

Stachová, Katarína; Stacho, Zdenko; Šamalík, Peter; Sekan, Filip

Article

The impact of E-HRM tools on employee engagement

Administrative Sciences

Provided in Cooperation with:

MDPI – Multidisciplinary Digital Publishing Institute, Basel

Suggested Citation: Stachová, Katarína; Stacho, Zdenko; Šamalík, Peter; Sekan, Filip (2024) : The impact of E-HRM tools on employee engagement, Administrative Sciences, ISSN 2076-3387, MDPI, Basel, Vol. 14, Iss. 11, pp. 1-14,
<https://doi.org/10.3390/admsci14110303>

This Version is available at:

<https://hdl.handle.net/10419/321109>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.


If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>

Article

The Impact of E-HRM Tools on Employee Engagement

Katarína Stachová ¹, Zdenko Stacho ^{1,*} , Peter Šamalík ² and Filip Sekan ²

¹ Faculty of Social and Economic Relations, Alexander Dubček University of Trenčín, Študentská 3, 911 50 Trenčín, Slovakia; katarina.stachova@tnuni.sk

² Faculty of Social Sciences, University of Ss. Cyril and Methodius, Herdu 2, 917 01 Trnava, Slovakia; peter.samalik@ucm.sk (P.Š.); filip.sekan@ucm.sk (F.S.)

* Correspondence: zdenko.stacho@tnuni.sk

Abstract: The examination of the impact of digital innovations on employee motivation and engagement is crucial given the rapid technological advancements. This study focused on digital HRM practices, such as digital interaction platforms. The results indicated that respondents generally had positive to neutral views on these practices, with big data analytics receiving the highest rating for its potential to enhance organizational performance and employee engagement. The study revealed a moderately strong positive correlation between the use of digital platforms and big data analytics, suggesting a holistic approach to digital transformation in HRM. However, a weak correlation between digital innovations and engagement suggests that the direct impact of digital tools on employee engagement is limited by other factors. Larger companies tend to implement advanced digital HRM practices more due to their greater resources. The study's limitations include a restricted sample from the Central and Eastern European region and reliance on self-assessed data. Future studies should include more diverse regions and long-term studies, combining quantitative data with qualitative insights. Digital innovations in HRM offer promises for process improvement and data-driven decision-making, but their impact on employee engagement is complex and requires an integrated approach of technological and managerial practices.

Keywords: digital innovations; employee motivation; engagement; managerial practices



Citation: Stachová, Katarína, Zdenko Stacho, Peter Šamalík, and Filip Sekan. 2024. The Impact of E-HRM Tools on Employee Engagement. *Administrative Sciences* 14: 303. <https://doi.org/10.3390/admsci14110303>

Received: 17 July 2024

Revised: 23 October 2024

Accepted: 7 November 2024

Published: 15 November 2024



Copyright: © 2024 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) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The topic of the impact of digitalization in human resource management (HRM) on employee motivation is not new, with the concept existing since the early 20th century. However, recent advances in data availability, computational tools, and interdisciplinary innovations have significantly increased its impact. Research shows that digital HRM practices, such as big data analytics and the resulting digital training or digital performance evaluation, have a significant impact on employee motivation and consequently on their job performance (Huselid 2018; Burnett and Lisk 2021).

The use of digital platforms for interaction between employees and management is another critical factor influencing employee motivation. Al-kharabsheh et al. (2022) emphasize that these practices can lead to increased employee engagement, which directly impacts their performance. Furthermore, e-HRM practices focusing on the development of employee skills and motivation can lead to the creation of sustainable e-HRM systems. These systems subsequently improve the overall performance of the company, as evidenced by studies from Bag et al. (2022) and Stareček et al. (2021).

Digital HRM practices are thus not merely technological enhancements but strategic tools that can significantly contribute to organizational success. Implementing advanced digital solutions in HRM, such as big data analytics, digital training, digital performance evaluation, and digital interaction platforms, can substantially increase employee motivation and overall company performance (Urbancová and Vnoučková 2015; Vetráková and Smerek 2019; Wojčák et al. 2018). However, the implementation of these solutions

requires a holistic approach that encompasses not only technology but also managerial and organizational changes to fully realize their potential.

This article critically analyzes the impact of digital innovations on employee motivation and engagement, addressing the growing need for research that examines the practical applications and consequences of digital tools within human resource management (HRM). Specifically, the study responds to calls for deeper exploration of how technologies such as big data analytics and digital interaction platforms shape employee experiences, engagement, and overall motivation (Huselid 2018; Al-kharabsheh et al. 2022). By leveraging organizational theory, this article provides a detailed evaluation of how these innovations transform traditional HR processes, offering a novel perspective on their strategic value.

The originality of this research lies in its focus on the relationship between digitalization and employee engagement, a topic that has been insufficiently examined in the existing literature (Burnett and Lisk 2021). While many studies have explored the technological benefits of digital HRM tools, few have comprehensively investigated how these tools affect human aspects, such as motivation and engagement. The central puzzle addressed by this research is whether digital innovations, often designed to improve efficiency and productivity, enhance or detract from employee engagement, particularly in the context of Central and Eastern Europe (Bolli and Pusterla 2022). This research aims to fill this gap by addressing the question: How do digital HRM practices influence employee motivation and engagement, and what specific conditions enhance or limit these effects?

The theoretical framework of this study is rooted in organizational theory, focusing on how digital technologies transform internal communication, decision-making, and the delegation of autonomy to employees. The study aims to illustrate the multifaceted nature of digital HRM practices by examining both technological and managerial aspects (Stofberg et al. 2021). The methodology employed combines quantitative survey data with qualitative insights from in-depth interviews. This dual approach enables a more comprehensive understanding of how digital innovations are integrated into HRM strategies and their impact on employees.

This article offers several significant contributions to the field of HRM. First, it addresses a gap in the literature by exploring the dual impact of digital innovations on both organizational performance and employee engagement. Second, the study's findings reveal that while digital tools such as big data analytics and digital interaction platforms can enhance organizational efficiency, their effect on employee motivation is complex and mediated by factors such as management style, organizational culture, and the extent of digitalization (Chan et al. 2021). These insights provide valuable guidance for organizations seeking to balance technological advancements with human-centered management practices.

