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A Framework for New Workforce Skills in the Era of Industry 4.0

Nesrin Ada
Department of Business Administration,
Ege University, Bornova, Izmir, Turkey.
E-Mail: nesrin.ada@ege.edu.tr

Derya Ilic
Department of Business Administration,
Ege University, Bornova, Izmir, Turkey.
E-Mail: derya.kelgokmen@ege.edu.tr

Muhittin Sagnak
Department of Information Management,
Izmir Katip Celebi University, Cigli, Izmir, Turkey.
Corresponding author: muhittin.sagnak@ikcu.edu.tr

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Abstract
Radical changes and developments resulting from global connectivity, automation, and technological innovations due to Industry 4.0 create different job demands for businesses. This requirement enforces human resource managers to rethink the acquisition and application of different skills in recruitment and other human resources functions considered essential for today's workforce. This paper aims to propose a framework identifying the skill set required for personnel selection in the era of Industry 4.0, and provide a roadmap for human resources managers by analyzing the importance of different skill categories. Fuzzy Analytic Network Process (ANP) was used to compute the factors' weights. Project Management skill was found as the most important factor, followed by Financial Management, Technology-based Skills, Digital Literacy, Literacy, Innovation, and Creativity skills. Discussions and implications are given based on obtained results.

Keywords- Industry 4.0, Fuzzy ANP, Human resources management, Human resources functions, Workforce skills.

1. Introduction

In today's world where everything changes rapidly, organizations have to renew themselves in order to survive and gain competitive advantage. Some of those changes are caused by developments in Industry 4.0. The change in the world caused by Industry 4.0 is characterized by high digitization and use of information technologies; therefore, causes important differences on job types and job characteristics. The organizations should respond these changes within its own workforce.

The feature of Industry 4.0 is characterized by real-time communication, connection, and interactions between machines, people, and products (Ozkan-Ozen et al., 2020). It develops a customized and digitalized smart manufacturing model for providing high flexibility to satisfy customer demands rapidly. Because of the need for new job demands, organizations must recruit new employees who have necessary skills for the new job requirements. In addition, the organizations must increase the qualifications of their current human resources. The skills and competencies provide employees to perform their jobs effectively and include the necessary requirements and behaviors for having high job performance (Boyatzis, 1982; Abraham et al., 2001).

According to Human Resource Management (HRM) literature (Boselie and Paauwe, 2005), human resources departments are responsible for designing development programs, proposing career maps, designing new structures, attracting, recruiting and retaining employees, developing performance and reward systems, forming competitive compensation packages, enhancing intra communication channels, and managing all national and global human resources activities in organizations. In this context, directors of human resources policies must be conscious about organizations' current and desired skills completely. Therefore, success profiles of new organizational tasks have to point out new skills for achieving strategies and goals (Kececioglu and Yilmaz, 2014). Human resources managers should redesign the job requirements, propose new recruitment standards, and train employees to adapt new demands in return to embrace the Industry 4.0 paradigm in a sustainable way.

Within this perspective, the aim of this study is to propose a framework for determining the required job skills in the era of Industry 4.0, and provide a roadmap for human resource managers. Within this framework, 4 main criteria and 41 sub-criteria were determined to evaluate the new job skills. Main criteria include workforce readiness, soft skills, technical skills, and entrepreneurship. Fuzzy Analytic Network Process (ANP) was applied to calculate the weights of the criteria. The research question of this study were structured as follows:

RQ1: How can a framework and a guideline be developed for personnel selection process?
RQ2: Which criteria and solution techniques can be used to identify the skill set required for personnel selection in the era of Industry 4.0?

Following the introduction, section 2 shows the theoretical background. Section 3 presents the proposed framework, and section 4 introduces the methodology. Section 5 shows the case study and the results. Section 6 proposes the implications and discussions, and finally, section 7 highlights the concluding parts and possible future research directions.

2. Theoretical Background

2.1 The Concept of Industry 4.0

In the last three years, the scope of the Fourth Industrial Revolution is at the top of the list when looking at the core issues in all global platforms and business world. The "fourth industrial revolution" that emerged firstly in Germany, Europe, and then in the USA, and after other developed countries, is on the agenda of the whole world. In 2011, the "Industry 4.0 Manifesto" on Industry 4.0, named for the first time by the German government, was published by the German National Academy of Science and Engineering.

