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An investigation on logistics firms' human resources qualifications
in transition to Industry 4.0: An insight from Türkiye

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Abstract

Industrial revolutions provide great opportunities for emerging countries concerning their aims of playing in the leagues of developed countries. Yet, accomplishing such an aim is up to their firms' adaptation to the new era. Human resources seem particularly important because Industry 4.0 is transforming job definitions. Although prior studies highlight this importance, they do not sufficiently amplify the gap between current and ideal human resources qualifications. This study aims to contribute by giving insights into the amount of this gap in emerging countries. We conduct qualitative research on domestic logistics firms in Türkiye for a better understanding of whether or not current human resources qualifications are sufficient and, if not, what kind of qualifications are needed and how they should be attained. Findings show that current human resource qualifications are insufficient for Industry 4.0. For the employees to adapt to this new era, firms should be first aware of these qualifications. Moreover, their processes should make these qualifications functional and useful. Besides, there is a need for training the current employees to equip them with the respective skills/competencies required in the new era. However, our findings reveal that training the existing human resources due to their poor educational background would be extremely costly for firms. Therefore, they expect government incentives and support. They also emphasize the significant role of universities that should be able to foresee new skills/qualifications in the future and update their curricula. Our results suggest that only governmental bodies' leadership in incentivizing firms to train employees and coordinating university programs to align them with new industry needs could enable firms' successful transition to Industry 4.0 by continuously supplying qualified human resources to the labor market.

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1. Introduction

Industry 4.0 is of great importance for firms and countries to which they should rapidly adapt because the ability to integrate new technologies and use modern production techniques plays a more critical role in competitiveness today [1]. However, this adaptation period seems particularly challenging for emerging country firms, as Industry 4.0 requires shifting current business processes radically through digitalization.

Four industrial revolutions have affected logistics processes as well [2]. The mechanization of transportation occurred after the first industrial revolution, and then automatic transport systems such as automated storage and sorting emerged after the second revolution. After the third industrial revolution, computer and information technologies gained prominence, leading to logistics management systems. Finally, the fourth industrial revolution introduced the term "Logistics 4.0" [2, 3]. Accordingly, physical logistics processes have been transformed into software-based applications. Besides, increased computing and communication skills have made information sharing easier and more autonomous [4].

The effects of each revolution on employment have become the topic of discussion. Also, in the Industry 4.0 era, many argue that employment will be affected negatively, while others argue for its positive effects on employment [5]. The communication of robots and machines among themselves plays a major role in this era. "Smart factories" in which M2M (machine-to-machine communication) prevails highlight production processes without human involvement [6]. Although these could reduce costs and boost efficiency, they may cause the problem that employees can lose their jobs [7]. However, the other viewpoint argues that Industry 4.0 will assign people different new roles/tasks, e.g., coordinating and repairing robots, analyzing big production data, and developing specialized software applications for production processes. Hence, according to this view, there will be more demand for qualified labor [5]. Instead of working under physically difficult conditions, employees need to manage and control integrated systems [8]. The previous revolutions are indeed supporting this viewpoint that none of them has reduced employment so far [9].

The skilled workforce is the key success factor in today's competitive conditions [10]. For the successful adaptation to new technologies and digitalized processes, the human resources that will control and implement these processes are crucial [11]. The fourth industrial revolution-led practices have indeed started to be implemented by some leading firms. Only looking at the job advertisements of these firms has shown that this new era demands new human resource qualifications. Thus, it has become highly critical for firms to explain the changes in the ways of doing business to human resources as well as to upskill and motivate them. Also, a new human resource that can be integrated with these new systems will be necessary. When looking at the job advertisements of the logistics companies (e.g., Amazon, DHL, etc.) that are thought to implement the best new technologies and digitalization in the logistics processes, it is observed that they are looking for the following three groups of qualifications in their human resources, which are the use of data analysis, use of information systems for logistics, and knowledge of programming languages.

