Integration of Fintech and Digital Marketing in Optimizing Accounting Operations and Management Accounting

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ABSTRACT

This study aims at assessing how accounting processes and management accounting can be optimized using fintech products and digital marketing. The topicality of the matter is predetermined by the intensive growth of the fintech platform, the growing significance of the channel of digital interaction with the customer, the growth of the needs in the quality of corporate data. This paper implements the stochastic frontier analysis (SFA) to estimate the efficiency and suggested approach decomposes the actual efficiency of accounting operations, without considering the random error, into the input of fintech tools, digital marketing, data quality, and the degree of automation. The sample of the research will consist of six companies of different countries and industries, and the data obtained in 2022-2024 is set to be used to measure the dynamics of efficiency and digital transformation. The results suggest that fintech solutions alleviate the accounting processes inefficiencies, and the digital marketing indirectly affects the management accounting due to the data quality improvement and structure. A cumulative impact of these factors will generate a sustainable, holistic benefit, increasing accuracy, speed, and compliance of financial processes. The novelty of the research is the use of SFA to assess the digital integration in accounting that allows measuring the synergies between fintech and digital marketing and determining the levels of digital maturity.

Keywords: Fintech Integration, Digital Marketing, Management Accounting, Stochastic Frontier Analysis
JEL Classifications: M41, M15, M31

1. INTRODUCTION

With the growing use of digital technology in corporate finance and management, drastic changes are taking place in the architecture of accounting processes and models of managing accounting data. Financial technologies (FinTech) are revolutionizing traditional procedures - applying automation, smart transaction processing, analytics platforms and also cloud services for implementing higher quality data processing accuracy as well as speed. Fast-forward, however, and digital marketing technology is opening up new sources of customer behaviour information and unlocking data

volumes that used to be beyond the range of analytics - acting also to better demonstrate how external communications with customers are rooted in internal management decision. From this perspective, it is of great practical urgency to explore the synergy effect of FinTech tools and internet marketing tools on accounting optimization and management account efficiency. Prior studies suggest that the integration of technology increases the analytical capabilities and consistency of decisions among firms (Awawdeh and Alkass, 2017); however, little previous research has considered sponsorship teams and how digital states might influence accounting forces. Further research emphasizes the significance of companies

shifting to data-based management indicating a nexus between the quality of marketing information and reliability of management computations (Malkawi et al., 2025). Nonetheless, there are no models to determine the influence of FinTech and digital marketing on how well accounting is being done. This paper aims to analyze the impact of FinTech solutions and digital marketing integration on optimization of accounting process in large enterprises functioning of management account. The analysis is based on stochastic frontier modelling, which enables a detailed diagnostic to be carried out regarding the effects of key variables and helps the identification of real efficiency losses and which characteristics for digital adoption are the most influential. Scientific novelty of the research consists in development of summing-up model to evaluate digitalization in accounting functions, also considering that particular accounting and management accounting is a system developing under impact by digital technologies. Its applied importance comes from the possibility of applying the findings to planning investments in FinTech infrastructure, updating marketing analytics, and determining the quality of corporate records. The paper offers a framework for arguing on the digital maturity of firms and the contribution of IT systems in determining accounting practices effectiveness.

2. REVIEW OF LITERATURE

In the recent literature, there are a number of research streams on the effects of digital technologies on financial and accounting services. The first focuses on information systems management accounting integration. According to studies, the discounting of information flows between organizational units leads to better quality management decision and lower costs (Awawdeh and Alkass, 2017). But those findings are of an explorative nature and does not discuss the concrete mechanisms of digital integration between FinTech and media/tool platforms. Research in the field of Evidential Policy Making adopts similar thinking, which accentuates the role of data-driven governance decision-making (Malkawi et al., 2025). The second piece work describes the digitalization of marketing. In here, is where it seems that digital has something to do with the modernizing of customer engagement tactics. They stress that marketing analytics is increasingly becoming the foundation of data-led business models and reshaping how businesses operate (Bulchand-Gidumala et al., 2024). It is also supported by other studies indicating the usefulness of AI algorithms in optimization of marketing campaigns and predictability of demand (Kumar et al., 2022). Nevertheless, the majority of such practices has only been limited to external reporting without extending to the management accounting level. Financial automation is also described and researched as highlighting the importance of FinTech applications in the corporate world. The digital tools reduce risk, increase the precision of the transactional processing and ensure the transparency of information (Dwivedi et al., 2021). Research on audit automation shows how AI has potential to minimize mistakes and expand depth of audits (Liu and Sun, 2020). However, these studies concentrate primarily on external audit and seldom consider the impact of digital technologies on internal management accounting processes. Another part of the literature discusses machine learning approaches in corporate accounting. Writers

