Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 7, July 2021: 4972 - 4978

Research Article

Aspects Of Non-Profit Stem Education System Creation For Industry 4.0 In Uzbekistan

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ABSTRACT

The paper analyses the role of modern human resources in creation of suitable education system for the fourth Industrial Revolution. As companies in Uzbekistan are beginning to embrace Industry 4.0 elements, such as automation and digitalization of agricultural sector of economy, there is a strong need of hiring new generation of talent with solid background in computer programming skillsets and digital culture. Main challenge facing successful implementation of Industry 4.0 in agricultural sector is the lack of talent and absence of staff training. In this regard, organization of non-profit STEM higher education institutions in Uzbekistan are key in digital transformation of the industry in the region.

Key words. Digital technologies, automation in agriculture, higher education institutions (HEI), STEM education, Industry 4.0, demography management.

INTRODUCTION

Nowadays marketization of higher education system grows dynamically. Expansion of for-profit higher education institutions (HEI) plays an important role in the coverage of population with HEIs. The main missions of HEI are to supply the society with highly skilled workforce that create glooming economy. Recently, manufacturing sector of the economy has been facing fourth industry revolution, which requires highly skilled graduates of science, technology, engineering and mathematics (STEM) schools. At the same time, the topic of organization of non-profit schools are lacking attention of policy makers of the region. In this research, the potential of non-profit STEM schools is discussed as the main driving force of talent search, education and supply to the rigorous manufacturing sector of the Central Asia and Uzbekistan in particular.

The first industry revolution started after the invention of internal combustion engine and motor power. Second industry revolution started with the invention of electricity. Third industry revolution occurred in the era of digitalization of all information and widespread expansion of personal computers. Fourth industry revolution is a cyber-physical system with high automation involving things and processes connected with each other via internet, for which is also called internet of things (IoT).

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Transformation of small and medium size businesses into mature companies employing Industry 4.0 technologies require company workforce with ultra-modern skills. Therefore, it is important to stress the pillars of Industry 4.0 in education system, such as artificial intelligence, internet of things, big data, wireless networks, collaborative robots and cloud computing. Reduced routineness, increased demand for creativity, ability to code are current trends in the job market and these tendencies make many current jobs obsolete in the near future.

Like any other industrial revolutions, the key ingredient of this transformation is people, their knowledge, skillset and know-how. Work requirements are shifting from routine labor to programming and data analysis. For example, a sorting line powered with machine vision technology can suggest the best calculated time for a scheduled maintenance of a machine, but it is a human decision that makes decision about it.

Industry 4.0 requires many more STEM graduates in the near future worldwide. For example, starting from 2020, the number of jobs in mathematics and computer engineering will increase by 4.3% annually, in management - by 1.39%, in the financial sector - by 1.34% and in trade - by 1.25 %. Such trend will reduce the number of jobs for office workers by 6.06% per year, while the Internet will lead to increased demand for ICT workers by 4.54% per year , design and engineering professionals by 3.54%. In the figure 1, we can see the effect of using the elements of Industry 4.0 in labor market. From the figure, it is crystal clear that the highest rate of employment is in the field of big data that people using from it, with the indicator of 2,95%. Next are cloud technologies and software internet (2,47% and 2,27%) respectively.

Figure 1. Percentage of employment by using the elements of Industry 4.0 [1]

One of the ways of keeping up with industrial transformation is upskilling current workers and on-the-job existing workforce training. Constant skills development helps companies to stay competitive in a highly dynamic manufacturing world. For this purpose, it is important to create brain centers for retraining employees.

Hiring the best talent is a big task, but educating the talent is more difficult challenge. Second way

of filling the job market with workforce is talent search and their education. Therefore, educating young generation of people with skills needed for the future industrial changes plays a paramount role in Industry 4.0 preparedness.

Other factor slowing the education system in this sphere is the fact that STEM specializations are not as competitive as other majors, such as economics, business administration or law. Because of rigorous intense curricula with deep study of math and physics, many pupils opt for humanitarian majors.

Moreover, due to the scarcity of universities in Uzbekistan, coverage of youth with HEIs has reached 25%[1]. Secondly, STEM education is out of reach for many low income families. Therefore, this paper presents an investigation of the effects of non profit STEM education higher education system on the formation of Industry 4.0.

MATERIALS AND METHODS

Demography challenges and demography management can be studied with focus groups of wide differences in the jobs (blue collar, white collar, etc.). They can be consolidated by using Mayring's [2] content analysis. Interviewees can be chosen with the principle of maximum contrast. With the method of interviews and inductive approach of qualitative analysis, content post processing can be done during the study.