Connecting billions of people and objects to mobile devices and new technological breakthroughs in the physical, digital, biological and technological transformation processes impose on companies to innovate and increase their abilities. The term Industry 4.0 is called as the fourth industrial revolution, which brings complex physical machine technology and software systems connected to the network integration of products' life cycle throughout a new value chain of organizations. Industry 4.0 forces companies to have the ability to change speed and agility by fulfilling individual customer needs which affects all value chain, starting from research and development to after-delivery services (Vaidya et al., 2018).

Industry 4.0, which is also expressed with different words such as Digital Transformation, Digitalized Industry, or Fourth Industrial Evolution, develops trends that will affect all sectors of

the economy and companies of all sizes. Industry 4.0 transformation is a main framework for companies focusing on the big picture in all forward-looking strategies and policies, investment, development plans-projects, and applications of institutions.

When the current literature is examined, many socio-economic variables drag countries to Industry 4.0. Some of those were skilled labor shortage, older society, late retirement, unstable markets and cost reduction pressure, dynamic value chain networks, shorter production life cycle, increase in production variability, cluster size, customer-oriented production, low noise high mixed factories, and smart production using efficient and clean resources.

The feature of Industry 4.0 is coming from real-time communication, connection, and interactions between machines, people, and products. It develops a digital model through smart manufacturing to satisfy customer demands with extremely high flexibility. Industry 4.0 has four main effects on companies in all sectors (Schwab, 2015):

(i) Customer expectations are changing as customers, individuals or companies are at the center of the digital economy;
(ii) Products and service improvements provide an increase in productivity of assets and digital capabilities;
(iii) As global platforms are closely connected with the physical world, inter-organizational interactions create collaborative innovations;
(iv) New organizational systems and operation models require rethinking of all areas of the companies and acquire redesigning of works and jobs.

2.2 Four Industrial Revolutions

Vaidya et al. (2018) demonstrate different aspects of four industrial revolutions and the technological differences, which are listed below.

During the 18th century, a series of technological developments was started to be seen in Europe, and centered in England called the Industrial Revolution (Industry 1.0). This was possibly the most important influence on production and management until that time. It provided a shift in production systems from workshop to factory, and from labor to machine power (Robbins and Coulter, 2002). The invention of steam-powered machines combined with the division of labor changed the production technology from piece-to-piece production to mass production.

By the middle of the 19th century, electrical technologies were first used in factories, and started to be used in production lines. This new technology led to the development of new production methods and was accepted as the 2nd Industrial Revolution (Industry 2.0). Henry Ford implemented assembly lines firstly, which were started to be applied in the automotive industry. This technology created a revolutionary effect in the production model based on low cost, mass production and standardized product.

In the early 1970s, due to the development of programmable machines, a new era of industrialization, was accepted as the 3rd Industrial Revolution (Industry 3.0). During this period, automation of production processes with development of communication technologies along with the supercomputer added a new dimension; and therefore, electronic and computer-based technologies have made the production structure more clear.

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By the beginning of the 21st century, huge developments in communication and information technologies, and software-based production technologies have enabled the development of smart systems. The production processes have started to be redesigned with the opportunities of using autonomous robots, additive manufacturing, the cloud systems, big data analytics, cybersecurity, vertical and horizontal integration, simulation, and augmented reality (Rüßmann et al., 2015). Therefore, new production systems have established a connection between the physical and digital systems and were called as the 4th Industrial Revolution (Industry 4.0).

Figure 1 identifies the different aspects of industrial revolutions.

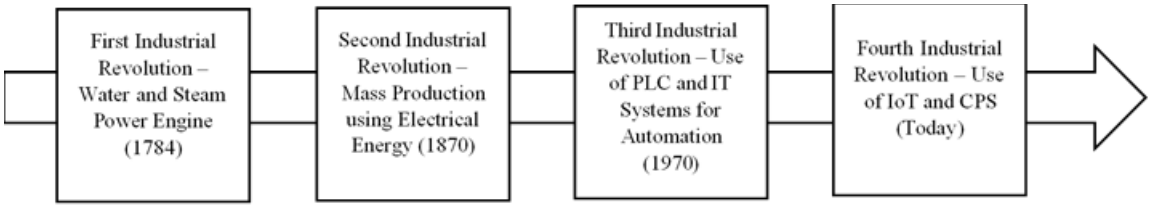

Figure 1. Industrial revolutions (Vaidya et al., 2018).