In the following sections, the article will progressively explore the key aspects of this research. Initially, we provide an overview of the current literature on digital innovations in HRM, with a focus on their influence on employee motivation and engagement. Subsequently, the research methodology is presented, including a comprehensive explanation of the research design, data collection processes, and analytical techniques. This is followed by an in-depth analysis of the results, which are drawn from data collected from companies in Central and Eastern Europe. The discussion then elaborates on the implications of these findings, both from a theoretical and practical perspective. In conclusion, the paper synthesizes the main insights, addresses the study's limitations, and offers suggestions for future research directions.

2. Literature Review

Academic literature is increasingly focusing on the study of employee engagement, examining a wide range of factors that influence this concept. The study by Susanto et al. (2023) highlights the importance of motivation, job satisfaction, and leadership as key elements that enhance employee engagement, which subsequently leads to improved performance and productivity within organizations. This research emphasizes the interconnection between these factors and their impact on work performance. Additionally,

Pincus (2022) proposes a more sophisticated model of engagement that integrates employees' psychological needs, such as autonomy and recognition. This model demonstrates that engagement is linked to fundamental human motives and that its sustainability depends on the organization's ability to support these needs. González-González and García-Almeida (2021) further develop the idea that engaged employees are more proactive in generating innovations, which, in turn, enhances the organization's adaptability to changing conditions. Moreover, according to Eliyana et al. (2019), organizational culture and the work environment play a decisive role in employee engagement. Their study shows that a positive work atmosphere and effective leadership style directly promote job satisfaction and contribute to increased employee performance. Collectively, these studies highlight that employee engagement is not simply the result of individual factors but a complex process in which motivation, organizational structure, and leadership intersect, with all of these aspects being critical for the long-term success of an organization.

Generally, it is often expected that the digitalization of the work environment contributes to increased engagement due to higher productivity, simplified interactions with colleagues and supervisors, greater worker autonomy, and flexible forms of work (Stofberg et al. 2021; Okkonen et al. 2019). A study focused on Generation Y employees in Malaysia published on SpringerLink confirms that younger employees are more engaged and satisfied when they have access to digital tools that facilitate communication and collaboration. This factor is crucial for retaining talent and reducing turnover, as younger employees seek a modern work environment that allows for flexibility and efficiency (Shahrudin and Daud 2018).

The results of a study by Bolli and Pusterla suggest that digitalization has a rather negative impact on employee job satisfaction. The increased time pressure caused by digitalization has a slight negative impact on job satisfaction, and the deteriorating work-life balance negatively affects job satisfaction. Analyses also show that this negative impact is more pronounced among men, employees over 35 years old, and those in executive positions. Conversely, the positive impact of digitalization on job satisfaction due to increased autonomy is seen in women and younger employees. In terms of productivity, digitalization is more beneficial for women, older workers, and non-executive employees. The positive impact on job satisfaction through simplified interaction with colleagues and supervisors is greater among non-executive employees than among executives (Bolli and Pusterla 2022).

Stofberg's research examines the impact of digitalization on employee engagement and creative teams. It shows that workplace digitalization and an innovative culture significantly influence employee engagement. Employees' digital literacy moderates the relationship between workplace digitalization and employee engagement (Stofberg et al. 2021). Similarly, the results of the study by Chan et al. indicate that employees' digital skills significantly increase their engagement in a digitally innovative workplace (Chan et al. 2021). This highlights the need to improve employees' digital literacy to increase their engagement. Providing training and skill development ensures that employees are better prepared for technological changes, leading to higher satisfaction, motivation (Cetindamar et al. 2021; Nikou et al. 2022), and engagement (Cetindamar Kozanoglu and Abedin 2021).

In the context of workplace digitalization, it is also important to focus on a managerial orientation towards employees. Studies by McKinsey & Company show that a people-centered approach helps improve collaboration and innovation, leading to better employee engagement and overall company performance (Bachmann et al. 2021). When implementing productivity and efficiency initiatives, employees' highly specialized knowledge offers potential for local adjustments and improvements. Moreover, employees who feel part of the change process and that their opinions and needs are considered are more motivated and engaged. Such bottom-up contributions typically require employees to "buy into" top management initiatives (Schneider and Sting 2020). Managers who actively communicate with employees and explain the reasons, consequences, and roles of employees in digital-

ization processes alleviate their concerns and resistance to change, ultimately increasing their engagement and motivation towards the initiative (Blštáková et al. 2020).

An important aspect is also the analysis of how digital platforms can improve communication and collaboration among employees, directly affecting their engagement and motivation (Copuš et al. 2019; Fajčíková and Urbancová 2019; Lorincová et al. 2019; Heim and Gierlich-Joas 2022; Aliyev 2024). Additionally, increased autonomy and flexible working conditions brought by these technologies can be key to retaining talent and reducing turnover. Although digitalization has the potential to improve the work environment, it is also necessary to pay attention to possible negative aspects, such as increased time pressure and the disruption of work-life balance.

In recent years, the importance of digital interaction platforms has significantly increased. Many organizations have transitioned to remote or hybrid work models, increasing the need for effective communication tools (Pal and Vanijja 2020; Howlett 2022). These platforms allow employees to communicate, collaborate, and share information electronically and in real time, which is crucial for the modern work environment. Platforms such as Yammer, Workplace by Meta, Asana, Trello, Zoom, Microsoft Teams, and Google Meet enhance collaboration and communication among employees regardless of their geographic location, which is essential for maintaining productivity and an innovative environment within organizations (Zhang et al. 2022; Tudose et al. 2023). Effective communication tools can significantly increase productivity by reducing the time needed to exchange information, discuss projects, and resolve emerging issues, leading to higher team efficiency (Zhang et al. 2022). Digital platforms also support innovation by creating a favorable environment for the emergence of new ideas and solutions (Tudose et al. 2023). With the capabilities these platforms bring in data analysis and feedback, managers can make better decisions, respond more quickly to changes, and optimize processes in real time (Kunath and Winkler 2018).

