

Article

Educational Factor of Human Capital: Key Point for Sustainable Development and Strategic Competitiveness in Kazakhstan's Metallurgical Enterprise

Sergey Polevoy ^{1,*}, Mariana Petrova ²  and Assiya Atabayeva ¹ 

¹ Economic Faculty, Karaganda National Research University Named After Academician Ye. A. Buketov, University Street, 28, Karaganda 100024, Kazakhstan; atabaeva.a@karnu-buketov.edu.kz

² Department of Information Technologies, St. Cyril and St. Methodius University of Veliko Tarnovo, Theodosiy Tarnovski Street, 2, 5000 Veliko Tarnovo, Bulgaria; m.petrova@ts.uni-vt.bg

* Correspondence: s.polevoy@tttu.edu.kz; Tel.: +7-(701)-431-18-85

Abstract

This research analyzes “educational” factors influencing the human capital of a labor collective from Karaganda Metallurgical Plant from the perspective of the enterprise’s potential qualitative development. The purpose of this article is to consider the importance of educational factors in understanding the concept of “human capital” by employees of the enterprise. An additional goal is the description of various factors, influencing satisfaction with the educational component. The authors tested the following hypothesis: the factor of education directly affects employees’ satisfaction with the level of human capital development at the enterprise. The research results are based on a personnel survey about level of educational satisfaction, its quality and its accessibility. The main analysis tool to verify the stated hypothesis was structural modeling in the Smart PLS. The analysis of the research results revealed dissatisfaction from a significant portion of the respondents with the approaches to vocational education established at the enterprise, despite the fact that a high importance of the educational aspect in human capital formation was confirmed by the respondents during the hypothesis testing procedure for same survey’s results. The identified problems were explained by a discrepancy between the manufacturing tasks and the skills and knowledge acquired by the respondents. This research has the potential for development within the framework of company policy analysis in the field of education.

Keywords: human capital; educational factor; metallurgical industry; knowledge creation; PLS-SEM; discrimination



Academic Editors: Ghaleb El Refae, Ahmad Aljumah and Mohammed Nuseir

Received: 18 March 2026

Revised: 19 April 2026

Accepted: 24 April 2026

Published: 26 April 2026

Copyright: © 2026 by the authors.

Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and conditions of the [Creative Commons Attribution \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) license.

1. Introduction

The sustainable and high-quality development of the metallurgical enterprise of Kazakhstan in the form of the Karaganda Metallurgical Plant (in the city of Temirtau, Karaganda region) is especially important for two main reasons:

1. The metallurgical industry is the largest manufacturing sector of the economy of Kazakhstan, outside of the export of raw materials. In the structure of the country’s manufacturing industry, it ranks first, with 45.7% of the total share (by a wide margin from second place, which is mechanical engineering with 13.7%). The preservation of this industry is necessary for the preservation and diversification of at least a small share of the manufacturing industry in the raw material structure of the country’s economy. The Karaganda Metallurgical Plant is the only full-cycle enterprise in the

country's ferrous metallurgy sub-sector (from ore mining to the production of finished rolled steel that is competitive in foreign markets).

2. This enterprise concentrates many business processes in its business relations. It is also an employer for thousands of employees and is the basis of the urban development process of the city of Temirtau. In part, this is a consequence of the planned socialist economic system, based on which the enterprise and the city around it were founded, and is a problem for the sustainable functioning of the region's economy. Closure or curtailment of its production facilities will lead to social (increase in mass unemployment), entrepreneurial (curtailment of sustainable business processes) and environmental problems related to sustainable development, which will painfully affect many aspects of sustainable livelihoods in the Karaganda region and at the national economic level.

Any crisis in the ecosystem generates a rapid stagnation of its other constituent elements. Therefore, any risks to the mining and metallurgical ecosystem of the Karaganda region created in the 1950s and 1960s are extremely significant, destructive, and dangerous for sustainable economic development in various aspects.

One of the most dangerous risks for Kazakhstan and global metallurgy is the reproduction of human capital. This can be achieved by accumulating and attracting new professional knowledge during the gradual generational change of employees at a metallurgical enterprise. This process cannot be conducted without a qualitative improvement in the education of current and future employees of the enterprise since metallurgy is a technologically dynamic and developing industry.

The modern labor market is characterized by rapid changes caused by digitalization, automation, and other global economic trends. The metallurgical industry (ferrous metallurgy) is also subject to these trends due to the high demand for steel production, as well as the equally prominent level of supplier competition in world markets for its sale. Therefore, vocational education (received in accordance with current production standards, as well as having the potential to be applied, at least in the short term) is the main factor contributing to the workforce of industrial enterprises integrating the above-stated changes in a timely manner. In turn, insufficient qualifications of both current and future employees, represented by graduates of universities and professional colleges, reduce the competitiveness of the economy and slow down the innovative development of enterprises.

The role of human capital as a key factor in the competitiveness of enterprises is significantly increasing in the context of industrial economies' transformation and accelerated technological development [1–3]. The educational component of human capital is of particular importance, as it determines the employees' ability to adapt to technological changes, introduce innovations and increase production efficiency [4,5].

The experience of numerous European countries demonstrates successful approaches to the formation of a personnel-training system that ensures a balance between supply and demand in the labor market. The research and adaptation of these practices can contribute to improving the effectiveness of educational strategies in Kazakhstan's realities, ensuring their compliance with modern challenges and the needs of enterprises in industrial economy. The metallurgical industry is not an exception. Education is still a significant factor in effective work.

Kazakhstan's enterprises must follow the context of existing innovation processes to maintain strategic competition with others in the Asian steel market. The administration and workers of the enterprise must continuously improve their managerial and engineering knowledge. They also need to update their manufacturing skills to follow these countries successfully in modern conditions to ensure their competitiveness.

Employee education is the main criterion for enterprise effectiveness from a long-term strategic development perspective, since digitalization, automation and rapid adaptation of production technologies are available only to highly educated employees. It does not matter who they are, whether workers or administrative staff. Compliance with production and environmental standards, quality control of production and improvement of production processes are also not possible without an elevated level of educational competencies. Education is only a small part of the success for enterprises nowadays. Knowledge-keeping and skill improvement (according to reality of today's world) are the main problems of modern professional education, both outside and inside the corporate structure of metallurgical enterprises [6].

To improve employee education, it is necessary to make vocational education a part of the sustainable development for the entire production ecosystem within the structure of the metallurgical enterprise. This transformation should take its place in accordance with the principles of sustainable development and orientation for humans in organizational processes.

However, educational programs and standards usually descend from the top to bottom within corporate processes in traditional industries such as metallurgy. This is especially true for the post-Soviet enterprises, which have been developing for many years within the framework of the command and administrative system of the economy. The “manufacturing” programs of vocational schools, colleges and universities also lag behind the practical requirements of the industry.

Despite the significant contributions of existing research, the issue of the perception of the educational factor by employees of industrial enterprises remains insufficiently studied, especially in the context of developing economies and industries with high technological inertia, such as metallurgy. There is a lack of empirical understanding of the extent to which employees relate their level of education to the quality of their own human capital and professional fulfillment.

In accordance with the purpose of this study, there is a need to put a main hypothesis forward: The factor of vocational education has a positive and statistically significant effect on the assessment of the quality of human capital of employees of the enterprise (Karaganda Metallurgical Plant). To clarify the differences between groups of workers, hypotheses for gender and occupational subsamples were additionally evaluated. This formulation of the question allows us to move from a general normative statement about the benefits of education to an empirical test of its perceived significance in a specific production environment.

As part of the verification of the main hypothesis of this study, the following additional hypotheses were formulated:

H1. *The educational factor has a statistically significant positive effect on the perceived quality of employees' human capital.*

H2. *The influence of the educational factor varies depending on the gender of employees.*

H3. *The impact of the educational factor varies depending on the professional group (administrative staff/production workers).*

The formulation of these hypotheses is based on the theoretical provisions of the theory of human capital and empirical studies, indicating the heterogeneity of educational returns in various socio-professional groups [7].

There is a need to ask the question in this situation: “Is the quality of education being monitored enough?” It is critical component of the strategic competitiveness of enterprises and human capital, so there is a necessity to assess it.

The example of the Karaganda Metallurgical Plant (Karaganda region, Temirtau city) will be considered in this case. Therefore, we create a hypothesis that the factor of vocational education directly affects employee satisfaction with the level of human capital development at the enterprise, and we are going to verify its veracity in the course of this research.

However, before proceeding to reflect the data of the stated target research, it is necessary to analyze the problems inherent in vocational education in terms of working and technological specialties for modern world practice.

2. Literature Review

The problem of the quality and conformity of vocational education is one of the main problems for human capital of industrial enterprises.

Education is considered as a key mechanism for the accumulation of an individual's productive abilities and the growth of their economic return in classical theories of human capital [8–10]. Modern research develops this approach, clarifying the institutional and sectoral conditions under which educational investments are converted into labor productivity and competitiveness of enterprises.

Several studies have shown that the impact of education on the quality of human capital is heterogeneous and depends on the degree to which the acquired competencies meet the technological and organizational requirements of specific workplaces. However, education can still give a direct positive effect to the profitability of a company, and to human capital of the company as a result [11,12].

Educational investments may not have the expected effect in terms of productivity, career advancement and employee satisfaction, with a weak correlation between the content of training and the actual tasks of work. However, the educational aspect remains extremely important in the industrial economy, according to modern authors. For example, Bulgarian authors S. Raleva and S. Petranov have determined that the level of education and employment of the population into informal economy have an inverse relationship between each other [13]. Consequently, formal employment, which includes the metallurgical industry, will always depend on the quality of personnel training and their educational level. However, formal education at school and university does not always correspond to the current realities of labor market. Today, the marketing of education leads to the fact that students must learn not just a set of standard skills in the profession, but also think about how to apply them, to make themselves useful to a potential employer. In this situation, students nowadays no longer act as “classical students” but must become “co-authors” of their own education [14].

Vocational and technical education have always played a huge role in skills improving of the workforce in socialist countries, but also in market economy (capitalistic) countries like the United States of America [15]. However, the change in job performance technologies and skills required for them in modern conditions is happening too rapidly, and therefore institutions that offer vocational and technical education programs cannot ignore the changing landscape of specialties. They must always be ready for changes within their training programs and courses [16]. After all, relevant and high-quality professional education today remains an invaluable aspect for maintaining sustainable economic development. It can also still provide qualifications that are not necessary or available in general secondary education [17]. However, extensive involvement of higher and secondary vocational education holders only in real manufacturing processes cannot always

solve the problem of skills updating in the industry: neither for the enterprise, nor for the employee. Poor-quality education leaves many potential workers out of the employment system; as a result, they either remain unemployed or join the ranks of the working poor in enterprises (at best) where employers save money instead of paying well for their labor and social guarantees [18]. The weak level of modern professional competencies of the teaching staff is also a significant barrier for students. The educational system is characterized by a certain conservatism in the preparation of educational programs. If universities do not take significant measures to encourage teaching staff to seek improvement of their professional competencies, updating their knowledge and skills taught, their educational programs might significantly fall behind in modern trends and technologies for real production [19]. However, secondary specialized vocational education cannot solve all the problems of graduates in employment finding. If earlier the countries of the world tried to solve the problems of employment by stimulating vocational secondary education, today we face an opposing situation. Graduated students of higher educational institutions still get large salaries and have advantages in finding employment, compared to graduates of vocational schools [20]. The advantage of university graduates is often associated with a broader set of transferable competencies that make it easier to adapt to changing working conditions, while highly specialized skills become obsolete faster in the face of technological shifts. Employers simply give a priority for such graduates in today's volatile labor market structure.

One of the few optimal solutions is the development of retraining tools, implemented by educational institutions in coordination with government and business institutions. It is one of the most applicable policies in such a situation for vocational and technical education [21]. The problems of updating vocational education also exist in the metallurgical industry, especially in developing countries [22]. Therefore, education for this production sector should also be developed in accordance with modern trends. It should follow human-oriented production models, as well as using a new approach to the study of knowledge accumulation processes—dynamic (organizational learning) and static (accumulated knowledge)—by improving them in both aspects to reproduce the educational part of human capital. It is proposed to monitor their quality within the framework of stable cyber-social systems organization for monitoring staff activities [23].

It is impossible to predict any other method for the development of human capital for manufacturing industries against the background of widespread population aging and an increase in the age structure of workers in traditional industries (such as metallurgy). If we have older age structure of workers as is typical for our metallurgical industry, it will need a greater percentage of manufacturing automation processes for its conditional requirements. This thesis is typical for all types of large-scale industry, according to the authors of such research [3]. This approach to automation is one of the most correct solutions, but for developing countries like Kazakhstan, it is poorly feasible, since it requires serious investments in mechanical engineering. Its population structure is young in comparison to European countries, and therefore its metallurgical enterprises can still rely on the human factor by creating better working conditions for young workers. This policy still can motivate them for proper work. To do this, it is necessary to pursue a human-centered policy for human capital quality improvement. It should be designed to reduce the deprivation aspects and eliminate the phenomenon of working poverty [24].

Metallurgical industries are very important in maintaining the social and economic condition of the Kazakhstan's society of the regions, where they are located, since the basis of these territorial entities is built around them. Therefore, the reform of enterprises in terms of matching educational competencies and the development of new technologies has

a positive impact on both employment and living standards. This thesis is typical for both ferrous and non-ferrous metallurgy industries [25].

Human labor is defined as the most important factor of manufacturing in European countries, since the position of enterprises and entire economic sectors of many countries directly depends on its condition and quality, both in the internal socio-economic life of the state and in global sales markets. According to opinion of Gritsenko N.N., the key point for recognizing the results of professional education is not the length of the course of study or name of the university where it was obtained. In European countries, it is important what graduates can do in a particular workplace and what competencies they possess [26].

To reorient education towards an approach focused on the improvement and development of real production competencies, European experts in the field of education have developed a regulated toolkit for strengthening the link between education and the world of work, expressed in the format of the European Qualifications Framework (EQF). This system was designed to become a mechanism for the levels of qualification comparison of different qualification systems, for subsequent use in the development of national qualifications frameworks (NQF). National qualifications systems (NQS) simultaneously include a set of interrelated, interacting and complementary elements: professional standards based on economic activities; a procedure for recognizing professional standards; a set of qualifications, indicating the results of necessary education and training in the form of programs catalog; and a system of qualifications qualities, including assessment and confirmation procedures. Although there is such a qualification system in Kazakhstan, it lacks one aspect in the format of implementing its provisions into manufacturing process itself.

The interaction between the state, educational organizations and enterprises in the framework of graduate employment (in accordance with the interests of all represented subjects of the educational and labor process) is named “social partnership”. The purpose of this type of relationship in the field of vocational training is to achieve the following principles: free employment, harmonious personal development in the process of work, respect for state interests and business in the format of improving labor relations for economy of real sector [26]. The absence of this mechanism of interaction is the problem for Kazakhstan’s vocational education.

Metallurgical education in modern conditions has a very significant set of problems. E. Jak and P.C. Hayes identify the key ones:

- A lack of a metallurgical educational profile, when students at high schools and universities do not even have a general understanding of such a specialty and its components;
- A lack of information about the functions and technologies that the metallurgical industry brings to the industrial sphere;
- The problem of admitting students to metallurgical specialties and financing their studies [27].

As a result, there is a problem of attracting young personnel to the existing industry. However, this is not the only problem. The current state of metallurgy development shows that to consolidate young specialists in the industry; it is extremely necessary to build a system of support and development of competence.

But such a system cannot be built for a few reasons:

- Young people’s perception of metallurgy as a “harmful and dirty” industry that defies qualitative deconstruction;
- The obsolescence of educational programs and their critical lag within the pace and realities of the development of the real metallurgical industry;

- Financial pressure from universities aimed at reducing funding for programs with a small number of applicants, including metallurgy. This leads to a reduction in qualified personnel, equipment obsolescence, and a shortage of other necessary resources acquired through financing;
- Weak partnerships with industry enterprises and the scientific community;
- A general decrease in the quality of graduates due to the above reasons [28].