Education system's responsiveness to labor demands can be modeled with analogy of vibrational analysis [3], i.e. two degree of freedom mass spring model (Figure 2), where the relation between education system transformation and perturbations in manufacturing sectors of economy are considered.

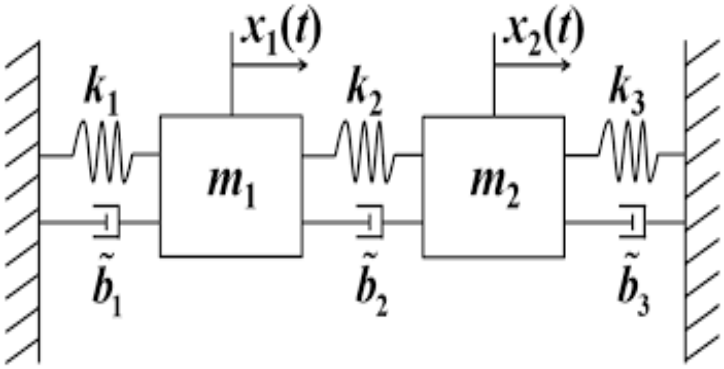

Figure 2. Vibrational mechanics analogy, where *k* and *b* are so called "stiffness and damping" coefficients, m_1 and m_2 are inertia of education and job markets respectively.

Research objective can be stated as following: what is the inertial displacement of m_1 for the perturbations in m_2 caused by Industry 4.0 revolution? Moreover, regression models can be built from the survey data to observe the relationships from hypothesis-specific dependent variables. Descriptive statistics of samples can be built for each model to build the predicted probabilities of achieving bachelor's degree across time, social origin and tuition fee.

1. Research objectives

No doubt, Industry 4.0 will have big impact to the manufacturing and service sectors of any economy, since the manufacturing has long been a key component of Uzbekistan economic diversification efforts.

Many researches have highlighted the potential impact of Industry 4.0 on future employment, but little research have been done in finding responsiveness of educational system to develop workforce able to employ next industrial revolution skillsets. As a vital part of the education system, non-profit private or government HEIs play an important role in creation of the well-rounded healthy society, where social lift is present.

Moreover, the topic of coverage of population with STEM HEIs is an important factor in the risk analysis of potential discrepancy between supply and demand in the job market due to the recent technological advances. More specifically, the following research questions need to be addressed:

1. What are the key Industry 4.0 features shaping the local job market?
2. What are the key parameters governing education responsiveness to job market changes?
3. What are the key Industry 4.0 features need to be developed in the local education system to bring up new generation of highly skilled workforce in line with the next industry revolution?
4. What is the impact of creation of a non-profit STEM school in Uzbekistan in short and near terms?
6. What is the financial burden of creation of non profit technical schools? Can the financial load of this project be offset by future socio economic potential in the region?

The main aim of this investigation is to conduct feasibility study of non-profit education institutions and its value to Uzbekistan job market in the context of fourth industrial revolution. Based on this main objective, the following tasks are set forth:

1. Analysis of the curricula of higher education system of Uzbekistan.
2. Analysis of demography of Uzbekistan.
3. Analysis of size, productivity and level of routineness of the manufacturing sector of Uzbekistan and Central Asia.
4. Quantifying the microeconomic issues of Industry 4.0 and problem statement in a macroeconomic stance.
5. Data collection, financial model and post processing and drafting recommendations for policymakers.

2. Preliminary Literature Review

A preliminary literature review shows that as a result of increasing growth in the for-profit private education sector in Uzbekistan, poorer families are ultimately left less able to access quality education than are their wealthier counterparts. Some scholars stated that the potential of non-profit education creates greater equity and accessibility.

According to Flynn [4], at present, educational systems appear not to be adapting fast enough to respond to future labor demands imposed by Industry 4.0. If not addressed, this challenge may result the required skills being undersupplied, thereby fueling disparities between labor supply and demand, which consequently may cause unemployment levels to rise.

While a few nations in Central Asia, such as Kazakhstan for example, have opted for establishing new universities from scratch, most interested countries have adopted a strategy combining mergers and upgrading of existing institutions [5].

Some authors from eastern Europe conclusion focused on the special case of a former socialist society, where higher education expansion has been very rapid and achieved mainly through marketization [6,7]. Their work highlighted the micro-level mechanisms that underlie the

inequality dynamic present in education system in the case of Poland.

