

THE IMPACT OF INVESTMENTS IN CLOUD COMPUTING AND WEBSITES UPON RESEARCH AND DEVELOPMENT COSTS IN THE PRIVATE SECTOR

Diana Aderina MOISUC¹, Sorin Adrian ACHIM^{2*}

1 Department of Business Informatics, Faculty of Economics and Business Administration, "Babes-Bolyai" University, 58-60 Theodor Mihali st., 400591, Cluj-Napoca, Romania, diana.moisuc@econ.ubbcluj.ro

2 Department of Accounting and Auditing, Faculty of Economics and Business Administration, "Babes-Bolyai" University, 58-60 Theodor Mihali st., 400591, Cluj-Napoca, Romania, sorin.achim@econ.ubbcluj.ro

** Correspondence: sorin.achim@econ.ubbcluj.ro*

Abstract: The accelerated digitalization of the private sector has led to a significant increase in investments in technologies such as cloud computing and websites, which are essential factors in business modernization and innovation support. This study analyzes the impact of investments in these technologies on research and development (R&D) expenses, using official data provided by the National Institute of Statistics (INSSE). Investments in cloud computing offer advantages such as reduced operational costs, easy access to advanced IT infrastructures, and optimization of research and development processes, allowing companies to allocate more resources to innovation. At the same time, the creation and modernization of websites enhance firms' visibility and competitiveness, generating opportunities for the development of new digital products and services. The study methodology involved collecting and processing data on investments in cloud computing, websites, and R&D costs, followed by correlation and statistical regression analyses to determine the influence of these factors on R&D spending. The results show that investments in cloud computing and websites have a positive impact on the evolution of research and development costs in the private sector.

Keywords: cloud computing, website, research and development costs

1 INTRODUCTION

Digitalization has become a crucial factor in transforming the private sector, influencing operational processes, business strategies, and companies' development directions. With the rapid advancement of digital technologies, businesses are compelled to adopt innovative

solutions to remain competitive in an increasingly dynamic market (Roztock, Soja, & Weistroffer, 2019).

This phenomenon has led to a significant increase in investments in digital infrastructure, advanced software, cloud solutions, and the development of online presence through modern and functional websites.

As the digital economy advances, an increasing number of enterprises are embracing digital technology to drive transformation and stay aligned with innovation trends (Hung, Nham, & Le, 2023).

As digitalization becomes a central pillar of the global economy, companies are reconfiguring their strategies to leverage new technologies and improve operational efficiency. Process automation and advanced data analytics enable businesses to reduce costs, enhance customer experience, and innovate more rapidly. This digital transition not only optimizes companies' current activities but also influences decisions regarding research and development (R&D) expenditures. In the digital economy, businesses are embracing digital transformation to swiftly adapt to major changes (Chen, Tu, Huang, Zhou, & Wu, 2024).

The impact of digitalization on investments in innovation is evident through increased spending on advanced IT solutions, which facilitate access to high-performance infrastructures and accelerate the development of innovative products and services. For example, the use of cloud computing allows companies to efficiently manage data, collaborate more easily, and implement scalable solutions at lower costs. At the same time, the development and modernization of websites provide new opportunities for innovation in e-commerce, digital services, and customer interaction.

In this context, analyzing the relationship between investments in cloud computing and websites and R&D expenditures is essential for understanding how digitalization influences innovation in the private sector. This study aims to investigate this relationship based on data collected from the National Institute of Statistics website, highlighting trends and the impact of these factors on economic development.

2 CLOUD COMPUTING AND WEBSITES – KEY FACTORS FOR INNOVATION

Emerging technologies such as cloud computing and websites play a crucial role in streamlining processes and enhancing company visibility. Cloud computing enables quick access to scalable IT resources, reducing operational costs and facilitating collaboration. At the same time, a well-structured and optimized website is essential for business success, providing accessibility, customer interaction, and expanded development opportunities. In the following sections, we will explore the impact of these technologies on the business environment and the benefits they bring to company management and promotion.

2.1 *Cloud Computing*

Cloud computing is an ever-evolving technology that consistently influences both the IT industry and academia. By leveraging virtualization techniques, it executes computational tasks over the Internet, eliminating dependence on complex hardware and software infrastructures (Ahmad, Bakht, & Mohan, 2017). Cloud computing provides flexibility, operational efficiency, and accessibility, reducing costs while facilitating scalability and real-time collaboration.