Even budgeting for financial support to students does not always help attract the younger generation to study metallurgical specialties.

Kazakhstan has allocated a state order (for budgetary training at the expense of the state) for the training of specialists in the group of educational programs “B171—Metallurgy” in the number of 604 places for 2025–2026 [29]. No more than 72 budget places were allocated of this quantity (11.92%).

This situation is also well-founded. In addition to attracting and training young professionals, there are also problems in organizing professional training within the enterprises themselves. They are related to the problems of the organization of labor processes, gender and job discrimination of people, because of which numerous employees of the metallurgical industry lose interest in developing their educational skills.

For example, the problem of organizing labor processes in Soviet and post-Soviet practice has always been an acute priority. Even during the periods of the most active university–enterprise partnership, metallurgical enterprises could not always survive periods of financial or structural crisis without attracting labor from outside: in particular, in the form of university students currently studying. Moreover, it should be noted that young specialists and students were often involved in the most difficult and unskilled types of work right during their training internships. There have been such egregious cases when the metallurgical industry not only ignored new potential employees in the face of students and violated the educational norms of universities, but also interfered unacceptably deeply in them, exploiting young workers to their advantage [30]. This controversial approach was explained by the management of enterprises by the “need to introduce young people to work” and the need to start a career with a less privileged status, since it was not earned by the youth with long service. Consequently, such an ageist approach did not betray the popularization industry and partially disrupted the relationship between universities and enterprises.

Despite the existence of such traditional practices, the problem of practice-oriented learning will not be solved without deepening cooperation between metallurgical enterprises and universities within the framework of production practices. The relevance of training in the real conditions of enterprises will only increase [31].

Therefore, as part of this process, it is necessary to develop clear legislative mechanisms aimed at creating a work environment that is resistant to any type of discrimination and violations of workers’ rights in their field of activity. Even the experience of socially oriented developed countries is not always positive in some cases for specific workers: being without the protection of a trade union and having few resources, they cannot always protect themselves from the arbitrariness of the employer. Only the existence of a single functioning ecosystem of trade unions, government agencies, industry committees and enterprises can protect the rights of workers in a traditionally masculine, authoritarian and conservative industry such as metallurgy [32]. Otherwise, an employee, especially one who arrives in a low position, will be disenfranchised by the fundamental strength of large metallurgical enterprises.

Neglecting the issue of how gender affects the working environment, labor and organizational processes carries the risk of reproducing a non-inclusive and repressive environment rather than transforming it [33]. On the other hand, a higher level of education for

women compared to men is one of the few ways to achieve gender equality in traditionally masculine economic sectors [34]. Several researchers also recognize gender equality in rights as the basis for sustainable development in the company's activities [35,36].

For this reason, real applied research is needed on the impact of gender attitudes towards education among focus groups of "workers" and "managers", as well as among groups of "women" and "men" in the aspect of human capital. They will allow us to consider the realities of priorities for employees in the development of their human capital. Of course, gendered structural barriers for women in industrial sectors are heterogeneous, since they are mostly determined by national institutional mechanisms and cultural expectations [37]. However, in many cases they are expressed in general characteristics: lack of proper recognition from the men's team; low wages; lack of access to some jobs during their work; and limitations in career prospects [38]. This set of factors contributes to their conscious exclusion from education in the prospects of making strategic decisions or competing for higher and more valuable positions in companies [39]. In Kazakhstan, the problem of women's participation in the manufacturing industry is not particularly considered by the expert community. It is taken for granted that women are mainly represented in low-paying industries such as public medicine, secondary education and catering services. This factor is paradoxical from the point of view of education, since women are not limited in obtaining it. They are evenly represented at all levels of education provided in the country [40]. Thus, this situation blocks the only qualitative opportunity to eliminate gender inequality in the working environment.

The lack of research on human capital in metallurgy, describing the main issues of gender, age and job discrimination for the Central Asian region and Kazakhstan, seems to be a big problem. There is no international or local literature devoted to the analysis of the impact of education on human capital with contextualization on possible aspects of discrimination. There is no information about specific recommendations for improving the quality of human capital from an educational perspective. This situation represents a significant theoretical gap in the framework of the research topic under consideration.

Despite this, there are many effective models of interaction between vocational education and the industrial environment in international practice.

The professional standard of education is regulated in the aspect of cooperation between enterprises and professional schools and colleges in the United Kingdom, without practicing at enterprises, it is impossible to get a diploma [41,42].

Germany has a dual system, expressed in the interaction of professional schools and partner enterprises in organizing students' production practices within the framework of social partnership. Vocational schools are funded entirely by state's money, from local and federal budgets. Companies themselves pay for internships at enterprises and training within their walls for students [43].

Danish development organizations (for social partnership) are actively involved in the formation of a vocational education system. They are represented in numerous professional education management institutes at various levels of government. They normalize the legislative aspects of this activity's management or directly help educational institutions to plan the content of programs to interact with the real sector of the economy [44].

Although the French model of vocational education management is classified as a model, it is dominated by public administration in accordance with the needs of the labor market. Social partners play an equally important consolidating role in it. Therefore, it is characterized by a state-social character [26].

The law "On Vocational Education and Training" has been developed for a long time and it is functioning in Finland. This country established procedure for organizing the interaction of education system and labor market. It covers legal regulation of the

entire functional period of employees' interaction with their company, starting from the bench of vocational schools and ending with the implementation of their graduates in enterprises of the real manufacturing sector. Social partners (both represented by relevant employers and public-private foundations) take a conscious and motivated part in activities of the committees for vocational training. Unfortunately, there is nothing like this in the Kazakhstan's metallurgical industry in terms of inter-institutional cooperation within such a framework. The Finnish state provides significant incentives: subsidies (grants) to employers who provide internships for students of VET educational institutions and organize in-house training for their own employees, and tax benefits to enterprises actively involved in the development of VET [26,45].

Large corporations actively invest to the educational process of their employees in the United States by financing these processes from their own funds. Training often provides mentoring and on-the-job practical training, and happens in form of group projects [46].

The Japanese model, on the other hand, is more characterized by internal corporate staff training, when they practice in manufacturing environments. Newly arrived employees are trained under the guidance of more experienced and senior mentors, who explain to them not only the production process, but also the labor collective's values within the framework of the current corporate culture. This approach supports the formation of a sense of family and belonging to the company, as well as increases their stable loyalty to it [26].

We can conclude that the Japanese and American approaches are more widespread in the Kazakhstan's realities, based on the consideration of the presented options above. The specifics of mentoring in manufacturing conditions have justification, since it was formed during the years of socialist management and it is very difficult to abandon this institution in such a short time because of industrial realities. There is complete non-interference of the state in the process of professional training for employees from the American approach. It is also funded and defined within the target directives of the companies from their side only: from organizational to financing part. A striking example of such an enterprise is the Karaganda Metallurgical Plant, where standardization of personnel training and qualifications is determined only by internal corporate services, meeting state requirements only in terms of compliance with the requirements of general provisions (within the framework of labor legislation). However, this approach is not conscientious of the aspects of industrial education development for manufacturing personnel under the conditions of the Karaganda Metallurgical Plant for several reasons.

Firstly, the institution of mentoring is fading away at the enterprise, due to its ideological transformation from the planned social context to the capitalistic competitive perception of labor reality by employees. There is no place for mentors now—each employee competes for their performance. Secondly, the patriarchal-family concept of corporate organizations is a feature of traditional Japanese morality. Such morality was mercilessly destroyed by communist ideology during the construction of socialist-type industrialization, and the concept of "family" was replaced by that of "collective", which also has no relevance in today's conditions. Thirdly, Kazakhstan's enterprises do not have enough money to maintain the educational level based on their own financing within the framework of the American model, as exemplified by American private owners (as domestic investors). Their abilities to invest in human capital are different.

Therefore, in conditions of fierce competition with foreign manufacturers, Kazakhstan's metallurgical companies must find the best approaches for adaptation. In our opinion, the example of such an adaptation is the European (specifically Finnish) model, combining state control in labor standardization, state co-financing and goal-setting of educational activities, expressed through the work of trust funds for the development

of industrial education, which at the same time will take into account mutual interests: interests of both the employee and the employer.

This model is the most acceptable for Kazakhstan, as it is based on the principles of universality, equal opportunities and systematic professional development.

If the metallurgical industry is not popular for employment among the general population, the threshold for entry into it and the level of assistance for vulnerable workers should be lowered.

However, society must be prepared for the inclusive implementation of the Finnish model, both to attract more women and young professionals to the industry and in terms of full respect for the rights of these vulnerable groups, especially in the positions of ordinary industrial workers.

Therefore, to preserve the sustainable development of the metallurgical industry, it is necessary to conduct research on the public opinion of workers, focused on focus groups of vulnerable workers. It is with consideration of approaches to improving vocational education in metallurgy, focused on the opinion of the workers themselves, that the true inclusivity of the development of the work environment begins.

It is extremely difficult to expect a social partnership between employee and employer, because cost savings in financing the development of human capital is sometimes a way to maintain the survival of the company from an employer's perspective. Nevertheless, this role of social partnership should be performed at the macroeconomic level under control of the state and industry trade unions. To identify the need for such a work in the practical realities of the ferrous metallurgy industry in Kazakhstan, it is simply necessary to analyze the unsatisfactory characteristics of the current system for intra-industry social partnership between employer and employee, currently represented in the present socio-economic paradigm, operating on the example of the Karaganda Metallurgical Plant.

However, it is necessary to understand the idea of education with high quality not only from the side of employer or state, but also from the side of employee.

Without this, its full actualization is not possible. To identify relevant issues within the framework of this concept, we used the following survey methodology and prioritization analysis for its results.

3. Materials and Methods

It is possible to determine the attitude of employees for the importance of education in the formation of high-quality human capital only through a survey about their opinion, either through direct interviewing or a questionnaire. We chose the survey method because the company is a high-security facility with a strict access control system and a standardized working day structure. The questionnaire method allows employees to answer questions remotely and more meaningfully, since they can answer them in their free time, excluding subjective factors such as the interviewer influencing the respondent (in the period when they are being interviewed).

The survey about the aspect of the educational factor was provided as part of a continuous survey about the factors influencing the quality of human capital, in the format of two questionnaires. The first questionnaire showed the qualitative attitude of respondents to education; the first "educational block" consisted of 10 questions (out of 32) to assess the quality of various educational aspects (8 questions were mandatory to answer, 2 were optional). The second questionnaire did not contain a standard quality assessment scale in the answers, as the answers were more specific and clarifying; it contained 6 questions from the "educational block" out of 20. The first questionnaire had a set of questions that filtered respondents by gender, professional and age. The results of the survey became the basis (materials) of research for the application of individual methods in their processing and

interpretation. A total of 155 respondents were interviewed. The questionnaire materials are presented in Appendix A of this research.

It is also necessary to note additional methodological aspects related to the specifics of the survey. The sample was collected based on the professional affiliation of employees who are employees of the “Qarmet” JSC Steel (Metallurgical) Department, since the electronic link to the questionnaire was sent only to the company’s structural divisions (to the Personnel Service of the Steel Department and the heads of structural production workshops). A questionnaire with survey questions was not sent for any contracting or other non-core enterprises. The participation of the respondents was completely voluntary and anonymous. In support of this, it is necessary to mention the criteria based on which the questionnaires were compiled:

- The absence of identifying questions in the questionnaire block for filling out personal data (according to the names of respondents, passport data, and other personalized identification criteria), except for specifying gender, age, work experience, form of education received, and job classification (working and administrative) with its specifications;
- The questionnaire was sent out as an online google survey link. It was provided only for the respondents to complete the survey in an online format. It did not require the researcher to be near the interviewed respondents: therefore, the risk of researcher influence on the survey results was negated;
- The questionnaire was not time-limited (in days, hours, minutes, seconds) and scheduled for completion between 15 october 2024, and 15 november 2024 (until the response form was closed). There were no time limits (within a given period of 1 month) for deep reflection and awareness of respondents’ responses. The authors wrote the estimated time for the respondents to complete the survey in the preamble to the questionnaire: no more than 10 min in total. However, the authors did not establish any mechanisms limiting the temporary passage, and they also did not give direct recommendations to respondents about the speed of filling out responses;
- The survey format was the most favorable, as it did not distract employees from their work activities. They could take it in their free time (any time convenient for them);
- The respondents were previously introduced to the definition of human capital, defined in the preamble of the questionnaire as follows: “the human capital of an industrial enterprise is a concept that considers professional self-realization and employee satisfaction with their professional activities in four aspects: motivation to work, vocational education, social guarantees and compliance of the company’s implementation of all these aspects with your professional ambitions.”

Regarding the ethical aspect of the study, the following provisions should be mentioned:

- The survey was conducted based on the signed Memorandum “On cooperation between “Qarmet” JSC and “Karaganda Industrial University” NPJSC (the place of practical work of the corresponding author of the article for the period of the survey). This document implies the free conduct of scientific research activities, in accordance with paragraph 1.1, in cases that do not imply the disclosure of confidential information, commercial, industrial or legally protected secrets (paragraph 4.1).
- The additional Report of the Commission for Ethics in Science (about the verification of the University’s scientists’ article for compliance with ethical standards) from the “Karaganda National Research University named after academician Ye. A. Buketov” NPJSC also confirmed that the study does not violate the ethical principles of scientific activity when conducting surveys of respondents. The conclusion confirmed the compliance of the study with legal norms in terms of compliance with the na-

tional legislation of the Republic of Kazakhstan on ethics in research activities. This confirmation was expressed in the following paragraphs:

- all respondents surveyed were in status of current employees of the company and were over the age of 18 years (they had reached the age of majority) at the time of the research period;
- the content of the questions did not directly relate to the field of medicine or healthcare of the respondents (in a personalized context). Their personal medical data was not collected;
- the survey of respondents was conducted anonymously, without specifying their personal data (names, phone numbers, e-mail and other identifying data), in an online format, on a voluntary basis (only based on the respondents' desire to participate in the survey in person). Consequently, the personal data of the respondents could not be disclosed in any way.

Commission for Ethics in Science of the University concluded that the study does not violate ethical standards in terms of national legislation regarding the participating respondents and can be published in open sources (based on these facts).

The initial questionnaire was written in Russian, since this language at the enterprise (Karaganda Metallurgical Plant) is the language of business correspondence, organization of labor relations and production activities. It is also understandable to the largest number of respondents of the enterprise, which significantly expanded the sample of the study. For this reason, translation and reverse translation procedures were not applied within the framework of the survey organization.

All 155 respondents who took part in the survey completed the survey at 100%, since all but two questions (1_9 and 1_10) were mandatory (indicated in Appendix A). The results of survey questions 1_9 and 1_10 were not included in the final model, as there were respondents who could not answer these optional questions. Consequently, the missing data and outliers, as well as their structural variables, were eliminated in advance from the model presented in the study results.

The percentages of the responses received for assigning respondents to the target focus groups were almost comparable. A breakdown of 55.5% of men (86 people) and 44.5% of women (69 people) participated in the study out of 155 respondents. Also, among the 155 respondents, 60% belonged to the group of production workers (90 people), and 40% belonged to the administrative staff (62 people). Therefore, the percentages of the identified focus groups are approximately equal.

There was no bias on the part of the authors in establishing the sample. The model included all the results obtained from the survey of all 155 respondents who took part in the survey and completed the responses in the Google Survey form.

Statistical comparisons of the obtained data were used as the analyzing method, expressed in the interpretation of the statistical proportions of respondents' responses to each question in a specific semantic definition of each option. The least squares structural modeling method was used in the Smart PLS program (version 4.0) to test the hypothesis about the direct and significant influence of the "educational" factor to the "quality of human capital", according to the respondents (H1) [47]. This software package was used to build a structural econometric model for verification of:

- (1) The importance of questions for respondents in terms of education, expressed in matrices of external loads;
- (2) The statistical significance of respondents' sample within the framework of this model;
- (3) The strength of the correlation between "educational" factor and "quality of human capital" factor in the model for common sample and special focus groups (men and women; administration and main manufacturing workers);

- (4) Additional hypotheses, created to confirm the general hypothesis by analyzing the coefficients of the path, using Bootstrapping analysis tools [48].