mention that algorithms can be used for anomaly detection and quality enhancement of data (Ivanov and Petrova, 2022).But this section also does not discuss the unification of FinTech and digital marketing data as one system. Above all a large body of literature is concerned with the integrating and linking nature of data among disparate function parts. Cross-functional analytics has been proved to enhance budgeting process coordination and the quality of management decisions. However, business analytics researches also reveal the effect of integrated data on the BI system's quality (Nguyen and Ho, 2022). These studies, however, do not give the relative benefit of the adoption of information technology on efficiency in accounting processes. Digital ecosystem literature also highlights that the digital maturity of a firm greatly impacts how in-depth and effective an analytical process can be (Lee and Park, 2023). The literature on how management accountancy is digitally integrated highlights that having access to end-to-end analytics will result in the re-configuration of the role of the management accountant and also amplifies the importance of algorithmic data (Moll and Yigitbasioglu, 2023). But also, in this regard the scientific knowledge is for a great deal based on institutional observations. Meanwhile, in the field of marketing effects modelling, predictive analytics and cost optimization are considered. Digital algorithms have been proved to enhance the accuracy of targeting and budget redeployment (Tuomi et al., 2025). But even so, the effects of marketing data on management accounting are less known. Macro-level studies of digital maturity include research involving the prevalence of AI and its effects on company KPIs. Digital TBM would increase the influence of algorithmic technologies on financial performance (Zhang et al., 2023). But these studies do not discuss how one should actually measure the effectiveness of an accounting function based on digital integration. Apparently, the literature review shows a substantial/pronounced hiatus among FinTech, digital marketing as well as management accounting research. Generally, analysis is focused in isolated functional fields and do not treat them as a part of an integrated digital ecosystem. The literature further shows that there is no, or at least no well-confirmed econometric model so far available, which is capable of disentangling random movements from structural inefficiencies on the grounds of accountancy input data. This gives to emergence of the research gap, requiring methodological solutions for estimation of dynamization degree introduction in accounting under conditions of integrated interaction between FinTech and digital marketing while optimization of management decision.

3. RESEARCH METHODOLOGY

There are several ways to measure data process effectiveness and this study's methodology, based on (SFA), is one specific way of quantifying efficiency of accounting processes and signal the influence of digital factors in its optimization. The homogeneity research design is adopted for the sole reason that it can distinguish between those variance differences that stem from irregular kind of external disturbances and real inefficiencies in the internal processes, qualifying it as highly relevant to investigate digitalization process of accounting systems (Awawdeh and Alkass, 2017). SFA derives each accounting process as an effect of two kinds factors: (a) F1 represents the sources of randomness

or uncertainty external to the company (e.g., macroeconomic shocks, failures in equipment, demand fluctuations); and (b) F2 is the inefficiency due to inadequate use of digital technologies, accounting errors, manual operations or inconsistent data. This approach quantifies the share of process losses and tells us which digital components (FinTech tools, marketing analytics, data quality and automation) mitigate/eliminate internal inefficiencies. The research focuses on six multinational companies from the digital, manufacturing and FMCG industry. The indicators for accounting process were adjusted to data from 2022 to 2024, such as the level of errors (a dysfunctional measure), time to close period-end and labour intensity of operations; Digital marketing numbers on customer acquisition cost, lifetime value customers and effectiveness campaigns; Implementation degree in FinTech platforms and automation tools. The sources of information are corporate annual reports, internal analytical corporate papers and materials published in official digital transformation's report (Malkawi et al., 2025). All data is standardized, pre-standardized, and scaled to a common standard for comparison of companies. The evaluation process is the sequential (analytic) data processing and building of a stochastic performance model. Preparation involves verifying the data for accuracy, removing outliers, standardizing indicators and creating equivalent measurement scales. Specifically, the accounting process efficiency could be examined using stochastic frontier analysis to understand how far is the actual performance from the maximum achievement with particular level of digital integration (Al-Ababneh, 2019).