Cloud computing has become an essential tool for optimizing IT costs within small, medium-sized, and micro-enterprises. Adopting this technology provides significant advantages, including lower capital expenses, improved access to ICT systems, enhanced data security, and reduced costs for agile development. The main goal is to guarantee continuous access to up-to-date ICT services via the cloud, eliminating the complexity of managing an internal infrastructure (Modisane & Jokonya, 2021).

Cloud computing systems are classified into four main types: public, private, hybrid, and community clouds. Key factors such as reliability, security, and cost-effectiveness are essential service quality attributes to consider when designing a successful cloud service (Singh Gill, Wu, Patros, Ottaviani, & all, 2024).

In the current context, large volumes of data and analytical tools can be hosted in the cloud, digitalizing processes. Cloud services offer solutions such as data storage and web dashboards, enabling companies to adopt emerging technologies. The main advantages include flexible access to innovation and reduced infrastructure and IT personnel costs (Saraswat & Choudhari, 2025).

Purchasing cloud services to enhance the processing power of equipment required for running a company's proprietary software is an efficient solution for businesses looking to optimize IT performance without making massive investments in hardware infrastructure.

In many industries, internal software used for data analysis, complex simulations, or resource management requires significant processing capabilities. Increasing computational demands may necessitate acquiring high-performance equipment, leading to high investment, maintenance, and upgrading costs. By leveraging cloud computing, companies can access scalable IT resources without the need for costly local hardware.

Depending on the nature of their activities, companies invest in cloud services for various essential applications, such as Customer Relationship Management (CRM), database hosting, email services, accounting software, file storage, and office software. Cloud-based CRM systems help companies manage customer relationships, optimize sales processes, and enhance user experience. These solutions enable remote access, integration with other platforms, and automatic updates (Mathias & Saqib, 2023).

Companies that process large volumes of data, such as those in e-commerce or finance, opt for cloud services to store and manage their databases. In Romania, solutions like Oracle, Star Storage, and OPTI offer scalability and enhanced security, reducing the risk of data loss.

The use of cloud-based email solutions enables companies to efficiently manage internal and external communication, providing generous storage space and advanced protection against cyber threats. In Romania, various cloud email service providers offer professional solutions tailored to business needs, such as:

- DataHost – Provides personalized email services through Google Workspace (formerly G Suite). This includes custom email addresses, an organizational calendar, storage and archiving in Google Cloud, as well as real-time document editing, all secured by Google's infrastructure (DataHost.ro, 2025).
- Cloud Romania – Offers managed email services, including email hosting, backup, and system security. These solutions are designed to allow businesses to focus on their operations while the technical aspects are handled by the provider (Cloud Romania, 2025).
- Hostlayer – Provides professional email hosting compatible with major email clients, including Apple, Google, Microsoft, and Mozilla. The service ensures high security, operates ad-free, and offers access to email anytime, anywhere (Hostlayer, 2025).

Cloud-based accounting applications help companies manage their finances without the need to install and maintain software on local computers. These solutions enable financial process automation, remote access, and periodic updates to ensure compliance with current legislation. In Romania, various cloud-based

accounting applications are tailored to businesses of different sizes, such as:

- SmartBill Conta – An online accounting application that provides features like real-time data synchronization, fixed asset management, and automatic generation of accounting records (Smartbill, 2025).
- SAGA Cloud – Allows accounting firms to work remotely, offering simultaneous access for multiple users without requiring multiple licenses. It ensures data security through automatic daily backups and allows access from any internet-connected device (IT Soft Group, 2024).
- Visma – A cloud-based accounting software designed for small businesses, simplifying complex tasks and facilitating report generation. The application ensures automated accounting, bank reconciliation, and precise tax management (Visma, 2025).
- CIEL – Provides integrated software solutions for accounting, management, and payroll, tailored to small and medium-sized businesses in Romania. Their applications are recognized for ease of use and adaptability to the specific needs of the local market (CIEL, 2025).

2.2 The Importance of Websites for Business Development

Websites play a crucial role in business development by providing visibility, accessibility, and extended opportunities for customer interaction. In a digitalized economy, an online presence is no longer just a competitive advantage but a necessity for any business aiming to strengthen its market position.

A website with poor navigation, an unclear structure, or slow loading times can negatively impact the user experience, potentially leading

to the loss of prospective customers. On the other hand, an intuitive, well-organized, and mobile-optimized website enhances user engagement, improves conversion rates, and supports the success of digital marketing strategies (Heemakshi & Khushboo, 2023).

An effective website must meet several essential criteria to provide optimized user experience and support a company's business objectives. It should deliver clear and detailed information about available products and services while ensuring the constant updating of prices and other relevant details (Orhionkpaiyo & Momodu, 2021).

