The role of digital influence in the transformation of human capital in the agrosphere*

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Abstract

Digital technologies in the agricultural sector, such as automation, the Internet of Things, big data, drone technologies, artificial intelligence, and others, provide opportunities for significantly increasing the productivity and sustainability of agricultural production. In view of this, the article is devoted to determining the role of digital influence on the transformation of human capital in the agricultural sector. However, in order for digital technologies to become an effective tool for development, an important condition is the ability of human capital to adapt to changes, improving its skills and competencies. Also, mathematical research methods were used to achieve the goal, which made it possible to propose a model of the impact of digital transformation on human capital, where the impact of artificial intelligence and machine learning is taken into account in digital transformation. It is studied that the transformation of human capital in the agricultural sector involves not only updating the knowledge and skills of employees, but also developing new management approaches and forms of labor organization that meet modern requirements. An important element of this transformation is increasing the level of education and professional training, implementing retraining and advanced training programs, which also take into account artificial intelligence tools to facilitate the learning process, allowing farmers to be competitive in the labor market and ready for rapid changes in the agricultural sector.

Keywords

digital economy, digital technologies, agrosphere, communications, digital tools

1. Introduction

The agricultural sector is one of the key elements of the economy of each country, ensuring food security, rural development and job creation. However, with the development of globalization and technological innovation, the agricultural sector faces a number of new challenges, among which the introduction of digital technologies is particularly important. Digitalization in the agricultural sector not only affects the efficiency of production processes, but also significantly changes the requirements for human capital, which becomes the main factor in the success of agricultural enterprises [1].

The transformation of the human capital of the agricultural sector in the context of digitalization includes several important aspects. Firstly, this is the need for new skills and knowledge. Specialists must master new digital tools for the effective use of technologies, such as data-driven agricultural management, work with drone systems, big data analysis and the use of

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geographic information systems [2]. Secondly, this is a change in management approaches. Digitalization requires more flexible and dynamic management solutions based on data, as well as the ability to quickly adapt and introduce innovations into work.

It should be noted that in modern conditions, traditional knowledge and skills are no longer enough for agricultural workers. They must constantly update their qualifications, master new technologies and become more adaptable to constant changes in the market.

Accordingly, an important part of this transformation is the creation of new educational programs and courses, as well as the promotion of constant retraining and upgrading of personnel skills. This will allow maintaining competitiveness in the labor market and ensuring sustainable development of the agricultural industry.

Despite the fact that the agrosphere is actively implementing innovations today, the problem of adapting human capital to the latest technological realities remains one of the most urgent. It is very valuable to take into account when studying the digital impact on the transformation of human capital in the agrosphere a systemic approach that ensures the effective use of the latest technologies in agriculture.

In the context of the study, attention is focused on the fact that the agricultural sector is gradually implementing innovative digital solutions that significantly change traditional approaches to farming. Technologies such as automation of production processes, the use of drones for monitoring, precision farming systems, big data, artificial intelligence, the Internet of Things and geographic information systems that provide greater efficiency, accuracy and speed of agricultural work, reducing costs and optimizing resources [3, 4, 5].

We also note that one of the biggest problems of the agricultural sector on the path to digitalization is the lack of readiness of human capital for digital changes [2]. Employees who do not have the proper knowledge and skills to work with digital tools often cannot effectively use technology, which, in turn, reduces the overall efficiency of agricultural enterprises. To solve this problem, it is important to create conditions for continuous training and retraining of employees. It is also necessary to change approaches to managing enterprises based on automated and digital systems that provide faster and more accurate solutions.

In the context of the study, the emergence of a new type of employee who possesses not only traditional knowledge in agricultural specialties, but also skills to work with modern digital tools is highlighted. This means that for effective work in the agricultural sector, it is necessary to have a wide range of competencies, ranging from technical skills in equipment management to the ability to work with big data and artificial intelligence algorithms.

It has been studied that for the effective transformation of human capital in the agricultural sector it is important to focus on creating new development strategies aimed at improving the digital skills of employees, attracting young personnel and increasing the level of digital literacy among already working specialists. Only in this way is it possible to achieve maximum efficiency from the implementation of digital technologies in the agricultural sector.

The aim of the article is to develop a methodological approach to determining the role of digital influence in the transformation of human capital in the agricultural sector.

