MINING AND METALLURGY INSTITUTE BOR
UDK: 622

ISSN: 2334-8836 (Štampano izdanje)
ISSN: 2406-1395 (Online)

UDK: 622.012:669.013:681.5.01(045)=111
DOI: 10.5937/mmeb2101043M

Received: 11.05.2021.
Revised: 25.05.2021.
Accepted: 28.05.2021.

Original Scientific Paper
Economics and Management

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ANALYSIS OF THE DIGITAL TECHNOLOGY IMPACT IN THE MINING AND METALLURGICAL COMPANIES[****]

Abstract

Dissemination of the new technologies brings the new challenges in business of the mining and metallurgical companies, as well as the care of accepting changes by the employees. This paper deals with an analysis of impact the digital technology development in the mining and metallurgical companies in Serbia. The research methodology is focused on measuring and interpreting the digitalization by the qualitative and quantitative methods. The research findings show how the business of mining and metallurgical companies is transformed into a digital age and provides everything that is needed to combine the mining and metallurgical processes with a new technology for sustainable development.

Keywords: sustainable development, digital technology, mining and metallurgy companies

1 INTRODUCTION

Dissemination of the new technologies brings the new challenges in business of the mining and metallurgical companies, but also a worry for the job security. Thus, the digital technologies provide a new way of managing in the modern business processes [1]. As the impact of digital business is important to many companies, many authors call it the industrial revolution [2,3]. The technological revolution provides to the mining and metallurgical companies a competitive advantage that enables them the potential benefits. Digital technologies bring the positive and negative changes to the companies both for managers and employees. Successful application of digital technologies surpasses the existing technology and requires creation of a transformative vision, elimination a lack of skills of the employees, changing the organizational structure and culture and enabling the creation of a skillful and agile organizational structure and development of digital strategy [4].

Development of the mining and metallurgical companies in Serbia is not a choice but an inevitability. Excessive exploitation of the non-renewable mineral wealth (mi-

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[****] *The research presented in this paper was done with the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the financing of scientific research work in the Institute of Mining and Metallurgy Bor, according to the Contract No. 451-03-9/2021-14/200052, and at the University of Belgrade, Technical Faculty in Bor, according to the Contract No. 451-03-9/2021-14/200131*

neral raw materials) is not the basis for survival. Optimal exploitation of mineral resources is a necessary precondition for survival and sustainable development. Rapid economic growth and sustainability, as an indicator of economic and social development, requires the implementation of digital technology.

Digitalization is today one of the main trends that creates faster and radical changes in society and companies [5]. Digitalization is the basic transition of society into digital generations where digital technologies are rooted in their everyday practice and culture [6]. In this context, the companies conduct research on the positive and negative criteria of digital technology.

The aim of research: A new current business including the information and communication technology creates the new business models for the mining and metallurgical companies. Business management is changed and there is a change in human resources development as well. This means that the society as a whole is undergoing a radical change due to the development of digital technologies [7]. This paper analyzes the impact assessment of the positive and negative criteria of digital technology by implementation the qualitative and quantitative methods of multicriteria decision making.

The Analytical Hierarchical Process, AHP method, was implemented of the qualitative and quantitative methods. The AHP method belongs to the group of multicriteria decision-making methods (MCDM).

2 LITERATURE REVIEW

Digitalization, one of the names of digital technology, brings the new ways of transformation to the key business operations and management practices [8]. Such a rise in the new technologies, digital technologies such as social networks and mobile devices, makes it possible for today's companies to conduct research and analyze their advantages [4,9]. The digital age has been identified as one of the most important trends changing the current business [10], which has gained in importance during the pandemic caused by COVID - 19.

The impact of digital business brings the new challenges. Dissemination of the new technologies brings the organizational changes. Much of the literature that focuses on organizational changes in the business processes points to a resistance among employees for fear that the changes will affect them either positively or negatively, as well as concerns about the job position stability [11].

