









“Digital transformation and improvement of management control: Empirical study in financial institutions”

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DIGITAL TRANSFORMATION AND IMPROVEMENT OF MANAGEMENT CONTROL: EMPIRICAL STUDY IN FINANCIAL INSTITUTIONS

Abstract

In developing economies, financial institutions are positioned as a catalyst for economic innovation, yet there is little empirical research linking digital transformation to an enhanced management control function within these institutions. This paper investigates the relationship between digital transformation and the management control function in financial institutions, based on a study conducted in Moroccan financial institutions.

A quantitative survey, conducted in 2025, focused on 149 controllers from about 90 Moroccan financial institutions. Clearly, the sample size was limited, and the representation was justified. Five hypotheses were tested in a regression analysis. The findings confirmed a positive relationship between the management controller effectiveness and the use of digital levers. Evidence indicated that automation had the most influence, followed by the implementation of Business Intelligence and Big Data, followed by Cyber Security, followed by Cloud-enabled mobile. Data visualization also had a weaker but significant impact. These findings were consistent with previous literature regarding the Moroccan context. It was an encouraging finding that the use of digital levers in management control provided operational efficiencies, as well as assisting controllers in the strategic advisory aspects. However, we caution against overgeneralizing based on the limited sample size. It is recommended that further research be conducted in more diverse types of institutions and that this validation work be expanded by using future digital integrations such as artificial intelligence and predictive analytics.

Keywords

digital transformation, management control, financial institutions, business intelligence, Big Data, automation, cybersecurity, Morocco

JEL Classification

M15, G21, L86, O33

INTRODUCTION

Digitalization is an unstoppable flow of organizational change currently taking place within organizations and impacting every aspect of business. Management control mediates this change in relation to monitoring the efficiency of financial resource use, assessing financial performance, and determining future planning (Möller et al., 2020). As digital tools are increasingly embraced as a central feature of the managerial function, digital capabilities are interlinked with a consequent need for new skills and competencies, resulting in a significant, perhaps radical change of the management control function. This development requires management controllers to update their skillset and technical competence with scope for strategic adaptability in a volatile and complex setting.

Although considerable literature exists on digital innovation and its contribution to a variety of businesses, we can say that the impacts of digital transformation on the functionality and adaptability of the

management control function are understudied (Amato et al., 2024). In particular, there is research regarding how technology and its associated innovations influence the adaptability of the management control system dimensions concerning responsiveness, decision-making, and strategic direction.

With current socio-economic disruptions, such as globalization, increasing competition, and uncertainty coined by recent events, firms have had to reconsider their mechanisms around resource allocation, financial governance, and strategic planning (Petricevic & Teece, 2019).

In this view, management control systems can go beyond the nature of financial compliance and operational efficiency; they can become strategic levers to steer firms into fluid and uncertain markets (Seghyar & Boussouf, 2023).

This study attempts to fill this gap by studying how digital transformation changes management control within any financial institution. It examines how automation, big data analytics, data visualization, cloud technologies, and cybersecurity drive operational and strategic aspects of control. In doing so, this study aims to enhance understanding of how digitalization enhances the strategic relevance and implications of the management controller's role within an organization.

This study focuses on the impact of digitalization on the improvement of the management control function. As demonstrated below, the integration of digital technology processes generates better control performance and streamlined decision-making within organizations. This enables managers to better manage financial and operational performance and improve transparency and governance. The empirical contribution of the study is part of the literature on the impact of digitalization on improving the management control function; it represents advice for decision-makers and regulators seeking to modernize these practices. It shows that the adoption of digital technologies has a direct impact on the effectiveness of management control and, consequently, on corporate performance. It improves risk management and transparency, and facilitates strategic decision-making in a digital context.

1. LITERATURE REVIEW AND HYPOTHESES

The pervasive adoption of digital technologies has reshaped how management works today. These innovations furnish managers with the tools that they can use to make decisions, communicate, and measure performance in real time (El Hammoumi et al., 2024). The result is organizations becoming more agile, responsive, and operating in contexts that revolve around the ethos of continuous improvement and innovation.