This study aims to investigate whether the human resources of domestic logistics firms in Türkiye are sufficient to achieve their timely adaption to the new era, and if not, what kind of qualifications are needed and how they should be attained. Therefore, this study investigates the progress made by domestic logistics firms in emerging countries so far, and given this progress, it seeks the answer to the questions listed below:

- Do employees of domestic logistics firms in Türkiye currently have the qualifications required by Industry 4.0?
- Do domestic logistics firms in Türkiye need new human resources during the period of Industry 4.0?
- Can the current employees of domestic logistics firms in Türkiye be trained to have the qualifications required by Industry 4.0?

The paper is organized into five sections. Section 2 provides a conceptual background and literature review. Section 3 presents our methodology. After Section 4 reports the findings, Section 5 concludes the paper.

2. Conceptual background and literature review

Logistics processes were affected by each industrial revolution [2]. Fig. 1 illustrates these effects in four stages [12, 13]. After the steam engine's invention, carrying capacity increased with the development of steamships and railways, and the use of machinery replaced animal power to transport goods and people. These developments were considered the initial steps of mass transport through the "mechanization of transport," i.e., Logistics 1.0. In this era, firms had to be close to their local suppliers and customers due to too long supply and delivery times. Nevertheless, satisfying volatile demand was challenging, causing shipment delays and stock increases. The second period (Logistics 2.0) was characterized by the better use of steel, copper, and aluminum in machine development. More access to electricity and oil resources accelerated transportation and automation, particularly in warehouses. The third industrial revolution, manufacturing with computers, paved the way for logistics management systems (Logistics 3.0), which enabled significant progress in controlling and managing logistics processes. During this period, supply chains became more global, and the digitalization in logistics processes significantly increased. Transportation, storage, and handling within factories and warehouses started using automated lines, forklifts, and robots [3].

