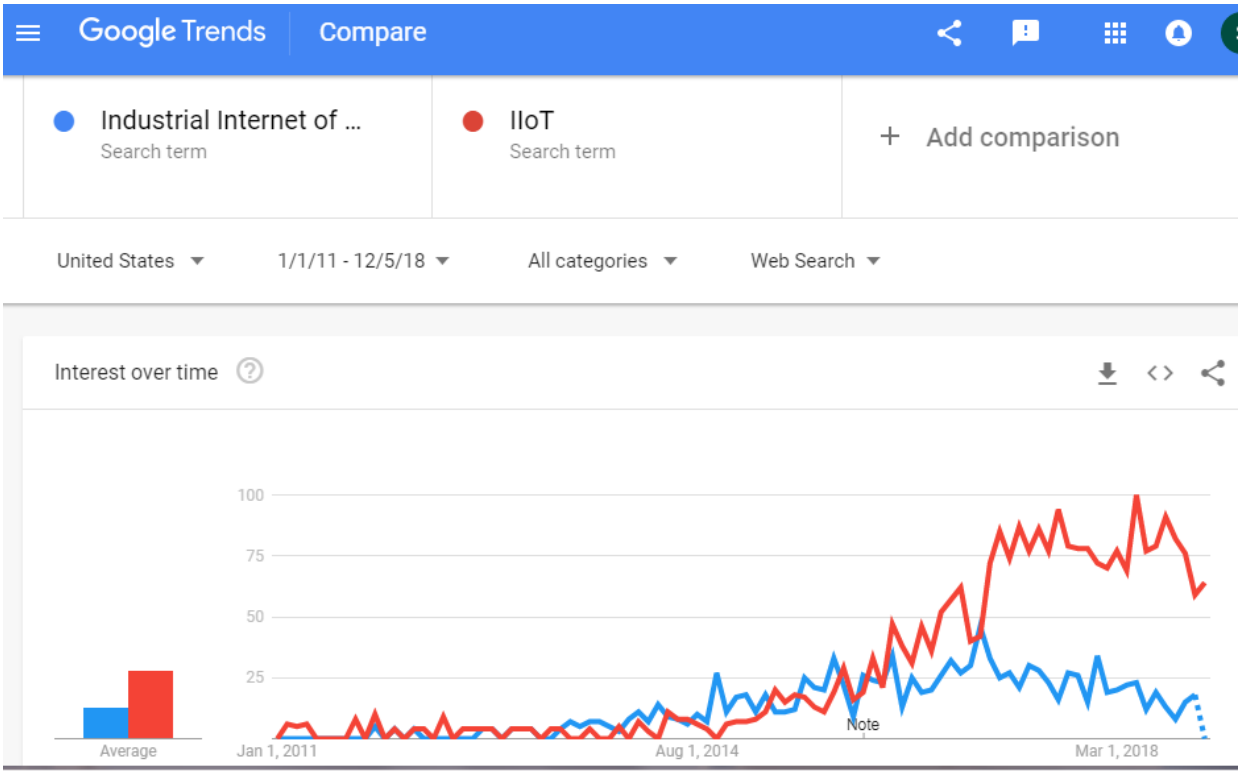

Fig. 2 Search Volume Index for the Data Provided by Google Trends Corresponding to the Industrial Internet of Things and IIoT Search Terms

Table 3: The Number of Scientific Publications on Industrial Internet of Things

Search	Web of Science	IEEE	Science Direct	Springer Link	Scopus	ACM digital library
Industrial Internet of Things	478	521	515	516	960	27
Industrial Internet of Things and academic affiliation	249	377	422	470	628	19