Digital transformation has also transformed business processes, and tools that are technologically driven have become essential to a collaborative and productive way to pull together day-to-day organizational activities. Management control is one of several important activities that ensure effectiveness and efficiency in managing financial resources, economic performance, and sound financial planning (Bharadwaj et al., 2013; Broccardo et al., 2024).

In this context, management controllers' responsibilities entail much more than merely reporting resources. As stated by Roffia and Dabić (2024), management controllers also play a role in supporting managers by continuously monitoring, measuring, and assessing corporate performance, while identifying gaps between planned objectives and results and recommending corrective measures that can be applied to bring strategies and organizational activities back in line.

In addition to improved strategic options by providing information that optimizes the allocation of resources in an increasingly complex and uncertain environment, management control also adds value. As discussed by Simons (2019), digital technologies are enabling management control systems to integrate more upfront as part of long-term strategic goals, while simultaneously becoming more proactive, adaptive, and aligned with real-time changes.

Digital technologies have absolutely altered management control information systems, causing major structural and functional changes while also improving the operational efficiencies and long-term organizational performance (Baiyere et al., 2020; Fähndrich, 2023). Simultaneously, the evolution of performance management itself is shifting the roles of management controllers and ushering in advanced forms of digital technologies, including automated processes, data visualization platforms, artificial intelligent programs, cloud computing, and cybersecurity, all drastically changing management control processes and procedures, raising questions about how to measure the efficiency, effectiveness, and strategic value of the management control role (Amer et al., 2024).

Automating management processes is a major lever to lower operating costs and use resources more efficiently. “Automation allows management control to shift their attention onto strategic decisions instead of being bogged down by repetitive tasks”, as re-iterated by Fähndrich and Pedell (2024). This shift can allow management control to be much more efficient and responsive in an increasingly complex and volatile environment.

The addition of Business Intelligence (BI) and Big Data provides management control with the added credibility of using the analytical capacity that is possible with BI and Big Data. BI and Big Data facilitate the processing of large amounts of data and the ability to analyze it in real time, whereby management can base decisions on accurate, up-to-date, and multidimensional information. Sun et al. (2018) showed that BI systems allow firms to consolidate data from both internal (e.g., their own customers) and external sources of information (e.g., industry and market data in specific localities) to frame emergent opportunities and threats with more coherent foresight.

Installed innovations, particularly the automation of financial and operational processes, are engaged in the process of inducing change. Automated systems reduce or completely remove the possibility for human error, automate a number of manual processes, and improve the quality of the process for financial transactions (Md Shakil et al., 2022). It enables management controllers to shift their focus from performing repetitive technician activi-

ties to the role of being a strategic advisor centered on value creation.

Management software, namely intelligent management software, which can be deployed in any function such as data entry, reconciliation, and financial reporting, de-emphasizes management controllers’ time on low-value and other time-consuming activities (Alao et al., 2024). Management controllers are more permitted to concentrate on strategic analysis and strategic guidance to an organization and the organization’s processes, thus the management controller and its activities can add value to organizational performance.

These technologies, together with predictive analytics models, allow organizations to assess future trends. Cavélius et al. (2020) assert that predictive analytics models can facilitate financial controllers’ foresight into market shifts, thus enabling them to adjust financial planning proactively. This lessens uncertainty and supports rapid financial decision-making. Additionally, recent technology in the form of BI dashboards and BI tools has provided the same value to controllers as it has allowed easier visual interpretation of results, rather than interpreting new data, transferring valuable advice for added value opportunities.

Barlette and Baillette (2022) go even further by saying that. The leverage of BI and Big Data provides increased organizational agility by enabling the swiftness not only to make strategic decisions but also to implement them quickly. This is important in managing the disruption of internal configurations and external shocks.

At the same time, the use of data visualization tools has become vital in a modern organization for management control. These visualization tools offer sophisticated representations of complex datasets through a visual format that is instinctive to organizations, such as dashboards, interactive graphs, and real-time performance indicators that facilitate the communicability and the clarity of financial information (Kokina et al., 2017). Those tools are much more than a form of colorful, aesthetically pleasing representation, as they support quicker interpretation of information and better communication with internal and external stakeholders.