To complete full visualization of the research's data, the hypothesis was confirmed for special samples of employees: for the common sample of respondents (1 common group) and for four additional focus groups; two gender divisions, men and women, and two focus groups with the division for specifics of staff activities, administrative employees and main production (manufacturing) workers. To confirm, we established five additional hypotheses, presented in Table 1.

Table 1. Hypotheses for Bootstrapping analysis in the Smart PLS 4.0 program, presented within various samples of respondents (first one for common group and 4 for focus groups), 2024.

No	Formulation of the Hypothesis
H1	There is a direct statistically significant relationship between the factor of education and the quality of human capital for the general sample of enterprise employees.
H2	There is a direct statistically significant relationship between the factor of education and the quality of human capital for the “men” focus group of enterprise employees.
H3	There is a direct statistically significant relationship between the factor of education and the quality of human capital for the “women” focus group of enterprise employees.
H4	There is a direct statistically significant relationship between the factor of education and the quality of human capital for enterprise employees (in the focus group of administrative staff).
H5	There is a direct statistically significant relationship between the factor of education and the quality of human capital for enterprise employees (in the focus group of manufacturing workers).

Source: Compiled by the authors.

The hypotheses, stated in Table 1, help us to test the validity of main hypothesis of research that the quality of education directly affects the quality of human capital (for common sample, in general meaning) by Bootstrapping procedure, with analysis of *p*-values and T statistics. It is important to prove that the quality of human capital plays a significant role in this case for some groups of respondents. *p*-values should have lower meaning, than 0.050 (<0.050); T statistics = or >1.96 [49]. This focus for individual groups allowed us to analyze the impact of educational factor to human capital in way that is more detailed.

There are several reasons why the authors used the PLS-SEM modeling methodology (as part of the Smart PLS version 4.0 software package) to confirm structural hypotheses:

- The method allows modeling complex relationships between hidden (latent) structural variables within the framework of visual model representation using the software package of the same name;
- The method allows modeling formative structures from various factors (influencing other individual factors or groups of factors) by establishing a direct (from one variable to another) structural relationship between them;
- The method does not require strict normality of the data distribution and allows researchers to work with small sample sizes (as in the case of this article, when more data could not be collected);
- The method is applicable for testing theories and hypotheses when conducting research with socio-economic content. This is expressed in the aspect of displaying power for significance (influence) statistical relationships within the framework of structural representations of related elements;
- The method can process the results of sociological surveys on economic issues (provided that the results are correctly encoded);

- The method supports multigroup types of analysis (for example, mga permutation analysis), which is important for researchers when conducting group comparisons in the context of testing the main hypothesis of this article.

It was decided to design and present a formative model of the quality of human capital within the framework of this study, because of the conditions described above. They favor the creation of a multifactorial model for describing complex social constructs (such as the “quality of human capital” factor).

The quality of human capital within its framework is formed due to the influence of 7 different variables on it, among which is the factor of “education”. Each factor in the visualization of the model, as well as within the framework of the statistically reflected structural relationship, shows the direct influence of the “education” factor on the “quality of human capital” factor. In other words, each factor, including “education”, directly shapes the “quality of human capital”. In this way, the design of the model is presented as formative, since it includes in its factors, such as “education”, heterogeneous elements in the form of access to educational resources, institutional conditions, subjective satisfaction of respondents with all factors of the educational environment and respondents’ perception of educational opportunities (specifically in the context of the block of questions on the education factor).

Indicators (education, income, social policy, etc.) jointly form a concept and are not required to correlate with each other in contradistinction reflexive constructions, where indicators display a single latent property, in formative structural models [31]. Therefore, the authors do not build additional relationships between them, since the idea of the study does not initially imply this.

Within the framework of the presented model, each indicator (factor), such as “education” or “income”, is considered as an “independent contribution” to the formation of the overall structure of the concept of “quality of human capital”.

The “quality of human capital” is interpreted as a perceptual integral assessment of employees’ own professional worth in this research, including satisfaction with the educational level for their professionalism, professional motivation, income level, etc.

It is particularly noteworthy that “education” in the framework of this model is a direct component of “human capital”, according to generally accepted theoretical descriptions, while other factors are considered as purely contextual, influencing the perception of the “quality of human capital” by respondents.

The survey results obtained for presentation within the framework of the model were appropriately encoded according to the standard and frequently used encoding (Likert-type scale), since the format of answers to the questions presented for the structural components of the model (from 7 to 38) had the same values. However, only 5 options were presented; therefore, the encoding was carried out on a scale from 1 to 5 (from the most negative response to satisfaction with the criterion in question (1) to the most positive (5)). The encoding is shown in Table 2:

Table 2. Coding of respondents’ answers to the survey’s questions for presentation of their results within PLS-SEM structural model’s format (in shortened Likert-type scale).

Code of Answer	Code’s Meaning
1	No
2	Rather no
3	It is hard to say
4	Rather yes
5	Yes

Source: Compiled by the authors.

According to the encoding provided in Table 2, the data was able to be encoded in an appropriate, statistically rigorous manner. After they were uploaded to the Smart PLS program (version 4.0), structural latent variables were formed for them (for each thematic block of questions, including the “education” factor). The results of the questions were included in each profile (factorial) latent variable, and direct structural links were drawn from the latent variables, forming the “quality of human capital” indicator.

Two types of calculations (using standard structural modeling algorithms) were implemented for the general sample and four focus groups as part of presentation for the formed structural model:

1. PLS-SEM algorithm (to check the overall predictive power of each model, as well as its reliability and validity indicators) for use in further interpretations;
2. Bootstrapping analysis (for the initial testing of structural hypotheses for the significance of the path in the direct relationship between the factor of “education” and “quality of human capital” for the general sample and focus groups).

Separately, a permutation multigroup analysis (MGA) was conducted between focus groups of women and men to establish the actual statistical significance in terms of multigroup differences in the perception of the importance of the “education” factor on the “quality of human capital”.

Based on the interpretation of the data on the results of the claimed calculations (presented in Section 4) obtained within the framework of the methodology under consideration, the corresponding theoretical conclusions were later presented (Section 6).

4. Results

The analysis of the results for survey of employees from the Karaganda Metallurgical Plant shows us the following indicators of their attitude to the quality of education, as part of human capital’s formation. The first question was presented with the following words: “Do you improve your skills on an ongoing or temporary basis?” The results of their responses are presented in Figure 1.

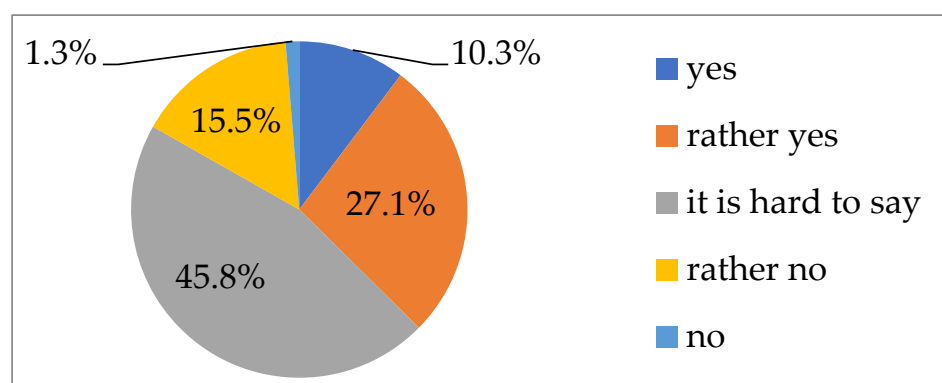


Figure 1. The results of respondents’ answers about the frequency of educational qualification improvement (155 responses). Source: Compiled by the authors, based on Karaganda Metallurgical Plant employees’ survey results (2024).

The results of the respondents’ responses to the stated question (1_1 in model), shown in Figure 1, demonstrate the following indicators: 37.4%, almost half of the employees, always do this; 45.8% find it difficult to answer this question; and 16.8% of employees are not involved in the process of obtaining production qualifications. These results indicate the importance of systematically improving educational level, associated with the work

process, for almost half of the company's employees, since among the doubters there may also be respondents who systematically improve their skills.

The next question (1_2 in model) for the respondents was formulated as follows: "Do you have any opportunities to improve your professional skills at the workplace by payment from the side of your employer (at universities, colleges, additional courses and seminars, during internships at other enterprises)?" Only 16.2% of respondents stated that they had such an opportunity, 41.3% found it difficult to answer, and 42.6% replied that they were deprived of such an opportunity. Consequently, out of the total number of employees, almost half of the surveyed employees are deprived of the opportunity to receive any professional education paid by the enterprise.

Approximately similar data is shown to us by the results about another question (1_3): "Are you satisfied with the system of professional development/education for the payment of your employer?" A total of 12.9% were satisfied with the vocational education system, paid by employer, 42.6% found it difficult to answer, 44.5% were clearly not satisfied with this aspect. The number of dissatisfied respondents is directly correlated with the number of those who do not receive vocational education opportunities financed by their employer, but the percentage of satisfied respondents was significantly lower, even though 16.2% of respondents indicated having the opportunity to receive vocational education.

The next question (1_4 in model) had a different formulation: "Does the development of your educational competencies contribute to the improvement of other aspects, forming your human capital at the enterprise (career growth, growth of social guarantees, income, health, a sense of personal fulfillment, etc.)?" A total of 36.2% of respondents stated that education directly affects the quality growth of other aspects for their professional realization and human capital, 51% of the respondents had doubts about this issue, and 12.9% answered that education does not play a significant role in this aspect.

Within the framework of the question (1_5 in model) "Does education contribute to the professional and personal growth of an employee in this enterprise (in your opinion)?", the respondents' opinion was divided as follows: 43.9% believed that education contributes directly to the growth of employees within the enterprise, 44.5% doubt this, and 11.6% believed that education does not play a significant role in this process.

The next question (1_6 in model) concerned the place where the respondents completed specialized internships. It was presented in this way: "Does the company provide you with advanced training courses or professional training in its educational centers?" A total of 14.9% of the respondents stated that they did, 44.5% expressed doubt about this issue, and 40.6% answered negatively.

According to a different formulation of the same question (1_7 in model), "Does the company provide you with internships, based on the functions of your professional activity, at any other enterprises (at other enterprises of the company's structure and outside its structure also)?", the respondents demonstrated this structure of their answers: 7.1% of respondents declared the possibility of obtaining professional internships at other training centers. 46.5% doubted this possibility of their organization, and 46.5% said that it is impossible. In other words, we can see that the priority in employees' training is still given by the enterprise in the format of internal corporate structure.

Now we move on to the most important issues, in our opinion, reflecting the essence of the problem with education in its impact to the quality of human capital. These issues affect the procedural nature of the possibility of obtaining professional education financed by the employer.

The first question (1_8 in model) was this: “Does your company have a program/strategy for developing professional and personal skills of employees?” A total of 11.6% of respondents knew for sure that such a program exists, 51% of employees found it difficult to answer, and 37.4% said that it does not exist.

The second question (not obligatory, not included in model) was formulated in this way: “If there is such a program/strategy, does it meet your expectations of the improving and developing quality for your professional/personal skills?” A total of 10.4% of respondents answered about the program’s compliance with their ideas (about the quality of professional knowledge and skills development), 64.6% doubted it, and 25% said that they are not.

The third question (not obligatory, not included in model) was stated in the following words: “If there is such a program/strategy, does your company have a single, accessible, clearly defined and practically implemented mechanism to application for education level upgrading?” A total of 11.8% of respondents told us about the existence of such a mechanism, 63.2% doubted its existence, and the same 25% thought that it does not exist.

As we can observe from the survey results from all three presented questions about the procedural nature of obtaining vocational education, the answers demonstrate consistency in terms of proportions presented and are logically explicable within their framework.

However, it is important to review the results of respondents’ responses to clarifying research questions on the “education” factor block, which affects the quality of human capital in the concept of our research. It is necessary to do this before testing the stated hypothesis (about the importance of vocational training in human capital’s formation) through a structural econometric modeling. The difference between these questions and the previous ones is that they are not ranked according to the rating scale of answers in a single format, according to the Likert scale criterion (from 1 to 5: “no”, “rather no”, “it is hard to say”, “rather yes”, “yes”—our coding legend).

We will not build a PLS model based on them, but their interpretation will be extremely important in the discussion block, since they contain detailed and differentiated answers. To demonstrate their difference from the ranked survey’s questions, we use the example of the respondents’ answers in a pie chart, shown in Figure 2, answering the following question: “Does your company give opportunity to improve the level of education for its employees at universities and colleges (in Kazakhstan) by allocation of targeted studying grants (financed by company)?”

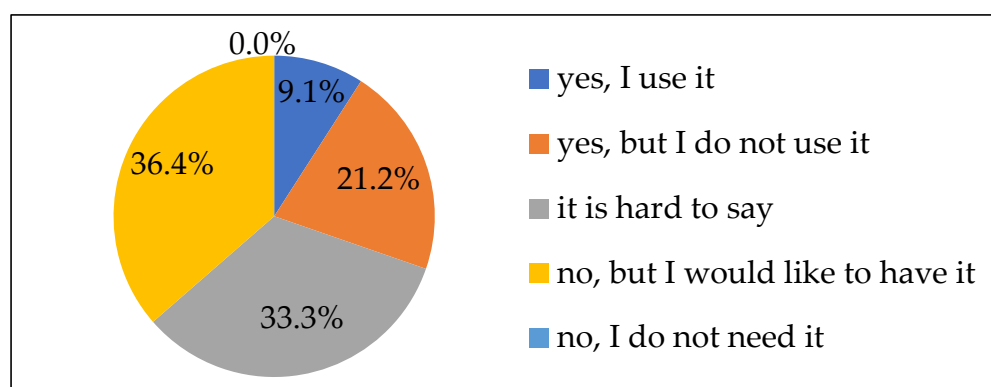


Figure 2. The results of respondents’ survey about the possibility of targeted grants (financing) provided by an enterprise to study at universities and colleges (in Kazakhstan, for enterprise’s financing) (155 responses). Source: Compiled by the authors, based on Karaganda Metallurgical Plant employees’ survey results (2024).

A total of 30.3% of respondents stated that such grants were given to them, and 33.3% of respondents did not know about their existence. About 36.4% believed that they are not provided, but at the same time, they would like to study, if it would be possible within the company's financing. The next clarifying question was: "Can employees (of the enterprise) get the opportunity to improve their educational level within the company's training centers?" A total of 39.4% of respondents were sure that such an opportunity exists, 36.4% doubted it, and 24.2% did not know about the availability of such an opportunity. Then, we asked the following question: "Can employees (of the company) get the opportunity to improve their educational level through internships in other enterprises (outside the corporate structure of "Qarmet" JSC)?" A total of 6.1% said they use it, 57.6% found it difficult to answer, 33.3% would like to use it but do not have such an opportunity, and 3% of respondents said they do not need it.

To the question "Which way did you use to improve your level of professional education (the most frequent way), paid by company's financing?", respondents answered in this way: 15.2% received education paid for by the company at university; 36.4% studied at the company's training center; 3% studied outside the company, but used its educational payment, 33.3% said they would like to, but did not receive approval or referral from the company for training, and 12.1% stated that they did not use this opportunity, because of the absence of a personal desire.

The question "What is the most effective way to improve your level of professional education, paid by the company in your opinion?" was answered by the respondents as follows: 30.3% of respondents believed that they can get the best education, paid by company at the university. Almost half of the respondents (45.5%) believed that the most effective way was internships at enterprises outside the company, but paid by it. Only 3% considered internships within the company to be effective, while 12.1% considered internships at its training center to be effective. A total of 9.1% believed that none of these methods are effective enough: 6.1% indicated they did not need education, while 3% were averse to the effectiveness of education because they are not involved in its framework at the company, and do not think that education is a great desire.

The last question, presented among the stated ones, was formulated in this way: "How often do you participate in short-term professional training at the company's training centers (in advanced training courses or in industrial training)?" Only 3% of respondents participated in training quarterly, 15.2% every six months, 30.3% once a year, 33.3% every three years, 3% every five years, and 15.2% do not complete them at all, without participation.