2.3 Industry 4.0 Impact on Human Resources Management

Human resources management focuses on the efficient use of human resources in achieving the strategic goals of the organizations, and meeting the individual needs of the employees. In the literature, workforce planning and staffing (selection, recruitment and placement, job analysis), training and development, motivation, performance management, compensation and reward, industrial relations, social security and communication, career planning, and organizational developments were defined as the functions of HRM. In Industry 4.0, HRM displays a visionary / strategic personality for its all roles in the development process assuming, from the daily "operational" focus to the long-term "strategic partner" vision.

Because of Industry 4.0, many HR functions change. Chen and Huang (2009) discussed the performance evaluation system by focusing on employee behavior-based approach, employee development and learning approach, results-based approach, and employees' regular feedback. In their study, they found that according to management by objectives approach based on quantitative performance evaluation, the measurement techniques and key performance indicators must be up-to-dated according to the new job requirements. Individual, group, and organizational performance indicators must be redefined based on employees' own success (Ma Prieto and Perez-Santana, 2014). Reestablishing compensation practices for an implicit relationship between performance and reward systems facilitate the learning and innovation climate in organizations that is needed in for Industry 4.0 (Shamim et al., 2016). Generally, HRM practices will differ in the following issues:

(i) Motivation studies will be considered more in Human Resources practices;
(ii) Today's popular activities such as teamwork, creating team spirit, building effective teams, and many HR concepts will disappear;
(iii) The use of artificial intelligence elements in HRM processes and practices will increase;
(iv) "Innovativeness and innovation" will be related to new ideas and inventions for providing efficiency;

(v) Skills and competencies will be redefined for adapting new technologies;
(vi) Training of employees for new skills will be a key success factor;
(vii) Especially the X generation can adapt to this process more easily with their work experience;
(viii) Z-Generation has to be managed carefully, "who will design the machines" will also determine the future.

The concern that Industry 4.0 replace human labor with smart machines, thus leaving employees, especially blue-collar workers, unemployed, overcomes expectations that Industry 4.0 will emerge new professions and have an increase on overall employment level. Meanwhile, it can be said that the competence level of the existing human resources is far from meeting the labor force requirement of industry 4.0. For the wholesale transformation of existing human resources based on intellectual capital and competence, non-formal school education, on-the-job training, and distance education opportunities will need to be arranged with an adaptation approach.

All industries and new business models are affected from technological changes like high digitization, autonomous robots, additive manufacturing, the cloud systems, big data analytics, cybersecurity, vertical and horizontal integration, simulation, and augmented reality. Major technological drivers and new business models changed the employment landscape and created different job demands (Davies et al., 2011). Employers of new business models look for both hard skills and also work-related practical skills and competencies that fit with the job requirements of new job demands.

There are critical developments on the nature of work because of the transformation process of the Industry 4.0 on the industrial workforce through 2025. The report of World Economic Forum (2016) showed that in great amount of countries and industries, the most in-demand specialties or occupations was not in existence in ten, or even five years ago. Industry 4.0 determines the transformation of design, production of goods and services, and production systems. These changes have major impact on employment landscape. Most occupations are facing with a fundamental transformation. Therefore, some jobs are disappeared. New jobs related with information and technological changes grow rapidly. Existing jobs are redefined through a radical change in the skill sets. To embrace the Industry 4.0 paradigm in a sustainable way, human resources managers should redesign the job requirements and skills for the new demands in the industries. Besides, all enterprises need to offer training programs for development of their workforce to provide technological transformations with new tools and technologies. Carnevale et al. (1990) mentioned that training for many of the-skills should be provided at the first level of supervisory training and succeeding levels, and explored how trainers should teach each skill as a task. It should be noted that Industry 4.0 requires gold-collar employees, who can work simultaneously in different project teams open to interdisciplinary approaches with expertise in different disciplines, and have the necessary conceptual skills for Industry 4.0, not standard bureaucrat-type white-collar workers.

2.4 Industry 4.0 Impact on Existing Skill Sets

Since demographic, technological, and socio-economic ambiguity transforms industries and business models rapidly, many business executives are uncertain if they determine appropriate work skills for the future. In this study, a decision-making tool is being proposed for human resources managers to determine the importance of the different skills that are needed for Industry 4.0. Firstly, different categories of skills were explained, and then fuzzy ANP technique is used to figure out the importance of different categories.