Khatri and Gupta (2022) argue that advanced visualization technologies facilitate a shortened interval between analytics and decision-making, thus providing greater flexibility and ability to adapt in real time.

One of the most significant benefits of digital transformation in management control is the capability to identify and react to budget variances more effectively and more quickly. Visualization tools and real-time access to data allow controllers to identify variances, act swiftly, and articulate results more clearly (Palermo et al., 2018). Improved reactivity means better financial risk, governance, performance monitoring, and action.

In particular, the introduction of cloud computing technology has profoundly changed how management controllers access and interact with financial information. Cloud-based systems allow real-time, location-independent access to the current data (Ashiedu et al., 2023). With this mobility, timely decision-making is an important consideration in today's fast-paced, highly interconnected economy.

As noted by Apooyin (2025), cloud-based access makes collaboration across financial and operational stakeholders more feasible, enabling more coordinated interventions and collaborative strategic insights. In this regard, McKinsey highlights the need for finance professionals to be nimble and agile to optimize their methodologies for accessing and allocating resources to new opportunities as conditions change in the environment. Thus, cloud computing represents a technical capability and, also more fundamentally, an enabler of organizational agility and strategic alignment (Christensen et al., 2022). Within this context, meeting the challenge of the increasing reliance on cloud and digital systems and the accompanying cyber security risks became a filler part of many management control meeting agendas as a result of decision-making based on the degree of cyber risk taken to protect sensitive financial information; the integrity and reliability of which is the basis of strategic decision-making (Mizrak, 2023). In a world where we are more digitally interconnected than ever, the cyber intrusion risk becomes increasingly greater with increasing data transfer and remote operating capacity.

This means that organizations are more often mandated to utilize strong cybersecurity frameworks, including compliance, encryption, and identity and audit management (Omotunde & Ahmed, 2023). Cybersecurity is not just a technical defense anymore; it is now considered an integral part of performance definiteness. A safeguard for digital assets gives confidence to stakeholders, builds trust in internal control systems, and enables the continuation and credibility of the management element of control in a constantly shifting cyber risk environment (Abrahams et al., 2023).

The use of many digital innovations, such as financial processes automation, Business Intelligence (BI) and Big Data tools, data visualization, mobility with cloud computing, and cybersecurity solutions, has been very beneficial for the efficiency of the management control function (Sahoo, 2022). The advancements in technology increase the precision of financial analytics and help management controllers to react quickly and to be more exaggerated in unpredictable and dynamic organizational contexts (Cudia & Legaspi, 2024).

As a consequence, digitalization can be seen as a powerful emergent strategy to improve the efficiency and effectiveness of management control. More than a technological change, it inscribed a profound change of managerial practice by repositioning the controller as a central actor in strategic decision-making.

In short, digitalization has revolutionized the management control function by automating data collection, analysis, and financial reporting processes. Digital tools are now so advanced that controllers are able to not only see where the budget is divergent, but they can also act upon it, making better-educated strategic decisions relative to their planning. Therefore, the role of the management controller is now much more efficient and future-oriented, given that organizational performance is continuously tracked in real time with greater transparency.

The purpose of this study is to examine the impact of digitalization on the enhancement of the management control function. Based on the theoretical aspects above, a few hypotheses can be suggested to empirically analyze the impact of digital transformation on the controller function performance.

- H1: *The automation of financial and operational processes, made possible by digitalization, will significantly improve the management control function.*
- H2: *The use of Business Intelligence and Big Data tools promotes a significant improvement in the management control function.*
- H3: *The use of data visualization tools promotes a significant improvement in the function of management controllers.*
- H4: *The use of ultramobility and remote access in favor of cloud technologies significantly improves the management control function.*
- H5: *The implementation of advanced cybersecurity solutions in accounting and financial systems leads to a significant improvement in the management control function.*

2. METHODS

This section of the study describes analytical techniques for examining models, variables, research-development assumptions, and the interdependency between digitalization and the integration of advanced technologies and the improvement of the efficiency of the function of management controllers in financial institutions in Morocco.

