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# BARRIERS TO THE ADOPTION OF INDUSTRY 4.0 TECHNOLOGIES IN THE PRACTICE OF OCCUPATIONAL SAFETY AND HEALTH OF SMES

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**Abstract.** The purpose of the paper is to identify the main problems and barriers to the adoption of Industry 4.0 technologies that help to improve the OSH system in small business enterprises, and to develop scientifically based recommendations for their elimination. The current study employed a qualitative research approach using two methods. The first method was to identify the problem by conducting interviews with managers and labor protection specialists and employees of small businesses. The second method is to study various sources and research works related to the opportunities and challenges of using digital technologies to improve OSH. The results of the study provide a comprehensive overview of the range and list of barriers to small businesses' willingness to use digital technologies and smart devices to ensure safe and decent working conditions. Also, this study substantiates that the use of Industry 4.0 technologies to improve working conditions in small business enterprises can bring high benefits for small business owners, employees and society.

**Key words:**, SMEs, OSH practice, barriers to adoption of Industry 4.0 technologies

# ПРЕПЯТСТВИЯ ВНЕДРЕНИЯ ТЕХНОЛОГИЙ ИНДУСТРИИ 4.0 В ПРАКТИКЕ ОХРАНЫ ТРУДА МАЛЫХ И СРЕДНИХ ПРЕДПРИЯТИЙ

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**Аннотация.** Целью данной статьи является выявление основных проблем и препятствий, возникающих при внедрении технологий Индустрии 4.0, которые могут способствовать совершенствованию системы охраны труда на малых и средних предприятиях, а также разработка научно обоснованных рекомендаций по их устранению. В данном исследовании использовался качественный метод исследования, включающий два подхода. Первый подход предполагает проведение интервью с руководителями малых предприятий, специалистами по охране труда и сотрудниками для выявления существующих проблем. Второй подход включает изучение различных источников и исследований, связанных с использованием цифровых технологий для улучшения охраны труда, а также анализ возможностей и проблем, связанных с их внедрением.

Результаты исследования позволяют всесторонне рассмотреть перечень и спектр препятствий, с которыми сталкиваются субъекты малого бизнеса при стремлении

использовать цифровые технологии и умные устройства для обеспечения безопасных и достойных условий труда. Кроме того, данное исследование подтверждает, что использование технологий Индустрии 4.0 для улучшения условий труда на малых и средних предприятиях может принести значительные выгоды как владельцам и сотрудникам таких субъектов, так и обществу в целом.

**Ключевые слова:** малые и средние предприятия, практика охраны труда, препятствия внедрения технологий Индустрии 4.0.

# KICHIK VA O`RTA BIZNES KORXONALARNING MEHNATNI MUHOFAZA QILISH AMALIYOTIDA SANOAT 4.0 TEXNOLOGIYALARINI JORIY ETISHDAGI TO'SIQLAR

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**Annotatsiya.** Ushbu maqolaning maqsadi kichik va o`rta biznes korxonalarida mehnatni muhofaza qilish tizimini takomillashtirishga yordam beruvchi Sanoat 4.0 texnologiyalarini joriy etishdagi asosiy muammo va to'siqlarni aniqlash va ularni bartaraf etish bo'yicha ilmiy asoslangan tavsiyalar ishlab chiqishdan iborat. Ushbu tadqiqotda ikkita usuldan foydalangan holda sifatiy tadqiqot usuli qo'llanildi. Birinchi usul kichik biznes subyektlari rahbarlari va mehnatni muhofaza qilish bo'yicha mutaxassislar hamda xodimlar bilan suhbatlar o'tkazish orqali muammoni aniqlashni nazarda tutsa, ikkinchi usul esa– mehnatni muhofaza qilishni yaxshilash uchun raqamli texnologiyalardan foydalanish imkoniyatlari va muammolari bilan bog'liq turli manbalar va tadqiqot ishlarini o'rganishno o`z ichiga oladi. Tadqiqot natijalari kichik biznes subyektlarining xavfsiz va munosib mehnat sharoitlarini ta'minlash uchun raqamli texnologiyalar va aqlli qurilmalardan foydalanish istagidagi to'siqlar doirasi va ro'yxatini har tomonlama ko'rib chiqish imkonini beradi. Shuningdek, ushbu tadqiqot kichik va o`rta biznes korxonalarida mehnat sharoitlarini yaxshilash uchun Sanoat 4.0 texnologiyalaridan foydalanish bunday subuektlar egalari, xodimlari va jamiyat uchun yuqori foyda keltirishi mumkinligini tasdiqlaydi.

**Kalit so'zlar:** kichik va o`rta biznes korxonalari, mehnatni muhofaza qilish amaliyoti, Sanoat 4.0 texnologiyalarini joriy etishdagi to'siqlar.