2. Materials and Methods

The problem of digital influence in the transformation of human capital in the agricultural sector is that, despite the powerful technological changes taking place in the agricultural sector, human capital is often not ready for the effective use of the latest tools and approaches [6-13]. Also worthy of special attention is the possibility of using artificial intelligence and machine learning in the process of improving the quality of human capital, improving the skills of specialists and adapting personnel to transformational changes in the economic space [15-20]. The unpreparedness of the agricultural sector for changes caused by digitalization, as well as digital influence, creates significant barriers to achieving maximum efficiency and competitiveness of agricultural

enterprises. To overcome the outlined problem, researchers have determined that it is necessary to invest in education, retraining and advanced training of employees.

It should be noted that the analysis of the digital impact on the transformation of human capital in the agrosphere requires a comprehensive and multi-parameter approach that takes into account various aspects of transformational changes: technological, educational, economic and social. In this regard, the methodological approach includes several stages, each of which aims to deeply study the relationship between digital technologies and changes in human capital in the agricultural sector (Fig. 1).

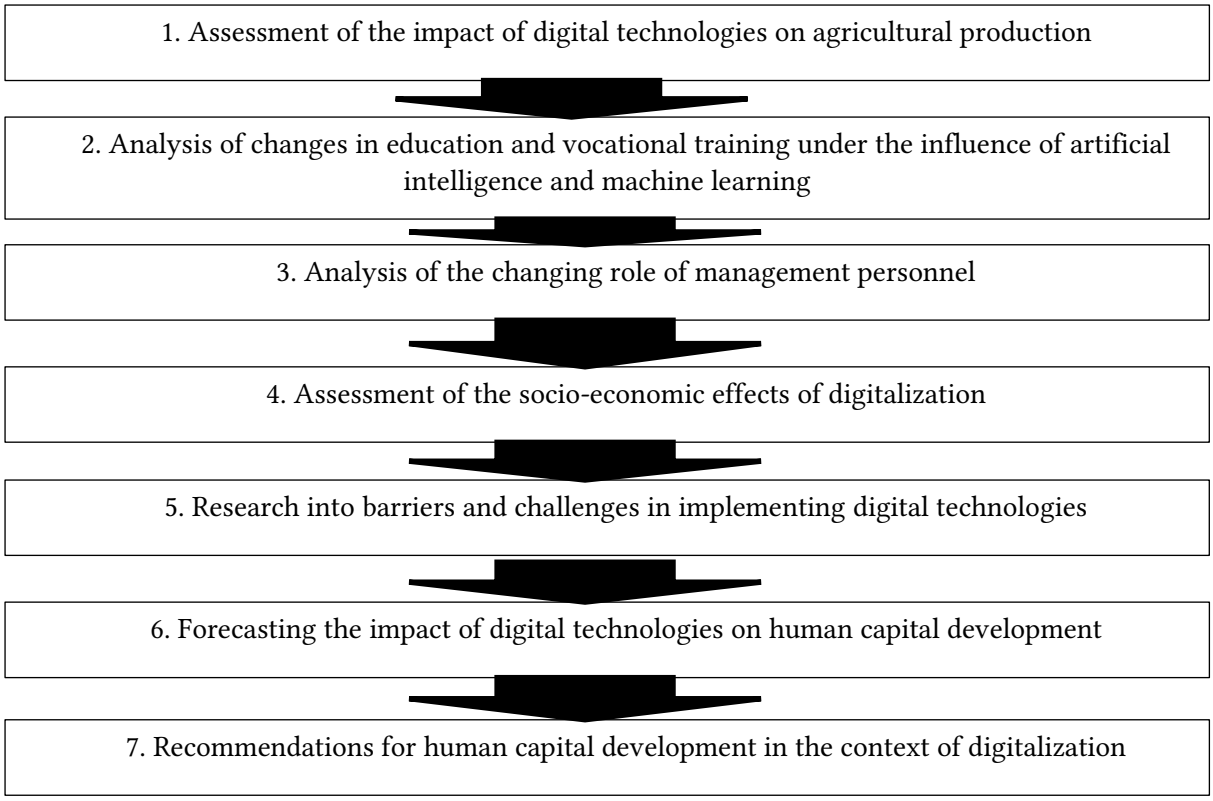

Figure 1: Methodological approach to analyzing the digital impact on the transformation of human capital in the agrosphere