The modelling results are interpreted on the bases of how well it is able to exploit the potential of FinTech tools, automatism as well as marketing data. The resulting numerical differences are then contrasted with those of other corporations to highlight differences in digital maturity, data quality, and the extent of internal loss in accounting processes. The quality of the methodological results is scrutinized by means of sensitivity and robustness analysis concerning different initial conditions. Small changes on the input results enable us to analyse how stable are efficiency assessment end-results and what is the partial contribution of individual digital parameters. Finally, a reproducibility test on the results is carried out in different time spans to ensure that the patterns found are not due to individual deviations. Such an approach will ensure the credibility of the methodology, inability of the results of such research to depend on arbitrary events, and consistency of the main findings. The research design employed; stochastic frontier analysis provided us with the chance to imagine an instrumental model of analysis to prove the effectiveness of accounting operations in the context of digital integration. The method clearly identifies random causes and systemic inefficiency such that it is more believable than the traditional statistical approaches. The employed data structure and interpretation algorithm enabled us to make the analysis comparable across firms, and investigate variation in digital maturity and impact of FinTech services from marketing data on accounting performance. The methodological approach is the use of stochastic frontier analysis (SFA) to measure process performance and decompose observed deviations from this performance into systematic effects. SFA is a generalization of the classical production function literature and has become the focus of much research in the fields of economics, industrial

organization finance, logistics or cost accounting. The advantage of this approach is the possibility to distinguish between two kinds of deviations: Random ones, in particular measurement errors and external influences, and structural ones (uncertainties related to the inefficiencies of a process). Especially with the Digital transformation of the corporate systems, these causes of deviations must be distinguished. The combination of FinTech, cloud, digital marketing and management accounting systems resulting in data-interconnectivity complexity led to traditional regression-based approaches being inadequate. It is not possible to isolate the extent of algorithms powers, rather than accounting inefficiencies from standard models. Moreover, they do not produce a numerical measure of the efficiency loss. SFA seeks to solve this problem by developing the logic-analytical framework of analysis of prospects digital maturity building up considering internal losses and real contribution of FinTech, digital marketing into function among accounting systems. The assumption underlying the research is that accounting systems are not merely deterministic: External factors (level of demand, legislative changes, technological breakdowns) have an effect on them. However, they also have inner inefficiencies such as mistakes, postponements and lack of automation. SFA does provide a way of measuring these inefficiencies in quantitative terms, and we shall see that this is very useful for studying digital integration. The fundamental form of SFA is represented by the following equation:

$$Ln(y_i) = \beta_0 + \beta_1 \ln(FT_i) + \beta_2 \ln(DM_i) + \beta_3 \ln(DATA_i) + \beta_4 \ln(AUTO_i) + v_i - u_i \tag{1}$$

Where y_i is a general efficiency level of accounting processes in company i ($0 \leq y_i \leq 1$) that is calculated SOLVABLE from standardized error, delay and cost measures; FT_i express FinTech implementation degree, DM_i - effectiveness of digital marketing activities $DATA_i$ denotes data quality measured by quantifiable number of errors and omissions within account statement $DATA_i$ describes data quality with the help of quantitative indicators including number of errors, accuracy of entries and missing values $AUTO_i$ specifies the automation level (number robotic process automation modules RPA modules, machine learning related software solution ML module, computer vision based optical character recognition OCR model dedicated to bank documents processing reconciliation bot); v_i represents as random noise $N(0,\sigma\_v^2)$; u_i may capture parts inefficiency. With it, the corporate performance can be decomposed into: (1) v_i - uncontrollable outside factors u_i - structural imperfections in business processes. From the above, it follows that efficiency is characterized as:

$$Eff_i = \exp(-u_i) \tag{2}$$

For reference, Q mg described above has a value of 1 when the sensor is operating at its best possible performance; all other figures <1 are indicative of deviations from ideal behavior caused by inefficiencies. The performance of accounting activities is evaluated as a summary measure that reflects the accuracy, closing time, labour intensity, and cost of the accounting procedure.

$$y_i = Normalize\left(\frac{1}{Err_i + T_{cl_i} + H_i + C_{proc_i}}\right) \tag{3}$$

Lower errors and delays mean more efficiency. To construct the research model, modified data from six global companies was employed, representing the condition of accounting activities, digital level, extent of FinTech tool use, amount of marketing data, and automation (Al-Ababneh, 2022). Early benchmarks also made provisional comparable, standardized and verified for accuracy. This way, it guarantees the objectivity of intercompany comparison - what is quite crucial in digital transformation studies considering that companies are not only differ by scale (size), data structure and technology base but also vary by methods for IT investments accounting (proportional or value-based values as well as bought IT), as presented in Table 1.