2.1. Data collection

The data used in the empirical research described in this article were obtained through face-to-face interviews with management controllers, financial directors, IT analysts, and experts working in financial institutions in Morocco who have met the following criteria:

- At least three years of professional experience in management control or corporate finance.
- Be a user or decision maker in adopting digital tools (Business Intelligence, Big Data, cloud, cybersecurity, etc.).

In this regard, it is noteworthy that there is no documented database on digitalization and inte-

gration of advanced technologies in Moroccan financial institutions. In addition, this study shows a particular interest in the use of primary data. For example, in addition to the questionnaire discussed in this paper, questionnaires on various topics were distributed to various stakeholders. Table 1 shows the breakdown of the respondents by position.

Table 1. Distribution of respondents in the position occupied

Category of respondents	Count	Percentage
Management controllers	45	30%
Financial directors	30	20%
Financial analysts	22	15%
Compliance and risk managers	15	10%
IT and Cybersecurity Experts	22	15%
Financial digitalization	15	10%
Total	149	100%

Interestingly, interpersonal relationships played a crucial role in the current study, facilitating appointments with targets. Through a questionnaire survey, 149 of the 420 selected individuals were surveyed based on their experience with Moroccan financial institutions and their exposure to management and financial technology tools.

3. DATA PROCESSING

After obtaining the data, two processing stages of multivariate statistical tests were conducted using SPSS 26 software. The first test consisted of factor analysis, specifically principal component analysis (PCA), and Cronbach's alpha to refine the measurement scale of the dependent variable in the conceptual model (the impact of digitalization and the integration of advanced technologies on the efficiency of the auditor function in Moroccan financial institutions). At this point, both models of this variable captured a clear factor structure, which corresponds to what Hair et al. (2006) recommended thresholds in terms of reliability and validity of the measurement scale (Table 2).

The second type of tests focuses on multiple linear regression analyses. They are used to assess the overall validity of the conceptual model, on the one hand, and the individual significance of its explanatory variables, on the other.

Table 2. Results of the validity and reliability of measurement scales

Components	Alpha Cronbach	Items	% variance explained	Number of items
Automation of financial and operational processes	.745	Reduced costs and human errors	73.98%	4
		Save time and efficiency		
		Improved regulatory compliance		
		Scalability and flexibility		
The use of business intelligence and big data tools	.756	Improved decision-making	70.98%	5
		Optimization of operations and cost reduction		
		Personalization of the customer experience		
		Improved data quality and access		
The use of data visualization tools	.724	Rapid understanding and analysis of data	71.876%	3
		Simplification of reporting information		
		Save time and efficiency		
Mobility and remote access through cloud technologies	.708	Remote working and flexibility	72.87%	4
		Collaboration in real time		
		Universal access to resources		
The integration of advanced cybersecurity solutions in financial systems	.737	Security and centralized management	70.65%	4
		Protection of sensitive data		
		Incident detection and response		
		Multifactor authentication and management		
Improvement of the function of management controllers	.753	Regulatory compliance and resilience	76.675%	5
		Optimization of decision-making processes		
		Efficiency in financial data analysis		
		Automation of repetitive tasks		
		Improved accuracy and reliability of forecasts		
		Real-time access to financial information		

4. RESULTS

The results of the conceptual model test (Table 3) show that the probability value associated with the Fisher test in the ANOVA model is below the 5% error limit ($\text{Sig} = 0.000 < 0.05$). This indicates that the null hypothesis is rejected and the model is globally significant. In particular, the proportion explained by the model (regression = 23.756) significantly exceeds the unexplained proportion (residual = 15.244).

This observation is consistent with the adjusted R-squared value (0.5854), which also provides evidence of the quality of the econometric model

(Table 4). The results show that the variables representing digitalization and advanced technology integration explain 58.54% of the variance in the effectiveness of management control functions in Moroccan financial institutions.

To assess the significance of the variables (Table 5), the values and probabilities of the Student's t-test generated with SPSS 26 show that two variables are statistically significant ($t > 2$ and $\text{sig} < 1\%$). These variables are the automation of financial and operational processes and the use of business intelligence and big data tools. This result is consistent with the first and second hypotheses of the study.