In recent years, the significance of digital platforms for interaction within HR has greatly increased, particularly in their role in supporting complex human resource management processes. Platforms such as Microsoft Teams, Slack, and Trello significantly contribute to real-time feedback management (Lechermeier et al. 2020). Building on this, Chalutz Ben-Gal (2019) in her study “Strategic HR Analytics: Shaping the Future of Human Resources” explores the impact of reports generated through digital analytical tools on HR decision-making processes. Furthermore, digital tools for training and development, such as Zoom and Google Meet, enable managers and trainers to efficiently train employees remotely, providing flexibility and real-time access to training materials (Hongsuchon et al. 2022). Additionally, digital onboarding tools using interactive platforms significantly improve the social adaptation of new employees and accelerate their integration into the organizational culture (Petrilli et al. 2022; Sani et al. 2023). Successful implementation of digital interaction platforms can thus provide companies with a significant competitive advantage.

The emerging field of workforce analytics promises significant improvements in organizational performance and career management of employees (Huselid 2018). Organizations have never had so many opportunities to measure and evaluate workforce effectiveness. While not all companies have adopted the available tools and technologies, leading ones have already utilized new technologies to track productivity, sales, customer satisfaction, workflows, quality, and workplace interactions frequently, sometimes in real time (Burnett and Lisk 2021; Skorupińska et al. 2024; Jankelová et al. 2020; Papula et al. 2019). Big data analytics enables the examination of large and diverse data sets (Mateen et al. 2024; Vassakis et al. 2018). This process involves using advanced analytical techniques, algorithms, and tools to extract hidden patterns, correlations, trends, and other useful information. Additionally, the tools for synthesizing and analyzing this data have rapidly advanced in recent years, with more common availability of statistical modeling, machine learning technology, and artificial intelligence applications (Raschka et al. 2020). Big data analysis using statistical analyses, machine learning, or text analysis through platforms like R and Python allows for trend identification (Bruce et al. 2020). Properly applied analytics help optimize processes and identify at-risk employees, taking mea-

asures to retain them (Luchtenberg and Migliorini 2022; Stephan et al. 2016). Tools such as SAP, SuccessFactors, and Workday provide comprehensive talent management solutions (De and Baroi 2022). The analysis results are then presented through various visualization tools such as charts, dashboards, and interactive maps via platforms like Tableau and Power BI, enabling managers and HR specialists to quickly understand findings and make informed decisions (Carlisle 2018). However, when it comes to measuring and tracking employee engagement, most companies still evaluate engagement on an annual or longer basis using traditional survey techniques (Burnett and Lisk 2021). Big data analytics in HR, particularly when incorporating analog and biometric data, provides organizations with the ability to gain deeper insights into the multifaceted factors that influence employee engagement and motivation. This analytical framework aids in identifying the underlying causes of low engagement, predicting potential risks to employee performance, and optimizing the effectiveness of interventions targeted at fostering employee engagement and motivation. By leveraging such data-driven insights, HR professionals can implement more strategic and impactful workforce management practices, ultimately enhancing overall organizational performance.

Current trends in enhancing organizational performance focus on two main areas. The first involves improving performance through the implementation of digital platforms used for direct performance analysis (Štaffenová and Kucharčíková 2023; Nedeliaková et al. 2019; Stareček et al. 2023), trend forecasting, and supporting employee interactivity. The second area focuses on increasing employee engagement (Tej et al. 2021) and motivation in a constantly changing environment influenced by the implementation of digital innovations.

Previous research on the digitalization of the work environment has predominantly focused on issues related to the use of new technologies and their application in supporting and stimulating employee engagement (Stofberg et al. 2021; Heim and Gierlich-Joas 2022). Additionally, the impact of implementing digital technologies on shaping and transforming organizational culture has been analyzed (Aliyev 2024). However, a research gap exists in examining whether the use of big data analysis on employees and digital communication tools for transmitting personnel and work-related information within HRM leads to adjustments in personnel policies in such a way that employee engagement ultimately increases. Given that HRM establishes personnel policies aimed at enhancing motivation and engagement, the proper use of big data analysis and digital tools can contribute to optimizing these policies, which, in turn, may foster greater employee engagement and well-being.

3. Materials and Methods

To gather existing theoretical and empirical knowledge relevant to the research questions, electronic scientific databases such as EBSCO HOST Research Databases, SCOPUS, Web of Knowledge, and Web of Science were used. The process involved defining search terms based on the research questions, conducting the searches, sorting the results by relevance, critically evaluating the selected literature to identify key findings and gaps, and summarizing these findings to create a theoretical foundation for the study.

These findings served as the foundation for formulating hypotheses aimed at examining the relationships between employee engagement, digital interaction platforms, and the use of big data analytics in the context of human resource management (HRM).

Hypothesis 1 (H1). *Employee engagement has a positive correlation with digital interaction platforms. This is based on the premise that digitized communication platforms, such as Microsoft Teams, Slack, or Trello, could potentially enhance employee engagement. While the literature suggests that these tools improve collaboration and communication (Al-kharabsheh et al. 2022), it has not yet been conclusively demonstrated that they have a direct and measurable impact on employee engagement. Thus, H1 is focused on verifying whether these platforms indeed lead to increased employee engagement.*

Hypothesis 2 (H2). *Digital interaction platforms and big data analytics are positively correlated. This explores whether companies utilizing digital interaction platforms are also effectively implementing big data analytics within HRM. This hypothesis does not assume that these two elements are automatically linked but seeks to determine whether their combined use occurs in practice. The literature does not yet provide clear support for this connection, so the goal is to assess whether these technologies function together or are implemented independently.*

Hypothesis 3 (H3). *Employee engagement has a positive correlation with big data analytics suggests that big data analytics could help optimize personnel policies, which in turn could increase employee engagement. Although theory supports the importance of employee engagement for organizational success, it has not been conclusively proven that the use of big data in HRM directly leads to increased engagement. Therefore, empirical testing is needed to verify whether big data analytics contributes to the optimization of these policies and, subsequently, to higher employee engagement.*