These are the results shared by the respondents, based on the results of this survey. Using these results, we tested the hypothesis about the direct importance of "vocational education" factor to the quality of human capital of employees. This verification was carried out through Bootstrapping analysis in the Smart PLS program (version 4.0). To test the stated hypotheses, we constructed a structural PLS model for numerous factors of human capital, as shown in Figure 3.

If we consider the model (presented in Figure 3) from the standpoint of statistical and predictive reliability, it fully meets the necessary criteria. The R^2 value (coefficient of determination) of the model is in the range above the average; it is 0.645, which means a good predictive power of the model.

The composite reliability indicators for "education" factor and for the rho_c and rho_a indicators are >0.7 (0.850 and 0.874 respectively for each one). Cronbach's alpha is also high (0.860). The discriminant validity according to the Fornell–Larcker criterion is respected, as evidenced by the information presented in Table 3.

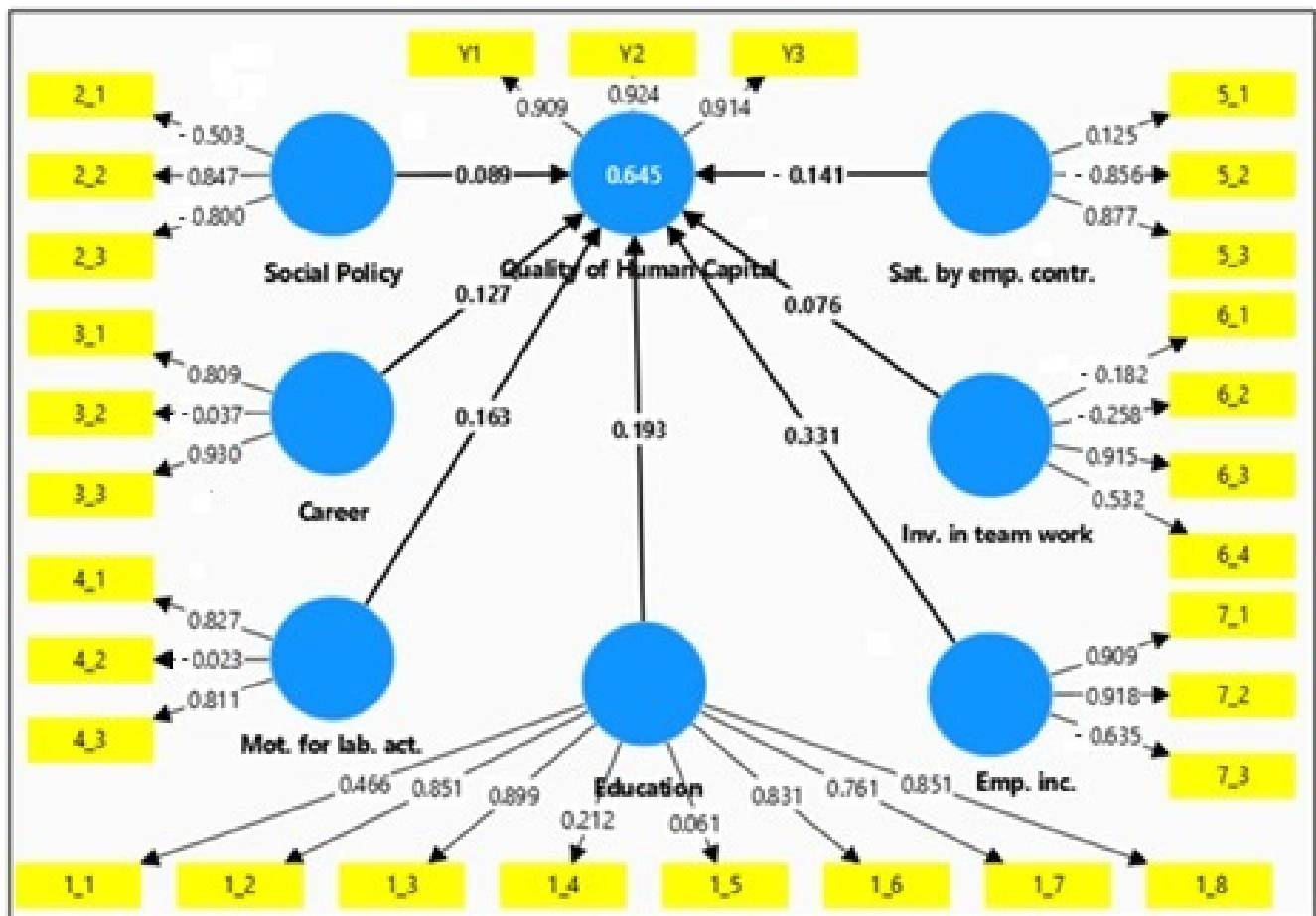


Figure 3. Structural model of factors with influence to human capital's quality for the common sample of respondents. Source: Compiled by the authors, based on Karaganda Metallurgical Plant employees' survey results (2024).

Table 3. The results of model's checking for discriminant validity, according to the Fornell–Larcker criterion, 2024.

Fornell–Larcker Criterion	C	E	EI	IiTV	MfLA	QofHC	SwIC	SP
Career (C)	0.712							
Education (E)	0.619	0.689						
Employee's income (EI)	0.468	0.404	0.831					
Involvement in teamwork (IiTV)	0.554	0.482	0.420	0.552				
Motivation for labor activity (MfLA)	0.211	0.353	0.247	0.206	0.669			
Quality of human capital (QofHC)	0.611	0.616	0.652	0.531	0.388	0.916		
Satisfaction with employment contract (SbIC)	−0.561	−0.469	−0.488	−0.575	−0.118	−0.566	0.711	
Social policy (SP)	0.605	0.570	0.480	0.429	0.181	0.557	−0.432	0.733

Source: Compiled by the authors and based on PLS-SEM analysis of survey results (1 December 2024).

According to complete statistical consistency of the model for Fornell–Larcker criterion’s compliance (value of each same crossing legend should be higher than meanings below column, presented in Table 3), we proceeded to the consideration of model values in the “Education” block.

Evaluating the matrices of external loads, based on the “Education” factor, statistically important values achieved high results for questions: 1_2 (0.851), 1_3 (0.899), 1_6 (0.831), 1_7 (0.761), 1_8 (0.851). Specifically, these questions are: the possibility of professional development in the workplace (1_2), satisfaction with it (1_3), the provision of advanced training courses in corporate (internal) and external educational centers (1_6; 1_7), as well as the availability of a professional skills program/strategy (1_8). They are all within the category of questions that are important to respondents (with a value > 0.7).

Considering individual focus group models, the results present a situation with a similar context. For example, in the model, based on the survey’s results of “administrative staff” focus group, R^2 is the average value and does not have as high predictive power as in the general sample ($0.645 > 0.544$). However, the matrices of external pressures for “Education” factor still play an important role for the respondents of this focus group, which is expressed in quantitative indicators and based on their answers to the questions (1_2), (1_3), (1_6) and (1_8). All of them are presented with a high strength value (> 0.7), except for question (1_7), since training in external educational centers is apparently not so important for this focus group (which is quite strange, because administration is the target audience for external training). Information about this aspect is presented in Figure 4:

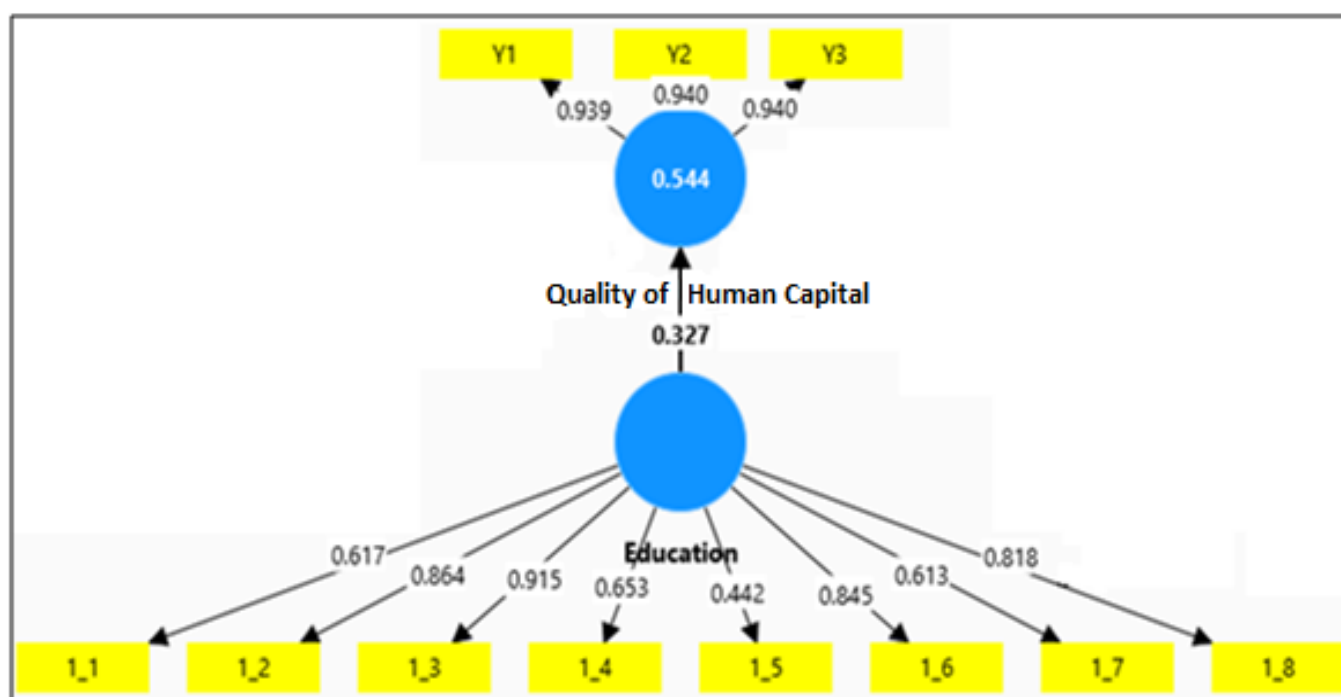


Figure 4. Structural model of human capital’s quality for the focus group “administrative staff” (in the context of educational influence). Source: Compiled by the authors, based on Karaganda Metallurgical Plant employees’ survey results (2024).

We have considered the information presented in Figure 4. Now, we proceed with consideration of an analogical model for the “main (production) workers” focus group, involved in manufacturing processes of metallurgical products.

This model has an even higher predictive power than the previous one ($0.744 > 0.645 > 0.544$) in terms of R^2 . The external load matrices are as high in their values as in the general (common) sample model, within the framework of the alloca-

tion for questions (1_2), (1_3), (1_6), (1_7) and (1_8), which makes the results of these indicators fundamentally similar to the model of the respondents' common sample. To the question of the continuity for professional development (1_1), as well as to the impact of education to the quality growth of other aspects of human capital (1_4) and the professional and personal growth of the employee (1_5), the respondents demonstrate united indifference.

This may be due to a misunderstanding of the question by the respondents. It also can be described by prevailing opinion that the education factor does not affect these individual aspects. Information about this model is presented in Figure 5.

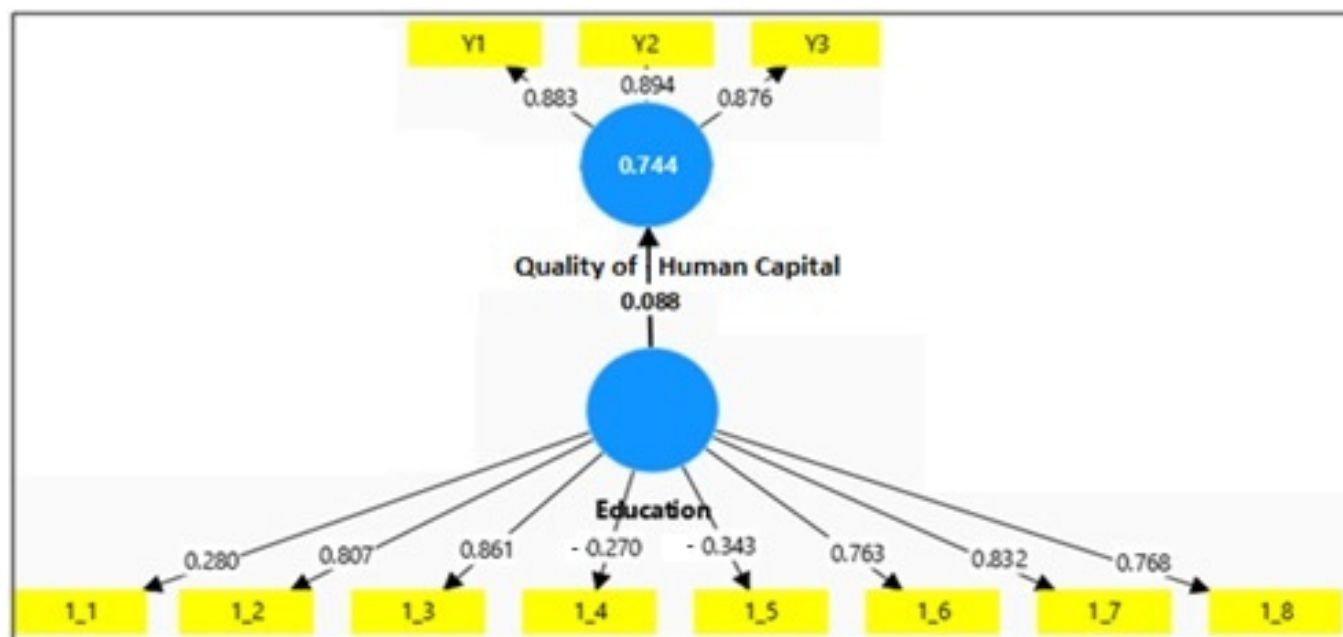


Figure 5. Structural model of human capital's quality for the focus group "main working (manufacturing) personnel" (in the context of educational influence). Source: Compiled by the authors, based on Karaganda Metallurgical Plant employees' survey results (2024).

If we consider the gender focus groups separately (Figure 5), the predictive power of R^2 in the models is higher for the "men" focus group relative to "women": $0.766 > 0.624$, respectively.

The "men" focus group shows high values on the external load matrices, which are similar to the focus group of the main production workers and the general sample (>0.7) for the questions (1_2), (1_3), (1_6), (1_7) and (1_8).

The "women" focus group demonstrates high values for the factors (1_2), (1_3), (1_6) and (1_8). It has direct analogy with the "administration" focus group.

Visualization of these models by gender focus groups will be presented in appendices B (for men) and C (for women), because there is no need to overload the main research's text with an excessive number of illustrations. These data are quite logically explicable, since among men, a greater number are represented among workers of the main (industrial) production, and a greater number of women are represented among the administrative staff.

All models were visually presented, as well as comparisons of their predictive power in terms of R^2 in relation to each other, and the indicators of the external load matrices were analyzed.

However, it is equally important to check the mathematical indicators of the models for all focus groups, confirming their reliability and validity for the "education" factor.

This was done before model testing for the significance of the path within individual focus groups. These indicators are presented in Table 4.

Table 4. Reliability and validity coefficients for models of all focus groups within the “education” factor (common sample + focus groups), 2024.

Construct Reliability and Validity Coefficients for Model’s Check Up	Cronbach’s Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
Education (Common group, no focus)	0.810	0.902	0.853	0.474
Education (“Men” focus group)	0.835	0.917	0.871	0.503
Education (“Women” focus group)	0.777	0.906	0.828	0.448
Education (“Administration” focus group)	0.872	0.910	0.901	0.543
Education (“Manufacturing workers” focus group)	0.696	0.868	0.753	0.441

Source: Compiled by the authors and based on PLS-SEM analysis of survey results (1 December 2024).

Cronbach’s alpha > 0.7 for all groups with small exception for group of “manufacturing workers” (Table 4). This indicates good reliability of the scale for most groups in the “educational” factor. There is a high level of internal consistency of indicators in the variable “education” for all structural models.