Skill was defined as the integration of muscular performances (Pear, 1948). Welford (1968) who defined skill as an integration of accurate, rapid, and competent performance focused on perceptual-motor performance. Generally, the term skill was defined as a degree of accurate and rapid performance (Winterton et al., 2006). Robbins and Coulter (2002) grouped employee skills into three categories, namely, interpersonal, technical, and problem-solving skills. Technical skills include basic skills, which can be summarized as the ability to read, write, and do computations, as well as job specific competences. Interpersonal skills consist of the interaction with managers and coworkers. Problem-solving skills involve activities as problem definition, alternative development, and secetion of optimal solutions. Carnevale et al. (1990) categorized workplace skills as learning, 3R's (reading, writing, computation), motivation, career development, organizational effectiveness, problem solving, creative thinking, interpersonal, teamwork, self-esteem goal setting, negotiation, and leadership. According to them, individuals and employers view skills differently; one side identifies skills for providing earnings and opportunities in the workplace, the other side focuses on measurement of the level of skills for hiring the most suitable candidate. These skill categories are redefined according to the industrial job demands. Employers also realize the importance of developing their human assets. Therefore, the categories are used not just for hiring but for all human resources practices for making job descriptions, offering training programs, planning career management activities and performance evaluation.

According to the most contemporary report for the new skills set, four main skills are used in this study for the development of a decision tool for human resources managers. These skills can be grouped as follows (Deloitte, 2018):

Firstly, workforce readiness skills that shows foundational abilities come from traditional educational systems and development programs such as Resume Writing, Self-Presentation and Time Management. These fundamental skills include both cognitive skills and non-cognitive skills. Non-cognitive skills are related to behavioral skills, which enhance an individual's job performance, interactions, and work discipline (Short and Keller-Bell, 2019). According to Robbins and Judge (2015) cognitive skills are the abilities such as problem solving and critical thinking skills.

Second group includes essential human skills commonly called as soft skills such as leadership, communication, collaboration and empathy. Having employees with good interpersonal skills is likely to make the workplace more pleasant (Robbins and Judge, 2015). According to Burris (2012) employees who know how to relate to others well with supportive dialogue and proactivity will find their ideas endorsed more often and lead workplace satisfaction.

Thirdly, technical skills are categorized such as computer programming, coding and project management, etc. coming from new job designs. Industry 4.0 self-managing intelligent systems with autonomic features will provide new manufacturing ecosystems. Thus, advanced manufacturing and industrial processes with cyber-physical systems in modular "smart factories" create machine-human cooperation and symbiotic product realization (Thames and Schaefer, 2016). Romero et al. (2016) also indicated that these near-future manufacturing enterprises, referred as to 'smart factories' with modern manufacturing workforce will need abilities for using advanced digital and industrial enabling technologies. These developments require more technical skills and targeted training.

Fourth group consists of entrepreneurship skills including searching opportunities, and creating

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different solutions in the work environment on job-related tasks such as innovation, creativity, industriousness, and risk taking. Chuang (2013) indicates that significant global leadership skills are much more needed to be identified to enhance competitiveness and performance efficiency of today's workforce.

3. Proposed Framework

In this section, a framework is developed to present the research work for personnel selection skills in the era of Industry 4.0. The criteria list includes 4 main criteria and 41 sub-criteria. The main criteria cover workforce readiness, soft skills, technical skills, and entrepreneurship.

Based on a literature review, proposed 4 main, and 41 sub-criteria are validated with four academics and two industry experts. Four academic experts consist of professors in universities from operations management, public relations, human resource management, and information management departments. two industrial experts consist of human resource management experts from the industry. two academic experts have experience of more than 25 years, two have more than 10 years, and industrial experts have more than 15 years. The criteria list is discussed with these experts using interviews. After the validation stage, these criteria were used to identify the personnel selection skills in the era of Industry 4.0. Fuzzy ANP is used to compute the respective main and sub-criteria weights. Figure 2 shows the overall flow of the present research work.