The aim of the questionnaire design and data collection was to assess the current level of implementation and future expectations of digital innovations in human resource management and the concept of supporting employee engagement and motivation. Google Forms were used for the distribution and collection of data. The questionnaire was designed to comprehensively map the extent of the application of modern tools and concepts in human resource management, the perceived importance of these tools and concepts for the future of the company. For the purposes of this study, we focused on questions related to digital innovations and their role in employee engagement and motivation strategies. Specifically, the following three questions were utilized:

- To what extent do you consider employees in your organization to be engaged in their work and contributing to the achievement of organizational goals?
 - Very low—Employees are minimally engaged in their work and contribute only to a basic extent toward organizational goals.
 - Low—Employees show limited engagement and rarely contribute beyond their core responsibilities.
 - Moderate—Employees are moderately engaged and regularly contribute to the organization's goals.
 - High—Employees are actively engaged and frequently contribute beyond their core responsibilities.
 - Very high—Employees are fully engaged, continuously contributing, and identify with the organization's goals.
- To what extent do you implement big data analytics of analog and/or biometric data to evaluate employee well-being and engagement levels in your organization?
 - Not implemented
 - Not yet implemented, but planned in the near future
 - Unable to assess the level of implementation
 - Partially implemented
 - Fully implemented
- To what extent do you use digital platforms for interaction and HR management in your organization?
 - Not used
 - Not yet used, but planned in the near future
 - Unable to assess the level of usage
 - Partially used

The distribution of the questionnaire took place from January to September 2020 and from March to December 2021, targeting managers responsible for human resource management in companies from Central and Eastern Europe. The composition of respondents was

determined considering the size of the enterprise by the number of employees to achieve a double-digit number of representatives in various size categories.

The authors of this article are members of an international research consortium consisting of 55 researchers from Europe. As part of the research conducted by this research network, more than 3000 managers from the private sector operating in Central and Eastern Europe, responsible for managing and developing human resources in their companies, were contacted. The selection of respondents in each country was random. In the context of the study conducted by the authors of this article, several surveys were conducted on a cumulative sample of more than 1550 managers (in the years 2020 and 2021) representing entities in the private sector. Out of the total number of 1552 companies contacted in 2020, 1112 questionnaires were fully completed, representing a participation rate of 72%. Similarly, in 2021, out of the total number of 1558 companies contacted, 1109 questionnaires were carefully completed, representing a participation rate of 71%. Specific demographic data of respondents, categorized by workforce size and business sector are provided in the Table 1.

Table 1. Workforce size, business sector structure.

Number of companies by size (number of employees):	2020	2021
1–9	324	326
10–49	242	244
50–249	243	243
250 and more	303	296
Number of companies by industry sector:	2020	2021
Industry	363	362
Services	493	500
Other	256	247

Source: own processing from survey data.

The authors used basic descriptive statistics for the initial processing of the collected data. The aim was to provide an overview of the distribution of values and their variability for the individual studied areas. They used indicators such as mean values, medians, modes, standard deviations, and variances, which allowed them to gain a basic understanding of the values of the variables of engagement, digital interaction platforms, and big data analytics.

To gain a deeper understanding of the relationships between the variables, the authors utilized Spearman's correlation analysis. This method allowed them to determine the strength and direction of relationships between individual variables, thus verifying the stated hypotheses. The correlation matrix showed which variables are positively correlated, allowing the authors to identify key relationships between the studied factors.

To verify the independence between pairs of variables, the authors applied the Chi-squared test. This test enabled them to assess whether there is a statistically significant dependency between the individual variables. Using this method, they identified which variables are dependent on each other, thus confirming or refuting their hypotheses about the relationships between the variables.

To determine whether the size of the enterprises affects the results, the authors used the Kruskal–Wallis test. This non-parametric test was chosen because their data are ordinal and the groups have different sizes. The Kruskal–Wallis test allowed them to compare multiple groups and determine whether there are statistically significant differences between them, providing a deeper insight into the impact of enterprise size on the evaluated areas.

4. Results

The authors of the paper initially processed the collected data using basic descriptive statistics. These statistical indicators provide an overview of the distribution of values and their variability for the individual areas studied. The following Table 2 presents the

mean values, medians, modes, standard deviations, and variances for the variables of engagement, digital interaction platforms, and big data analytics.

Table 2. Basic Descriptive Statistics for the Variables of Engagement, Digital Interaction Platforms, and Big Data Analytics.

Variable	Engagement	Digital Interaction Platforms	Big Data Analytics
Mean	1.940789	2.368421	2.911184
Median	2	2	3
Mode	2	2	2
Standard Deviation STDEV.S	0.944828	1.340949	1.428818
Variance	4	4	4

Source: own processing from survey data.

The data presented in Table 3. indicates that the majority of respondents rated the examined areas positively. Average values on a five-point scale for different aspects are as follows: employee engagement achieves an average score of 1.94, suggesting that employees in organizations are somewhat engaged in their work, although there is still room for improvement. Digital interaction platforms used in HRM are rated with an average score of 2.37, indicating a limited level of use. The highest average score was recorded in the area of big data analytics in HRM, with an average of 2.91, suggesting that the companies in the sample still utilize these tools relatively infrequently for employee assessment.

Table 3. Spearman Correlation Matrix.

Variable	Engagement	Digital Interaction Platforms	Big Data Analytics
Engagement	1.000		
Digital Interaction Platforms	0.161	1.000	
Big Data Analytics	0.169	0.609	1.000

Source: own processing from survey data.

The average values, which are close to the midpoint of the scale, reflect slightly positive opinions from respondents on these areas, but highlight the necessity for improvement in certain aspects. Other statistical indicators, such as the median and mode, which mostly score at 2, confirm the overall tendency toward slightly positive responses. The variability in responses is most pronounced in the evaluation of big data analytics, which may indicate differing levels of adoption of these technologies in the analyzed organizations.

To gain a deeper understanding of the relationships and to verify the stated hypotheses, the authors conducted a Spearman correlation matrix. This matrix shows the strength and direction of the relationships between all variables.

The overall results indicate varying levels of positive correlations between the variables. The strongest moderately strong positive correlation, with a coefficient of 0.609, is between digital interaction platforms and big data analytics. Conversely, engagement shows only very weak positive correlations with the other variables: 0.169 with big data analytics and 0.161 with digital interaction platforms.