The employees in companies are afraid of changes that could lead to the changes in comfortable social dynamics, to desirable and undesirable jobs [12]. Organizational changes affect a job satisfaction due to stress because with greater stress, the job satisfaction decreases [13-15]. Some factors of organizational change have a positive impact on the job satisfaction, while the others have a negative impact [16,17]. The level of employee satisfaction depends on the effectiveness of changes in the organization [18]. Changes are constant and they are the only ones that are safe in today's business. The changes are: technological, structural and systematic, products and services are changed, as well as the employees [19]. But the change management is important for a company and it represents a modification of organization [20, 21]. Change management is one of the most difficult tasks for the company managers [22].

Forecasts show that the demand for mineral resources worldwide has increased due to the increase in the number of inhabitants on the Earth. With the introduction of digital technology, it is important to ensure that the benefits of digital transformation are felt by both the customer and organization [23]. Thus, the managers of mining and metallurgical companies can use digital technology to build the innovative business models and mineral resource management.

The research methodology is focused on measuring and interpreting the positive and negative effects of digital technology in the mining and metallurgical companies. The

analysis of positive and negative effects was done by a qualitative and quantitative method, the AHP method developed by the mathematician Satie, [24]. The AHP method is an effective tool that serves as an aid to the managers in making the realistic decisions. It assists the decision makers in solving complex problems by structuring a hierarchy of criteria and alternatives to assess the priorities. The AHP method is one of the most applicable MCDM methods. In a number of studies, the MCDM methods have been successfully used for the purpose of: assessment a progress towards the Europe 2020 goals using the MULTIMOOR method [25]; assessment an organizational culture by the AHP method [26]; solving the problem of personnel selection by the Fuzzy method [27]; staff assessment and selection by the integrated AHP and PROMETHEE method [28], etc.

3 RESEARCH METHODOLOGY

The research model was built on the basis of a previous review of literature using the AHP method presented in Figure 1. Objective, assessment the impact of positive and negative impacts of digital technology are at the top (LEVEL 0) while the alternatives are at the level II and criteria at the level I.

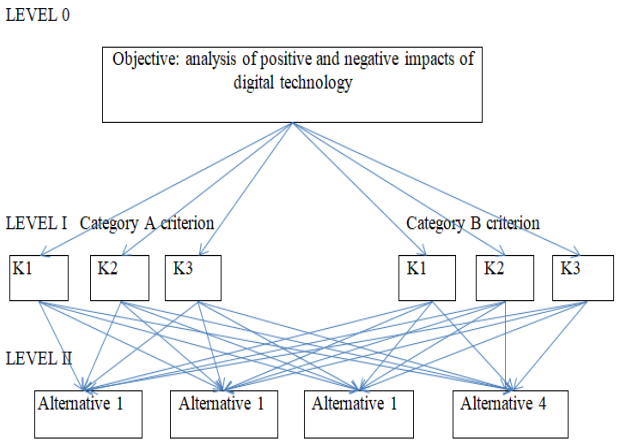


Figure 1 *Implementation of the AHP method*

The criteria depend on the given objective set by the decision maker. They determine the way in which the digital technology affects the business of stakeholders. The objective of research is aimed at assessment the positive and negative effects of application the digital technology in the mining and metallurgical companies.

Criteria category A, the positive effects of digital technology:

- Criterion C_1 – Electronic business and management. The digital transformation has led to the creation of a new way of doing business and management, e-business and management.
- Criterion C_2 – Improving the operation way. Digitalization improves the operation way through digital means such as e-mail, video tools and other systems [29]. Companies invest into mobility, common technology and connect facilities to provide the value-added services to the employees to improve the quality and efficiency of work [30]. Dissemination of digital

technology creates the new business models, which facilitates and simplifies the production process in the mining and metallurgical companies.

- Criterion C_3 – Reduction of costs. Digital business models differ from traditional ones because the product and service are made with almost zero marginal costs [31]. Digitalization of the information-intensive processes can reduce costs by up to 90 percent and can improve turnaround times by several orders of magnitude [32].
- Criterion C_4 – Job automation. Digitalization is one that can improve the work of employees through automation, which leads to an increase in their satisfaction [32]. Throughout history, the companies have used automation to speed up the processes and reduce manual labor.
- Criterion C_5 – Increasing profits. With the progress of digitalization, the quality of products and services in the industrial sector is improved, and the income of companies is increased. Internal optimization of the company's business provides a great benefit (profit) [34].
- Criterion C_6 – Increasing the customer (consumer) satisfaction. Relationship between the users (consumers) and company with the advancement of digital technology enables their greater connection [35], trust in the product and services [36] and meeting the changeable needs of consumers [37]. Companies build a theory of possibility analysis regarding changes in a consumer behavior due to better understanding of a given process [38].
- Criterion C_7 – Innovative business models. The latest advances in digital technology, linking of information, communication and computing create the innovative business models [39].
- Criterion C_8 – Competitiveness. Digital technology gives a company a competitive advantage based on making better decisions. Making decisions based on facts with the help of digitalization makes companies more competitive. Companies that were characterized as digital (data-driven) were on average 5% more productive and 6% more profitable compared to the competitors [40].