Table 3. Regression indices of the ANOVA model

		ANOVA ^a				
Variable		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23,756	5	4,751	44,402	,000 ^b
	Residuals	15,244	142	,107		
	Total	39	147			

Note: a. Dependent variable: Improvement of the function of management controllers. b. Predictors: (Constant), Automation of financial and operational processes; The use of business intelligence and big data tools; The use of data visualization tools; Mobility and remote access through cloud technologies; The integration of advanced cybersecurity solutions in financial systems.

Table 4. Summary of the models

Modele	R	R-two	R-two adjusted	Standard error of estimate	Edit statistics					Durbin-Watson
					Variation of R-two	Variation of F	ddl1	ddl2	Sig. Variation of F	
1	,768*	,5898	,5754	,39598	,5898	44,402	5	142	,000	1,653

Note: a. Predictors: (Constant), Automation of financial and operational processes; The use of business intelligence and big data tools; The use of data visualization tools; Mobility and remote access through cloud technologies; The integration of advanced cybersecurity solutions in financial systems. b. Dependent Variable: Improvement of the function of management controllers.

By automating processes, institutions have the ability to improve efficiency, reduce transaction errors, improve and accelerate financial and administrative processes, and reduce paperwork, among other benefits. These results in better resource allocation reduced operational expenses, and streamlined internal processes. Yet, automation allows financial organizations to optimize their volume of transactions in real time and deliver faster and more accurate reports. Automation frees up time by reducing manual tasks for managers and enables faster and better decisions. It is easier to see what is happening and make it easier to improve the processes; the normalization makes management control much more efficient.

The importance of this result is that a financial institution that strengthens its internal processes with automation not only retains operational costs but also improves the quality of service. This directly impacts the institution's profitability and competitiveness, enabling it to respond and move faster in an increasingly digital economic landscape.

Business Intelligence and Big Data tools indeed help analyze complex data from multiple sources inside and outside the financial institution. These tools assist managers in spotting trends, diagnosing potential issues, and anticipating future trends. They enable proactive risk management and better strategic planning. The data collected, as well as information, can act as a backbone to set the strategy at a higher level and monitor it using relevant management control processes with the integration of the above tools.

Business intelligence and Big Data act as core components of the control management process in financial institutions in the age of digital transformation. These technologies allow institutions

to manipulate huge volumes of data and extract sophisticated analytics, which support more informed fact-based decisions throughout their organization, which is important in an increasingly competitive and dynamic financial industry. They also better prepare them for market trends and for an agile response to change.

It was also observed that variables such as the use of data visualization tools, mobility and remote access through cloud technologies, and the integration of advanced cybersecurity solutions into financial systems are statistically significant ($t > 2$ and $\text{sig} < 5\%$) and have a minor impact on the effectiveness of the management auditor function in Moroccan financial institutions.

State-of-the-art cybersecurity products must be integrated to protect financial institutions from potential threats and data breaches, and to preserve the integrity and confidentiality of financial information. Strong cybersecurity measures also support client confidence and regulatory compliance, which are critical to ensuring the long-term sustainability of financial institutions' performance.

In fact, financial institutions deal with sensitive and confidential information, and given the increasing use of digital technologies and tools, they are increasingly exposed to cyberattacks. With the adoption of high-level cybersecurity measures, these institutions can better protect their systems and information and ensure that their operations will not be interrupted by security breaches. This makes the management control system more trustworthy and guarantees that it will not be interrupted by security breaches.

Although the impact is considered to be minimal, cybersecurity is a facilitative pillar that makes the

entire process of digital transformation possible. Without effective protection, the effectiveness of all digital tools, such as data visualization, cloud technologies, and management control systems, could be compromised. Safe cybersecurity infrastructure is thus important in safeguarding the effectiveness of the management control function, although its immediate impact on performance could be less readily visible than that of other technology innovations.