*author's vision

The methodological approach to analyzing the digital impact on the transformation of human capital in the agrosphere involves a multi-level approach, including both quantitative and qualitative methods for assessing the effectiveness of the implementation of digital technologies, changes in education and professional training, as well as studying the economic and social aspects of this transformation. Taking into account all these factors allows us to more accurately assess the opportunities and challenges that human capital in the agrosphere faces in the context of digitalization. That is why, to analyze the changing role of managerial personnel, we will examine the features of investing in education. So, the variables y are investments in education; x_1 are total expenses per household per month; x_2 are the volume of scientific and scientific-technical work in real prices; x_3 are the volume of industrial products sold (by type of economic activity); x_4 are GDP. The data are presented in Table 1.

Table 1
Output data

Year	Investment in education	Total average monthly expenses per household, UAH.	Volume of scientific and scientific-technical works performed in actual prices	Volume of industrial products sold (by type of economic activity)	GDP
	y	x1	x2	x3	x4
	million UAH	million UAH	million UAH	million UAH	million UAH
2013	2276,235	3814	11781,1	1322408	1454931
2014	2378,654	4048,9	10950,7	1428839	1566728
2015	2445,795	4952	12611	1776603	1979458
2016	2456,754	5720,4	13712	2158030	2383182
2017	2567,684	7139,4	14098	2625862	2982920
2018	2658,654	7346,1	15789	2507122,7	3558706
2019	2815,795	7765,2	16568	2480308,8	3974564
2020	2356,724	6754,1	17034	2479337,0	4194102
2021	2577,54	7347,8	17890	3584251,0	5459574
2022	1698,1	5734,1	16309	2813790,1	5191028
2023	1712,0	6542,2	18934	3274630,1	6537825

* based on source [14]

As a result of the calculations, a pairwise regression was determined and the most influential factor was identified: x4 – GDP.

2.2. Case study

The model has the following representation:

$$y = -321{,}2 + 0{,}0013464 * x_4$$

After analyzing the regression coefficients, it can be concluded that with an increase in GDP by 1 million UAH. the level of investment increases by 0.0013464 million UAH.

The level of statistical significance of the regression coefficient is confirmed by the calculated value of the Student's t-test, which is t (x_4)= 8.67237. Since this value exceeds the tabular value (2.07), we can confidently state the significance of this parameter in the model.

The coefficient of determination is 81.545%, which indicates that 81.545% of the variation in the level of investment in education in Ukraine can be explained by the studied factor.

The measure of statistical significance of the improvement in the quality of the model, which is assessed by Fisher's F-test, is 322.11. This value indicates a high level of reliability of the model and confirms its statistical significance.

Within the framework of econometric modeling, forecasting is also carried out using the Durbin-Watson criterion. For our model, the Durbin-Watson coefficient is 1.01204. According to the Durbin-Watson table for n=22 and k=1 (at a significance level of 5%), the comparative values are 1.24 and 1.43. Since the calculated coefficient is between these values, this indicates the presence of autocorrelation, which allows us to conclude that forecasts based on this model may be unreliable.

Thus, the analysis indicates that the model can be used to describe the relationship between factors and the result. However, it should be noted that 17.3458% of the variation in the result is explained by other factors that were not taken into account in the model. It is important to

emphasize that the level of investment in education in Ukraine largely depends on GDP. The resulting econometric model demonstrates that to increase the level of investment in education, it is necessary to increase GDP.

Based on the presented methodological sequence and calculation of the presented model, it is possible to identify the key features of human capital transformations under the influence of digitalization: changing the structure of professions and competencies, increasing the role of digital literacy, transition to analytical-oriented management, continuous learning, taking into account the gap between generations and regions, transformation of management culture. The presented features have a significant impact on the development of human capital in the agricultural sector. It should also be noted that the use of artificial intelligence tools (for example, Google Cloud AI, Azure AI, IBM Watson, Amazon SageMake) for personnel training in the agricultural sector becomes a guarantee of competitiveness for agricultural enterprises.

As an alternative to the presented model, it is possible to propose a model of the economic potential of human capital using artificial intelligence tools in the agricultural sector, which involves several stages, including the formulation of model parameters, determination of variables, use of data for forecasting and assessment of the effectiveness of technology implementation. The sequence of the specified model is presented in Fig. 2.