## Introduction

It is obvious, small business enterprises play an important role in providing employment worldwide. Small business enterprises have a high potential for creating new jobs and providing quantitative and qualitative indicators of employment. Today, these enterprises provide one-third of the world's employment.[1]

In particular, in Uzbekistan, according to official statistics, as of 2023, 523,450 small business entities have passed state registration. This type of enterprises accounts for about 60 percent of the country's gross domestic product (GDP) and the share of the total number of people employed in the economy is almost 80 percent.[2] These statistics show that small business

enterprises play an important role in ensuring employment, the well-being of the population and economic growth in Uzbekistan.

Although small business enterprises provide employment to the majority of the employed population, the state of the OSH system in such enterprises is not at the required level. Of course, this is explained by a number of factors, such as the use of outdated and high-risk technologies in the production and service process due to lack of funding, the lack of serious attention of employees to their own safety, and insufficient interest of employers in creating safe working conditions for employees. This poses a serious threat to the health and safety of many workers employed in the industry.

In such conditions, it will be difficult for employers to find a solution other than automating the labor OSH system and making safety equipment and tools smart in accordance with the requirements of Industry 4.0. For example, even low-tech personal protective equipment can become smart and Internet-connected as a result of technological advancements.

Taking into account the development of the digital economy, it can be more effective to develop safety instructions for employees in small business enterprises, using the capabilities of virtual reality technologies, showing all safety rules in the facility, and instructing employees on this basis. Studies conducted by experts show that it is known that a person receives almost 90% of all the information he receives through his eyes and keeps it in memory.

Almost 80 percent of dangerous work processes based on manual labor in enterprises established on the basis of Industry 4.0 technologies are entrusted to autonomous robots (Cobots). This causes a sharp decrease in the number of low-skilled employees and an increase in the number of qualified employees in enterprises. Also, it is possible to reduce the scope of factors that are dangerous for a person in the work process.

Employees experience high stress during the work process, and this stress can cause psychological problems and reduce work productivity. Employees with psychological problems may be more prone to accidents and illnesses, especially older employees. Wearable devices that record changes in the physiological state of employees and work conditions can monitor and control vital signs of the body. Such devices can provide employees with various hazard warnings, recommendations, reminders to take breaks, drink water, and increase physical activity.[3]

It is also possible to reduce the level of accidents by monitoring and evaluating working conditions in small business enterprises with the help of Industry 4.0 technologies. Identifying workplace hazards helps occupational health professionals take preventive measures before any accidents occur.

The purpose of this research work is to identify the main problems and barriers to the adoption of Industry 4.0 technologies that help to improve the

labor protection system in small business enterprises, and to develop scientifically based recommendations for their elimination..

### Literature review

Research conducted by I.Aslan cites that six technology categories such as big data, Internet of Things (IoT), cyber-physical systems, computer networks, r(c)obotics, artificial intelligence (AI) and simulations can be used to improve workplace accident prevention and occupational safety in the workplaces.[4]

The literature review provides deeper insights into the more specific use of digital solutions in the field of occupational health and safety. For example, environmental sensors, laser scanners, and cameras can be used to prevent collisions between operators and machines by determining relative position and distance.[5]

Another study explains the classification of Industry 4.0 technologies that can be used in the OSH practices of enterprises. [6]

| I40 Technology | Description |
| --- | --- |
| **Robotics (RB)** | … aims to ensure the interaction between robots and humans. It should take place safely and the robots should learn from humans. [7] |
| **Artificial Intelligence (AI)** | … is a cognitive science with the objective of making the best decisions about different research activities: robotics, automatic learning and image processing, natural language processing.[8] |
| **IoT** | … seeks to connect machines and information technologies through the use of intelligent devices, such as sensors, to optimise decision-making and respond in real time to the complexity of manufacturing processes. [9] |
| **Virtual and Augmented Reality (VAR)** | develops real situations in order to train operators, avoiding dangerous situations and improving the decision-making process. VAR even allows introducing objects into virtual models that do not exist in reality. [10] |
| **Big Data and Advanced Analytics (BDAA)** | … gathers information from different sources and then evaluates it, to make the best decisions in real time and at a more advanced level than with traditional tools. [11] |

Zhou and his research team divided OSH technologies used in enterprises into four main categories: information and communication technologies (ICT), sensor-based technologies, radio frequency identification (RFID), and virtual reality.[12]

There are many factors influencing the adoption of Industry 4.0 technologies to prevent accidents and improve working conditions for small businesses, which can act as barriers to adoption or as incentives for adoption.[13] Dodoo and his research team divided the barriers to the adoption of digital technologies into OSH practices of small businesses into behavioral, technological and organizational ones. Among the behavioral barriers, the issue of privacy and management control is an important barrier, as digital solutions

can be perceived as a means of controlling workers.[14] Other behavioral barriers include resistance to change and social influence from colleagues.