The use of cloud technology for mobility and remote access allows financial institutions to work more efficiently and flexibly, especially in an expanding digital and remote working setup. The technology provides employees with access to vital systems and data from anywhere, supports real-time decision-making, removes communication lags, and ensures business continuity. Additionally, cloud solutions enable remote access to financial data and systems and, therefore, allow employees and managers to have improved communication and connections anywhere to make well-informed decisions. It raises responsiveness and agility levels within financial institutions since they are better placed to embrace changes at any time to suit operating environments or market changes. Cloud-based technologies also facilitate collaborative working by departments and teams, a simple feat that improves operations' efficiency as well as levels of management coordination.

Although the impact is categorized as minor, remote access to finance and data systems equates to

a valuable operational advantage in the world today, which is now more globalized and fast-paced. It allows for better decision-making because it ensures management has data at their fingertips at all times, regardless of location. Cloud technology also maximizes the scalability of financial institutions and minimizes costs of maintaining on-premises facilities, and therefore is a valuable instrument in the digitalization of control of management.

Finally, data visualization tools play a vital role in improving the effectiveness of the management control function by allowing decision-makers to easily and speedily comprehend complicated data. From the visually available data in graphical form, via dashboards, and through charts, banks make it simpler to identify trends, patterns, and outliers, which aid in making decisions. Data visualization tools increase the speed of decisions and the quality of decisions throughout the process of management control. In fact, the use of data visualization tools allows managers to see KPIs, financial measures, and operational information in a readily accessible format and thus track performance in real time. This enhances the ability to detect problems early, which in turn enables better problem-solving and timely corrective action. Data visualization enhances reporting and communication of performance to stakeholders.

Although the data visualization tool contribution may be seen as minor compared to more directly impactful technologies, it is still an important

Table 5. Coefficients of individual significance

Model	Coefficients ^a						
	Non-standardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Error standard	Beta			VIF	Tolerance
(Constant)	-.123	.510		-.045	.964		
Automation of financial and operational processes	.434	.170	.471	2.547	.003	.534	4.873
The use of business intelligence and big data tools	.368	.128	.414	3.059	.001	.103	5.108
The use of data visualization tools	.084	.129	.119	2.006	.037	.230	4.887
Mobility and remote access through cloud technologies	.148	.179	.186	2.150	.028	.225	4.081
The integration of advanced cybersecurity solutions in financial systems	.214	.145	.256	2.145	.031	.423	5.187

Note: a. Dependent Variable: Improvement of the function of management controllers.

Table 6. Synthesis of hypotheses results

Hypotheses	Explanatory variables	Variables to explain	Coefficient β	Significance	t Student	Validation
H1	Automation of financial and operational processes	Improvement of the function of management controllers	.434	.003	2.547	Confirmed
H2	The use of business intelligence and big data tools	Improvement of the function of management controllers	.368	.001	3.059	Confirmed
H3	The use of data visualization tools	Improvement of the function of management controllers	.084	0.037	2.006	Confirmed
H4	Mobility and remote access through cloud technologies	Improvement of the function of management controllers	.148	.028	2.350	Confirmed
H5	The integration of advanced cybersecurity solutions in financial systems	Improvement of the function of management controllers	.214	.031	2.145	Confirmed

contribution towards enhancing the efficiency of management control functions. It facilitates managers to quickly absorb complex information, which increases decision-making effectiveness. As a result, these tools contribute to better management and enhanced strategy alignment with operational performance.

The analysis of the data collected made it possible to evaluate the proposed assumptions in connection with the digitization of the management control function. Table 6 summarizes the results obtained.

5. DISCUSSION

Based on these results, this article can positively answer the central research question regarding the impact of digitalization and the integration of advanced technologies (automation, Business Intelligence, Big Data, data visualization, cloud, and cybersecurity) on the effectiveness of the function of management controllers within financial institutions in Morocco. First of all, automation of financial and operational processes is the feature that most contributes to explaining the improvement in the efficiency of the function of performance controllers within financial institutions in Morocco ($\beta = 0.434$, $p = 0.003 < 0.01$). It has a positive influence on the effectiveness of the function of performance auditors in these institutions. This result is consistent with previous research. The study by Chami and Moussaoui (2022) explores how the Regional Directorate of Marrakech adopts digital technologies to modernize its tax audit operations. It highlights the

impact of digitalization on the effectiveness of tax controls in Morocco. In the future, the integration of advanced technologies such as AI and Big Data could further increase the effectiveness of management controls in financial institutions.