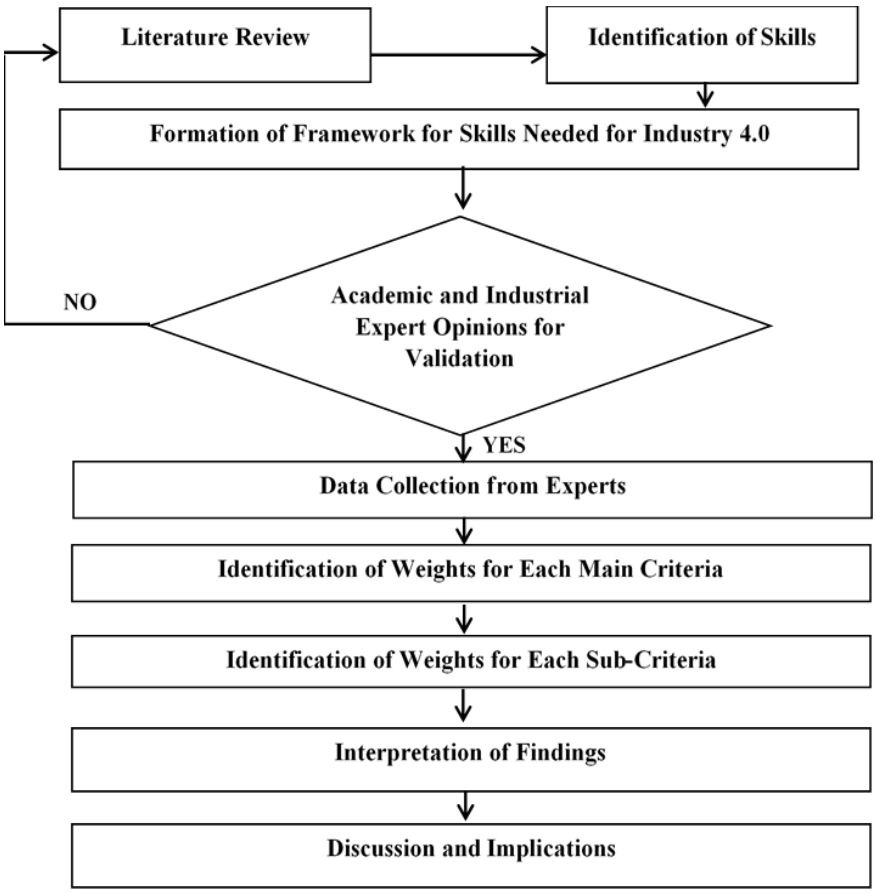

Figure 2. The proposed framework.

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Table 1 shows the criteria set including the skills set needed for Industry 4.0.

Table 1. Skill set needed for industry 4.0.

Workforce Readiness	Soft Skills	Technical Skills	Entrepreneurship
Literacy	Communication	Computer Programming	Initiative
Numeracy	Critical Thinking	Coding	Innovation
Digital Literacy	Creative Thinking	Project Management	Creativity
Resume Writing	Collaboration	Financial Management	Industriousness
Self-Presentation	Adaptability	Mechanical Functions	Resourcefulness
Time Management	Leadership	Scientific Tasks	Resilience
Professionalism	Social-Emotional Learning	Technology-based Skills	Ingenuity
Etiquette	Teamwork		Curiosity
Social Norms	Self-Confidence		Optimism
	Empathy		Risk-Taking
	Growth Mindset		Courage
	Cultural Awareness		Business Acumen
			Business Execution

In the next section, the fuzzy set theory, and fuzzy ANP technique were introduced.

4. Methodology

4.1 Fuzzy Set Theory

The decision-makers face with uncertainties owing to the vagueness inherent in the decision-making process. In an attempt to deal with uncertainties, fuzzy set theory was introduced (Zadeh, 1965). The theory helps decision-makers minimize subjectivity and vagueness.

4.2 Fuzzy Analytic Network Process

Saaty (1996) introduced the ANP technique. It is one of the most common MCDM techniques. Its main advantage is its capability to cope with qualitative and quantitative variables (Sagnak and Kazancoglu, 2019; Sagnak et al., 2020). However, its applicability is limited due to the uncertainties and vagueness inherent in the decision-making process (Kazancoglu et al., 2020). Therefore, in this study, ANP was integrated with fuzzy set theory.

Fuzzy ANP is different from Saaty's (1996) approach (Kazancoglu et al., 2020). Pairwise comparisons were carried out using triangular fuzzy numbers. Saaty's (1980) scale has advantages in terms of simplicity; however, using fuzzy numbers instead of crisp values to translate human judgments into numerical values is always a better option. The steps of Fuzzy ANP are as follows (Sagnak and Kazancoglu, 2019; Sagnak et al., 2020):

Step 1: Establishment of Pairwise Comparisons: Pairwise comparisons were established to identify the relations among criteria.