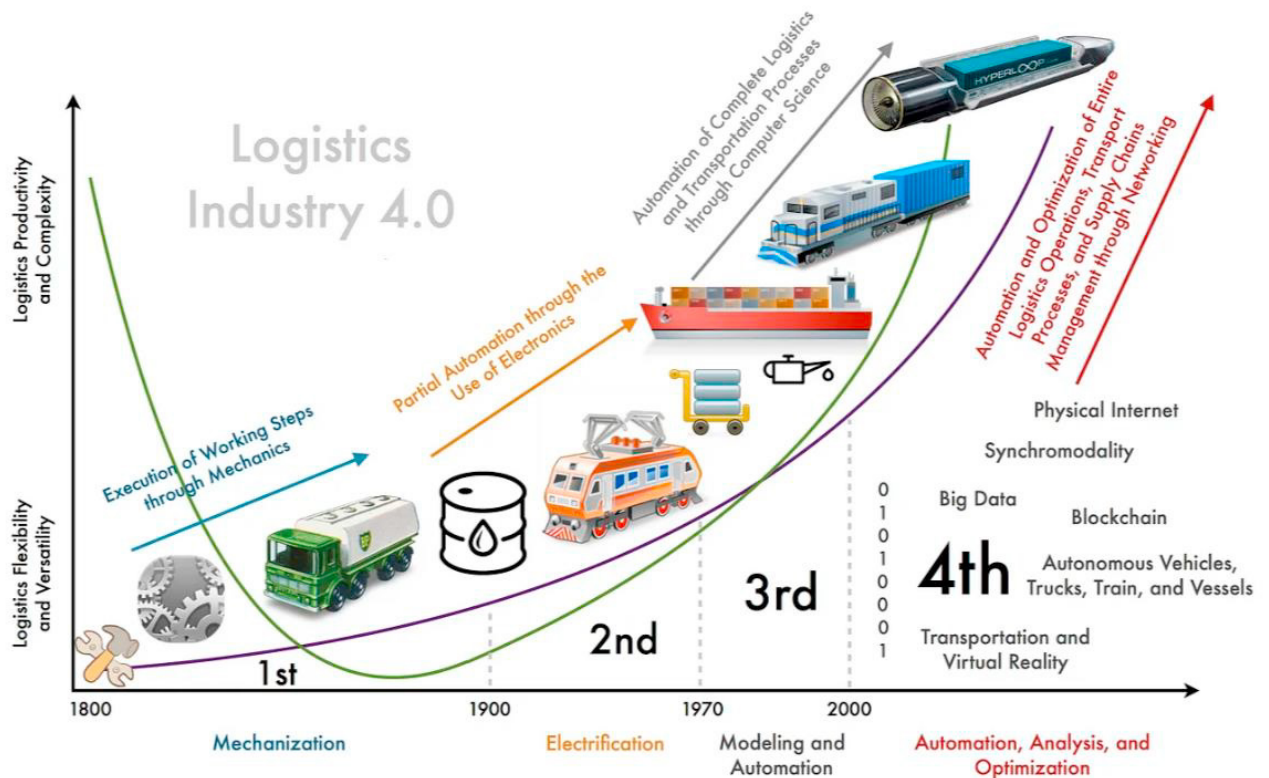


Fig. 1. Transition to Logistics Industry 4.0 [12,13]

Industry 4.0, characterized by the blend of numerous technological progress, has also led to significant changes (Logistics 4.0) in the logistics sector [2]. One of these is enabling real-time communication between machines and between machines and people [14]. In addition, cyber system applications and innovations in this field accelerated the concept of Logistics 4.0 [15]. Nowadays, virtual and physical structures are aimed to be effectively used throughout production, from sourcing to distribution, to enable companies to rapidly adapt to changes to mitigate risks [16]. Owing to the progress in information, communication, and sensor technologies, firms can now collect and analyze large amounts of data by integrating physical processes with computers [10]. This has significantly increased logistics systems' measurability, efficiency, and sustainability.

One of the most critical factors in gaining competitive advantage is human resources, whose distinctive knowledge, skills, and attitudes are essential in achieving excellent performance [17]. Human resources were indeed regarded as a cost element by the "Fordist-Taylorist" paradigm until the 1980s. Still, it has gained strategic importance along with globalization because intellectual capital has appeared to be prominent in making a difference for enterprises [18, 19]. It is emphasized that intellectual capital in the information society is key to providing a competitive advantage, and companies that cannot manage their intellectual capital cannot survive [20]. Employees primarily offer significant value with their intellectual capacities to companies that have to use high technology in their operations.

Industry 4.0 has changed the human resources qualifications sought by firms. Many new occupational groups and jobs have emerged, whereas many may no longer exist soon, and many existing processes seem to change radically. Herein, the effect of technological innovations on human resources is evaluated from two perspectives [5,7]. The first view argues that new technological developments, especially emerging with Industry 4.0, increase automation and robot usage, and these developments may cause people to lose their jobs, which will negatively affect employment [7, 21, 22]. However, this view has never been supported in any industrial revolution until today, so some economists are not concerned about this issue. New technologies are thought to increase employment because they will lead to new products and services [23]. In this respect, the second view asserts that technological innovations that have emerged since the first industrial revolution increase employment over a long period because they assign people new roles and create new jobs [5]. Besides, the increased automation and robot usage in the Industry 4.0 era enhances productivity and competitiveness, which, in turn, stimulates demand and new business opportunities. For example, at BMW in the US, after robots started installing insulated doors that previously required a physical human force, employees did only the controlling task, achieving a 50% increase in productivity [24]. Also, the second viewpoint holds that new technologies increase wages because they urge labor to gain new skills.