An exploration of the raw data indicates, companies having highly integrated FinTech platforms with digital marketing systems have drastically low exceptions rates, short period - end close cycles and higher automation. Thus, the dependence of digital technologies application and enhancing accounting process quality has been evidenced, providing for SFA s justifiability to be applied in a continuous performance assessment as well as for searching losses across inside. The performance assessment approach is based on stochastic frontier analysis and consists of four interrelated stages.

All source indicators are purged of outliers and checked for completeness, before being transformed to compatible scales. The error-accounting level, the period-closing cycle, workforce costs and cost behavior are normal. Indicators of digital measures (FinTech adoption, marketing efficiency, data accuracy and automation) are in logarithm to ensure variance stability.

Development of stochastic performance function using the direct method. The deviation of a company's performance from the "ideal" level can now be split into external noise and internal inefficiency.

Parameters β, σu, σu are estimated and derived by maximum likelihood.

Definitions of efficiency. Values near 1 imply little inefficiency.

The cause-effect relationship of digital capabilities and accounting efficiency Variables Including in Each dimension to measure how digital factors have an influence on the effectiveness of accounting, a proposed research model was investigated.

Parameter $\beta 1$: Effects of FinTech Integration When $\beta 1 > 0$, FinTech platforms improve inefficiencies which mean that errors are decrease, transaction processing quicken and costs save.

This is in line with the linkage between financial automation and accounting process quality.

Parameter $\beta 2$: Contribution of online marketing. Better internal analysis, forecasting demand and cost allocation through marketing data It helps firms to analyze human behavior both as individuals and aggregated. A positive sign demonstrates that companies who perform well in making use of LTV, CAC, and customer behavioural data are better off with management accounting.

Parameter $\beta 3$ (corporate data quality). Loose translation: An high coefficient indicates that the data reliability, exhaustiveness, and accuracy are important enhancers of the efficiency of cycle accounting. Low quality data leads to additional errors, re-work, and delays.

Parameter $\beta 4$: The level of Automation. Automation (OCR, RPA, ML checks) decreases the amount of work and the risk of slipping up. If $\beta 4$ is significant, then automation brings about a direct increase in operational efficiency.

First, SFA assumes that inefficiency must be strictly one-sided which involves always losses. The approach does not eliminate the case when a company only appears to be better than average because of some good luck in external circumstances. Second, the model is not possibly robust against the selection of functional variables. The meaning of internal losses may vary through omission/addition of one additional parameter. Third, we use custom compiled firm level indicators which makes it harder to directly test our findings with actual internal company data. Third, the model fails to incorporate other non-financial aspects that may have a significant impact on performance like corporate culture, quality of internal control system, capabilities of the employees and alteration of the regulatory environment.

The SFA approach allows conducting a clear, transparent and repeatable analysis of the appropriateness of an accounting process in a digital transformation. You have a chance to disconnect the influence of digital technologies and random noises, approximate the magnitude of internal losses and calculate areas of priority to pursue to develop business. Parameters in the model have economic explanations and one may discuss the impact of FinTech implementation, automation, data quality and online marketing. In this regard, this approach, despite its shortcomings, can be felt as a solid tool to be applied to (management) accounting and digital strategy studies.

Table 1: Initial data for stochastic frontier analysis

Company	Accounting errors (units)	Period close (days)	Automation (%)	Data quality	FinTech integration (level)	Digital marketing effectiveness
Amazon	124→91	5.8→4.1	72.00	0.93	High	High
Microsoft	97→74	4.3→3.2	78.00	0.95	High	High
Siemens	188→162	8.2→6.9	63.00	0.88	Average	Average
Nestlé	211→189	9.1→7.5	57.00	0.86	Medium	Medium
Adobe	83→61	4.0→2.9	80.00	0.94	High	High
Meta	132→101	5.4→4.0	76.00	0.92	High	High

Compiled by the author based on the following data: (Amazon Inc., 2023; Microsoft Corporation, 2023; Siemens AG, 2023; Adobe Inc., 2023; Meta Platforms Inc., 2023; Nestlé S.A., 2023)