Step 2: Formation of Initial Super matrix: The initial supermatrix is formed to present the relative importance of cluster k to cluster 1.

Step 3: Weighted Super Matrix Formation: The weighted supermatrix is calculated by multiplying the first element of the respective eigenvector by all entries in the first block of that column, the second element by the second block, and so on.

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Step 4: Formation of Limit Super matrix: The limit supermatrix is calculated by taking the power of the weighted supermatrix until all values for the same row will be the same.

Step 5: Normalization: The final weights can be found by the normalization process for each block of the limit supermatrix.

5. Case Study

This paper considers the implementation, which is conducted in 12 companies from different industries located in Izmir, Turkey. The main aim is to understand the role of skills needed for personnel selection in the era of Industry 4.0.

In the data collection process, data were gathered through pairwise comparisons. These comparisons are conducted with the permission and approval of the Board of Directors. Large-scale group decision-making has been adopted. Thirty authorities carried out pairwise comparisons. Table 2 presented information about participants in detail.

Table 2. Information about participants.

Experts	Position	Total Work Experience in Years	Experts	Position	Work Experiences (Year)
1	Human Resource Manager for Company 1	14	16	Human Resource Vice Manager for Company 4	12
2	Human Resource Manager for Company 2	17	17	Human Resource Vice Manager for Company 5	10
3	Human Resource Manager for Company 3	11	18	Human Resource Vice Manager for Company 6	8
4	Human Resource Manager for Company 4	9	19	Human Resource Vice Manager for Company 7	9
5	Human Resource Manager for Company 5	10	20	Human Resource Vice Manager for Company 8	9
6	Human Resource Manager for Company 6	13	21	Human Resource Vice Manager for Company 9	10
7	Human Resource Manager for Company 7	11	22	Human Resource Vice Manager for Company 10	8
8	Human Resource Manager for Company 8	12	23	Human Resource Vice Manager for Company 11	7
9	Human Resource Manager for Company 9	12	24	Human Resource Vice Manager for Company 12	10
10	Human Resource Manager for Company 10	7	25	Human Resource Employee	5
11	Human Resource Manager for Company 11	4	26	Human Resource Employee	4
12	Human Resource Manager for Company 12	10	27	Human Resource Employee	6
13	Human Resource Vice Manager for Company 1	8	28	Human Resource Employee	4
14	Human Resource Vice Manager for Company 2	6	29	Human Resource Employee	5
15	Human Resource Vice Manager for Company 3	7	30	Human Resource Employee	5

The proposed framework is generic and applicable to similar studies where the role of skills needed for personnel selection in the era of Industry 4.0 are studied; however, the results are unique and shall not be generalized.

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The weights of the main criteria can be shown in Table 3. These weights were found by applying the step-by-step formation of Fuzzy ANP. Firstly, pairwise comparisons were established to identify the relations among criteria. Then, the initial supermatrix is formed to present the relative importance clusters. Then, a weighted supermatrix is calculated. Lastly, the limit supermatrix is obtained by taking the power of the weighted supermatrix until all values for the same row will be the same. After all, values are normalized, and then the weights were found as can be seen in Table 3.

Table 3. Weights of main criteria for personnel selection for industry 4.0.

Workforce Readiness	0.198
Soft Skills	0.176
Technical Skills	0.383
Entrepreneurship	0.243

According to Table 3, the most important criterion for the personnel selection skills in the era of Industry 4.0 was found as technical skills with a weight of 0.383, followed by entrepreneurship, workforce readiness, and soft skills with weights of 0.243, 0.198, and 0.176, respectively. The reason why this result comes out is that technical skills have included the most important skill set based on Industry 4.0 principles. Analysis of the results demonstrated that traditional skill sets including workforce readiness, soft skills, and entrepreneurship are still critical for personnel selection in the era of Industry 4.0.

The weights of sub-criteria in each cluster can be shown in Tables 4, 5, 6, and 7, respectively.

Table 4. The weights of sub-criteria within workforce readiness cluster.