It is conjectured that in the Industry 4.0 era, significant changes occur in how employees do their jobs. Robots will help people, not replace them. As a result, while robots will perform physical work, people will be needed for qualified work [9]. Technological innovations change the role and responsibility of people and increase employment with a qualified workforce. It is highlighted that new technologies introduced with Industry 4.0 will increase human-machine interaction [8]. As a consequence of such interaction, new professions will emerge, requiring new technology-based qualifications from workers. Some new jobs can be exemplified as the Internet of Things solution managers and robot coordinators [8]. Enterprises that strive to adapt to new environmental conditions characterized by high technological shifts must reconstruct processes in their corporate identities. Accordingly, nowadays, businesses must get out of a static structure and learn to be dynamic organizations. This creates a critical employment gap and leads to new business opportunities. Therefore, highly qualified human resources are gaining increasingly more importance in the new era [25].

3. Methodology

To find an answer to our research questions, the four domestic logistics firms in Türkiye were examined, and then the necessary qualifications required by Logistics 4.0 were investigated [26]. The respective qualifications were identified in job advertisements of companies known to implement their logistics activities in line with the principles of Industry 4.0 (Amazon, DHL, Bosch, Ocado, Siemens, Wayfair). The job advertisements for the job positions – warehouse/stock, transportation, and supply chain managers/analysts were mainly considered according to the classifications of the study [14], emphasizing that Industry 4.0 firstly affected warehouse, transportation, and supply chain planning departments in the logistics sector. The qualifications identified from job advertisements were classified into three groups according to their functions, which are listed below:

- Use of data analysis, e.g., Oracle, Hadoop, Unix, Vlookup, Mahout, Pivot Tables, Access.
- Use of information systems for logistics, e.g., SAP, ERP, WMS, TMS
- Knowledge of programming languages, e.g., SQL, MYSQL, VBA, Phyton, Perl, R, Ruby, Java.

This study conducted qualitative research to investigate four domestic logistics firms operating in Türkiye [26]. Semi-structured interviews were conducted with the high-level managers of firms. Due to their request to remain

anonymous, we do not present firms by their real names. Firm A is a logistics company that has been performing its activities for 35 years. It has around 300 workers and mainly focuses on storing and transporting, especially construction materials, within the country's borders. Firm A has two warehouses in different cities in Türkiye. Firm B is a family company that has been operating logistics activities since 1967. It mainly focuses on storage and transportation activities with its 220 workers. The firm has particular competence in rail transportation. Firm C has been operating activities for 18 years domestically. It gives the services of storage and transport of all kinds of products. The firm carries out the majority of transportation by road. Firm D, one of the largest logistics companies in Türkiye, has been operating since 1990. It has around 1000 workers. This firm predominantly transports textile products. Table 1 below summarizes the characteristics of the sampled firms.

Table 1. Sample characteristics.

Firm	Age	# of employees	Main activity	Country
A	35	300	Storing and transporting construction materials	Türkiye
B	33	220	Storing and transporting all kinds of products	Türkiye
C	18	120	Storing and transporting all kinds of products	Türkiye
D	30	1000	Transporting textile products	Türkiye

The interviews lasted about an hour on average, and they were recorded. At the beginning of interviews, the logistics applications of Industry 4.0 were first explained and exemplified to interviewees when necessary. The interviews mainly investigated whether the firms' current employees had the qualifications required by Logistics 4.0, i.e., the three qualification groups (use of data analysis, use of information systems for logistics, and knowledge of programming languages). With this aim, we prepared an interview guide consisting of the main theme and follow-up questions, designed after a literature review and examining job advertisements. Our main theme questions aim to collect data, in general, on the ways the examined firms analyze their data and exploit which information systems and programming languages. Then, the follow-up questions aim to delve into the applications/programs currently used by firms and the potential applications/programs that firms aim to use in the near future by probing the sufficiency of the current human resources qualifications. Similar questions were asked of these firms' employees to validate our findings. Based on the content analysis of all interview data using open coding, inferences were derived to address our research questions. Fig.2 below summarizes our methodological process.