In the case of India, some experts suggested experiential learning. A digital capability center, for example, replicates an actual, digitally-enabled working environment that lets leaders learn in a way that's far more realistic than a classroom, and far more effective in promoting exhibits.In Uzbekistan, some researchers have highlighted the shift of the manufacturing sector to the next phase of digitalization [8]. Their research described the transformation process of a training-addressed process with reorganization of the structure of the existing engineering degree university. Some leading international consulting firms of Big Four, such as Boston Consulting Group have studied the oil-gas [7], automotive and agricultural machinery sectors of Uzbekistan and highlighted importance of shifting trends of local market in the shadow of global industrial movement towards Industry 4.0 and made their suggestions for policy makers. Industry experts of Uzbekistan proposed a draft Industry 4.0 Strategy of Uzbekistan based on the experience of G20 countries such as Germany, USA, Canada, Japan, China and South Korea. They proposed main directions for the basis of legislative and normative documents to support the introduction of Industry 4.0 elements [9].

Companies in Central Asia are beginning to embrace them at an increasing rate. For example, a regional aerospace manufacturing company is on course to establishing a digital factory in which product/ process traceability, process automation and digital feedback will be a norm. Another, in the retail sector, is using micro-location-based technology in the form of beacons that can track consumer and product flow [10]. The potential is to examine dwell times of consumers in stores, identify the presence of high-value customers, keep track of staff interaction with customers, allowing the aggregation of information and generation of 'big data' that can be analyzed and used to optimize product and sales [11].

By taking advantage of digitization, integration and automation opportunities, companies in the region can seek to stay relevant globally by taking actions as the era of digitally-connected smart infrastructure develops.

In the transition to a strategic role, there is a paradigm shift in the role of human resources (HR), which allows for a broader aspect of HR than mere administrative role. With Industry 4.0, the role of HR will change and thus require HR professionals to be strategic partners of the organization. The findings indicate that HR needs to ensure delivery, strategic shift and reskilling talent and ensure effective talent management [12].

Scholars suggested that there would be a change in terms of how HR delivers their work in near future. Currently, organizations deal with numerous people issues, such as improved mobility, an inter-generational workforce, changing digital job descriptions, work–life balance and pandemic lockdown. Therefore, it is imperative that HR improves its function to be digitally perceptive and agile to be able to manage the distinctive, hyper-connected workforce [13]. Moreover, emerging technologies and a different generation of employees will change HR processes such as talent on boarding and off boarding, as well as learning and development. Thus, there is a need to reskill and upskill people to meet the changing demand of work, to ensure that employees have correct and pertinent skills to compete in Industry 4.0 [14].

Holistic model for navigating Industry 4.0 for human resources

In the Figure 2, there is a cyclic co-operational model of Industry 4.0 and HR. In this cyclic life model, modern HR accomplishes 4 main functions in Industry 4.0:

Figure 3. Authors' addition to the holistic model for navigating Industry 4.0 for human resource professionals [15].

1) Effective HR delivery. HR Service Delivery refers to the function that supports and provides services to employees [16]. The HR Service Delivery solution will span the entire employee lifecycle—from hire to retire, such as onboarding, payroll, and benefits.
2) Reskilling of employees. Companies can have many benefits to learn knowledge from reskilling a workforce for the employees. It is clear that reskilling advantages not only top-level employees, but also workers at all levels in the organization. In fact, it might be the case that retraining provides the most benefits to lower-level employees in the general workforce [17]. Some of them are chance of to change the position or job, gaining new skills, more likely to remain engaged, starting new career path.
3) Strategic shift. Industry 4.0 is a leading source of organizational growth and profitability. Many organizations try to have an effective and long-term innovative approach when face with innovation strive to offer.
4) Efficient talent management. Putting together an effective talent management strategy is something that many HR headers face some difficulties. There are a number of reasons. One would think that Business leaders would understand the importance of ensuring the appropriate people are driving their organizations to an optimal level of performance. While this is intellectually understood, however, it takes a particular level of thought and discipline to implement.

CONCLUSION

Companies in Uzbekistan are beginning to embrace Industry 4.0 elements. By taking advantages of automation and digitalization, companies are in need of hiring new generation of talent with solid background in computer programming skillsets and digital culture. Main challenge facing successful implementation of Industry 4.0 is the lack of talent and absence of staff training. In this regard, organization of non-profit science, technology, engineering and mathematics higher education institutions in Uzbekistan are key in digital transformation of the industry in the region.

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