Hypothesis 1 (H1). *Engagement has a positive correlation with digital interaction platforms—was not supported. The Spearman correlation coefficient between engagement and digital interaction platforms is 0.161, indicating a very weak positive correlation. This result shows that respondents' engagement has only a very weak relationship with the use of digital interaction platforms.*

Hypothesis 2 (H2). *Digital interaction platforms and big data analytics are positively correlated—was supported. The Spearman correlation coefficient between digital interaction platforms and big*

data analytics is 0.609, indicating a moderately strong positive correlation. This means that higher use of digital interaction platforms is associated with higher use of big data analytics.

Hypothesis 3 (H3). Engagement has a positive correlation with big data analytics—was not supported. The Spearman correlation coefficient between engagement and big data analytics is 0.169, indicating a very weak positive correlation. This result shows that respondents' engagement has only a very weak relationship with the use of big data analytics.

Based on the findings, we conducted a Chi-squared test for each pair of variables to test the independence between them. The test results are presented in the following Table 4.

Table 4. Chi-squared test.

Variable 1	Variable 2	Chi2	<i>p</i> -Value	Degrees of Freedom
Engagement	Digital Interaction Platforms	58.82	8.25×10^{-7}	16
Engagement	Big Data Analytics	53.37	6.57×10^{-6}	16
Digital Interaction Platforms	Big Data Analytics	567.06	2.19×10^{-110}	16

Source: own processing from survey data.

The Chi-squared test results confirm that there is a statistically significant dependency between all examined pairs of variables. The very low *p*-values (much less than 0.05) indicate that the dependencies between the variables are statistically significant and cannot be attributed to chance. The strongest dependency was found between digital interaction platforms and big data analytics (Chi2 = 567.06, $p = 2.19 \times 10^{-110}$), consistent with our previous findings from the Spearman correlation analysis. These conclusions support the claim that companies simultaneously invest in the development of digital innovations and increasing employee engagement, with the greatest emphasis on the connection between digital interaction platforms and big data analytics.

The authors were also interested in whether the results could vary depending on the size of the enterprise. Therefore, they decided to use the Kruskal–Wallis test to determine if the size of the enterprises plays a role in the results. This test was chosen because the data are ordinal, the independent groups have different sizes, and the assumptions for parametric tests like ANOVA were not met. The Kruskal–Wallis test allows comparing multiple groups and determining if there are statistically significant differences between them, providing a deeper insight into the possible impacts of enterprise size on the evaluated areas. The results of the test for the variables engagement, digital interaction platforms, and big data analytics based on the size of the enterprise are shown in the following Table 5.

Table 5. Kruskal–Wallis test.

Column	Kruskal–Wallis Stat	<i>p</i> -Value
Engagement	4.32	0.229
Digital Interaction Platforms	8.67	0.034
Big Data Analytics	6.11	0.107

Source: own processing from survey data.

As Table 6. indicates, for the variable engagement, the *p*-value of 0.229 suggests that the differences between the groups (based on enterprise size) are not statistically significant at the 0.05 significance level. Similarly, for the variable big data analytics, the *p*-value of 0.107 indicates that the differences between the groups are not statistically significant at the 0.05 significance level. Only the variable digital interaction platforms has a *p*-value of 0.034, suggesting that the differences between the groups are statistically significant at the 0.05 significance level.

Table 6. Median Usage Values of Digital Interaction Platforms by Enterprise Size.

Number of Employees	Median Value
1–9	1.5
10–49	2.0
50–249	3.0
250 and more	4.0

Source: own processing from survey data.

Based on these findings, we were interested in which enterprises exhibit higher values of digital interaction platform usage.

These results indicate that smaller enterprises are likely to use digital interaction platforms less compared to larger enterprises.

5. Discussion

Digitalization in human resource management (HRM) represents a revolutionary step. This study focuses on analyzing the impact of utilizing digital tools in HRM on employee engagement. The results of the presented research indicate that respondents generally hold neutral to positive views regarding the evaluated areas of digitalization in HRM, with big data analytics receiving the highest average rating (2.91 on a five-point scale). This suggests that companies in the sample still use these tools for employee evaluation relatively infrequently. Basic descriptive statistics suggest that the values for engagement, digital interaction platforms, and big data analytics are close to the middle of the scale, indicating slightly positive outcomes of the application of these variables in the organizations' practice. This aligns with the expected trend and is consistent with the study by [Bhatti et al. \(2022\)](#), which confirms that organizations in CEE are positively oriented towards adopting current trends to maintain competitiveness. A study published by McKinsey & Company further states that companies in Central and Eastern Europe, referred to as "digital challengers", are undergoing digital transformation and using digital technologies to increase productivity and innovation. These companies are successfully integrating digital platforms and big data analytics into their business processes, enabling them to better respond to rapidly changing conditions and employee needs.

Despite the general assumption that the implementation of innovations in HRM will not only contribute to the efficiency of performing individual tasks but also to the more successful achievement of strategic goals—among which increasing employee engagement certainly belongs—the results of our study suggest that there is no particularly strong relationship between these variables. The results of the Spearman correlation matrix indicate that employee engagement has only a very weak positive correlation with digital interaction platforms used in HR administration at a level of (0.161), and therefore, the proposed hypothesis H1 was not supported. This suggests that focusing on enhancing employee engagement is not directly linked to the use of digital interactive platforms in HRM. Similarly, hypothesis H3, stating that employee engagement is significantly correlated with the use of big data analytics in HRM, was also not supported, as the analysis again showed only a very weak positive correlation at a level of (0.169). This essentially aligns with the findings of [Bolli and Pusterla \(2022\)](#), which suggest that digitalization can have both positive and negative effects on employee engagement. However, it is important to note that the positive focus on engagement in organizational practice indicates that this trend is of interest to organizations.