Composite reliability (rho_a and rho_c) is also >0.7 for all focus groups and the general sample. This alternative reliability indicator considers the different load of the indicators. In this case, the high consistency of the data is confirmed by this reliability criterion.

The average variance extracted (AVE) has the weakest values for the education factor. It is not satisfactory for the general sample, as well as for the “female” and “working” focus groups (<0.5).

This indicates that the convergent validity of the model is not very good, since the indicator reflects the proportion of variance explained by this latent variable in the overall structure of the formative model. For the indicators of the “male” and “administrative” groups, this indicator is satisfactory.

If we analyze the reliability and validity of the educational factor in the overall structure of the presented models, only four of the 20 values presented are unsatisfactory (and not very critical). Therefore, the model is reliable and mathematically valid within the framework of these indicators by 80% out of 100% possible.

However, this information does not show us full picture. In addition, it is necessary to consider the correlations between the factor “education” and “quality of human capital” before testing the hypotheses of the focus groups.

There is a need to consider these correlations, as shown in Table 5.

It can be concluded that correlation indicators between “education” and “quality of human capital” are close to a strong value for the male focus group, based on the results presented in Table 5, as well as partially for the group of administrative staff.

Table 5. Correlations between the “educational” factor and factor of “human capital’s quality” for all 5 groups, stated in the hypotheses (common sample + focus groups), 2024.

Correlations Between “Education” Factor and Other Factors Within Models for Different Focus Groups, Including “Quality of Human Capital”	Education (Common Group, No Focus)	Education (Men Focus Group)	Education (Women Focus Group)	Education (Administration Focus Group)	Education (Workers Focus Group)
Career	0.619	0.639	0.585	0.643	0.528
Education	1.000	1.000	1.000	1.000	1.000
Employee’s income	0.404	0.457	0.364	0.346	0.469
Involvement in teamwork	0.482	0.562	0.419	0.392	−0.516
Motivation for labor activity	0.353	0.425	0.306	0.632	−0.192
Quality of human capital	0.616	0.694	0.558	0.635	0.545
Satisfaction with employment contract	−0.469	−0.576	−0.326	0.482	−0.507
Social policy	0.570	−0.582	0.545	0.490	−0.636

Source: Compiled by the authors and based on PLS-SEM analysis of survey results (1 December 2024).

The correlation values of the female focus group, as well as the main workers in industrial employment, underestimate indicator of common sample for all respondents, bringing it to 0.6. Therefore, hypotheses cannot be tested here. Correlations of individual groups show a connection, what tends to average values, bringing the indicator for the overall sample from their meanings. On the basis of considered situation, we can conclude that there is no way to check reliability of educational influence to the quality of human capital without basic Bootstrapping testing. Its results are presented in Table 6:

Table 6. The Bootstrapping testing results for the stated hypotheses in the context of common sample and focus groups (about the direct impact of the educational factor to the quality of human capital in the perception of respondents), 2024.

Path Coefficients Mean, STDEV, T Values, <i>p</i> -Values	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	<i>p</i> -Values	Hypothesis Status
Education -> Quality of Human Capital (Common group, no focus)	0.193	0.200	0.077	2.492	0.013	Approved
Education -> Quality of Human Capital (“Men” focus group)	0.201	0.206	0.092	2.179	0.029	Approved
Education -> Quality of Human Capital (“Women” focus group)	0.176	0.177	0.127	1.389	0.165	Disproved
Education -> Quality of Human Capital (“Administration” focus group)	0.327	0.308	0.151	2.161	0.031	Approved
Education -> Quality of Human Capital (“Manufacturing workers” focus group)	0.088	0.107	0.078	1.117	0.264	Disproved

Source: Compiled by the authors and based on PLS-SEM analysis of survey results (1 December 2024).

The significance coefficients of the paths (*p*-values) must be <0.05 and T statistics more than 1.96. This situation is characteristic for only three of five hypotheses about the “education” factor’s significance to the “quality of human capital” (approved by the results

of Table 6): for the common sample, the “men” gender focus group and the focus group of “administration”. These hypotheses were not confirmed for the focus groups of “workers” and “women”.

However, despite the results obtained, it is still too early to draw conclusions about the significance of these hypotheses in relation to each other, since the significance of the path coefficients is strong only in internal groups.

To identify any differences in the perception of the educational factor, it is necessary to conduct a multigroup analysis to determine whether the educational factor is really being perceived differently by representatives of different focus groups.

The permutation multigroup analysis (MGA) is a PLS-SEM modeling technique used to compare whether predefined groups (e.g., men and women, workers and administration) have significant differences in parameter estimates such as path coefficients or external loads. It performs the function of moderation analysis, checking how the categorical variable affects the model’s relationships. These are the results presented in the form of data (within Table 7).

Table 7. The results of permutation multigroup analysis (MGA) for gender focus groups (in their permutation *p*-values’ comparing), 2026.

Permutation Multigroup Analysis (MGA) for Gender Division	Original (Group_Women)	Original (Group_Men)	Original Difference	Permutation Mean Difference	5.0%	95.0%	Permutation <i>p</i> -Value
Career -> Quality of human capital	0.359	0.053	0.306	−0.014	−0.318	0.321	0.065
Education -> Quality of human capital	−0.007	0.201	−0.208	0.015	−0.207	0.213	0.045
Employee’s income -> Quality of human capital	0.326	0.242	0.084	0.000	−0.261	0.279	0.305
Involvement in teamwork -> Quality of human capital	−0.054	0.323	−0.377	0.029	−0.275	0.310	0.005
Motivation for labor activity -> Quality of human capital	0.221	0.037	0.185	−0.002	−0.261	0.260	0.120
Satisfaction with employee’s contract -> Quality of human capital	−0.033	−0.206	0.173	0.034	−0.417	0.399	0.445
Social policy -> Quality of human capital	0.137	−0.056	0.193	0.010	−0.341	0.350	0.480

Source: Compiled by the authors based on PLS-SEM analysis survey results (10 April 2026).

In MGA, differences are considered statistically significant if the *p*-value is less than 0.05 or higher than 0.95. This indicator is quite satisfactory for the “education” factor (*p*-values = 0.045), which highlights the fundamental differences in the perception of the “education” factor in the formation of the “human capital” factor between women and men (Table 7). Consequently, from the statistical point of view, these differences are quantitatively confirmed.

It is equally important to test differences in the perception of “education” factor in this context (for its impact on the “quality of human capital”) between focus groups based on the classification of personnel activities, “administration” and “workers”. It is also acceptable to use MGA analysis for this purpose. The results are shown in Table 8.

Table 8. The results of permutation multigroup analysis (MGA) for personnel’s functional focus groups (in their permutation *p*-values’ comparing), 2026.

Permutation Multigroup Analysis (MGA) for Gender Division	Original (Group_Women)	Original (Group_Men)	Original Difference	Permutation Mean Difference	5.0%	95.0%	Permutation <i>p</i> -Value
Career -> Quality of human capital	0.030	0.152	−0.122	0.002	−0.293	0.325	0.255
Education -> Quality of human capital	0.267	0.604	−0.337	−0.017	−0.308	0.286	0.040
Employee’s income -> Quality of human capital	−0.005	0.009	−0.014	0.009	−0.189	0.215	0.430
Involvement in teamwork -> Quality of human capital	0.058	0.007	0.051	0.022	−0.273	0.290	0.420
Motivation for labor activity -> Quality of human capital	0.283	0.024	0.259	−0.021	−0.313	0.228	0.040
Satisfaction with employee’s contract -> Quality of human capital	0.111	−0.182	0.293	0.045	−0.432	0.448	0.340
Social policy -> Quality of human capital	0.249	−0.079	0.328	0.006	−0.364	0.360	0.100

This intergroup analysis (Table 8) also shows differences in the perception of the importance of the “education” factor. The permutations indicator was tested for the “education” factor (*p*-values = 0.040), which highlights the fundamental differences in the perception of this factor in the formation of the “human capital” factor between workers and the administration. Consequently, from the statistical side of the review, these differences are quantitatively confirmed in the same way as the results of the analysis for gender groups.

Consequently, groups of men and women, just like administrative workers and production workers, really perceive the educational factor on the “quality of human capital” in a completely different manner.

However, this is also not the final point for approving these differences. Statistical data should not be used in an excessive manner to substantiate practical conclusions (without checking the qualitative indicators of the proportion of respondents).

Of course, on the one hand, the study does not have a very large sample, although it is sufficient for a representative presentation of the results (Smart PLS, when using PLS-SEM analysis, allows meaningful models to be built even with small samples, unlike CB-SEM analysis). A total of 155 people is enough of a sample size.

However, such a small sample makes it easy to determine the proportion of respondents who consider education to be important in the formation of high-quality human capital (as well as those who think otherwise).

For example, it is possible to determine the percentage of respondents by examining the structure of their responses to the model’s question (1_4) “Does the development of your educational competencies contribute to the improvement of other aspects, forming your human capital at the enterprise (career growth, growth of social guarantees, income, health, a sense of personal fulfillment, etc.)?”

In this way, it is useful to analyze the percentage of satisfaction by gender focus groups. It is necessary with the women’s group (69 people from the total sample).

A total of 85.5% of women do not believe that education will significantly improve the quality of their human capital or other formative factors. Moreover, they strongly disagree with this statement; 4.35% disagree, and 2.90% doubt. Only 7.25% have a positive idea that the level of education can have a qualitative impact on human capital. These results are shown in Figure 6.

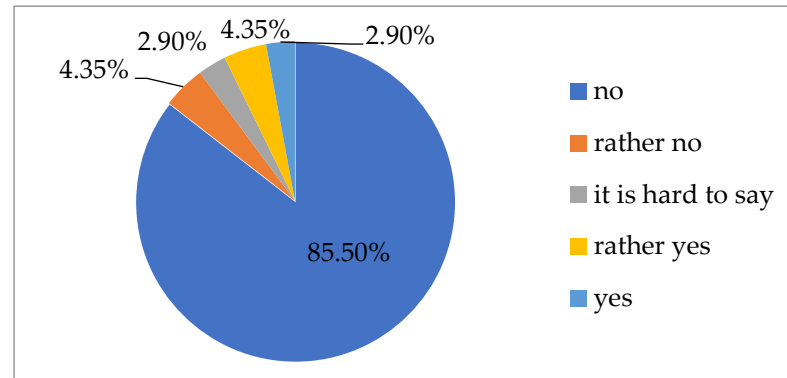


Figure 6. The results of detailed survey for “women” focus group about education’s impact to the quality of their human capital improving and its constituent factors (question 1_4). Source: Compiled by the authors, based on Karaganda Metallurgical Plant employees’ survey results (2024).

If we compare these values (Figure 6) with the values of the “male” focus group, we can see striking differences. A total of 50% of men doubt the importance of education in the formation of high-quality human capital, 33.72% attach great importance to the education factor in this matter, while only 16.28% deny the impact of education on improving human capital. These values are shown in Figure 7.

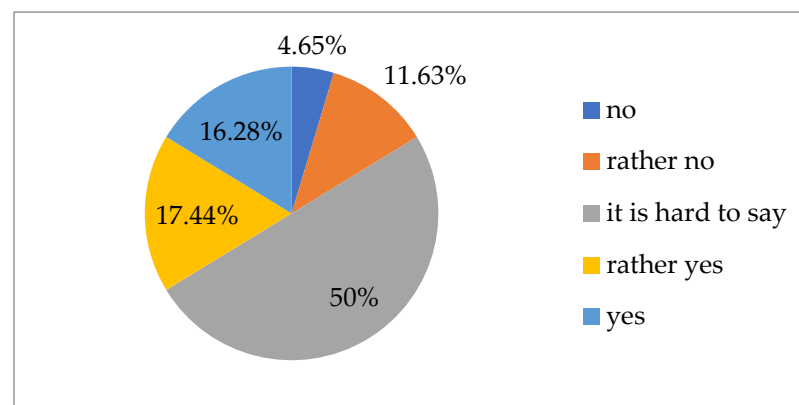


Figure 7. The results of detailed survey for “men” focus group about education’s impact to the quality of their human capital improving and its constituent factors (question 1_4). Source: Compiled by the authors, based on Karaganda Metallurgical Plant employees’ survey results (2024).

If we compare the results of Figures 6 and 7, we can conclude that when it comes to the impact of education on the quality of human capital, negative opinions in the “female” group are 5.5 times higher than in the “male” group. Positive opinions in the “male” group prevail 4.7 times over similar ones in the “female” group. If we compare the share structure of opinions in the focus groups of “administration” and “workers”, it is also presented with significant intergroup differences. Figure 8 shows the data from the answers to question 1_4 for the “administration” focus group:

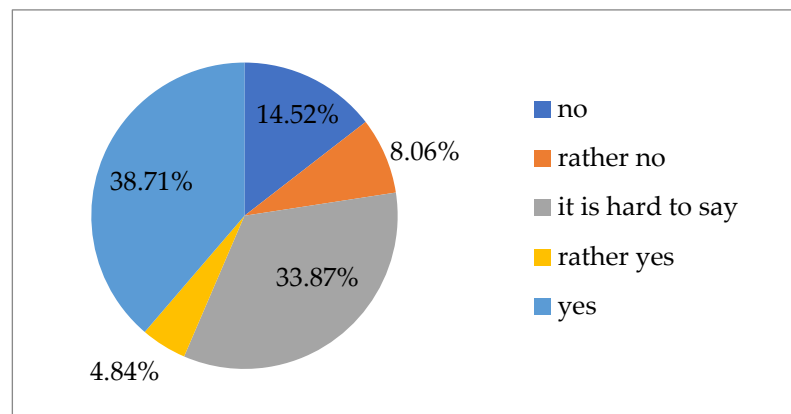


Figure 8. The results of detailed survey for “administration” focus group about education’s impact to the quality of their human capital improving and its constituent factors (question 1_4). Source: Compiled by the authors, based on Karaganda Metallurgical Plant employees’ survey results (2024).

A total of 33.87% of respondents doubt the impact of education on the quality of human capital, 43.55% have positive opinions about its importance in this context (as Figure 8 shows), and 22.58% negatively view the ability of the educational factor to improve human capital. Next, these values should be compared with the structural results obtained by the focus group of “workers”. Information on them is presented below (in Figure 9).

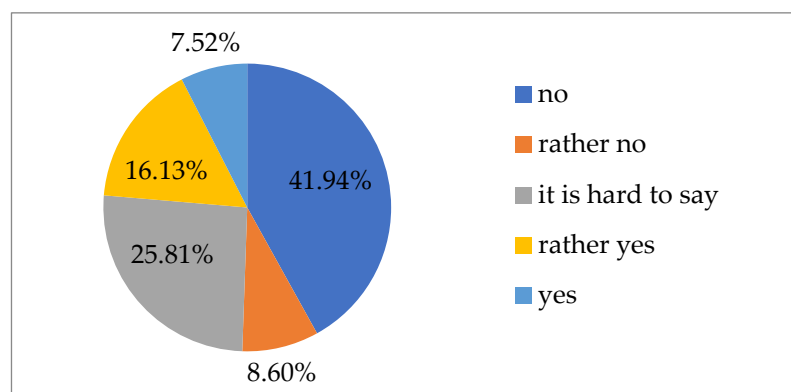


Figure 9. The results of detailed survey for “workers” focus group about education’s impact to the quality of their human capital improving and its constituent factors (question 1_4). Source: Compiled by the authors, based on Karaganda Metallurgical Plant employees’ survey results (2024).

A more negative perception by workers of the role of education in the formation of high-quality human capital can be traced more clearly based on the data in Figure 9.

A total of 50.54% of workers do not see education as a factor that has a significant impact on the quality of human capital, and 25.81% doubt the ability of education to improve this quality. About 23.65% of respondents attach great importance to the factor of education in the qualitative improvement of human capital, but only 7.52% of them are unequivocally confident in this. The position of 16.13% of respondents is less categorical in their positive perception.

Consequently, the number of positive responses to question 1_4 is higher among the respondents of the “administrative” focus group: almost two times more than among the “workers” (1.84 times). The number of negative opinions on the focus group of “workers” is more than two times higher than that of the “administration” focus group (2.24 times).