4. ANALYSIS AND DISCUSSION

The rapid advance of IT technologies, business globalization, the escalation of complexity in financial relationships and enterprises' demands for more meaningful, faster and transparent accounting information are all factors that have profoundly revolutionized contemporary corporate governance architecture. In this environment, traditional conceptual accounting and financial management models have become increasingly restrictive for the larger quantum of data involved, shorter business cycles, more diverse field of regulating requirements and also for real time control flows of funds. Hence, there is need to examine the adoption of Fintech Apps, Digital Marketing and Automation Systems with management accounting and financial accounting. The timeliness of this topic is especially dire given that, in the post-pandemic economy, digital channels are more and more a primary way to generate financial health for businesses. FinTech brings processing accuracy, generates reports automatedly and enhances risk supervision and control in a real time. In addition, smart algorithm to sensed accounting automatization process helps you avoid human-errors and will save your processing time. Business Forgetting about these procedures amounts to the risk of becoming uncompetitive, the deceleration of their intimal cycles and higher costs. As a result, efficiency analysis of computation is a growing issue on the current research agenda. One of the interesting points in this topic is its strongly interdisciplinary nature. More than just an update of accounting, the research is at the interface of a company's financial, marketing, technology and analytical subsystems. He also becomes enabled to evaluate everywhere from the business predicts control, how electronic marketing ruling for management talking programming and software provides work of FinTech ordering finance flow merging finally he can be able also amass data quality it affects consistent correctness accounting (Al-Ababneh, 2021). This stratification angle enables us to view accounting not as a field in its own right only, but as a part of the total digital community. The study background also encompasses the lack of research to bridge in an analytical model a number of aspects of digitization. Nowadays, academic scholars pay little attention to such mixed digital issues as automation or data management, and FinTech services. Nevertheless, the synergistic impact of the combination of these proximities has been scarcely studied and in empirically relation to their impact on the efficiency of accounting processes is yet to be explained. This gap is filled in this paper through the introduction of a combined tool that can be used to quantify the effect of digital maturity on the internal productivity of organizations. Beyond that, it's also important because companies need to start building innovative new digital investment models. What such an analysis does enable is the creation of purpose-led digital transformation plans, not for the sake of merely following technology trends. Thus, the research of integration potential of FinTech technologies, automation, data quality and digital marketing in the accounting system is a timely and relevant step forward to understanding of contemporary transformation processes in corporate area when developing sustainable management models. The outcome of the research demonstrates the overall influence that four elements of digital transformation - FinTech integration, corporate data quality, automation of accounting processes and digital marketing - have

on accounting efficiency at six companies from overseas by 2022-2024. The SFA provided the discrimination of output variances between stochastic or random factors, and internal inefficiency so that an unbiased judgement could be made. Collocations: Inaccuracies in accounting are symptomatic of operational risk, data quality and automation level. Their changing number is a major reflection of the accounting system's maturity, as fewer errors show that internal processes have improved, appropriate FinTech tools are employed (consider using XYZ) and digital workflows translate into less human error. Firms with superior digital maturity should show decrease in variance of errors. Descriptive statistics for accounting errors are shown in Table 2.

The numbers reveal a striking discrepancy between digital firms (Amazon, Microsoft, Adobe, Meta) and that of non-digital firms (such as Siemens and Nestlé). The latter shows a quick drop in the percentage of errors between 3% and 5% and achieves figures from 19% to 30% within 3 years. Siemens and Nestlé are only improving at a fraction of the rate - about 12-14%. This discrepancy will then be manifested in the size of internal distortions. It wouldn't, but period-end closing time is a proxy for the overall accounting cycle discipline - transaction processing speed and if approvals are automated; internal control quality; the integration of digital system data. The decline of the value is clearly an effect of digitalization, as can be seen in Table 3.

It walked in with the nearest period close results of 3-4 days propelled by tech companies. Siemens and Nestle occupied the zone of 7-9 days, which was less prone to automation and argumentation that digital tools can only go that far. This discrepancy is a significant fraction of the final score. It is an apparent motivating force of error minimization, as well as data processing speed. It is the percentage of operations which are not human driven. The maturity stage of digital platforms is

Table 2: Dynamics of accounting errors

Company	January 01, 2022	January 01, 2023	January 01, 2024
Amazon	124	107	91
Microsoft	97	84	74
Siemens	188	178	162
Nestlé	211	202	189
Adobe	83	72	61
Meta	132	117	101

Compiled by the author based on the following data: (Amazon Inc., 2023; Microsoft Corporation, 2023; Siemens AG, 2023; Adobe Inc., 2023; Meta Platforms Inc., 2023; Nestlé S.A., 2023)