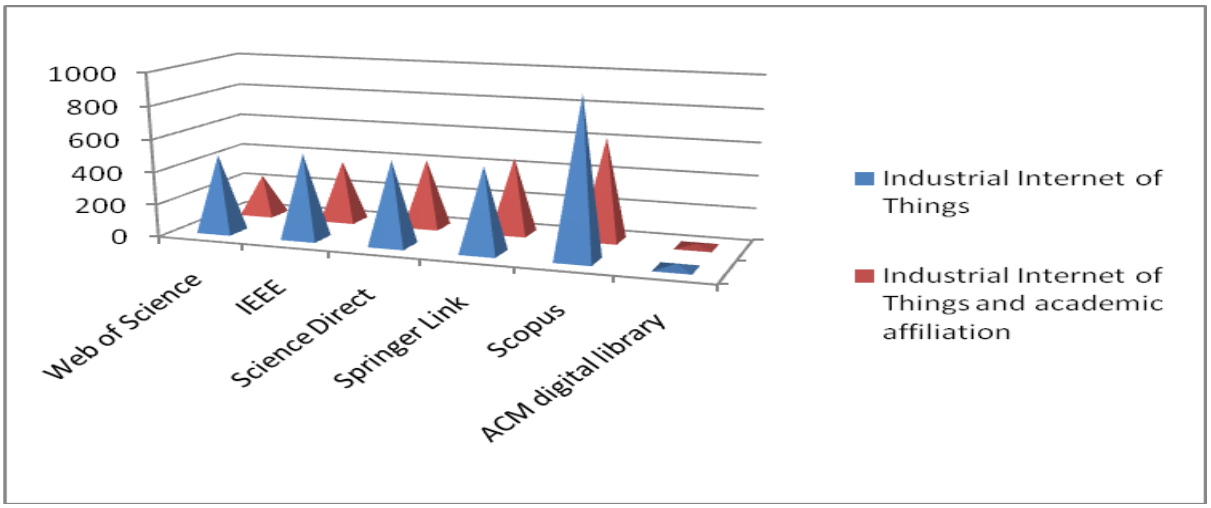

Fig. 3 Number of Scientific Publications Related to the IIoT.

3.2 The Educational viewpoint

Secondly, we have in vision the educational measurement of the IIoT Higher Education.

A variety of worldwide studies, reports and scientific papers expose the truth that the largest challenge of the Industrial Internet of Things followers is not so on a lot technology itself but the people. Though digital technologies are speedily flattering a goods, success mostly depends on an association‘s Digital IQ [19]. Therefore, it is serious to get better the digital proficiency of the employees who want to compress digital developments and examine [20].

Based on the offered trends, experts guess that deep changes preliminary from the comfortable to the release contained by the Internet of Things and Industrial Internet of Things are required in regards to the key characteristics of education. In order to meet the altering necessities and respond to the growing demand for an expectations extremely skillful workforce, novel efficient educational programmes will have to be enhanced or developed and/or the presented academic program will have to be modernized. Additionally, higher education institutions have to conquer the conventional way of learning, by acceptance the latest technologies in order to innovate the learning process. According to [21], human resources who are skillful at developing and deploying IIoT systems will come across themselves in bigger command. Digital competences and innovation are extensively measured to be some of the key drivers to improve the competitiveness of companies inside the IIoT context. In this respect, troublesome technologies, such as those scheduled in the preceding section, which have been leveraged for the development of IIoT, should be viewed as building blocks for the basis of a curriculum familiar to meet the IIoT‘s necessities. Furthermore, according to the proposals of different studies and reports, universities must outfit students with attributes that will allow them to answer to a doubtful prospect – by — emotional intelligence, handling ambiguity, flexibility [22]. It is a actuality that the center on the technical growth of the individual is just an element of the IIoT‘s educational dream. According to [23], —the continuing redeployment and rearrangement of education systems will also be of a supreme significance.

The changeover from higher education towards service is a challenge that could be further simply addressed throughout the hard work of both universities and employers, as component of universities-employers joint ventures. Actually, the significance of employer-university interaction is also supported by the graduate employment rate as an input presentation indicator for universities. As a result, universities have augmented their focus both on sustaining the employability speed of students and graduates, and on their affiliation with the business and industry areas. The principle is dual: to get ready students for the employment market as well as to enlarge the graduate employment rates. Indeed, some universities have to effort harder and in more modern ways to draw potential employers. A key that has extremely been used in the modern years is to engage the private sector in upward the educational curricula, based on particular needs.

Furthermore, positions and internships in a variety of companies offer students an opportunity to get work skill.
Yet, as proficient indicate, the present approaches concerning the Industrial Internet of Things education and training do not emerge to the challenge [24]. Thus, in order to develop an improved environment for Industrial IoT teaching, the teaching requests in separate domains have to be examining in a more in depth manner. Educational and Higher Vocational learning and Training (EVLT) programs, work-based education, practical and distant laboratories for educational intentions, national and international learning policies and tools, extensions, etc. should be measured.