Sub-Criteria	**Weights**
Literacy	0.235
Numeracy	0.116
Digital Literacy	0.266
Resume Writing	0.050
Self-Presentation	0.055
Time Management	0.090
Professionalism	0.080
Etiquette	0.049
Social Norms	0.058

According to Table 4, the most important criterion within the Workforce Readiness cluster was found as Digital Literacy with a weight of 0.266, followed by Literacy, and Numeracy with weights of 0.235, and 0.116, respectively. Analysis of the results demonstrated that among 9 sub-criteria, Digital Literacy, Literacy, and Numeracy have nearly 60% of total importance within the Workforce Readiness cluster.

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Table 5. The weights of sub-criteria within soft skills cluster.

Sub-Criteria	Weights
Communication	0.084
Critical Thinking	0.191
Creative Thinking	0.152
Collaboration	0.081
Adaptability	0.064
Leadership	0.116
Social-Emotional Learning	0.049
Teamwork	0.070
Self-Confidence	0.066
Empathy	0.043
Growth Mindset	0.044
Cultural Awareness	0.040

According to Table 5, the most important criterion within the Soft Skills cluster was found as Critical Thinking with a weight of 0.191, followed by Creative Thinking, and Leadership with weights of 0.152, and 0.116, respectively. Analysis of the results demonstrated that among 12 sub-criteria, Critical Thinking, Creative Thinking, and Leadership have nearly 45% of total importance within the Soft Skills cluster.

Table 6. The weights of sub-criteria within technical skills cluster.

Sub-Criteria	Weights
Computer Programming	0.100
Coding	0.073
Project Management	0.332
Financial Management	0.154
Mechanical Functions	0.110
Scientific Tasks	0.090
Technology-based Skills	0.141

Table 7. The Weights of sub-criteria within entrepreneurship cluster.

Sub-Criteria	Weights
Initiative	0.074
Innovation	0.185
Creativity	0.187
Industriousness	0.089
Resourcefulness	0.058
Resilience	0.058
Ingenuity	0.054
Curiosity	0.055
Optimism	0.046
Risk-Taking	0.051
Courage	0.047
Business Acumen	0.048
Business Execution	0.050

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Table 8. The weights of each criterion in overall manner.

Criteria	Sub-criteria	Weights
Workforce Readiness	Literacy	0.047
	Numeracy	0.023
	Digital Literacy	0.053
	Resume Writing	0.010
	Self-Presentation	0.011
	Time Management	0.018
	Professionalism	0.016
	Etiquette	0.010
	Social Norms	0.012
Soft Skills	Communication	0.015
	Critical Thinking	0.034
	Creative Thinking	0.027
	Collaboration	0.014
	Adaptability	0.011
	Leadership	0.020
	Social-Emotional Learning	0.009
	Teamwork	0.012
	Self-Confidence	0.012
	Empathy	0.008
	Growth Mindset	0.008
	Cultural Awareness	0.007
Technical Skills	Computer Programming	0.038
	Coding	0.028
	Project Management	0.127
	Financial Management	0.059
	Mechanical Functions	0.042
	Scientific Tasks	0.034
	Technology-based Skills	0.054
Entrepreneurship	Initiative	0.018
	Innovation	0.045
	Creativity	0.045
	Industriousness	0.022
	Resourcefulness	0.014
	Resilience	0.014
	Ingenuity	0.013
	Curiosity	0.013
	Optimism	0.011
	Risk-Taking	0.012
	Courage	0.011
	Business Acumen	0.012
	Business Execution	0.012

According to Table 6, the most important criterion within Technical Skills cluster was found as Project Management with a weight of 0.332, followed by Financial Management, and Technology-

based Skills with weights of 0.154, and 0.141, respectively. Analysis of the results demonstrated that among 7 sub-criteria, project management, financial management, and technology-based skills have nearly 60% of total importance within the technical skills cluster.

According to Table 7, the most important criterion within the Entrepreneurship cluster was found as Creativity with a weight of 0.187, followed by innovation, and industriousness with weights of 0.185, and 0.089, respectively. analysis of the results demonstrated that among 13 sub-criteria, creativity, innovation, and industriousness have nearly 50% of total importance within the Entrepreneurship cluster.

Table 8 shows the sub-criteria weights on an overall scale.