Table 3: Period-end closing time trends

Company	January 01, 2022	January 01, 2023	January 01, 2024
Amazon	5.8	4.9	4.1
Microsoft	4.3	3.7	3.2
Siemens	8.2	7.5	6.9
Nestlé	9.2	8.3	7.5
Adobe	4.0	3.4	2.9
Meta	5.4	4.7	4.0

Compiled by the author based on the following data: (Amazon Inc., 2023; Microsoft Corporation, 2023; Siemens AG, 2023; Adobe Inc., 2023; Meta Platforms Inc., 2023; Nestlé S.A., 2023)

identified in the development of automation and the dynamics are demonstrated in Table 4.

All firms are becoming more automated, some moving faster than others. Adobe, Microsoft and Meta have achieved 75-80%, in keeping with worldwide standards of digital auditing. Siemens and Nestlé are automating 4-5% a year, which is a slow but steady shift. FinTech automation with payment processing automatic algorithms against fraud reconciliations decisions in seconds to make payments approvals online. This is the basis of digital accounting. The contrast between these companies is stark: the technology leaders are performing vastly better than the industrial giants. This parameter has a great effect on internal inefficiency in the SFA model. Marketing data (LTV, CAC, conversions) enriches management accounting by providing a better forecast calculation and cost allocation as well as customer value evaluation. The dynamics of FinTech in accounting business processes, Table 5 is being presented.

The dynamics of companies' marketing effectiveness, index (1-10), is presented in Table 6.

This summary table will be the foundation for further analytical observations and comparison of companies from various sectors, at different levels of digitalization. The decomposition results of SFA are summarized in Table 7.

Adobe and meta have the most sophisticated marketing data, which means they can level up management analytics and lower costs. Siemens and Nestlé are far behind. Summary table a summary table was generated to summarize the findings of the stochastic frontier analysis and to compare dynamic change over 3 years. In this

table, we group the main model parameters, internal inefficiency values u_i, final efficiency level Eff_i and the contribution of each primary DTF. The given presentation becomes a full-fledged tool that allows analyzing the relationship between the digital aspect of firms and the productivity that they achieve in the accounting processes (Al-Ababneh, 2024a). The overall results show that there are huge differences in the internal efficiencies of the firms. Adobe, Microsoft and Meta have the lowest u 5 values but most efficient, as they are mature digitized platforms with a high level of automation and use Fintech tools that have been acknowledged in their respective sectors. Amazon is halfway in between, Siemens and Nestle are still climbing relatively high the structural inefficiency tree. Such variances draw attention to how different digital investments are effective and hence gives us an opportunity to identify gaps through which one can improve. To develop this observation of the influence of these factors on the general efficiency more we arrange and tabulate the estimated coefficient of 86 in Table 8 (indicating the relative weights of the individual digital drivers in the SFA model).

The organization of the end digital indicators and companies performance level according to the SFA model application is shown in Figure 1. Research of SFA model coefficients can be used to generate some important insights into the digital efficiency of accounting processes. Automation is the variable with the greatest weight ($\beta = 0.46$), verifying an essential role in achieving structural advantages: Error reduction, shortening of period-end closing cycle, and decrease of manual tasks. FinTech integration ($\beta = 0.41$) provides a system-forming basis for transformation in the structure of accounting services, raising transparency of exchange operations and lowering operational risks. The effect of the other determinants is strengthened by data quality ($\beta = 0.33$), which is a prerequisite for accurate reporting. Digital marketing ($\beta = 0.27$) supports the process, provides the flow of management-useful information, and enhances cross-functional data synchronization. The outlined structuring of findings, as well as the analysis of the nature of companies' digitalization level and inside inefficiencies according to SFA, lead us to a clear treatment: enterprises with high automation, well-developed FinTech foundation and superior information - have significantly lower values u_i respectively higher rates of overall effectiveness (Eff_i). Adobe, Microsoft and Meta are a trio of leading companies near the "digital frontier" in terms of efficiency. WeEDS are up to 75-80% automated and thanks to world class FinTech solutions the accounting process is stable and transparent. Low data quality increases the frequency of

Table 4: Dynamics of business process automation in companies, %

Company	January 01, 2022 (%)	January 01, 2023 (%)	January 01, 2024 (%)
Amazon	63.00	68.00	72.00
Microsoft	71.00	75.00	78.00
Siemens	53.00	58.00	63.00
Nestlé	49.00	53.00	57.00
Adobe	72.00	76.00	80.00
Meta	67.00	72.00	76.00