To facilitate user access, a well-structured website should include functionalities that allow order placement and online reservations, thereby increasing the efficiency and accessibility of the services offered. Additionally, order tracking is essential, giving customers real-time updates on their purchases, ensuring transparency and trust in the buying process.

A modern website should also be connected to the company's social media platforms, enabling user interaction and expanding online visibility. Responsive design and mobile optimization are essential aspects, allowing seamless navigation across different screen types. Moreover, data security and protection are priorities, requiring the implementation of proper measures such as SSL certificates to safeguard user information (Liao & Shi, 2017).

Search engine optimization (SEO) contributes to increased visibility, making the website easier to find by potential customers. At the same time, page loading speed significantly impacts the user experience and conversion rates, making performance optimization a key factor for success.

By integrating these elements, a website becomes more efficient, accessible, and competitive, aligning with the demands of an ever-evolving digital environment.

Through a well-developed website, companies can expand their market reach,

eliminate geographical barriers, and provide global access to their products and services. Additionally, maintaining an active online presence through continuous content updates and SEO improvements attracts more visitors and strengthens relationships with existing customers.

Thus, a website is not just a digital business card but an essential tool for sustainable growth and development, enabling companies to remain competitive in an increasingly digital-oriented business landscape.

3 RESEARCH METHOD

The database used in our analysis, comprising information available on the INSSE website (Institutul Național de Statistică, 2025) over a period of 13 years (2009–2021), consists of 12 variables, as follows:

- Research and Development Costs (RDC) – as the dependent variable, and
- 11 potential independent regressor variables, summarized in Table 1.

Table 1. Summary of Independent Variables (I)

No.	Regressor Variable Name	Notation
1	Website with Order Tracking	I1
2	Website with Detailed Descriptions	I2
3	Website with Order/Reservation Options	I3
4	Equipment Power Improvement	I4
5	Website Ownership	I5
6	Storage Space Acquisition	I6
7	Office Software Acquisition	I7
8	Email Service Acquisition	I8
9	Cloud Computing Service Acquisition	I9
10	Database Hosting Acquisition	I10
11	Accounting Applications Acquisition	I11

To validate the analysis model, we utilized EViews software for data processing, beginning with a correlation analysis between variables. The computed values are shown in Table 2.

Table 2. Correlation Matrix

	RDC	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11
RDC	1,00	0,49	0,61	0,53	0,66	0,61	0,79	0,76	0,77	0,82	0,80	0,78
I1	0,49	1,00	0,60	0,85	0,56	0,79	0,59	0,60	0,59	0,67	0,61	0,58
I2	0,61	0,60	1,00	0,84	0,65	0,89	0,69	0,67	0,70	0,79	0,71	0,68
I3	0,53	0,85	0,84	1,00	0,68	0,94	0,68	0,69	0,70	0,80	0,71	0,67
I4	0,66	0,56	0,65	0,68	1,00	0,58	0,64	0,62	0,62	0,84	0,67	0,65
I5	0,61	0,79	0,89	0,94	0,58	1,00	0,78	0,78	0,79	0,81	0,80	0,76
I6	0,79	0,59	0,69	0,68	0,64	0,78	1,00	0,99	0,99	0,94	1,00	0,99
I7	0,76	0,60	0,67	0,69	0,62	0,78	0,99	1,00	0,99	0,93	0,99	0,98
I8	0,77	0,59	0,70	0,70	0,62	0,79	0,99	0,99	1,00	0,94	0,99	0,99
I9	0,82	0,67	0,79	0,80	0,84	0,81	0,94	0,93	0,94	1,00	0,94	0,94
I10	0,80	0,61	0,71	0,71	0,67	0,80	1,00	0,99	0,99	0,94	1,00	0,99
I11	0,78	0,58	0,68	0,67	0,65	0,76	0,99	0,98	0,99	0,94	0,99	1,00

As observed in the correlation matrix (Table 2 – Correlation Matrix), the values are very high, necessitating the multicollinearity test to validate the potential model.