On the other hand, the Spearman correlation matrix shows a moderate (0.609) correlation between the use of digital interaction platforms in HRM and the application of big data analytics in HRM, indicating that higher use of digital platforms is associated with higher utilization of big data analytics. Hypothesis H2, that digital interaction platforms and big data analytics are positively correlated, was supported (0.609). In practice, this suggests that companies implementing digital platforms for interaction tend to also use big data analytics and vice versa. This relationship may be due to the fact that both approaches

are part of a broader strategy of digitalization and modernization of HR processes, which includes improving communication, collaboration, and decision-making processes through technology. These results are consistent with studies by [Bhatti et al. \(2022\)](#) and [Ajah and Nweke \(2019\)](#), which indicate that companies investing in digital innovations, such as communication platforms, often also seek other technologies, such as big data analytics, to maximize efficiency and gain a competitive advantage. This is also confirmed by the Chi-squared test results, which showed a statistically significant dependence between all variables, with the strongest dependence being between digital interaction platforms and big data analytics.

According to research by [Dahlbom et al. \(2020\)](#), larger companies are more inclined to implement advanced technologies in HRM, including big data analytics. These companies have better resources to invest in the technologies and infrastructure needed for effective use of big data. Larger organizations also more often possess the technical and analytical capacities needed to implement and manage complex human resource management systems (HRM). Our Kruskal–Wallis test results supported this assertion, showing that the size of the company affects the use of digital interaction platforms, with larger companies using them more than smaller ones.

6. Conclusions

Examining the impact of digital innovations on employee motivation and engagement is an important area of research, especially given the rapid technological progress and its extensive impact on modern workplaces. The objective of this research was to fill a gap in the existing literature by examining how digital human resource management practices, such as the use of digital platforms for employee interaction and big data analytics, impact employee engagement. The results of our study suggest that the implementation of digital innovations in HRM does not directly contribute to increasing employee engagement.

Respondents generally held neutral to positive views on the practices of digital human resource management. The study revealed a moderately strong positive correlation between the use of digital interaction platforms and big data analytics, suggesting that companies investing in one form of digital innovation tend to adopt the other as well. This indicates a holistic approach to digital transformation in HRM. However, the weak correlation of digital innovations with engagement suggests that while digital tools can improve certain HRM functions, their direct impact on employee engagement may be limited or influenced by other factors. Finally, larger companies are more inclined to implement advanced digital HRM practices compared to smaller companies, due to their greater resources and capacity to invest in and manage complex technologies.

This study successfully addressed a gap in understanding the dual focus on digital HRM innovations and employee engagement. It provided empirical evidence that while digital tools are adopted by organizations for efficiency and data-driven decision-making, their impact on employee motivation and engagement is complex and may require supportive cultural and managerial practices to be fully realized.

The authors recognize the limitations of the study in the research sample, which was limited to organizations operating in Central and Eastern Europe, and may not fully represent global trends. Additionally, reliance on self-assessed data and the use of a five-point scale may have partially limited the depth of the insights gained. Another limitation could be the relatively short data collection period, which might have overlooked long-term trends and effects of digital HRM practices. There is also a wide range of other digital tools applicable in HRM that were not evaluated by the authors. Additionally, these trends are relatively new, and therefore, the actual impact of their use may only become evident after a certain period of time.

Future studies should include more diverse regions to capture global trends in the adoption of digital HRM innovations. Longitudinal studies would be appropriate to understand the long-term impact of digital innovations on employee engagement. Quanti-

tative data could be supplemented with qualitative insights from in-depth interviews or case studies.

In conclusion, while digital innovations in HRM offer significant promises for improving organizational processes and data-driven decision-making, their direct impact on employee satisfaction and engagement is complex and influenced by many factors. Organizations must adopt a balanced approach that integrates technological advancements with supportive managerial practices to fully realize the potential benefits for employee engagement and overall performance.

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

Funding: This research was funded by [Scientific Grant Agency Ministry of Education] grant number [No. 1/0038/22] and by [Cultural and Educational Grant Agency Ministry of Education] grant number [KEGA 012UCM-4/2022].

Institutional Review Board Statement: Ethical review and approval were waived for this study due to the research presented in the submitted paper was not conducted on humans, the respondents were representatives of organizations and expressed their professional opinions on the current state of HRM in their organizations. The research did not include any personal questions, except for identifying the examined organization and defining the job position.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data will be made available upon receipt of a reasonable request by the corresponding author.

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

References

- Ajah, Ifeyinwa Angela, and Henry Friday Nweke. 2019. Big data and business analytics: Trends, platforms, success factors and applications. *Big Data and Cognitive Computing* 3: 32. [CrossRef]
- Aliyev, Jeyhun. 2024. The Impact of Digital Transformation on Organizational Culture and Employee Engagement. SSRN. Available online: <https://ssrn.com/abstract=4772230> (accessed on 15 May 2024).
- Al-kharabsheh, Sami Awwad, Murad Salim Attiany, Rawan Odeh Khalaf Alshawabkeh, Samer Hamadneh, and Muhammad Turki Alshurideh. 2022. The impact of digital HRM on employee performance through employee motivation. *International Journal of Data and Network Science* 7: 275–82. [CrossRef]
- Bachmann, Hugh, Keith Beattie, Paolo Stefanini, and Tom Welchman. 2021. Banking on the ‘soft stuff’. *McKinsey and Company*. Available online: <https://www.mckinsey.com/capabilities/transformation/our-insights/banking-on-the-soft-stuff/> (accessed on 12 May 2023).
- Bag, Surajit, Pavitra Dhamija, Jan Harm Christiaan Pretorius, Abdul Hannan Chowdhury, and Mihalīs Giannakis. 2022. Sustainable electronic human resource management systems and firm performance: An empirical study. *International Journal of Manpower* 43: 32–51. [CrossRef]
- Bhatti, Sabeen Hussain, Adeel Ahmed, Alberto Ferraris, Wan Mohd Hirwani Wan Hussain, and Samuel Fosso Wamba. 2022. Big data analytics capabilities and MSME innovation and performance: A double mediation model of digital platform and network capabilities. *Annals of Operations Research*. Available online: <https://link.springer.com/article/10.1007/s10479-022-05002-w> (accessed on 12 May 2024).
- Blšťáková, Jana, Zuzana Joniaková, Nadežda Jankelová, Katarína Stachová, and Zdenko Stacho. 2020. Reflection of digitalization on business values: The results of examining values of people management in a digital age. *Sustainability* 12: 5202. [CrossRef]
- Bolli, Thomas, and Filippo Pusterla. 2022. Decomposing the effects of digitalization on workers’ job satisfaction. *International Review of Economics* 69: 263–300. [CrossRef]
- Bruce, Peter, Andrew Bruce, and Peter Gedeck. 2020. *Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python*. Boston: O’Reilly Media.
- Burnett, Jenifer Rae, and Timothy C. Lisk. 2021. The future of employee engagement: Real-time monitoring and digital tools for engaging a workforce. In *International Perspectives on Employee Engagement*. London: Routledge, pp. 117–28. [CrossRef]
- Carlisle, Stephanie. 2018. Software: Tableau and microsoft power bi. *Technology | Architecture+ Design* 2: 256–59. [CrossRef]