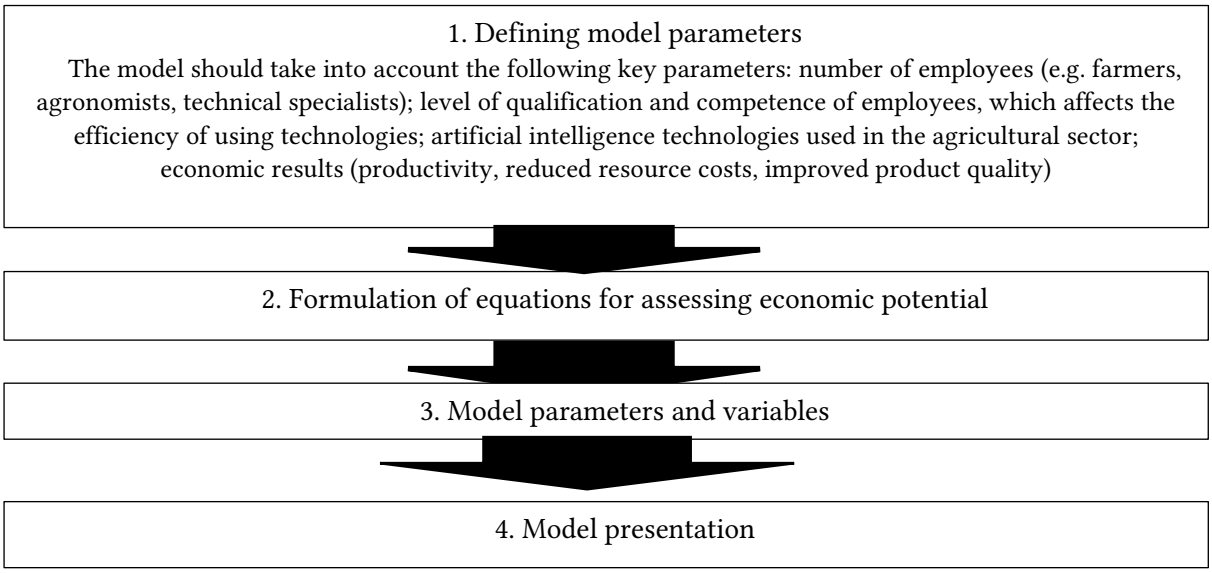

Figure. 2. Consistency of the model of economic potential of human capital
*proposed by the authors

The general appearance of the model may look like this:

$$EP = HC + P + E_{tech}$$

Where EP is the total economic potential of human capital in the agricultural sector, taking into account the use of AI.

E_{tech} is the total economic benefit from the implementation of AI technologies,

P is the total productivity,

HC is the economic potential of human capital.

Here is an example of a model calculation:

Let's calculate the model for an agricultural company with 100 employees, of which 40 are highly qualified specialists, 30 are medium-skilled, and 30 are low-skilled. The cost of investment in AI is UAH 1 000 000, which aims to improve efficiency by 15%.

1. Human capital assessment:

For example, if the average skill level for highly skilled workers is 0,9, medium-skilled workers is 0,7, and low-skilled workers is 0,5, then the economic potential of human capital can be estimated as:

$$HC=(40\cdot0,9)+(30\cdot0,7)+(30\cdot0,5)=36+21+15=72$$

2. Productivity after AI implementation:

Assume that for highly skilled workers after using AI, efficiency increases by 20%, for medium-skilled workers by 15%, and for low-skilled workers by 10%, then:

$$P=1.2\cdot(40\cdot0,9)+1.15\cdot(30\cdot0,7)+1.1\cdot(30\cdot0,5)= 90,75$$

3. Economic benefit from AI:

$$E_{tech} =1000000\cdot0,15=150000$$

4. Total economic potential:

$$EP=72+90,75+150000=150162,75$$

Thanks to the introduction of AI technologies in the agricultural sector, the total economic potential of human capital increases significantly. This allows for greater productivity, lower costs and improve economic results for agricultural enterprises, and also contributes to the development of employee competencies, which leads to a more sustainable and effective development of the agricultural sector as a whole.

3. Discussion

Based on the presented research, we note that the adaptation of agricultural workers to digital changes is a key factor for success in the context of constant innovation, the importance of this process becomes obvious at all levels. Training of personnel and investing in their continuous education is becoming a guarantee of long-term competitive advantage in the agricultural sector.