Using the Stepwise Regression method, we included all regressor variables and set a maximum p-value of 0.1, as our objective was to include an optimal number of regressors to determine their influence on the dependent variable. Based on this approach, we obtained the following model:

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
WEBSITE_OWNERSHIP	0.007993	0.001769	4.517022	0.0011
CLOUD-COMPUTING- SERV-ACQUI..	0.010376	0.002826	3.671569	0.0043
WEBSITE_WITH_ORDER_RESERV...	-0.011657	0.005100	-2.285525	0.0454
R-squared	0.727075	Mean dependent var		0.226923
Adjusted R-squared	0.672490	S.D. dependent var		0.060743
S.E. of regression	0.034762	Akaike info criterion		-3.681384
Sum squared resid	0.012084	Schwarz criterion		-3.551011
Log likelihood	26.92899	Hannan-Quinn criter.		-3.708181
Durbin-Watson stat	1.441621			

Figure 1. Initial Regression Model

Observation: As observed, the software used for data processing eliminated 8 out of the 11 regressor variables, retaining only I5, I9, and I3, which are also statistically significant at a 5% threshold, as the remaining 8 variables had a p-value greater than 10% (the maximum set limit).

Next, we checked for multicollinearity among the regressor variables, as the correlation matrix (Table 2 – Correlation Matrix) showed high values. Using Variance Inflation Factors (VIF), we obtained two very high values in the Uncentered VIF column (>>10), indicating that another variable must be removed from the model. Thus, I3 was eliminated as it had the highest coefficient, as shown in the following figure:

Variable	Coefficient	Uncentered VIF
WEBSITE_OWNERSHIP	3.13E-06	63.82095
CLOUD-COMPUTING_SE.	7.99E-06	7.871471
WEBSITE_WITH_ORDER..	2.60E-05	88.94432

Figure 2. Variance Inflation Factors

After eliminating the respective variable, we obtain the following model, which will represent our final model (presented in Figure 3), as the remaining regressor variables no longer exhibit multicollinearity, as shown in Figure 4, obtained by reapplying the Variance Inflation Factors analysis.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WEBSITE_OWNERSHIP	0.004092	0.000549	7.452796	0.0000
CLOUD-COMPUTING- SERV-ACQUI..	0.006111	0.002497	2.447597	0.0324
R-squared	0.584509	Mean dependent var		0.226923
Adjusted R-squared	0.546737	S.D. dependent var		0.060743
S.E. of regression	0.040895	Akaike info criterion		-3.414966
Sum squared resid	0.018397	Schwarz criterion		-3.328051
Log likelihood	24.19728	Hannan-Quinn criter.		-3.432831
Durbin-Watson stat	0.813300			

Figure 3. Final Regression Model

Variable	Coefficient	Uncentered VIF
WEBSITE_OWNERSHIP	3.01E-07	4.439499
CLOUD-COMPUTING- SE.	6.23E-06	4.439499

Figure 4. Variance Inflation Factors 2

4 RESULTS ANALYSIS

Analyzing the final regression model, we can state the following:

- a) A 1% increase in the proportion of enterprises that own a website leads to a 0.41% increase in RDC.
- b) A 1% increase in the proportion of enterprises that acquired cloud computing services results in a 0.61% increase in RDC.
- c) 54.6% of the variation in RDC is explained by the proportion of enterprises that own a website and those that have acquired cloud computing services, while the remaining 45.4% is attributed to other factors.

Observation: The remaining indicators calculated in the model are irrelevant, either due to their values or because multiple models were not used, making it unnecessary to select the most relevant one.

F-statistic	2.398840	Prob. F(2,10)	0.1409
Obs*R-squared	4.214840	Prob. Chi-Square(2)	0.1216
Scaled explained SS	2.300649	Prob. Chi-Square(2)	0.3165

Figure 5. Heteroskedasticity Test: Breusch-Pagan-Godfrey

To validate the final regression model, it is also necessary to apply the Breusch-Pagan-Godfrey test to determine whether heteroscedasticity (variance) exists in the residuals

Following the application of this test, we can conclude that the residuals are homoscedastic, meaning they have constant variance, as the significance indicator value in the above figure exceeds the 5% threshold.

Upon validating the model, we confirm that investments in cloud computing and websites have a positive impact on the evolution of research and development costs in the private sector.

5 CONCLUSIONS

Digitalization has become a crucial factor in transforming the private sector, having a direct impact on business strategies, operational process optimization, and increased investments in digital infrastructure. The results of this study, based on data provided by the National Institute of Statistics, highlight the strong relationship between the use of digital technologies and R&D costs, demonstrating that adopting modern solutions is a key driver of innovation.

The multiple regression analysis identified two significant regressor variables:

Website ownership, which contributes to a 0.41% increase in research and development costs for each 1% increase in the proportion of firms using this solution.

Cloud computing service acquisition, which has a positive impact on research and development costs, leading to a 0.61% increase for each 1% increase in adoption.