Secondly, this research explores the significant contribution of business intelligence and big data tools to improving the efficiency of the function of financial controllers within financial institutions in Morocco ($\beta = 0.368$, $p = 0.001 < 0.01$). This finding is echoed in some previous research, such as the study by Vitale et al. (2020), which highlights how Big Data can improve the management control function by enabling controllers to manage structured and unstructured information, thus strengthening their role as strategic advisors. In the future, increased use of artificial intelligence and predictive analytics could further increase the effectiveness of financial controls in Moroccan institutions.

Third, this study explores the significant contribution of the integration of advanced cybersecurity solutions in financial systems to improving the efficiency of the function of performance controllers within financial institutions in Morocco ($\beta = 0.214$, $p = 0.031 < 0.05$). This is consistent with a study by Gordon and Loeb (2002), which showed that investments in cybersecurity improve financial risk management and decision-making, and Islam et al. (2018), which highlights the importance of cybersecurity in risk management and performance of auditors. In addition, Vasarhelyi and Alles (2017) highlighted the impact of cybersecurity technologies on financial control and continuous monitoring, thus reinforcing the rel-

evance of these results in the context of Moroccan financial institutions. In the future, a continuous improvement of cybersecurity solutions could further optimize the management control function, particularly with the integration of new technologies such as artificial intelligence for real-time anomaly detection.

Fourth, this study explores the positive contribution of mobility and remote access through cloud technologies on improving the efficiency of the function of management controllers within financial institutions in Morocco ($\beta = 0.148$, $p = 0.028 < 0.05$). This result is consistent with Granlund and Mouritsen (2003), who studied the impact of information technologies on management control, and Spathis and Ananiadis (2005), who demonstrated that the adoption of cloud-based solutions improves the performance of accounting and management processes. In addition, Caglio (2003) highlighted the transformation of the role of management controllers with the emergence of digital technologies and their remote access to financial systems. In the future, greater integration of cloud solutions and optimization of remote access could further improve the effectiveness of financial con-

trols by facilitating rapid decision-making based on up-to-date information.

Fifth, this study explores the low positive contribution of the use of data visualization tools on improving the efficiency of the function of performance controllers within financial institutions in Morocco ($\beta = 0.084$, $p = 0.037 < 0.05$). This finding is consistent with Du et al. (2025), who points out that visualization tools improve understanding of financial data but are still limited by users' ability to use them effectively. In addition, Yigitbasioglu and Velcu (2012) highlighted that the impact of visualization tools on decision-making strongly depends on the organizational context and the training of management controllers. Finally, M. Al-Okaily and A. Al-Okaily (2025) showed that while data visualization facilitates the analysis and reporting of financial information, its impact on decision performance is moderated by other factors such as user experience and data quality.

In the future, improved training of performance auditors and optimization of visualization tools could enhance the impact of these technologies on the effectiveness of performance audits.

CONCLUSION

Throughout this study, the focus is on examining the impact of digitalization and the integration of advanced technologies on improving the efficiency of management controllers' functions, using Moroccan financial institutions as a context for study. According to a literature review, five key variables of digitalization and the integration of advanced technologies are likely to have an impact on improving the effectiveness of the function of management auditors in financial institutions in Morocco: Automation of financial and operational processes, Use of business intelligence and big data tools, Use of data visualization tools, Mobility and remote access through cloud technologies and the integration of advanced cybersecurity solutions into financial systems. The effects of these variables on improving the efficiency of management controllers' performance function are examined through a sample of 149 professionals involved in financial management and management control, with direct exposure to digital technologies, Business Intelligence, Big Data, visualization tools, cloud solutions, and cybersecurity. Indeed, the regression analysis revealed the significance of the five characteristics, but with different contributions. Therefore, financial institution executives are encouraged to strengthen the integration of advanced technologies (automation, business intelligence, big data, data visualization, cloud, and cybersecurity) to optimize the performance of management controllers, improve decision-making, and reduce operational risks.