Criteria B, negative impacts of digital technology:

- Criterion C_1 – Employee resistance to the changes (fear of the unknown). The employees are the ones who determine whether they will accept the changes or not. Successful organizational change requires the acceptance of employees [41]. The employees are the ones who always offer resistance when it comes to a change due to the personal fear for their existence.
- Criterion C_2 - Uncertain jobs. With digitalization, we get the organizationnal changes that require a reduction of employees.
- Criterion C_3 - Digital application security. Digitalization in companies is not safe because it is still in development.
- Criterion C_4 - Organizational changes. Much of the literature that focuses on organizational change shows that the changes often fail due to the employee resistance. Resistance arises out of personal fear. The employees are afraid that the changes will cause them to lose comfort or get heavier jobs from less desirable jobs.
- Criterion C_5 – Lack of skills. The employees often face difficulties and tensions in maintaining the previous levels of performance, adapting to a new job requirement [42].

Using Satie 's Scale, Table 1, the criteria are compared

Table 1 *Satie's scale of comparison of two elements*

$$S=\left\{\frac{1}{9},\frac{1}{8},\frac{1}{7},\frac{1}{6},\frac{1}{5},\frac{1}{4},\frac{1}{3},\frac{1}{2},1,2,3,4,5,6,7,8,9\right\}$$

Value a_{jk}	Analysis of the results
1	Elements *j* and *k* are equally important
3	Element *j* is somewhat more important than *k*
5	Element *j* is more important than *k*
7	Element *j* is much more important than *k*
9	Element *j* is absolutely more important than *k*
2,4,6,8	Intermediate value between two elements

If criterion C_1 is slightly better, more desirable than criterion C_2, then C_1 is graded 3, and C_2 is graded 1/3. The degree of consistency CR is calculated to precisely determine the weight coefficients of all given elements that are compared with each other. Sometimes there is inconsistency in solving the problem and then the results are not reliable. CR should be less than 0.10. Then the result is correct and there is no need to recalculate.

Empirical assessment the comparison of two elements, positive criteria is shown by the matrix 8x8 - Table 2. Calculation was done using the software SuperDecisions, Figure 2.

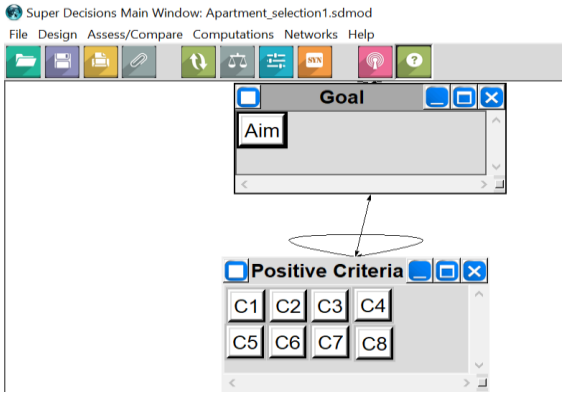
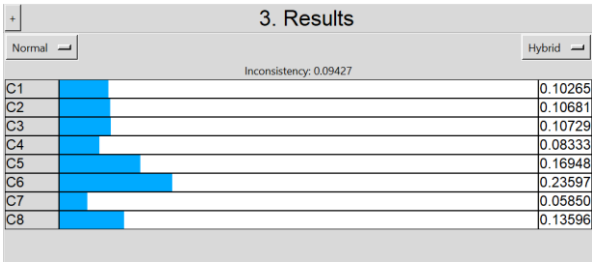


Figure 2 *View the calculation of positive criteria using the Super Decisions*

Table 2 *Matrix of comparison the positive pairs for weight coefficients of criteria*