According to Table 8, the most important criterion in an overall manner was found as project management with a weight of 0.127, followed by financial management, technology-based skills, digital literacy, literacy, innovation, and creativity with weights of 0.059, 0.054, 0.053, 0.047, 0.045, and 0.045, respectively. analysis of the results demonstrated that among 41 sub-criteria, 7 of them, namely, project management, financial management, technology-based skills, digital literacy, literacy, innovation, and creativity have a total 43% importance weight. also, it can be seen that the most important 3 criteria had been classified within the technical skills cluster, which means, the most important skills required for personnel selection in the era of industry 4.0 are technical skills.

6. Discussion and Implications

The last decade brought a rapid change towards industrial HRM and HRM software occupied the field particularly. The rise of artificial intelligence, digital business, and performance economy push towards greater diversity. In 2020, in a new decade, it is necessary to look ahead for HRM trends that will continue to initiate transformation and will be vigorous to shape the future of work. Companies, which do not recognize the need for transformation, will be missing an opportunity to be more competitive. In other words, developing a digital transformation strategy will be effective to cover both technology and human resources issues as well. Understanding industry changes is essential to cope with the rapidly changing business world. To contribute to the field of human resources for digital transformation, it is critical to evaluate the important criteria of HR trends.

Criteria classified as workforce readiness, soft skills, technical skills, and entrepreneurship formed the best foundation for further investigation of the research questions. The fuzzy ANP method was applied to determine the weights signifying the importance of the criterion for recruitment decisions of HR managers in the era of Industry 4.0.

Implications of the results of this study can be further extended to cover all critical decisions of HRM. Nowadays, the crucial criteria of managing and recognizing the competitive market conditions related to new technologies such as Industry 4.0 entails collecting, process, and analyze data. To have an advantage in the increasingly competitive business world, the business companies must utilize data analytics to experience data-driven visions into the workforce trends and put into practice enhanced recruitment programs, incentive, and compensation schedules to satisfy the growing interests and goals of the employees. HR database systems must provide instant data that can be derived from a firm's software algorithms that are used to give decisions to hire and manage the workforce. The result will be an increase in productivity and a decrease in employee turnover.

Another implication can be related to the need for a digitized workforce management system. Necessary operations for processing, reporting, and tracking the huge amount of data transformed duties of employees which was once a yearly enrollment event into a monthly basis. To meet the business requirements, various workers in finance and accounting, operations, marketing, human resource, tax, legal, and information technologies must be trained and empowered according criteria specified in this study. It will be a challenge to collect the crucial data from the multiple disciplines; therefore, there is a need for more significant integrated managerial model for human capital.

Industry 4.0 requires the merging of business functions. It will continue to be challenging for most of the industries. More and more challenges will be raising for the business companies for old generation workforce, and efficiency and effectiveness of the HRM with new technologies. Becoming the most required and preferred employee for the future workforce would not be easy.

7. Conclusion

Criteria classified as workforce readiness, soft skills, technical skills, and entrepreneurship formed the best foundation for further investigation of the research questions. According to the Fuzzy ANP solution, the most important criterion cluster was found as Technical skills, followed by Entrepreneurship. Therefore, HR managers must pay attention to technical skills, such as project management, financial management, and scientific tasks, and entrepreneurship skills such as innovation and creativity, more than the other criteria throughout the recruitment process in Industry 4.0 era.

A more detailed analysis of the employee selection criteria specified as sub-criteria must be analyzed during the recruitment in a new technology environment. Technical skills that must be evaluated are Project Management, Financial Management, Technology-based Skills, and Mechanical Functions in descending order.

The second conclusion of the study implies the importance of entrepreneurial skills sorted from the most important to less important as Innovation, Creativity, Industriousness, and Initiative. Those skills are crucial to be competitive in the industrialized business world. People endowed with them must be preferred for procurement.

The next conclusion specifies moderately less important selection criteria clusters, Workforce Readiness, and Soft Skills. Calculated weights of the criteria by Fuzzy ANP solution can be used successfully in recruitment decisions with designated weights of the criteria such as Digital Literacy, Literacy and Numeracy and Soft skills, Communication, Critical Thinking, and Creative Thinking.

Since the data collection process includes subjective judgments, the findings of this study is unique and specific; and therefore, cannot be generalized. However, the proposed framework and the criteria set was generic.

In this study, one of the basic activities of HRM, procurement process, and related criteria for procurement process in the Industry 4.0 era are investigated. Similar studies can be done for the other functions of HRM such as job definitions and job evaluation, on-the-job training, wage and salary management, and performance management as future work.

Conflict of Interest
The authors confirm that there is no conflict of interest to declare for this publication.

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