3.3 The Technological Perception

No doubt that the growth made in the pasture of IIoT technologies has and surely will have the possible to renovate the industrial sector. Industrial Internet of Things is an idea with a high level of modernization. Over the precedent few years, we have seen numerous advances that have been considered as solutions to the innovative challenges created by the IIoT and Industry 4.0. Yet, technology transfer is necessary for communicating the information and getting used to these innovations in real life situations. Technology transfer is classified by the Association of University of Technology Managers (AUTM) as ―the procedure of transporting scientific result from one society to another for the function of more growth and commercialization. Internationally, there are a big number of studies that deal with the university technology transfer development. The vigorous academic technology transport could be of overhaul to a university, the territory and the country, industry partners, and the community in a record of ways. A few of them have been discovered in a widespread numeral of scientific papers and studies. Thus, for instance, we could talk about the piece of writing from the National Academy of Inventors that challenges to observe the significance of "technology transfer" for universities [25].
Without making things easier, the overall technology transfer course from the opinion of the diversity of activities that technology transfer course includes, the current study focuses exclusively on patenting in relation to the Industrial Internet of Things inside the Fourth Industrial Revolution.
Based on the most modern existing information on copyright applications on the Fourth Industrial Revolution that has been existing until 2016, the European Patent Office (EPO) conducted a background study on "Patents and the Fourth Industrial Revolution (4IR)" [26], by only if a first cartography of this self-motivated technological pasture derived from patent activity. According to this study, ―European patent applications connected to smart associated objects are growing speedily, attaining a development rate of 54% in the last three years [26]. The EPO report discloses that although the truth that the expansion rate of patent applications in this area is advanced than in any other territory of technology and is growing at a speedy rate, the patent applications still stand for a comparatively modest fraction of all European patent applications (only 3,3%). Furthermore, the 25 leading 4IR applicants for the EPO in between 2011-2016 are huge, conventionally ICT-focused companies.
In order to sustain IIoT modernization with superiority patents, universities must think their hard work in this route and give confidence allocation the outcome collected by their own researchers all the way through licensed patents. Additionally, besides motivating students' creativity, providing students with patenting proficiency is extremely essential. Academic innovations and technology transfer could carry important benefits to students, by giving those openings ―to contribute in real-world translational research, grow knowledge in the process of acquiring a patent, and effort with industry, start-ups, and producers [25].

4. Conclusions

This paper is aimed to study the “Industrial engineering learning”, focusing on the acceptance of the Internet of Things in industry (Industrial Internet of Things) and the necessities for higher education in the era of the fourth industrial revolt. The pictures of Internet of Things, Industrial Internet of Things and Industry 4.0 are still moderately fuzzy. Because these ideas have no accurate and broadly acknowledged definitions, I offered some well thought-out appropriate by scientific literature. The paper also highlights the most significant resemblances and differences between these perceptions. IIoT can bring key profit to companies in all kinds of industries. To grab the opportunities passed forth by IIoT, numerous difficulties would require to be conquered. Thus, for instance, further focusing only on the technological issues, the associations between all stakeholders, from persons to organizations, and from productions to governments, must also be taken into thought. Over the upcoming years, business and governments must strengthen their pains and rise investments, but also must alter their approach to learning, skillfulness and employment. Higher education must also increase efforts designed at undertaking skills gaps and it must obtain further actions in order to predict and address in a appropriate manner the issues linked to the prospective large-scale transformations of the employment background and the holistic ‘nature of abilities requirements. In this high opinion, rising stronger employer university knots for internships, training needs evaluation, etc. is a precious approach required to be optimistic and unlimited in the near future.

5. Future Research

As transformation in higher education acquire time, all stakeholders will currently have to perform in arranging for the Industrial Internet of Things. An investigation concerning the Industrial Internet of Things higher education should also take into thought other features, which has not been offered in this paper, due to liberty limitations. A complete study on how to expand an IIoT education system should think about and address obtainable approaches, the proficiency necessary and also the suitable contexts. Innovative digital workforce models could be built-up. Also, the learning should focus deeply on all the learning actions linked to IIoT, together with academic and Higher Vocational Learning and Education (HVLE) programs, employment based learning, practical and remote laboratories for instructive educational functions, but also countrywide and worldwide educational policies and tools, etc. Together with the rearrangement of university curriculum, the key findings should focus on a wide-ranging approach, to build up good practices and proposals to change education so that it becomes more approachable to the necessities of the future workforce; the objective is to more construct and make stronger the partnership between education and the labor market, in order to merge future employment trends.

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