In this way, it can be concluded that the respondents of the “administrative” and “male” focus groups value education much more in terms of the formation of high-quality human capital than representatives of the “working” and “women” groups. This thesis has

been sufficiently tested by the permanent mission of Bootstrapping analysis (for the significance of path coefficients for given structural hypotheses, within the weekly focus groups); permutation multigroup analysis (MGA) (additional testing of significant multigroup differences (by gender and job title) and their comparisons); and analysis of the structure of responses to the most fundamental substantive question (1_4) for each individual focus group.

Considering that for representatives of individual focus groups there is clearly a problem in the perception of education as a factor forming high-quality human capital, it is necessary to proceed to a discussion of the causes and potential solutions for the current situation. This must be done because these opinions do not correspond to the generally accepted position of the theory of human capital (education is a key factor in the formation of human capital), as well as the fact that these opinions clearly differ negatively from the opinions of respondents based on the results of testing the general sample.

5. Discussion

The obtained results demonstrate the heterogeneity of the influence of the educational factor on the quality of human capital in different groups of workers. Hypotheses H1, H2 (partially) and H3 (partially) were confirmed only for the general sample, the male group and administrative staff, while no statistically significant relationship was found for women and production workers.

This discrepancy requires additional explanation. First, the results may reflect differences in access to educational opportunities within the enterprise. According to the survey data, a significant proportion of employees do not have a clear understanding of the availability of professional development programs, which reduces the perceived importance of education.

Secondly, for some of the production staff, education may not be perceived as a factor in increasing human capital due to the dominance of practice-oriented skills and limited career paths. This is consistent with research indicating differences in educational returns between cognitive and non-cognitive professions.

Thirdly, gender differences may be due to the institutional and cultural characteristics of the industry, where metallurgy has traditionally been characterized by a low representation of women in production and managerial roles.

In this way, the revealed differences do not contradict the general hypothesis but indicate a structural heterogeneity of the impact of the educational factor, which requires a differentiated approach to human capital management.

The results obtained confirm that professional education is perceived by employees as an important component of human capital, but they evaluate the institutional organization of training at the enterprise ambiguously. On the one hand, descriptive statistics show employees' requests for advanced training, access to internships and clearer procedures for participating in educational programs. On the other hand, the PLS-SEM results indicate that a statistically significant positive relationship between the educational factor and the quality of human capital is not typical for all subgroups of workers. This suggests that the subjective value of education depends on the employee's position in the organizational structure of the enterprise and on how much training they perceive as an accessible and useful resource.

This conclusion is consistent with research showing that the return on educational investments is determined not only by the fact of learning itself, but also by the correspondence of acquired competencies to specific production tasks, career prospects and institutional employment conditions. For administrative staff and a part of the male sample, education is probably more strongly associated with career mobility, managerial responsi-

bility and the need for constant updating of competencies. For other groups of workers, educational trajectories may be perceived as less accessible or less convertible into real advantages in the workplace, which explains the lack of statistically significant effects in terms of subsamples.

In practice, this means that it is not enough for industrial enterprises to declare the importance of professional development. Transparent selection procedures for training are needed, as well as clear channels for informing employees, a closer link between training programs and the actual tasks of workplaces and the institutionalization of career and educational trajectories. The results of this research should be interpreted taking into account its limitations at the same time: the research was conducted at one enterprise, has a cross-sectional design and is based on self-assessments of employees, which limits the possibilities of causal interpretation and generalization of the results.

The importance of vocational education for the “men’s” focus group and the “administration” focus group is explained by structural employment for men and by the desire for career growth for administrative staff. It will be difficult not only to meet production targets, but also to maintain health and safety at work, without continuous improvement of manufacturing skills, with the accelerating pace and increase of production volumes at the plant in recent years. “Men” form the basis of “manufacturing workers”, and therefore the obligation to participate in short-term industrial safety trainings and individual technological processes is understandable for them. Moreover, social status plays a much more important role for men in Kazakhstan’s society, which tends towards the traditional way of life. It is extremely important for them to be better educated, more developed and more capable than women to win in the competition for the best positions, where people of all genders take part. The situation with the administration is also understandable. Sales managers, engineering staff, the financial and economic units and other management structures cannot be incompetent in decision making, which requires them to be responsible daily. This includes various issues, from achieving strategic output targets to taking responsibility for the lives of people in manufacturing halls and workshops. The situation with employees’ understanding of the educational factor’s importance stays within the normal range in this aspect for their human capital quality’s maintaining. Men also occupy many important positions in the company’s structure, with the exception of the financial and economic block. The role of education is certainly high within the framework of requirements to their job responsibilities from their perspective.

The respondents of the “women’s” focus group and the focus group of “manufacturing workers”, on the contrary, do not think so. It seems that there is a situation which contradicts all context above—education is not important for workers. However, if we analyze this focus group of respondents, based on the results of the responses presented in the Google table, it can be revealed that low importance of education was attached not for employees of the main manufacturing, but for employees of auxiliary positions: security guards, cleaners, and transport drivers. It was a rare situation to see a respondent, who considered them as the main “manufacturing staff” who would select a low priority of the educational factor in their attitude at the same time.

The problem of gender discrimination remains a significant problem for classical manufacturing industries around the world as a whole [50–52]. Women do not attach much importance to the role of education due to gender stereotypes typical of the metallurgical industry, as they are usually focused on their goals [53,54]. They understand that metallurgical production is considered a “male profession”, both from the point of view of productivity and from the point of view of production process management [55,56].

It is not difficult to understand why it is possible to see such results in the research, understanding the specifics of the industry and men’s low opinion about their abilities.

Gender stereotypes, restrictions on employment and the complexity of the work environment itself are imposed on the lack of stable institutions and a high-quality ecosystem that could better integrate women into the modern metallurgic system in terms of improving education and skills and supporting their rights. Instead, the environment of industrial enterprises, including metallurgical enterprises, retains its “toxicity” and reproduces not high-quality human capital, but rather the problems associated with its formation. This also applies to the education factor. This situation remains relevant for the manufacturing industry and the metallurgical industry as a part of it in both developed and developing countries. Kazakhstan is no exception to this context. Gender discrimination against women is present everywhere in the labor sphere of this country [57–59].

The metallurgical industry is also affected in terms of the application of vocational education, despite the growing role of women in industry and the increasing proportion of women receiving vocational education [60]. Young women are particularly susceptible to gender discrimination, which intersects with ageist stereotypes at the heart of the reasons for its formation [61]. A similar situation has developed during political and managerial inaction in the field of forming a legal environment to prevent gender discrimination in Kazakhstan over the years. Several Kazakhstani authors recognize the existence of the problem and propose to intensify its solution by specific mechanisms that comply with international standards for combating gender discrimination [62–64]. Among them, there are specific recommendations on legislative changes [65].

There are also other types of discrimination in metallurgy. For example, discrimination is ageist, which leads not only to little interest in developing skills, but also poses a direct threat to the life and health of employees. This is associated with overloading young employees with responsibilities, the volume of which not only makes them lose interest in industrial training but also risks their health. As a result, metallurgy workers aged 20 to 49 usually get much more injuries (two or three times more than the older generation of workers) [66]. This situation is typical for the Polish metallurgical industry, which is trying to comply with EU standards in the field of occupational safety and non-discrimination. However, the implementation problem of international employment standards in Kazakhstan only exacerbates this negative situation, which is typical for the entire industry [67,68].

A positive factor for Kazakhstan’s metallurgic industry is the absence of ethnic discrimination [69,70]. However, the presence of gender, age and job discrimination based on the authoritarianism of management and the lack of legal mechanisms for the high-quality defense of rights among many workers in the metallurgical industry negates this positive effect [71]. As a result, there are many employees who are not satisfied with either the quality of education or its role in the formation of human capital. The main reasons for this are the lack of necessary autonomy in the rights of ordinary workers employed in hierarchically “low” positions.

However, the educational factor plays a significant role in the quality of human capital for the common sample of respondents. The most significant indicator of Bootstrapping testing characterizes it, and it is clear from all tested hypotheses.

If we analyze the nuances regarding the results of the employee survey, it is possible to draw the following findings for Section 5:

- Education is perceived by most workers (according to the general sample) as an important aspect of human capital’s quality;
- The educational aspect is particularly important in the formation of high-quality human capital according to opinion of the “men” focus group employees and the focus group of “administrative” employees;

- The importance of education for quality of human capital in the “women” focus group’s perception is not significant; however, it is perceived by this focus group as stronger than by the focus group of “working staff”;
- In general, the results of hypothesis testing fit the information provided by the statistical survey’s results, within the framework of employees’ attitude to the educational aspect.

The improvement of educational aspects in human capital’s quality development at this enterprise should be concentrated in detailed work with representatives of the women’s focus group and the focus group of industrial workers.

This work should be oriented towards gender equality and the absence of job discrimination in providing of professional development opportunities.

Without such work, these focus groups are unlikely to change their attitude towards the importance of education. There will be no qualitative reassessment of the values for the entire manufacturing team (without changing of this perception), which threatens the company with risks of sustainable economic development in the human resource management system.

Only systematic work on the provision of targeted training programs for these groups with their subsequent targeted encouragement (based on learning outcomes) can contribute to breaking of such negative conditions for their perception about the role of education in their job.

It will be possible to achieve a fully sustainable development in human resource management policy only in this case, based also on full collective’s inclusion to educational processes.

Practical Implications

If we talk about practical recommendations in terms of government and managerial (on the part of the enterprise) policymaking measures, which are necessary to improve the perception of the educational factor by employees of metallurgical enterprises, it is necessary to implement the following political actions, presented in Table 9.

Table 9. Political recommendations (for governments’ policymakers and enterprises in business) to encourage people’s interest in education for the field of metallurgy.

Policy Direction	Problem	Recommendation	Expected Effect
Educational policy of the company	Low employee awareness	Implementation of transparent training programs	Increased engagement
Access to education	Limited access for workers	Subsidies and quotas	Professional development
Gender policy	Low importance of education for women	Career development programs	Reduction of the gender gap
The link between education and career	Lack of communication	Introduction of training KPI	Increased motivation
Interaction with the state	Weak partnership	Development of dual programs	Increasing the relevance of education

Compiled by the authors, based on results of discussion.

The policymaking recommendations proposed in Table 9 are focused on the formation of a systematic approach to the development of human capital and can be used both at the enterprise level and within the framework of state policy in the field of vocational education.

Theoretical conclusions for discussion: From a theoretical point of view, the results of this study expand the provisions of the theory of human capital, demonstrating that the educational factor is not universally significant for all categories of workers. Its influence is context-dependent and determined by institutional, professional and social conditions.

Practical conclusions: From a practical point of view, the results indicate the need to develop differentiated strategies for the development of human capital, considering the specifics of different groups of workers. Universal educational programs do not provide a uniform effect and require adaptation to the needs of specific categories of staff.

6. Conclusions

The conducted research has shown that vocational education is a significant element of the perceived quality of human capital of employees of the Karaganda Metallurgical Combine; however, the effectiveness of this factor depends on the organizational conditions of its implementation at the enterprise. Descriptive results revealed limited satisfaction with the current professional development system, insufficient awareness of existing programs among employees and poor transparency of training participation procedures.

The PLS-SEM results confirmed the positive and statistically significant impact of the educational factor on the quality of human capital for the general sample, as well as for the male and administrative focus groups. No statistically significant relationship was confirmed for the female and working focus groups, indicating a heterogeneity in the perception of educational opportunities in different segments of the staff.

The scientific contribution of the research consists in empirical clarification of how employees of an industrial enterprise perceive the educational component of human capital. The practical conclusion is that there is a need to move from fragmented forms of education to a more systematic corporate professional development policy, consistent with production objectives, career promotion mechanisms and principles of transparent access to educational resources. It is advisable to expand the study through comparisons between enterprises, validated tools and the inclusion of objective indicators of professional development of employees in the future.

Summing up all the above, it can be argued that the factor of vocational education plays a significant role in the perception of human capital's quality for most employees from the Karaganda Metallurgical Plant. It is important for the greater part of the labor collective. It is very important because metallurgical production remains a complex, multidimensional and responsible process, despite its archaic nature and weak innovativeness in the post-Soviet realities.

The "men" focus group (which is an important part of the main production staff) needs fundamental professional education and continuous improvement of skills through advanced training, since the technology of the production process itself is complex, multi-stage and requires great responsibility. This thesis is valid both for the process of manufacturing finished products and in terms of compliance with all necessary safety standards at the enterprise (which also require a large amount of knowledge).

A large amount of organizational and managerial tasks depends on the administration, which must be performed in the best possible way to increase manufacturing of a high-quality steel product within the existing conditions of technological backwardness for this industry in comparison with similar industries in competing countries. At the same time, the administration is responsible for the structural divisions, entrusted to its management, where the quality management of human resources depends on it: from ensuring their industrial safety and health to maintaining work motivation in a team with complex industrial specifics within terms of labor relations. It is extremely difficult to perform all tasks, presented above, without an adequate level of middle or higher professional education. Therefore, understanding its importance from administrative departments remains high in terms of formation for personal high-quality human capital by employees.

If we consider the potential for further research of educational factor in the development of high-quality human capital of this Kazakhstan's ferrous metallurgy enterprise,

it would be useful to analyze the perception of this aspect by focus groups of employees of various structural divisions. Such an analysis would not only identify the problems of education in human capital's formation inside individual workshops or departments. It would also have the potential to make managerial decisions for costs optimization in organization of educational process for each individual structural unit. The only thing which is necessary for this research is to obtain a specialized permit for such research providing a targeted survey of respondents by questionnaire from the corporate board and managers of this enterprise.

The presented research also highlights the need to integrate the educational policy of the enterprise with national strategies for the development of human capital. The prospects for further research are related to the expansion of the sample, cross-industry comparison and the use of longitudinal data.

Limitations and Future Directions of Research

This study has several valid limitations. First, it is impossible to conduct an intersectoral analysis for the ferrous metallurgy industry of Kazakhstan. The Karaganda Metallurgical Plant is the only enterprise in the country with a full production cycle. Comparison with similar plants and plants in the field of non-ferrous metallurgy is fundamentally impossible, since many of them have different approaches to the organization of human capital (and are managed by foreign companies). These enterprises are also smaller, and they have no critical importance for the labor market in places of deployment, unlike the Karaganda Metallurgical Plant. The sample is made only within the framework of one enterprise because of this fact.

The second important limitation is the time limit for conducting the study (which was only 1 month long). It was held from 15 October to 15 November 2024. This limit was agreed upon by the authors for two reasons. The first was an oral request from the representatives of the Personnel Department of the Steel Department to conduct the study in a shorter time so as not to distract employees from extraneous tasks. Since the Memorandum of Cooperation between the University of the corresponding author (from which the sample of respondents was collected) and the enterprise presupposes the principles of mutual respect, the authors had to agree to these conditions. The second reason for such a period was established by the authors themselves: the need to maintain the purity of the data obtained.

A respondent's opinion is dynamic, not a static category of scientific analysis. It is subject to change over time, including in the perception of the factors that form human capital. It is influenced by many factors, the dynamic variability of which is manifested in the monthly perspective: salary, bonus level, going on vacation, business trip, sending for sanatorium treatment (rehabilitation at the expense of the company), etc. All these activities are mainly carried out in production with strict regulations in a monthly context (the next month after the completion of the main working period). Therefore, the authors decided to exclude as much as possible the possibility of external factors influencing the opinion of respondents and conduct a survey only for employees engaged in performing direct work functions during their working period. If the respondents had been given the opportunity to complete the survey over a longer period, they might have expressed a desire to replace their answers, which could have led to data distortion. As authors, it was important for us to see a genuine opinion at a single moment, not one transformed during a possible lengthy reflection.