- Cetindamar, Dilek, Babak Abedin, and Kunio Shirahada. 2021. The role of employees in digital transformation: A preliminary study on how employees' digital literacy impacts use of digital technologies. *IEEE Transactions on Engineering Management* 71: 7837–48. [CrossRef]
- Cetindamar Kozanoglu, Dilek, and Babak Abedin. 2021. Understanding the role of employees in digital transformation: Conceptualization of digital literacy of employees as a multi-dimensional organizational affordance. *Journal of Enterprise Information Management* 34: 1649–72. [CrossRef]
- Chalutz Ben-Gal, Hila. 2019. An ROI-based review of HR analytics: Practical implementation tools. *Personnel Review* 48: 1429–48. [CrossRef]
- Chan, Ai Joo, Lai Wan Hooi, and Kwang Sing Ngui. 2021. Do digital literacies matter in employee engagement in digitalised workplace? *Journal of Asia Business Studies* 15: 523–40. [CrossRef]
- Copuš, Lukáš, Emil Wojčák, Miriama Majtánová, and Helena Šajgalíková. 2019. Industry 4.0 and its impact on organizational systems and human resources. *The Journal of Culture* 9: 3–8.
- Dahlbom, Pauli, Noora Siikanen, Pasi Sajasalo, and Marko Jarvenpää. 2020. Big data and HR analytics in the digital era. *Baltic Journal of Management* 15: 120–38. [CrossRef]
- De, Suman, and Ivy Baroi. 2022. An Analytical Approach for Improving Workplace Environment using HRM Systems and Application Programming Interfaces. Paper presented at the 2022 IEEE 7th International Conference for Convergence in Technology (I2CT), Mumbai, India, April 7–9, pp. 1–6. [CrossRef]
- Eliyana, Anis, Syamsul Ma'arif, and Muzakki. 2019. Job satisfaction and organizational commitment effect in the transformational leadership towards employee performance. *European Research on Management and Business Economics* 25: 144–50. [CrossRef]
- Fajčíková, Adéla, and Hana Urbancová. 2019. Factors influencing students' motivation to seek higher education—A case study at a State University in the Czech Republic. *Sustainability* 11: 4699. [CrossRef]
- González-González, Tamara, and Desiderio J. García-Almeida. 2021. Frontline employee-driven innovation through suggestions in hospitality firms: The role of the employee's creativity, knowledge, and motivation. *International Journal of Hospitality Management* 94: 102877. [CrossRef]
- Heim, Sophie, and Maren Gierlich-Joas. 2022. The mutual interaction of employee empowerment and digital innovation: A case study about an employee-initiated AR/VR sales tool at a German trade fair company. *Management Revue* 33: 213–39. [CrossRef]
- Hongsuchon, Tanaporn, Ibrahim M. M. El Emary, and Taqwa Hariguna. 2022. Assessing the impact of online-learning effectiveness and benefits in knowledge management, the antecedent of online-learning strategies and motivations: An empirical study. *Sustainability* 14: 2570. [CrossRef]
- Howlett, Marnie. 2022. Looking at the 'field' through a Zoom lens: Methodological reflections on conducting online research during a global pandemic. *Qualitative Research* 22: 387–402. [CrossRef]
- Huselid, Mark A. 2018. The science and practice of workforce analytics: Introduction to the HRM special issue. *Human Resource Management* 57: 679–84. [CrossRef]
- Jankelová, Nadežda, Zuzana Joniaková, Katarína Procházková, and Jana Blštáková. 2020. Diversity management as a tool for sustainable development of health care facilities. *Sustainability* 12: 5226. [CrossRef]
- Kunath, Martin, and Herwig Winkler. 2018. Integrating the Digital Twin of the manufacturing system into a decision support system for improving the order management process. *Procedia CIRP* 72: 225–31. [CrossRef]
- Lechermeier, Jonas, Martin Fassnacht, and Tillman Wagner. 2020. Testing the influence of real-time performance feedback on employees in digital services. *Journal of Service Management* 31: 345–71. [CrossRef]
- Lorincová, Silvia, Miloš Hitka, Ľubica Bajžíková, and Dagmar Weberová. 2019. Are the motivational preferences of employees working in small enterprises in Slovakia changing in time? *Entrepreneurship and Sustainability Issues* 6: 1618–35. [CrossRef] [PubMed]
- Luchtenberg, Daphne, and Roberto Migliorini. 2022. Coca-Cola: The People-First Story of a Digital Transformation. *McKinsey and Company*. Available online: <https://www.mckinsey.com/capabilities/operations/our-insights/coca-cola-the-people-first-story-of-a-digital-transformation> (accessed on 15 March 2024).
- Mateen, Arab ul, Qasim Ali Nisar, Samia Jamshed, Sumaira Rehman, and Muhammad Ali. 2024. HRM effectiveness as an outcome of big data: The role of big data-driven HR practices and electronic HRM. *Journal of Knowledge Economy*. [CrossRef]
- Nedeliaková, Eva, Štefancová Vladimíra, and Michal Hranický. 2019. Implementation of Six Sigma methodology using DMAIC to achieve processes improvement in railway transport. *Production Engineering Archives* 23: 18–21. [CrossRef]
- Nikou, Shahrokh, Mark De Reuver, and Matin Mahboob Kanafi. 2022. Workplace literacy skills—How information and digital literacy affect adoption of digital technology. *Journal of Documentation* 78: 371–91. [CrossRef]
- Okkonen, Jussi, Vilma Vuori, and Miikka Palvalin. 2019. Digitalization Changing Work: Employees' View on the Benefits and Hindrances. In *Information Technology and Systems. ICITS 2019. Advances in Intelligent Systems and Computing*. Edited by Álvaro Rocha, Carlos Ferrás and Manolo Paredes. Cham: Springer, vol. 918, pp. 439–47. [CrossRef]
- Pal, Debajyoti, and Vajirasak Vanijja. 2020. Perceived usability evaluation of Microsoft Teams as an online learning platform during COVID-19 using system usability scale and technology acceptance model in India. *Children and Youth Services Review* 119: 105535. [CrossRef]
- Papula, Ján, Lucia Kohnová, Zuzana Papulová, and Michael Suchoba. 2019. Industry 4.0: Preparation of Slovak companies, the comparative study. In *EAI/Springer Innovations in Communication and Computing*. Cham: Springer. [CrossRef]