It has been studied that digital technologies can significantly increase the efficiency and productivity of labor in the agricultural sector. Therefore, it is difficult for business structures that cannot quickly adapt their employees to new conditions to remain competitive in the market. Updating hardware and software without appropriate personnel training can lead to a decrease in efficiency and time costs, which will ultimately affect the financial results of the enterprise.

It should be noted that the use of automated systems, data management software, as well as modern technologies reduces the number of errors, optimizes work processes and reduces time costs.

Employees who acquire new digital competencies become more mobile in the labor market, which contributes to their career stability and development. At the same time, it allows companies to respond more quickly to changes in the technological environment and adapt their strategies, while maintaining high qualifications of their personnel.

One of the main barriers in the process of digital transformation is employee resistance to change. Modern technologies can cause employees to fear the new, low trust in technological innovations or fear of losing jobs due to automation. Therefore, it is important to ensure adequate staff training, education and the formation of a positive attitude towards change.

Given the results of the study, we note that digitalization requires employees not only to master new technologies, but also to constantly update their knowledge. Organizations that create an environment for continuous development and learning are able to respond effectively to market changes and technological trends. In this context, the adaptation of personnel to digital changes

becomes a necessary condition for sustainable development and long-term successful operation of the company.

Therefore, the adaptation of personnel to digital transformation is not just a technical task, but also an important strategic process that affects the efficiency of the organization, competitiveness and ability to innovate. Investing in training and retraining employees, developing their digital skills is the key to success in today's economy, where technologies are rapidly changing and dictate new requirements for professionals.

4. Conclusions

The digital impact on the agricultural sector requires significant changes not only in technical processes and production practices, but also in the very essence of human capital, which is an important factor in the development of the industry.

In the context of digitalization, the agricultural sector is becoming increasingly technologically dependent, and the ability of employees to quickly adapt to new technologies, master innovative work and management methods determines the effectiveness of their use and the overall success of agribusiness. Under such conditions, one of the main opportunities for rapid learning is programs based on artificial intelligence and machine learning. For example, the use of such programs as Google Cloud AI, IBM Watson, Microsoft Azure ML allows relevant specialists in the agricultural sector to analyze large data sets, predict trends and build models of customer behavior.

It has been studied that the main areas of human capital transformation are the expansion of knowledge and skills necessary to work with new digital tools, such as big data, the Internet of Things, drone technology and process automation. This requires continuous education and advanced training, as well as adaptation to rapid environmental changes. Educational programs aimed at training specialists should take into account the current needs of the industry and contribute to the development of technological competence of agricultural workers. Given global trends, digital technologies in agriculture can become the basis for the development of sustainable and efficient models of agricultural production, in particular through precision agriculture, which optimizes resources and minimizes negative environmental impact. The successful implementation of these models is also impossible without human capital capable of evaluating and implementing these new technologies in practice.

Declaration on Generative AI

The authors have not employed any Generative AI tools.

References

[1] A. I. Krysovatyy, Y. V. Savelyev (Ed.), Sustainable development of Ukraine in the context of the new global economic and financial framework, Ternopil, 2019.

[2] O. Desyatnyuk, M. Naumenko, I. Lytovchenko, O. Beketov (2024) Impact of Digitalization on International Financial Security in Conditions of Sustainable Development. Problemy Ekorozwoju/Problems of Sustainable Development 1/2024, 104-114 URL: https://ph.pollub.pl/index.php/preko/article/view/5325/4341

[3] M. Rubmann. Industry 4.0: The future of productivity and growth in manufacturing industries. The Boston Consulting Group. Inc. 2015. Retrieved from https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries

[4] I. Shevchenko, H. Zavadskykh, O. Ptashchenko, V. Zvonar and I. Vishka. The Application of Digitization in the Economy as a Promising Direction in the Growth of Human Capital.