The third important limitation is the unfavorable environment for conducting such a survey. Employees of metallurgical and other industrial enterprises in Kazakhstan, who are subject to the authoritarian and sometimes not the most humane attitude of the leadership,

do not see the point in taking such surveys, because they do not believe that their results will be accepted as a reason to implement a policy to eliminate objective factors of discontent. They fear that if they provide answers that contradict the management's agenda, they will face negative consequences in the work environment. Moreover, many industrial enterprises in Kazakhstan do not provide third-party organizations to collect research data from their enterprises. In its policy, "Qarmet" JSC has decided to reverse such trends from 2024 and work with a focus on the opinion of employees in creating a human-centered work environment, involving the academic community of local universities in research. However, inertness in the perception of the past corporate period, when the company was under the control of another company, makes such surveys potentially risky in the eyes of metallurgy workers. In some cases, they even believe that taking any kind of opinion polls is not part of an effective dialogue to improve their rights, but part of the additional burden of implementing administrative formalities.

The fourth important limitation is the limitation of the total sample and, as a result, working with extremely small samples when analyzing focus group data. We partially agree with the fact that there is not enough data from 155 respondents to obtain more significant practical results. The authors would like to cover at least 300 people with the desired sample size. However, the main condition for ethical admission to mailing the questionnaire to respondents by the company's services was voluntary participation. Therefore, we could not ask them to influence the expansion of the number of participants extensively, because in this context, this principle of ethics and norms of cooperation with the enterprise would be violated. However, it is worth noting once again that, given the context of the third limitation, the collected data is of significant practical value. The PLS-SEM analysis methodology, unlike covariance CB-SEM, allows use of very small samples and presents analytical results on them at statistically significant values. Therefore, the results of the study can be accepted as significant, but only presentable to a small extent. It would also be wrong and unethical to send the questionnaire to representatives of subsidiaries and subsidiary enterprises. For this reason, only the Karaganda Metallurgical Plant was declared as the location for this research.

The fifth important limitation is the lack of several studies and publications on this and similar topics in the Kazakhstan's realities section and for the Central Asian region. This research gap seriously complicates the work in terms of a possible and adequate comparison of literature. The authors have difficulties in comparing the literature for analysis at the level of regional contexts. This is partly the reason for the low presence of specific specialized literary sources in the work.

This research has prospects for multiplication and expansion for the enterprise in question, as well as for other (smaller) metallurgical enterprises. This thesis is equivalent both in terms of methodology not previously used for this industry, and in the format of a general transformation of the attitude towards an employee in Kazakhstan's economic practice in a personality-oriented manner.

The research also does not deeply consider the factors leading to a lack of perception of the role of education in shaping the quality of human capital. This fact provides the potential for further research of the identified problem in a deeper format, involving new researchers in this process.

Author Contributions: Conceptualization, S.P. and M.P.; methodology, S.P. and A.A.; software, S.P. and A.A.; validation, S.P. and A.A.; formal analysis, S.P. and M.P.; investigation, M.P.; resources, A.A.; data curation, S.P. and A.A.; writing—original draft preparation, M.P. and A.A.; writing—review and editing, S.P. and M.P.; visualization, S.P.; supervision, M.P.; project administration, S.P. and A.A.; funding acquisition, S.P. and M.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study by the Commission for Ethics in Science of the “Karaganda National Research University named after academician Ye. A. Buketov” by the Report, which confirms that there is no need for an ethical review from the point of view of the Republic of Kazakhstan’s legislation. The study also does not violate the University’s internal ethical standards.

Informed Consent Statement: Written informed consent was obtained from all participants rather than verbal because the survey of respondents was conducted remotely, in an online format, using a Google Forms link to the questionnaire. If the respondents really wanted to complete the survey, they had to activate the survey by clicking on the link and sending a fully completed response form. Consent was implied by the respondent’s participation at the beginning of the actual survey. The authors did not work with the respondents personally; therefore, it was not possible to obtain written consent from respondents. The authors did not influence the respondents to complete the survey. The respondents were informed about the anonymity of the survey.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

USA	United States of America
JSC	Joint-stock company
PLS	Partial least squares
VET	Vocational education and training
UK	United Kingdom
OECD	Organization for Economic Co-operation and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
STDEV	Standard Deviation

Appendix A

The list of survey questions for respondents of Karaganda Metallurgical Plant.

I. Block of personal data (4 questions) for potential filtration to focus groups.

1. Specify your gender, please:

- (A) male;
- (B) female.

2. Specify your age, please:

- (A) up to 20 years old;
- (B) from 20 to 30 years old;
- (C) from 31 to 40 years old;
- (D) from 41 to 50 years old;
- (E) from 51 to 60 years old;
- (F) from 61 or elder.

3. Please, indicate your full working experience at the Karaganda Metallurgical Plant (for the period of your entire career):

- (A) from 1 working year;
- (B) from 1 to 3 working years;
- (C) from 3 to 7 working years;

- (D) from 7 to 10 working years;
- (E) from 10 to 15 working years;
- (F) from 15 working years or higher.

4. Specify your level of education (meaning fully completed education at each educational level in Republic of Kazakhstan):

- (A) full secondary education (school for 11 classes);
- (B) secondary special education (vocational college);
- (C) secondary special education (high professional college)
- (D) higher education (bachelor or specialist);
- (E) 2 or more higher education degrees (bachelor or specialist level);
- (F) postgraduate education (Master's degree, PhD degree).

II. Block of questions about job and its specifics for professional activity (2 questions) for potential filtration to focus groups.

5. What type of employment does your position belong to?

- (A) working staff;
- (B) administration staff.

6. Please, specify your specific activity block:

- (A) the main manufacturing staff (involved in the production of products);
- (B) auxiliary working staff (maintenance of buildings, communications, equipment, cleaning of the territory and premises);
- (C) logistics and transport workers (loading, shipping, transportation);
- (D) administrative staff, related to human resource management;
- (E) administrative staff of the financial and economic unit (accounting, finance, planning and economic services, procurement department, investment and consulting issues);
- (F) administrative staff related to the sale of products (sales, marketing, advertising, PR department);
- (G) administrative staff of the Legal Service and Control (Legal Department, internal audit and compliance);
- (H) administrative engineering and technical staff;
- (I) staff, related to labor safety (safety services);
- (J) security staff (employees of checkpoints, employees of the physical departmental security of the enterprise);
- (K) other specifics of the activity not specified in the survey.

III. Block of questions about vocational/higher education and the possibility of its improvement in the framework of work (10 questions, but 1–8 obligatory* only, 9–10 are not obligatory (NO)) for structural modeling, according to Likert-scale Data (from 5 “yes” to 1 “no”).

1_1. Do you improve your skills in ongoing or temporary basis?* (Obligatory question)

- (A) yes (5);
- (B) rather yes (4);
- (C) I find it difficult to answer (3);
- (D) rather no (2);
- (E) no (1).

1_2. Do you have any opportunities to improve your professional skills at the workplace by payment from the side of your employer (at universities, colleges, additional courses and seminars, during internships at other enterprises)?* (Obligatory question)

- (A) yes (5);
- (B) rather yes (4);
- (C) I find it difficult to answer (3);
- (D) rather no (2);
- (E) no (1).

1_3. Are you satisfied with the system of professional development/education for the payment of your employer?* (Obligatory question)

- (A) yes (5);
- (B) rather yes (4);
- (C) I find it difficult to answer (3);
- (D) rather no (2);
- (E) no (1).

1_4. Does the development of your educational competencies contribute to the improvement of other aspects, forming your human capital at the enterprise (career growth, growth of social guarantees, income, health, a sense of personal fulfillment, etc.)?* (Obligatory question)

- (A) yes (5);
- (B) rather yes (4);
- (C) I find it difficult to answer (3);
- (D) rather no (2);
- (E) no (1).

1_5. Does education contribute to the professional and personal growth of an employee in this enterprise (in your opinion)?* (Obligatory question)

- (A) yes (5);
- (B) rather yes (4);
- (C) I find it difficult to answer (3);
- (D) rather no (2);
- (E) no (1).

1_6. Does the company provide you with advanced training courses or professional training in its educational centers?* (Obligatory question)

- (A) yes (5);
- (B) rather yes (4);
- (C) I find it difficult to answer (3);
- (D) rather no (2);
- (E) no (1).

1_7. Does the company provide you with internships, based on the functions of your professional activity, at any other enterprises (at other enterprises of the company's structure and outside its structure also)?* (Obligatory question)

- (A) yes (5);
- (B) rather yes (4);
- (C) I find it difficult to answer (3);
- (D) rather no (2);
- (E) no (1).

1_8. Does your company have a program/strategy for developing professional and personal skills of employees?* (Obligatory question)

- (A) yes (5);
- (B) rather yes (4);
- (C) I find it difficult to answer (3);
- (D) rather no (2);
- (E) no (1).

1_9. If there is such a program/strategy, does it meet your expectations of the improving and developing quality for your professional/personal skills? (Not Obligatory)

- (A) yes (5);
- (B) rather yes (4);
- (C) I find it difficult to answer (3);
- (D) rather no (2);
- (E) no (1).

1_10. If there is such a program/strategy, does your company have a single, accessible, clearly defined and practically implemented mechanism to application for education level upgrading? (Not Obligatory)

- (A) yes (5);
- (B) rather yes (4);
- (C) I find it difficult to answer (3);
- (D) rather no (2);
- (E) no (1).

Appendix B

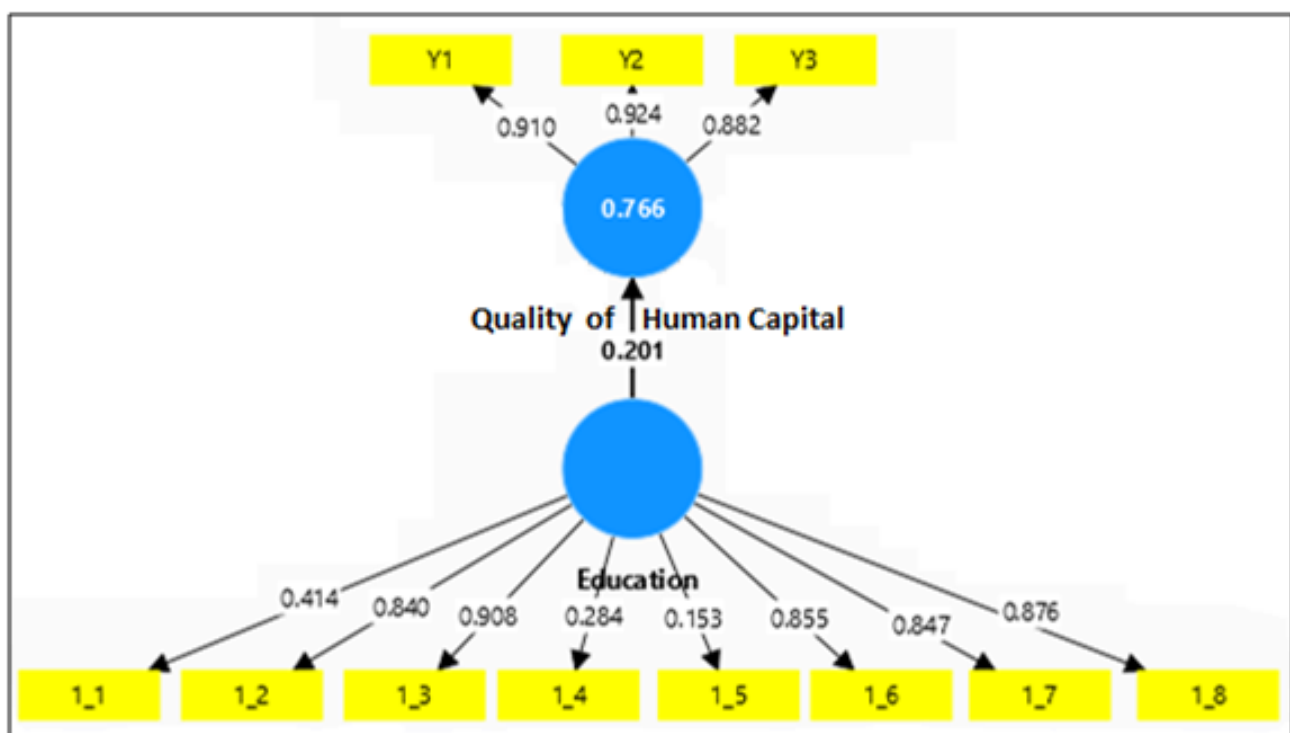


Figure A1. Structural model of human capital's quality for respondents of "men" gender focus group.

Appendix C

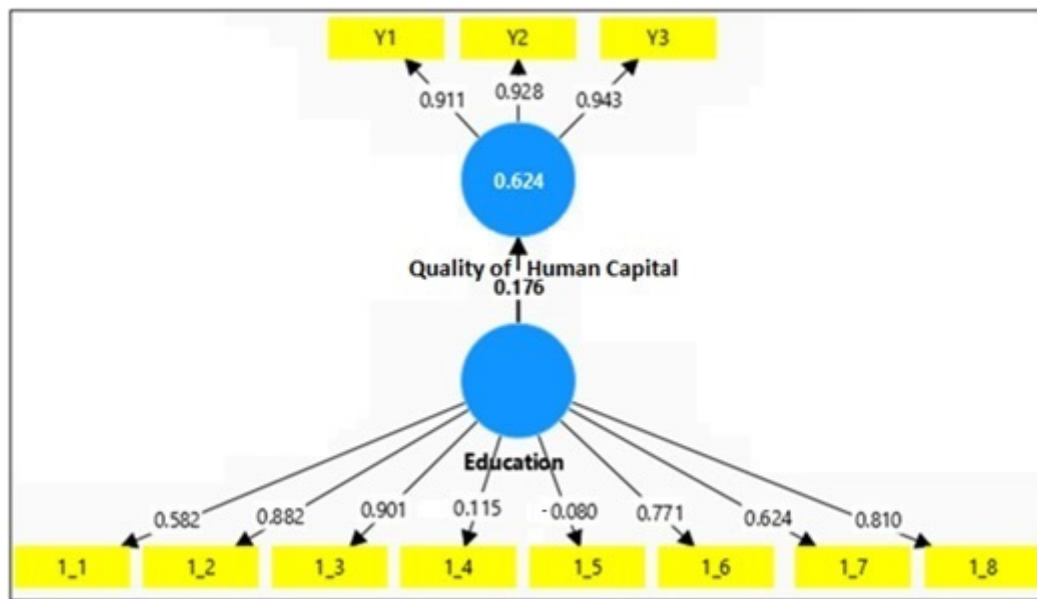


Figure A2. Structural model of human capital's quality for respondents of "women" gender focus group.