- Petrilli, Sara, Laura Galuppo, and Silvio Carlo Ripamonti. 2022. Digital onboarding: Facilitators and barriers to improve worker experience. *Sustainability* 14: 5684. [CrossRef]
- Pincus, David. 2022. Engaging with the engaged: Unpacking the complexities of employee engagement in organizational settings. *Integrative Psychological and Behavioral Science* 56: 350–66. [CrossRef]
- Raschka, Sebastian, Joshua Patterson, and Corey Nolet. 2020. Machine learning in python: Main developments and technology trends in data science, machine learning, and artificial intelligence. *Information* 11: 193. [CrossRef]
- Sani, Kareem, Toyin Adisa, Olatunji Adekoya, and Emeka Oruh. 2023. Digital onboarding and employee outcomes: Empirical evidence from the UK. *Management Decision* 61: 637–54. [CrossRef]
- Schneider, Paul, and Fabian J. Sting. 2020. Employees' perspectives on digitalization-induced change: Exploring frames of industry 4.0. *Academy of Management Discoveries* 6: 406–35. [CrossRef]
- Shahrudin, Shafiq, and Normala Daud. 2018. Employee engagement determinants and employee retention: A study among generation Y employees in Malaysia. In *Proceedings of the 2nd Advances in Business Research International Conference: ABRIC2016*. Singapore: Springer, pp. 315–24. [CrossRef]
- Skorupińska, Ewa, Miloš Hitka, and Maciej Sydor. 2024. Surveying quality management methodologies in wooden furniture production. *Systems* 12: 51. [CrossRef]
- Štaffenová, Nikola, and Alžbeta Kucharčíková. 2023. Digitalization in the human capital management. *Systems* 11: 337. [CrossRef]
- Stareček, Augustín, Zdenka Gyurák Babel'ová, Natália Vraňáková, and Lukáš Jurík. 2023. The impact of Industry 4.0 implementation on required general competencies of employees in the automotive sector. *Production Engineering Archives* 29: 254–62. [CrossRef]
- Stareček, Augustín, Zdenka Gyurák Babel'ová, Helena Makysová, and Dagmar Čagánová. 2021. Sustainable human resource management and generations of employees in industrial enterprises. *Acta Logistica* 8: 45–53. [CrossRef]
- Stephan, Michael, Brett Walsh, and Roberta Yoshida. 2016. Digital HR—Revolution, Not Evolution. *Deloitte Insights*. Available online: <https://www2.deloitte.com/us/en/insights/focus/human-capital-trends/2016/digital-hr-technology-for-hr-teams-services.html> (accessed on 10 May 2024).
- Stofberg, Lize, Arien Strasheim, and Eileen Koekemoer. 2021. Digitalisation in the Workplace: The Role of Technology on Employee Engagement and Creativity Teams. In *Agile Coping in the Digital Workplace*. Edited by Nadia Ferreira, Ingrid L. Potgieter and Melinde Coetzee. Cham: Springer, pp. 231–57. [CrossRef]
- Susanto, Primadi Candra, Siera Syailendra, and Ryan Firdiansyah Suryawan. 2023. Determination of motivation and performance: Analysis of job satisfaction, employee engagement and leadership. *International Journal of Business and Applied Economics* 2: 59–68. [CrossRef]
- Tej, Juraj, Matúš Vagaš, Viktória Ali Taha, Veronika Škerháková, and Michhaela Harničárová. 2021. Examining HRM practices in relation to the retention and commitment of talented employees. *Sustainability* 13: 13923. [CrossRef]
- Tudose, Mihaela Brindusa, Amalia Georgescu, and Silvia Avasilcăi. 2023. Global Analysis Regarding the Impact of Digital Transformation on Macroeconomic Outcomes. *Sustainability* 15: 4583. [CrossRef]
- Urbancová, Hana, and Lucie Vnoučková. 2015. Investigating talent management philosophies. *Journal of Competitiveness* 7: 3–18. [CrossRef]
- Vassakis, Konstantinos, Emmanuel Petrakis, and Ioannis Kopanakis. 2018. Big data analytics: Applications, prospects and challenges. In *Mobile Big Data: A Roadmap from Models to Technologies*. Edited by Georgios Skourletopoulos, George Mastorakis, Constandinos X. Mavromoustakis, Ciprian Dobre and Evangelos Pallis. Cham: Springer, pp. 3–20. [CrossRef]
- Vetráková, Milota, and Lukáš Smerek. 2019. Competitiveness of Slovak enterprises in Central and Eastern European region. *E+M Ekonomie a Management* 22: 36–51. [CrossRef]
- Wojčák, Emil, Lukáš Copuš, and Miriama Majtánová. 2018. Requirements on human resources in context of Industry 4.0. *Grant Journal* 7: 6–11.
- Zhang, Chenxi, Pengyu Chen, and Yuanyuan Hao. 2022. The impact of digital transformation on corporate sustainability—New evidence from Chinese listed companies. *Frontiers in Environmental Science* 10: 1047418. [CrossRef]

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.