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
C_1	1	3	1/2	1	1/3	1/3	3	1/3
C_2		1	3	1	1/2	1/3	3	1/2
C_3			1	2	1	1/3	1	1
C_4				1	1/2	1/2	1	1
C_5					1	1	3	1
C_6						1	3	3
C_7							1	1/2
C_8								1

Table 3 *Results obtained by the AHP calculation*



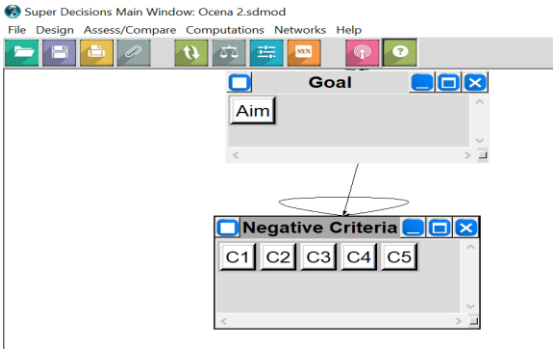


Figure 3 *View the calculation of negative criteria using the Super Decisions*

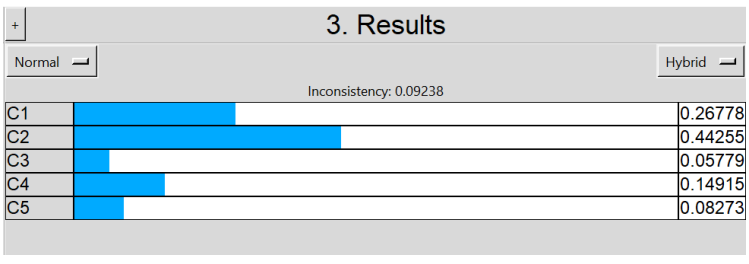
Empirical assessment the comparison of decision makers of negative criteria is shown by the matrix 5x5 - Table 4.

The calculation was done using the software SuperDecisions, Figure 3.

Table 4 *Matrix of comparison the negative pairs for weight coefficients of criteria*

Criteria	C_1	C_2	C_3	C_4	C_5
C_1	1	1/3	3	3	5
C_2		1	5	3	5
C_3			1	1/3	1/3
C_4				1	3
C_5					1

Table 5 *Results obtained by the AHP calculation*



4 ANALYSIS OF THE RESULTS

When making decisions, it is important that the criteria are relevant for solving the relevant problem. That is, the criteria should be complete to cover all important aspects used in decision-making to achieve objectives. It depends on the adopted criteria which final decision will be made by the manager (decision maker).

4.1 Analysis of the assessment of positive criteria

Based on the calculation of positive criteria (Table 3), criterion C_6 has the highest score and takes the first place. Criterion C_6, increasing the customer satisfaction has the weight coefficient of 0.23597. The connection and understanding of users and companies, the trust of users in products and services and satisfaction of changeable needs of consumers by the company makes it to increase the customer satisfaction with the advancement of digital technology.

The second place is evaluated by criterion C_5, increase in profit, with the weight coefficient of 0.16948. Internal business optimization provides the high profits. The quality of products and services in the industrial sector is constantly improved with digital technology which increases profits.

Criterion C_8, competitiveness, was evaluated on the third place, because its weight coefficient is 0.13596. Companies with the help of digital technology are more competitive than those companies that have not introduced digital technology because they make decisions based on facts and are guided by data.

Evaluations of criterion C_1 (electronic business and management), criterion C_2 (improvement of operation methods) and criterion C_3 (reduction of costs) are approximate and by ranking these criteria take the third place. The weight coefficient for criterion C_1 is 0.10265; criterion C_2 is 0.10681 while for criterion C_3 is 0.10729. Digital technology has created a new way of doing business and managing. Mobility, e-mail, interconnection and networking bring the decreased costs to the companies and improve the way they operate. Digital business creates the e-business, management and payment. All this shows that criteria C_1, C_2 and C_3 are interconnected, integrated.

Job automation (criterion C_4) was evaluated with 0.08333. It ranks at the fourth place in the ranking order. Automation speeds up the business processes, reduces manual labor and increases customer satisfaction.