According to various theories, such as the technology use or technology acceptance model, willingness to adopt a technological solution depends on its perceived usefulness. Therefore, it is advisable to use digital technologies when the hazards are perceived.[15]

On the contrary, overconfidence in smart tools and lack of awareness of risks, even distraction or fatigue, inhibit the adoption of digital technologies in occupational health and safety practices in small and medium-sized enterprises and, as a result, support risky behavior.[16]

A team of researchers led by Enrico Cagno cites the lack of perceived benefits, privacy issues, implementation challenges and costs as the main barriers to adopting digital solutions for occupational health and safety practices for small businesses compared to large enterprises.[17]

Malomane and his research team point out that the lack of expertise in the use of digital health and safety technologies among construction professionals is one of the main reasons why these technologies are rarely used in the industry.[18] Osunsanmi and his research team also noted that while digital technologies such as radio frequency identification (RFID) help monitor the safety of workers, low levels of technical expertise have hindered its adoption.[19]

In some studies, it is not excluded that there are some negative consequences of the use of industry 4.0 technologies in ensuring labor safety. An analysis by the European Agency for Safety and Health at Work stated that the use of digital tools to constantly monitor the behavior, performance of employees can create an environment of professional uncertainty, invasion of privacy and psychological pressure. It can also reduce communication between employee and supervisor and between employee and co-workers, which has been concluded to worsen the workplace atmosphere by increasing work-related stress and causing long-term negative health effects.[20] A study by M.Vasic and A.Billard concluded that engineering and human errors, or errors in peripheral equipment programming and interface setup, lead to injuries to personnel working with robots.[21] Another study found that workers may experience tension between the virtual and real worlds due to augmented technological integration in the workplace.[22]

Summarizing the above, it can be noted that despite the growing demand for the use of digital technologies and smart devices in the practice of labor protection by enterprises, there are many difficulties and limitations in the adoption of such technologies. Some of the limitations to the adoption of digital technologies in the OSH sector are related to costs, as "simply" adopting a new system for safety and health can be seen as a cost.

In addition, adopting new technology requires training workers, which can be costly. Additional problems are data security and storage, worker resistance to new technologies, and lack of standardization in use. Currently, there are few or no standards for the use and adoption of new OSH technologies. The mentioned problems can affect the willingness of organizations to use OSH technology, which can influence the decision maker and complicate the adoption process. Therefore, more research is needed to identify the challenges and barriers to successful adoption of digital technologies in occupational health and safety practice, especially from the perspective of small businesses.

As a result of studying and analyzing a number of sources, it can be concluded that it is appropriate to identify and analyze the possibilities and obstacles to the use of "Industry 4.0" technologies and smart devices in the practice of labor protection in small business enterprises, and to form a list of proposals for the integration of the labor protection system into the production process at the "Industry 4.0" level.

**Data and methodology**

The current study employed a qualitative research approach using two methods. The first method was to identify the problem by conducting interviews with managers and labor protection specialists and employees of small businesses. The second method is to study various sources and research works related to the opportunities and challenges of using digital technologies to improve OSH.

In the course of the research, obstacles to the introduction of Industry 4.0 technologies and their reasons in OSH practice in some small business enterprises operating in Uzbekistan were studied based on the survey method. Questionnaire questions are formed on the basis of a Likert scale, according to which the answers to 8 questions based on 5 parameters are formed in the following order: "5" - strongly agree, "4" - agree, "3" - not sure, "2" -I don't agree, "1" - I don't agree at all.

Organization of research includes several stages, including: organizational (preparatory) stage; survey implementation process; the stage of analysis of the obtained results; drawing up conclusions based on the obtained results and developing scientifically based proposals and recommendations for improving activities.

The liquidity and reliability of the questionnaire options created for the study were checked by evaluating its internal consistency, and the "Cronbach's alpha" coefficient was evaluated using the "IBM SPSS Statistics 22.0" program to evaluate the reliability of the questionnaire.

**Results and discussion**

As a result of the analysis, Cronbach's alpha coefficient was found to be 0.78. This confirms that the statistical reliability of the research is positive.