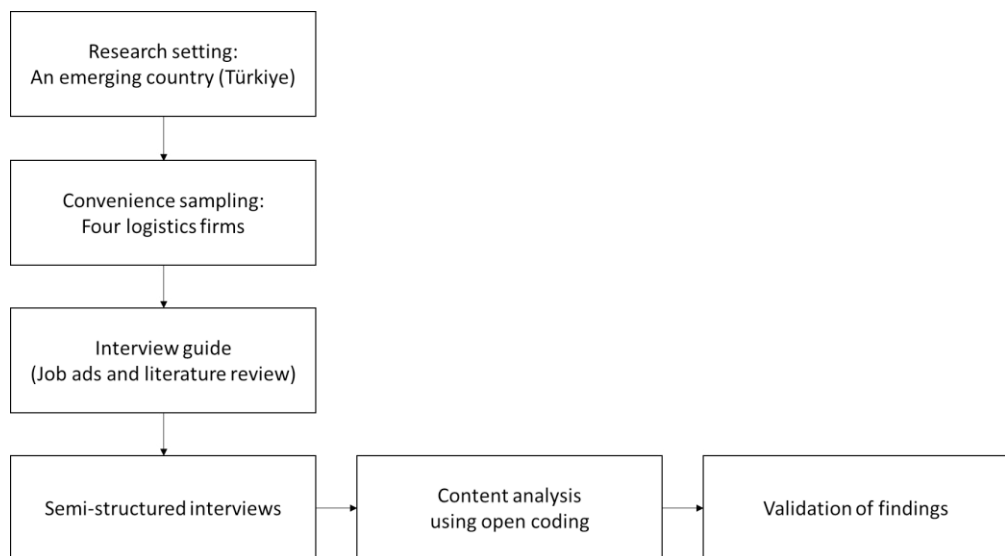


Fig. 2. Methodological process.

4. Results

Table 2 below shows the main themes and subthemes we have identified after our analysis:

Table 2. Main themes and subthemes.

Main themes	Subthemes
Lack of managerial awareness	Ambiguity in the potential contribution
	Lack of technical knowledge
	Outsourcing
Non-applicability	No automation
	Low technology
	A few customer potentials
The fear of escalated costs	Labor costs
	Education costs
	High fixed costs
	Government support
	Lack of time
The need for leadership	Governmental coordination
	University foresight and proactive actions
Low education level	Poor educational background
	Insufficiency in qualifications and skills

The first remarkable finding of our analysis is that many new qualifications required by Industry 4.0 in the logistics sector, e.g., the knowledge of programming language, are not familiar to employees. Moreover, there is no technology and automation in most of the firms requiring the use of programming language. The interviewees stated that today, even in the whole industry, automation is scarce; therefore, the use of qualifications we question is currently unthinkable in the logistics sector. It was also stated that the work in the logistics firms is mainly carried out by the human workforce. Furthermore, the interviewees admitted that they do not have the necessary information systems for logistics and have no idea about these systems. The reason why employees do not use these systems is that managers do not clearly know how these systems can contribute to their firms.

Our findings show that although some firms utilize automation and high technology, their employees do not know any programming language because their work does not make it necessary. This is not because they are not interested in learning. Instead, such work is either outsourced to another firm or assigned to an IT team within the organization. One interviewee stated that the workers in the warehouse and transport departments do not know these systems. They already have a team that creates and maintains the local software that resembles the ERP system. This team is doing all the software coding. Another interviewee indicated that employees do not need any programming language knowledge because they use particular software, and it was stated that this program is enough for them to carry on the business. The employees do not need to know programming languages to use this program, and the firm does not have automation systems that require programming language. It was stated that they do not use information systems because managers also do not have clear information about these systems.