The evaluation of innovative models, criterion C_7 is 0.05850. It ranks at the fifth place in the ranking of criteria. With the development of digitalization, linking of information, communication and computing, the new models of work are being created.

The degree of consistency is $CR = 0.09427 < 0.1$, which means that the criteria are relevantly evaluated by the decision maker.

4.2 Analysis of the assessment of negative criteria

In the case of negative criteria (Table 5), criterion C_2 (unsecured job positions) was rated with the highest value because its weight coefficient is 0.44255 (first place in terms of negative criteria). Digital technology brings about such changes that change or abolish the organizational units. As a result, the dissemination of job digitalization reduces the number of employees, which is perceived as the biggest problem in this process.

Criterion C_1, resistance of employees to the changes was evaluated with a value of 0.26778. According to the assessment of negative criteria, it is at the second place.

Digital technology changes the way of business in the mining and metallurgical companies. Digitalization in business brings great technological changes that have a negative effect on employees due to fear for their existence. This fear of the unknown usually leads to the resistance to changes given by the employees.

Criterion C4, organizational changes, is at the third place. C_4 was rated 0.14915. Digital technology creates the organizational changes that affect employees. Employees are resisting to the changes due to the possible job losses. However, the organizational changes can positively and negatively affect employees.

Lack of skills, criterion C_5 was rated with 0.08273. According to the assessment of negative criteria, it is at the fourth place. Adapting of employees to the digital technology often brings difficulties and tensions. Training and education are inevitable for employees.

Criterion C_3, the safety of digital technology application ranks at the fifth place because its weight coefficient is 0.05779. Digitalization in the mining and metallurgical companies is still in development.

The degree of consistency in the negative criteria, CR is 0.09238 and is less than 0.1, which is considered as a good level of consistency.

5 CONCLUSION

This work presents the results of research, evaluation of digital technology development in the mining and metallurgical companies using the AHP method. The AHP method is the most effective means of assessment the criteria. The results of assessment the positive criteria using digital technology in the mining and metallurgical companies are as follows:

1. Criterion C_6 - increase in customer satisfaction was rated with the best score of 0.23597,
2. Criterion C_5 - profit increase was rated with 0.16948,
3. Criterion C_8- competitiveness was rated with 0.13596,
4. Criteria C_1 - e-business and management was rated with 0.10 65, C_2 - improving the way of operation with 0.10681 and C_3 - cost reduction with 0.10729,
5. Criterion C_4 - job automation was rated with 0.08333,
6. Criterion C_5 - innovative models was rated with 0.05850.

Successful application of digital transformation in the mining and metallurgical companies:

- Overcomes the outdated and creates a new technology,
- Creates e-business and payment,
- Elimination of deficiencies of the employee skills,
- Creates a new way of engaging the organization,
- Creates the skillful and agile organizational structures,
- Digitally connects the user with the company,
- Customer trust in products and services,
- Increase customer satisfaction,
- Decisions are made on the basis of facts,
- Reduce manual labor,
- Increases the company's profit,
- Companies are more competitive,
- Reduces costs,
- Creates innovative models,
- Requires creation of a transformative vision, and
- Develops the new digital strategies.

The results of assessment the negative criteria using digital technology in the mining and metallurgical companies were obtained in the following order:

1. Criterion C_2 - insecure job positions with the highest value of 0.44255,

2. Criterion C_1 - resistance of employees to the changes with a score of 0.26778,
3. Criterion C_3 - organizational changes with a score of 0.149,
4. Criterion C_5 - lack of skills with a score of 0.08273, and
5. Criterion C_3 - security of digital technology application with a score of 0.05779.

Negative impacts of digital technology:

- Reduction the number of employees,
- Training and retraining of employees are performed,
- Eliminate the old and create the new digitized jobs,
- Organizational structure and culture are changed,
- Creation the difficulties and tension for employees from the resulting digital changes, and
- Development the employees' perceptions for digitalization.

The results indicate that business is more efficient applying the digital technology. Negative effects are indicators of how and in what way they should be overcome. It is necessary to invest into appropriate measures to adapt to the digital transformation because the producers will eventually have higher profits, productivity and competitiveness [43].

In this way, an opportunity is created for further research of the customer satisfaction applying a digital change in business.

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