Economic Affairs, Vol. 68, No. 01s, pp. 345-352, February 2023 DOI: 10.46852/0424-2513.1s.2023.37. URL: http://ndpublisher.in/admin/issues/EAv68n1sz11.pdf
[5] O. Desyatnyuk, A. Krysovatyy, O. Ptashchenko, O. Kyrylenko, O. Kurtsev, Innovative Digital Economy Strategies for Enhancing Financial Security in Logistics Optimisation. Journal of Information Systems Engineering and Management. 2025,10(2s) e-ISSN:2468-4376, https://www.jisem-journal.com/P. 397-407, https://doi.org/10.52783/jisem.v10i2s.328, https://jisem-journal.com/index.php/journal/article/view/328
[6] M. Rachinger, R. Rauter, C. Müller, W. Vorraber, E. Schirgi «Digitalization and its influence on business model innovation» Journal of Manufacturing Technology Management 30(8) 1143-1160. 2019. DOI: 10.1108/JMTM-01-2018-0020
[7] J. Mensah «Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review», 2019. URL: https://www.tandfonline.com/doi/pdf/10.1080/23311886.2019.1653531?needAccess=true
[8] D. T. Mollenkamp, Economic Security: Meaning, History in the US, FAQs. 2022. URL: https://www.investopedia.com/economic-security-5213404
[9] L. Buiak, K. Pryshliak, O. Bashutska, A. Buiak, M. Shynkaryk, Yu. Semenenko. Digital Transformation of the Process of Monetary Evaluation of Agricaltural Land // International Conference on Advanced Computer Information Technologies (ACIT), Ceske Budejovice, Czech Republic 2024, pp.288-292. DOI: 10.1109/ACIT62333.2024.10712614
[10] L. Buiak, K. Pryshliak, O. Bashutska, L. Buiak, T. Polozova. Simulation and Forecasting of Agricultural Land Market Development. 13th International Conference on Advanced computer information technologies ACIT'2023. Wrocław, Poland, 21-23 September 2023. P. 70-74. DOI: 10.1109/ACIT58437.2023.10275415
[11] L. Buiak, N. Harmatiy, I. Fedyshyn, K. Pryshliak. The impact of crisis events in Ukraine on the export of agricultural products to eu countries and the world. Management Theory and Studies for Rural Business and Infrastructure Developmen. Volume: 46. Issue: 2. 2023. P. 193-201. DOI: https://doi.org/10.15544/mts.2023.19
[12] L. Buiak, O. Bashutska, K. Pryshliak, V. Hryhorkiv, M. Hryhorkiv, V. Kobets. Models of Rental Payments Formation for Agricultural Land Plots Taking into Account the Ecological Level of Economy. 10th International Conference on Advanced Computer Information Technologies ACIT 2020. Deggendorf, Germany September 16-18, 2020 P. 204-208 (Code 9208959) DOI: 10.1109/ACIT49673.2020.9208959
[13] L. Buiak, S. Matiukh, O. Gonchar, L. Yemchuk, L. Dzhulii, L. Bilorusets. Modeling in the Processes of Assessment and Forecasting of Technological Aspects of Sustainable Enterprise Development. // International Conference on Advanced Computer Information Technologies (ACIT), Ceske Budejovice, Czech Republic 2024, pp. 299-303. DOI: 10.1109/ACIT62333.2024.10712530
[14] Statistical annual of Ukraine. URL: https://ukrstat.gov.ua.
[15] E.Hermann Leveraging Artificial Intelligence in Marketing for Social Good - An Ethical Perspective, Journal of Business Ethics, Volume 179, 2022. p. 43-61, DOI: https://doi.org/10.1007/s10551-021-04843-y
[16] J. Gill, Deloitte, Generative AI in marketing and sales, URL: https://www2.deloitte.com/us/en/pages/technology-media-and-telecommunications/articles/generative-ai-in-marketing.html
[17] F. Butollo, L. Schneidemesser Platforms in Industry – disruptors of traditional manufacturing? 2022. URL: https://digitalage.berlin/wp-content/uploads/2022/02/Brief_ButolloSchneidemesser_4.pdf
[18] Deloitte, Marketing and IT: The new data duo for AI-powered growth, URL: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/consulting/us-the-new-data-duo-for-ai-powered-growth.pdf

[19] C. Campbell, S. Sands, C. Ferraro, A. Mavrommatis, H.-Y. Tsao From data to action: How marketers can leverage AI, Business Horizons, Volume 63, Issue 2, 2020, p. 227-243, DOI: https://doi.org/10.1016/j.bushor.2019.12.002

[20] C. Burlacu, The Impact of AI-Powered Content Generation on Customer Experience, University of Twente, 2023. URL: https://essay.utwente.nl/95515/1/Burlacu_BA_IBA.pdf

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