The results of this study confirm that digitalization is not just a trend but a necessity for companies looking to remain competitive and accelerate innovation. Cloud computing and online presence are essential tools that allow businesses to optimize resources, reduce operational costs, and facilitate access to global markets. Furthermore, the validation of the model through the Breusch-Pagan-Godfrey test demonstrated that residuals are homoscedastic, confirming the robustness of the results.

In the future, further research on this topic could include an analysis of other factors influencing innovation, such as investments in artificial intelligence, automation, or cybersecurity, to gain a more detailed understanding of the impact of digitalization on the economy.

BIBLIOGRAPHY

- Ahmad, I., Bakht, H., & Mohan, U. (2017). Cloud Computing - A Comprehensive Definition. *Journal of Computing and Management Studies*, 1 (1), 1-9.
- Chen, L., Tu, R., Huang, B., Zhou, H., & Wu, Y. (2024). Digital transformation's impact on innovation in private enterprises: Evidence from China. *Journal of Innovation & Knowledge*, 9 (2), 1-11. doi:10.1016/j.jik.2024.100491
- CIEL. (2025). *Program de facturare Gratuit și Online - Ciel Facturare*. Retrieved from: <https://ciel.ro/produse-ciel/ciel-facturare/>
- Cloud Romania. (2025). *Cloud Romania - Servicii IT*. Retrieved from: <https://cloudromania.ro/>
- DataHost.ro. (2025). *Gmail cu propriul domeniu - Google Workspace (G Suite)*. Retrieved from: <https://www.datahost.ro/business-email>

- Heemakshi, S., & Khushboo, T. (2023). The Importance of Website Usability in Digital Marketing - A Review. *International Journal of Innovative Research in Computer Science & Technology*, 11 (3), 27-31.
- Hostlayer. (2025). *Hostlayer - Găzduire email profesională pentru afacerea ta*. Retrieved from: <https://hostlayer.ro/gazduire-email/>
- Hung, B., Nham, N., & Le, T. (2023). The importance of digitalization in powering environmental innovation performance of European countries. *Journal of Innovation & Knowledge*, 8 (1), 1-22.
- Institutul Național de Statistică. (2024, 11 22). *Cheltuieli totale pentru activitatea de cercetare-dezvoltare in sectorul privat*. Retrieved from: <http://statistici.insse.ro:8077/tempo-online>
- Institutul Național de Statistică. (2025, 01 10). *TIC100A - Principalii indicatori ai utilizarii produselor TIC in intreprinderile cu 10 sau mai multe persoane ocupate*. Retrieved from: <http://statistici.insse.ro:8077/tempo-online>
- IT Soft Group. (2024). *Saga CLOUD - Contabilitate la distanta*. Retrieved from: <https://www.itsoftgroup.ro/saga-cloud/>
- Liao, Z., & Shi, X. (2017). Web functionality, web content, information security, and online tourism service continuance. *Journal of Retailing and Consumer Services*, 39, 258-263. doi:10.1016/j.jretconser.2017.06.003
- Mathias, L., & Saqib, L. (2023). Cloud-Based Customer Relationship Management: Enhancing Business Relationships. *ResearchGate*, 1-8.
- Modisane, P., & Jokonya, O. (2021). Evaluating the benefits of Cloud Computing in Small, Medium and Micro-sized Enterprises (SMMEs). *Procedia Computer Science*, 784-792. doi:10.1016/j.procs.2021.01.231
- Orhionkpaiyo, C., & Momodu, I. (2021). A Survey of Website Key Quality Characteristics across Different Domains. *International Journal of Innovative Science and Research Technology*, 461-469.
- Roztock, N., Soja, P., & Weistroffer, H. (2019). The role of information and communication technologies in socioeconomic development: towards a multi-dimensional framework. *Information Technology for Development*, 25, 171-183.
- Saraswat, J., & Choudhari, S. (2025). Integrating big data and cloud computing into the existing system and performance impact: A case study in manufacturing. *Technological Forecasting and Social Change*, 210 (16). doi:10.1016/j.techfore.2024.123883
- Singh Gill, S., Wu, H., Patros, P., Ottaviani, C., & all. (2024). Modern computing: vision and challenges. *Telematics and Informatics Reports*, 13, doi:10.1016/j.teler.2024.100116
- Smartbill. (2025). *Program de contabilitate online SmartBill Conta*. Retrieved from: <https://www.smartbill.ro/produse/conta>
- Visma. (2025). *Software de contabilitate în cloud dezvoltat pentru întreprinderi*. Retrieved from: <https://www.visma.ro/companii/contabilitate-in-cloud>