<div align="right">**Table 1**</div>

**Classification of barriers to the adoption of Industry 4.0 technologies in OSH practice of small business enterprises**

| № | Barriers to adoption | Statistical mean (x) | Standard deviation |
|---|---|---|---|
| 1 | Lack of financial resources | 4,0260 | 0,54052 |
| 2 | Fear of change when adopting digital and smart technologies | 4,1020 | 0,52001 |
| 3 | Lack of qualified personnel and experience in the use of digital technologies | 3,8340 | 0,56732 |
| 4 | Lack of ICT infrastructure | 3,7560 | 0,52281 |
| 5 | Privacy issues | 3,6200 | 0,62716 |
| 6 | Lack of support from the government | 3,4200 | 0,47610 |
| 7 | Cyber security issues | 3,3800 | 0,74833 |
| 8 | Lack of scientific and research work in the use of digital technologies for labor safety | 3,2070 | 0,61373 |

A total of 40 small business entities participated in the questionnaire and expressed their attitudes to the questions of the questionnaire. The answers given by the respondents to the questions of the questionnaire were analyzed and their average statistical value and standard deviation were calculated and the results were expressed in (Table 1).

From the analysis of the obtained results, it became clear that the statistical value of the lack of financial resources in the implementation of digital technologies in the labor protection practice of small business enterprises is $\bar{x}$=4.02 and SD=0.54. Here, the statistical value of $\bar{x}$ is almost equal to 4. According to the Likert scale, the respondents answered "I agree" to the problem of lack of financial resources. From an economic point of view, since work-related injuries, occupational diseases, and accidents create additional costs for both the employer and the employee, such situations may not be positively perceived by small business managers. Small business leaders believe that providing safe working conditions for employees is very costly, while not providing enough safe working conditions can be even more costly. SMEs tend to have higher rates of occupational accidents and diseases, owing primarily to human and financial resource deficits in adopting digital and smart technologies.[23]

Another important aspect of the research is that the average statistical $\bar{x}$ value of the answers received in the fear of changes in the use of digital and smart technologies, the lack of skilled personnel and experience in the use of digital technologies, the lack of ICT infrastructure and privacy problems is close to 4. It follows that the respondents answered "I agree" to these points as well.

It was found that the average statistical value of the results obtained for lack of support from the government, cyber security issues and lack of scientific and research work in the use of digital technologies for labor safety is close to 3. It is known that the respondents who participated in the study are not sure about the opinions on this matter. Public policy measures to support the design, acquisition, and evaluation of the use of digital OSH monitoring systems (attached to financial support instruments) may improve the use of these systems and strengthen the evidence base in terms of their impact in preventing or reducing OSH risks and adjustments that need to be made.[24]

Taking into account the above, lack of financial resources in the implementation of digital technologies in the studied enterprises, fear of changes in the use of digital and smart technologies, lack of qualified personnel and experience in the use of digital technologies, lack of ICT infrastructure and privacy problems in OSH practices for small business enterprises considered as the main obstacles in the application of industry 4.0 technologies. However, barriers such as lack of government support, cyber security issues, and lack of scientific and research work in the application of Industry 4.0 technologies in the OSH practice of small business enterprises were assessed as secondary problems.

In practice, due to the management and financial problems of small business entities, the possibilities of fully fulfilling all the employer's obligations regarding OSH in relation to large business entities are limited. Therefore, it is difficult to fully comply with the principles of continuous implementation of changes in the field of OSH. In our opinion, in order to ensure the full fulfillment of these specified requirements, it is appropriate to expand the possibilities of using digital and smart technologies in the practice of OSH to small business entities and thereby increase their interest in ensuring safe working conditions.

**Conclusions and suggestions**

In conclusion, the elimination of barriers to the adoption of industry 4.0 technologies to the OSH practices of small business enterprises will improve safe working conditions, increase the level of labor productivity, and provide a path to a favorable eco-environment.

Moreover, because prevention is always better than cure, eliminating barriers to reduce OHS related risks and hazards through adopion of Industry 4.0 technologies will be a good first step to guarantee a safe workplace in the present-day and in the forthcoming.

Taking into account the above, we have developed the following suggestions and recommendations for improving the OSH system in the context of "Industry 4.0":

- greater stimulation of collaborative research and development aimed at aligning labor protection with the principles of "Industry 4.0";

- development of new labor protection standards and revision of the existing ones depending on their compatibility with the requirements of using new technologies;

- taking into account human health and safety and the principles of decent work when designing a new work environment and working conditions;

- organization of permanent training courses for labor protection specialists, which will improve the influence of the principles of "Industry 4.0" on working conditions at the workplace and their skills in using new technologies;

- introduction of socio-technical approaches to the implementation of "Industry 4.0" solutions in order to ensure that technical innovations, work organization and professional development models are closely aligned with economic and social conditions in the labor process.

- promoting the allocation of subsidies and interest-free loans for small business enterprises to purchase safe and efficient production technologies and smart devices that help prevent risks and accidents to support the provision of decent working conditions for employees.

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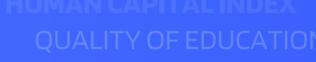
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# Mehnat iqtisodiyoti va inson kapitali