The CEO of firm A stated that he does not think that employees should have the qualifications we question because he has no information about the subject. He also declared that the company needs more customer potential, so these qualifications are too early for them. He is still determining how these systems will contribute to their work. He also believes purchasing these systems and training their employees would be very costly. In addition, he stated that it is necessary to discuss the advantages and disadvantages of these systems in companies with small potential. He exemplified that the forklift is a new concept in their lives and emphasized that they are far behind the standards.

Another firm's manager also does not think that his employees should have the respective qualifications because they should be paid more when they have these qualifications. She also does not want to have the cost of these systems because their potential does not seem very large to her. They do not have these systems and do not need them to carry out their business, so the manager does not expect these qualifications from their employees. The profit margin of the transported products is very low, so many firms do not want to pay high storage costs just because they implement high-technology warehouse processes. Hence, the firm does not consider using management systems required by Industry 4.0 because of cost.

The CEO of firm C stated that current employees' education level is very low, and they cannot adapt to the Industry 4.0 systems. He mentioned that he had tried to integrate his workers into the barcode system and the use of smart tablets before but failed. As workers could not adapt to them, he believes they cannot attain the qualifications we investigate. Therefore, he stated that he would prefer new ones rather than training existing human resources. At this point, firms expect the support of the state for training because it is difficult for the firm to train its employees due to cost and time. The manager remarked that emerging countries need to strengthen their technological production capabilities because the country's low level of technological production negatively affects the digitalization of firms [27]. In order to prepare employees for the digitalization period, firms must first enter into the digitalization process. Universities should focus on logistics departments. Programming language and data analysis should be concentrated on at the universities.

5. Conclusion

In the Industry 4.0 era, business processes are changing, and the change is occurring in the expectations from employees. It is highlighted that people will work in controlling, programming, and monitoring production instead of working under harsh conditions, forcing the limits of body strength [5,8]. Especially through increased automation and robotic systems, people will work at qualified jobs. However, this study shows that almost all domestic logistics firms' human resources have an unqualified workforce and need help adapting to new technologies and systems. Also, domestic logistics firms' CEOs/managers do not think existing human resources can easily be trained and adapted to the Industry 4.0 era. Therefore, they prefer new human resources. Moreover, their motivation to train them for these qualifications is very low because of the domestic logistics sector, whose competitiveness depends on cheap labor in emerging countries. The managers hold that training the existing human resources due to their poor educational background would be extremely costly for them. They expect government incentives and support to this end. They also emphasize the significance of the respective university programs' curriculum design. Accordingly, the universities should be able to foresee new skills and qualifications in the near future and design and update their logistics program curricula. Thus, our results suggest that only the leadership of governmental bodies in terms of incentivizing firms to train employees and coordinating university programs with the aim of keeping them in line with new industry needs could enable the achievement of the transition of emerging country logistics firms to Industry 4.0 by continuously supplying qualified human resources to the logistics labor market.

Our study has limitations. First, our study's findings are based on a conveniently sampled few logistics firms operating in Türkiye. Thus, the generalizability of our findings to all emerging countries should be assessed with caution. Second, we prepared our interview guide based on the job advertisements of companies known to implement their logistics activities in line with the principles of Industry 4.0 (Amazon, DHL, Bosch, Ocado, Siemens, Wayfair). Considering that these companies operate in developed countries, the qualifications requested by them as the benchmark for emerging country firms may not be so appropriate. Future studies can enhance our research in various ways by addressing our limitations. Future research can be conducted in multiple emerging countries to generalize our findings. They can compare the logistics firms with their best example counterparts in their own countries or at least in emerging country borders. Our study aims to give insights into the gap between current and ideal logistics human resources qualifications in emerging countries in the transition to Industry 4.0. Future research can more precisely amplify this gap through quantitative analyses focusing on specific qualifications. They may also conduct experimental design studies to show whether existing employees could gain the qualifications and skills through training. At this point, future research could also make a cost-benefit analysis to compare whether training existing employees or hiring new employees would be more lucrative for firms.

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