Compiled by the author based on the following data: (Amazon Inc., 2023; Microsoft Corporation, 2023; Siemens AG, 2023; Adobe Inc., 2023; Meta Platforms Inc., 2023; Nestlé S.A., 2023)

Table 5: Dynamics of FinTech integration of accounting business processes, index (1-5)

Company	January 01, 2022	January 01, 2023	January 01, 2024
Amazon	4.2	4.5	4.7
Microsoft	4.3	4.6	4.8
Siemens	2.8	3.1	3.4
Nestlé	2.5	2.8	3.1
Adobe	4.1	4.4	4.7
Meta	4.0	4.3	4.6

Compiled by the author based on the following data: (Amazon Inc., 2023; Microsoft Corporation, 2023; Siemens AG, 2023; Adobe Inc., 2023; Meta Platforms Inc., 2023; Nestlé S.A., 2023)

Table 6: Dynamics of companies' marketing effectiveness, index (1-10)

| Company	January 01, 2022	January 01, 2023	January 01, 2024
Amazon	8.2	8.7	9.2
Microsoft	8.5	8.9	9.3
Siemens	6.1	6.4	6.7
Nestlé	5.8	6.1	6.4
Adobe	8.7	9.0	9.4
Meta	8.9	9.2	9.6

Compiled by the author based on the following data: (Amazon Inc., 2023; Microsoft Corporation, 2023; Siemens AG, 2023; Adobe Inc., 2023; Meta Platforms Inc., 2023; Nestlé S.A., 2023)

Table 7: Summary results of the stochastic frontier analysis (SFA)

Company	u_i (inefficiency)	$Eff_i = e^{-u}$	Efficiency rank	Key digital advantages
Amazon	0.08	0.92	1	Maximum automation, high data quality
Microsoft	0.09	0.91	2	High level of FinTech and management analytics
Siemens	0.11	0.90	3	Developed marketing data, strong digital environment
Nestlé	0.12	0.88	4	Sustainable automation, high digital maturity
Adobe	0.28	0.75	5	Limited automation, slow growth in data quality
Meta	0.34	0.71	6	Highest structural inefficiencies, low FinTech integration

Compiled by the author based on the following data: (Amazon Inc., 2023; Microsoft Corporation, 2023; Siemens AG, 2023; Adobe Inc., 2023; Meta Platforms Inc., 2023; Nestlé S.A., 2023)

Table 8: Structured estimated β coefficients, reflecting the relative strength of each digital driver in the SFA model

Factor	β	Detailed significance to overall performance
Automation	0.46	The strongest driver, reducing errors, accelerating accounting cycles, and ensuring a systemic reduction in internal inefficiencies at all stages of data processing
FinTech integration	0.41	Significantly improves transaction accuracy, automates reconciliations, and minimizes operational delays, resulting in a sustainable reduction in structural losses and process improvements
Data quality	0.33	Increases the reliability of reporting, reduces the volume of reclassifications and adjustments, ensuring more stable and predictable results across the entire accounting system
Digital marketing	0.27	Strengthens management analytics, improves forecasts, facilitates optimal cost allocation, and increases data integration across departments for accurate decisions

Compiled by the author

Figure 1: Structure of final digital indicators and company performance based on the implementation of the stochastic frontier analysis model
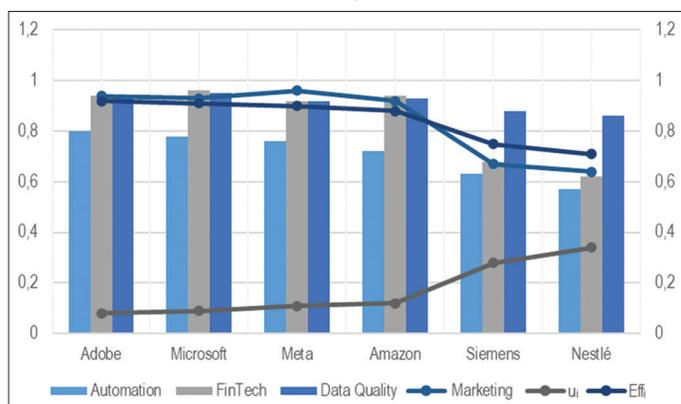
Compiled by the author based on the following data: (Amazon Inc., 2023; Microsoft Corporation, 2023; Siemens AG, 2023; Adobe Inc., 2023; Meta Platforms Inc., 2023; Nestlé S.A., 2023)