References

1. Becker, G.S. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*, 2nd ed.; National Bureau of Economic Research Inc.: Cambridge, MA, USA, 1975; pp. 1–268.
2. Schultz, T.P. *The Role of Education and Human Capital in Economic Development: An Empirical Assessment*; Center Discussion Paper, No. 670; Yale University, Economic Growth Center: New Haven, CT, USA, 1992; pp. 1–33.
3. Acemoglu, D.; Restrepo, P. Demographics and automation. *Rev. Econ. Stud.* **2022**, *89*, 1–44. [\[CrossRef\]](#)
4. Mincer, J. Investment in Human Capital and Personal Income Distribution. *J. Political Econ.* **1958**, *66*, 281–302. [\[CrossRef\]](#) [\[PubMed\]](#)
5. Hanushek, E.A.; Woessmann, L. A quantitative look at the economic impact of the European Union's educational goals. *Educ. Econ.* **2020**, *28*, 225–244. [\[CrossRef\]](#)
6. Malec, M.; Stańczak, L. Human Capital for Industrial Innovation: Competence Development, Job Satisfaction and Entrepreneurship at a Mining Institute. *Prod. Eng. Arch.* **2025**, *31*, 410–418. [\[CrossRef\]](#)
7. Kucharčíková, A.; Mičiak, M.; Tokarčíková, E.; Štaffenová, N. The Investments in Human Capital within the Human Capital Management and the Impact on the Enterprise's Performance. *Sustainability* **2023**, *15*, 5015. [\[CrossRef\]](#)
8. Becker, G.S. Investment in Human Capital: A Theoretical Analysis. *J. Political Econ.* **1962**, *70*, 9–49. [\[CrossRef\]](#)
9. Mincer, J. Human Capital and the Labor Market: A Review of Current Research. *Educ. Res.* **1989**, *18*, 27–34. [\[CrossRef\]](#)
10. Schultz, T.W. *Human Capital: Policy Issues and Research Opportunities, Human Resources; Fifteen Anniversary, Colloquium V1*; NBER: New York, NY, USA, 1975; pp. 1–234.
11. Nelson, R.; Phelps, E. Investment in Humans, Technological Diffusion and Economic Growth. *Cowles Found. Discuss. Pap.* **1966**, *56*, 69–75.
12. Benhabib, J.; Spiegel, M. The Role of Human Capital in Economic Development. Evidence from Aggregate Cross-Country Data. *J. Monet. Econ.* **1994**, *34*, 143–173. [\[CrossRef\]](#)
13. Petranov, S.; Raleva, S. Education and Human Capital Impact on Formal and Informal Economy. *Strateg. Policy Sci. Educ.-Strateg. Na Obraz. I Nauchnata Polit.* **2025**, *33*, 222–233. [\[CrossRef\]](#)
14. Cai, J.; Kosaka, M. Conceptualizing Technical and Vocational Education and Training as a Service Through Service-Dominant Logic. *SAGE Open* **2024**, *14*, 21582440241240847. [\[CrossRef\]](#)
15. Gordon, H.R.D.; Schultz, D.D. The history and growth of career and technical education in America. Available online: <https://opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1268&context=ojwed> (accessed on 16 April 2026).
16. Kanwar, A.; Balasubramanian, K.; Carr, A. Changing the TVET paradigm: New models for lifelong learning. *Int. J. Train. Res.* **2019**, *17*, 54–68. [\[CrossRef\]](#)
17. Hao, X.; Yang, X.; Kou, K.; Zhang, Y.; Guo, C. Research on the Contribution Mechanism of Vocational Human Capital Characteristics to Income. *Educ. Sci.* **2023**, *13*, 246. [\[CrossRef\]](#)

18. Aizenman, J.; Jinjarak, Y.; Ngo, N.; Noy, I. Vocational education, manufacturing, and income distribution: International evidence and case studies. *Open Econ. Rev.* **2018**, *29*, 641–664. [\[CrossRef\]](#)
19. Ter Beek, M.; Wopereis, I.; Schildkamp, K. Don't Wait, Innovate! Preparing Students and Lecturers in Higher Education for the Future Labor Market. *Educ. Sci.* **2022**, *12*, 620. [\[CrossRef\]](#)
20. Kriesi, I.; Sander, F. Academic or vocational education? A comparison of the long-term wage development of academic and vocational tertiary degree holders. *J. Labour Mark. Res.* **2024**, *58*, 10. [\[CrossRef\]](#)
21. Tian, Y.; Liu, J.; Xu, X.; Wu, X. Knowledge mapping of vocational education and training research (2004–2020): A visual analysis based on CiteSpace. *Sci. Rep.* **2023**, *13*, 22348. [\[CrossRef\]](#)
22. Chimezie, F.U.; Igharo, P.E.; Vianney, C.I.K. Vocational skill development in powder metallurgy technology through appropriate instructional objectives formulation: Leverage to unemployment and technological retardation. *Int. J. Soc. Sci. Manag. Stud.* **2025**, *4*, 134–142.
23. Chernenko, I. The Impact of Industry 5.0 Human Capital on Production System Performance: Evidence from Russian Metallurgy. In *The Future of Industry. Lecture Notes in Information Systems and Organisation*; Appolloni, A., Kumar, V., Kuzmin, E., Akberdina, V., Eds.; Springer: Cham, Switzerland, 2024; p. 70.
24. Polevoy, S.V.; Gelmanova, Z.S.; Gelashvili, N.N. The impact of industrial poverty deprivation risks to the quality of human capital in Kazakhstan. *Buketov Bus. Rev.* **2024**, *29*, 96–109. [\[CrossRef\]](#)
25. Aubakirova, G.; Rudko, G.; Isataeva, F. Assessment of metallurgical enterprises activities in Kazakhstan in the context of international trends. *Econ. Ann.-XXI* **2021**, *187*, 121–130. [\[CrossRef\]](#)
26. Gritsenko, N.N. On Cadres' Training Process Taking into Account Needs of Labor Market: Reference on Experience of EU Countries, Alma Mater, Higher School Herald, 2018. Available online: <https://almavest.ru/en/node/1310> (accessed on 10 December 2024). (In Russian)
27. Jak, E.; Hayes, P.C. Options for Sustaining Metallurgical Engineering Education. In *New Directions in Mineral Processing, Extractive Metallurgy, Recycling and Waste Minimization (TMS 2023)*; The Minerals, Metals & Materials Series; Reddy, R.G., Anderson, A., Anderson, C.G., Fleuriault, C., Spiller, E.D., Strauss, M., Vidal, E.E., Zhang, M.M., Eds.; Springer: Cham, Switzerland, 2023; pp. 95–105. [\[CrossRef\]](#)
28. Hannah, B.; Hayes, P.C. The Challenges for Professional Metallurgical Education. In *Celebrating the Megascala*; Mackey, P.J., Grimsey, E.J., Jones, R.T., Brooks, G.A., Eds.; Springer: Cham, Switzerland, 2014; pp. 473–480. [\[CrossRef\]](#)
29. Quality of Grants Given for Educational Program B171-Metallurgy. Available online: <https://univision.kz/edu-program/group/B171-metallurgiya.html> (accessed on 16 April 2026).
30. Chapaev, N.K.; Erofeev, A.G.; Dvořáková, L. Peculiarities of Educational Environment at Mining and Metallurgical Schools of the Urals. *Int. J. Environ. Sci. Educ.* **2016**, *11*, 7066–7078.
31. Liu, Y.; Wang, C.; Gao, J. Research of Deepening the Training Path for Students at the Vocational Undergraduate Level in Iron and Steel Metallurgy from the Perspective of School Enterprise Integration. *Int. J. Educ. Teach. Res.* **2024**, *1*, 1–5. [\[CrossRef\]](#)
32. Peltier-Huntley, J. Embedding Anti-Discrimination Policies and Allyship in Mining and Engineering Workplaces: A Pathway to Decent Work. *Merits* **2025**, *5*, 24. [\[CrossRef\]](#)
33. Heimann, S.; Johansson, K. Gender in industrial mine work and organizations—Recommended actions toward gender equality. *Min. Econ.* **2025**, *38*, 513–526. [\[CrossRef\]](#)
34. Salminen-Karlsson, M. Women in the Steel Industry: Closed in Corners or Provided with Possibilities. *Nord. J. Work. Life Stud.* **2020**, *10*, 65–83. [\[CrossRef\]](#)
35. Tolettini, L.; Di Maria, E. Gender equality strategies in the steel sector: An innovative perspective on the chances and challenges of the female workforce in production. In *Feminist Perspectives in Business Studies*; Edward Elgar Publishing: Cheltenham, UK, 2025; pp. 317–333. [\[CrossRef\]](#)
36. Rakowski, C.A. Women in steel: The case of Ciudad Guayana, Venezuela. *Qual. Sociol.* **1987**, *10*, 3–28. [\[CrossRef\]](#)
37. Sahin, B. Gender Knowledges, Cultures of Equality, and Structural Inequality: Interpreting Female Employment Patterns in Manufacturing Through Interpretable Machine Learning. *Soc. Sci.* **2025**, *14*, 545. [\[CrossRef\]](#)
38. Castañeda-Burciaga, S.; Guirette-Barbosa, O.A.; Ramírez-Salazar, M.A.; Celaya-Padilla, J.M.; García-Estrada, L.I. Inclusion of Women in the Mining Sector: Challenges and Opportunities Through Education. *Educ. Sci.* **2025**, *15*, 69. [\[CrossRef\]](#)
39. Tyshchenko, M.; Verba, D.; Garashchenko, S.; Verkhovod, I. Factors of the gender wage gap at Ukrainian energy enterprises. *Financ. Credit Act. Probl. Theory Pract.* **2021**, *6*, 512–520. [\[CrossRef\]](#)
40. Atakhanova, Z.; Howie, P. Women in Kazakhstan's energy industries: Implications for energy transition. *Energies* **2022**, *15*, 4540. [\[CrossRef\]](#)
41. Cedefop; UK NARIC. Vocational Education and Training in Europe: United Kingdom. 2019. Available online: <https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/united-kingdom> (accessed on 13 December 2024).
42. OECD. Higher Technical Education in England, United Kingdom: Insights from Selected International Experience. In *OECD Reviews of Vocational Education and Training*; OECD Publishing: Paris, France, 2024; Available online: <https://doi.org/10.3390/su18094287>

- https://www.oecd.org/en/publications/higher-technical-education-in-england-united-kingdom_7c00dff7-en.html (accessed on 16 December 2024).
43. Cedefop; BIBB—Federal Institute for Vocational Education and Training. Vocational Education and Training in Europe—Germany: System Description. 2022. Available online: <https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/germany> (accessed on 17 December 2024).
 44. Cedefop; University College Copenhagen (UCC). Vocational Education and Training in Europe—Denmark: System Description. 2023. Available online: <https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/denmark-u3> (accessed on 17 December 2024).
 45. Cedefop; Finnish National Agency for Education (EDUFI). Vocational Education and Training in Europe—Finland: System Description. 2023. Available online: <https://www.cedefop.europa.eu/en/tools/vet-in-europe/systems/finland-u3> (accessed on 18 December 2024).
 46. UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training; U.S. Centre on Education and Training for Employment (CETE). World TVET Database of United States of America. 2014. Available online: https://unevoc.unesco.org/wtdb/worldtvetdatabase_usa_en.pdf (accessed on 19 December 2024).
 47. Esposito Vinzi, V.; Chin, W.W.; Henseler, J.; Wang, H. *Handbook of Partial Least Squares: Concepts, Methods and Applications*; Springer: Berlin/Heidelberg, Germany, 2010; p. 798.
 48. Hair, J.F.; Hult, G.T.M.; Ringle, C.M.; Sarstedt, M. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 3rd ed.; Sage Publications Inc.: Thousand Oaks, CA, USA, 2021; p. 208.
 49. Sarstedt, M.; Hair, J.F.; Ringle, C.M. Partial Least Squares Structural Equation Modeling. In *Handbook of Market Research*; Homburg, C., Klarmann, M., Vomberg, A., Eds.; Springer: Cham, Switzerland, 2022; pp. 587–632.
 50. Stamarski, C.S.; Son Hing, L.S. Gender inequalities in the workplace: The effects of organizational structures, processes, practices, and decision makers' sexism. *Front. Psychol.* **2015**, *6*, 1400. [CrossRef]
 51. Yaotian, Z. Discrimination against Women in the Workplace. *J. Educ. Humanit. Soc. Sci.* **2024**, *27*, 135–140. [CrossRef]
 52. Chenghao, J.; Shukun, X. Gender Discrimination and Differences in the Workplace. *J. Educ. Humanit. Soc. Sci.* **2024**, *27*, 343–348. [CrossRef]
 53. Simelane, N.; Mulaba-Bafubandi, A.F. Factors influencing career progression of female physical metallurgists in the steel foundry industry in Ekurhuleni, Gauteng, South Africa. In *6th Young Professionals Conference Hatch Africa, Greenstone*; The Southern African Institute of mining and Metallurgy: Marshalltown, South Africa, 2023; pp. 105–112.
 54. Ewim, D.R.E.; Dosunmu, A.G. Bridging gaps: The intersection of women in engineering and gender studies—Challenges, advances, and future directions. *Discov. Glob. Soc.* **2025**, *3*, 43. [CrossRef]
 55. Dabić, M.; Obradović Posinković, T.; Maley, J.F.; Vlačić, B.; Marzi, G.; Kraus, S. Exploring the Multifaceted Challenges of Women in Engineering: A Comprehensive Literature Review. *IEEE Trans. Eng. Manag.* **2024**, *71*, 3325–3339. [CrossRef]
 56. Tonkin, L. Women of Steel: Constructing and Contesting New Gendered Geographies of Work in the Australian Steel Industry. *Antipode* **2000**, *32*, 115–134. [CrossRef]
 57. Meurs, M.; Nugmanova, M.; Salimzhanova, A.; Marvin, S. Gender Regime and Women's Employment in Kazakhstan. *Comput. Econ. Study* **2021**, *63*, 603–622. [CrossRef]
 58. Kireyeva, A.A.; Kangalakova, D.M.; Nurgaliyeva, K. Analysis of the level of gender inequality in the labor market in Kazakhstan. *J. Econ. Res. Bus. Adm.* **2023**, *144*, 14–24. [CrossRef]
 59. Mubarakov, Y.Y.; Bordiyanu, I.V. Gender analysis of the main indicators of the labour market of the Republic of Kazakhstan. *Cent. Asian Econ. Rev.* **2024**, *3*, 59–68. [CrossRef]
 60. Kredina, A.A.; Vasa, L.; Nurgaliyeva, K.O. Analysis of the Gender Segregation of Labor in Higher Education of Kazakhstan: Regional Aspect. *Econ. Strategy Pract.* **2023**, *18*, 227–240. [CrossRef]
 61. Zhidelbai, Z.; Yeszhanova, Z. Gender Inequality and Its Implications for the Youth Labor Market of Kazakhstan. *Eurasian J. Gend. Stud.* **2024**, *1*, 5–16. [CrossRef]
 62. Buribayev, Y.A.; Khamzina, Z.A. Gender equality in employment: The experience of Kazakhstan. *Int. J. Discrim. Law* **2019**, *2*, 110–124. [CrossRef]
 63. Khamzina, Z.; Buribayev, Y.; Taitorina, B.; Yessengazieva, A.; Kuttygalieva, A. Towards Nondiscrimination and Gender Equality: The Role of International Labor Standards. *Sustainability* **2022**, *14*, 5349. [CrossRef]
 64. Beloeva, S.; Venelinova, N. Digital Discrimination Risks in the Transformation of Higher Education. *Strateg. Policy Sci. Educ.-Strateg. Na Obraz. I Nauchnata Polit.* **2024**, *32*, 98–108. [CrossRef]
 65. Nurmagametov, A.M.; Zhumabayeva, A.B. Discrimination in the field of labor and obligations of the parties to labor and directly related relations. *Sci. Leg. J. «Bull. Inst. Legis. Leg. Inf. Repub. Kazakhstan»* **2024**, *1*, 98–105. (In Russian) [CrossRef]
 66. Matysa, T.; Nowacki, K.; Lis, T. The correlation between structure of employment and accidents at work in metallurgical enterprises. In Proceedings of the 26th International Conference on Metallurgy and Materials, Brno, Czech Republic, 24–26 May 2017; pp. 2244–2249.

67. Adibayev, A.M.; Omirzhanov, Y.T. The main problems with the implementation of the international standards for the employment of persons with disabilities in the Republic of Kazakhstan. *Bull. LN Gumilyov Eurasian Natl. Univ. Law Ser.* **2022**, *2*, 109–121. [[CrossRef](#)]
68. Abdulla, K.; Mourelatos, E. Does war increase ethnic discrimination in the labor market? Evidence from a field experiment. *Econ. Model.* **2025**, *149*, 107111. [[CrossRef](#)]
69. Seitzhanov, S.; Kurmanov, N.; Petrova, M.; Aliyev, U.; Aidargaliyeva, N. Stimulation of entrepreneurs' innovative activity: Evidence from Kazakhstan. *Entrep. Sustain. Issues* **2020**, *7*, 2615–2629. [[CrossRef](#)]
70. Islamgaleyev, A.; Petrova, M.; Kurenkeyeva, G.; Shalbayeva, S.; Kadirbergenova, A. Increasing customer focus in metal trading. *Entrep. Sustain. Issues* **2020**, *8*, 604–617. [[CrossRef](#)]
71. Nurbekova, Z.; Zhanazarova, Z.; Beisenova, A. Assessment of the social potential of industrial enterprises in Kazakhstan. *Public Adm. Civ. Serv.* **2017**, *1*, 115–123. Available online: <https://journal.apa.kz/index.php/path/article/view/185> (accessed on 15 December 2024). (In Russian)

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.