Based on the results obtained, this paper argues that this study makes a valuable contribution to the study of the effectiveness of the financial controller function in the digital age. However, it also has some limitations that can serve as directions for future research.

This study supports the view expressed by some researchers that integrating digitalization and advanced technologies improves the effectiveness of the auditor function.

In addition to these theoretical contributions, the results of this study are valuable for managers and administrators of Moroccan financial institutions, providing them with management tools based on digitalization and the integration of advanced technologies that they can use to ensure the effectiveness of the management auditor function in these institutions.

The limitations of these results are mainly due to the small sample size. We consider the number of respondents in the sample to be relatively small, although this represents an average response rate of 35%, or 149 usable responses. Finally, this study did not take into account some advanced technologies that are considered relevant and that could facilitate the exchange of information and expertise between actors in highly digitalized fields.

In light of these limitations and contributions, new avenues could be explored. Thus, it would be appropriate to expand the sample to include other respondents by considering selection criteria such as work experience, technology use, company size, etc., to ensure a relevant assessment of the impact of digitalization and AI on the effectiveness of the management control function.

AUTHOR CONTRIBUTIONS

Conceptualization: Ahmed El Hammoumi, El Mahdi El Massaoudi, Adil El Ouali.

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Formal analysis: Ahmed El Hammoumi, El Mahdi El Massaoudi, Nabil Seghyar, Adil El Ouali.

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APPENDIX A

Questionnaire on Digital Transformation and the Management Control Function

- Fact sheet and informed consent

This questionnaire is anonymous and confidential. It aims to collect your perception on the impact of digital transformation in financial institutions, especially on the management control function. No personally identifiable information will be collected. Your participation is free and voluntary, and you may withdraw at any time.

By completing this questionnaire, you consent to the collection and analysis of responses for academic research work.

- General information (optional or anonymized):

Job title: _____

Seniority in the institution: _____ years _____

Type of institution:

- Commercial bank
- Microfinance
- Insurance
- Other: _____

Please indicate your level of agreement with each of the following statements by checking the appropriate box:

1 = Not at all, 2 = Rather not agreed, 3 = Neutral, 4 = Rather agree, 5 = Quite agree

1. Automation of financial and operational processes

Statement	1	2	3	4	5
1.1. Digitalization has reduced costs and human errors.					
1.2. It has saved time and improved efficiency.					
1.3. Improved regulatory compliance.					
1.4. It has brought more scalability and flexibility in management.					

2. Use of business intelligence and big data tools

Statement	1	2	3	4	5
2.1. BI/Big Data tools have improved decision-making.					
2.2. They have resulted in optimized operations and reduced costs.					
2.3. They have allowed for a personalized customer experience.					
2.4. Improved data quality and access.					
2.5. They facilitate the identification of risks and opportunities.					

3. Use of data visualization tools

Statement	1	2	3	4	5
3.1. The visualization allows a quick understanding of the data.					
3.2. It simplifies the reporting of information.					
3.3. It saves time and efficiency.					

4. Mobility and remote access via the cloud

Statement	1	2	3	4	5
4.1. Telework is easier and more flexible thanks to the cloud.					
4.2. Real-time collaboration is improved.					
4.3. Universal access to resources is ensured.					
4.4. Centralized management and security are strengthened.					

5. Integrating cybersecurity into financial systems

Statement	1	2	3	4	5
5.1. Sensitive data are well protected.					
5.2. Incidents are detected and processed quickly.					
5.3. Multifactor authentication is well managed.					
5.4. Regulatory compliance is strengthened through cybersecurity.					

6. Improvement of the function of management controllers

Statement	1	2	3	4	5
6.1. Decision-making processes are optimized.					
6.2. Financial data analysis is more efficient.					
6.3. Repetitive tasks are automated.					
6.4. Forecasts are more reliable and accurate.					
6.5. Real-time access to financial information is provided.					