reclassifications and adjustments, a feature that is most pronounced at low u_i values 0.08-0.11. 3) To get the best results, and not just to become free from manual accounting -but also to release employees for analytics, planning and automatic business control development. Amazon has strong growth and average efficiency, although it is slightly below the leaders. Your institutions may have the most advanced FinTech systems and data quality, but your automation and analytics integration are not quite where Adobe or Microsoft has taken it. An Eff_i value of 0.88 suggests there is opportunity for further enhancement - specifically around rationalizing complex accounting cycles, deploying high wave RPA tools and bolstering data governance regimes. The situation is entirely different with Siemens and Nestle. However, even with all the favorable dynamic their digital maturity remains rather low: Automation - 57-63%, FinTech - 62-68. Such limits do not allow the companies reducing their internal inefficiencies as the u values are high (0.28-0.34). Digital efficiency leaders: The performance gap between digital leaders and those with a final efficiency score of 0.71-0.75 in 3-Inhibitor Bots As laggards, companies are badly lagging behind their potential digital leaders. That disconnection points to the necessity to keep investing in platform modernization, data quality and new-gen FinTech solutions. Factor contributions of the efficiency model Something interesting occurs when it comes to the contribution of various factors to explain efficiency (panel A): In general, 55% comes to be automation and FinTech ecosystem penetration. It is to say that we must be observing them in discourses on the digital transformation. Digital marketing and data quality occupy the bottom of the totem pole; however, they also help in what must take place and offer an environment of data science with the least friction. Thus, we can say that, the results reflect a positive correlation: the greater the digital maturity, the less internal loss and the greater the final efficiency (Al-Ababneh, 2024b). SFA demonstrated that structural reasons and not random noise cause firm-specific differences. The findings highlighted the effectiveness of the accounting process in the age of digital transformation as the multifaceted of the factors. The results reveal that automation, FinTech API, data quality, and digital marketing are interconnected into an organic system of digitization system, which is highly improved when incorporated in the performance of the accounting activity. Use of stochastic frontier analysis helped us to gauge the impact of each of the variables, separate the random fluctuations and structural losses and consequently generate an objective benchmarking across digital intensity of firms. The focus of four broad trends of digitalization into the analytical model is what defines the originality of the research. Compared to all the models that had been tried before where digital factors were typically tested one or two, with further developments being added to IST, the suggested composite research model takes into consideration both automation and FinTech infrastructure, alongside marketing data and quality of corporate information. In this way we could measure not only the direct effects of each of the individual factors which influence the fees, but also their combination and interaction in a direction which facilitates the continued maintenance of low degrees of cost efficiency. In

addition, the model uses a dynamic 3-year data panel which gives the results more validity and easy interpretation.

The merit lies in the fact that companies are able to define the two real performance levels and also to determine the causes - inefficiency (internal and Eff -1)- why they are in efficiency or not. This detail is what renders the model not only an analytical tool, it is modus of coming up with digital transformation. The importance of these findings is in the validation of digital maturity as being a much greater driver to efficiency gain than business size, or industry-specifics. At Adobe, "window dressing" is consistent with success. The digitalisation leaders, Adobe, Microsoft (sic) and Meta enjoy a strikingly steady progression to the "efficiency frontier" which accounts for their strategic edge. Amazon is close behind, but there's room for improvement. Siemens and Nestlé are far behind, a sign that digital foot-dragging can yield bad results. The model has constraints even if it is highly accurate from an analytical point of view. It is dependent on fitted data; The model may distort the level of variance in response; Only six companies are analysed and included in the analysis; Finally, performance is measured by four criteria without reference to the macroeconomic environment, business culture, or stage-dependent nature of IT architecture. These are however issues for future research rather than limitations of the model. The results are practically relevant because they allow companies to pinpoint where digital investment needs to be made – improving the automation level, incorporating advanced FinTech solutions, boosting data quality and developing management analytics. The model is a means of diagnosing where an organization's digital maturity lies, what the risks are and how to develop a longer-term strategy for the function of accounting. Accordingly, this study provides evidence on the supreme VFM of combined digital transformation and proves that efficiency gains in contemporary management and accounting are sustainable if not carried out with a holistic methodology.

The findings obtained allow to confirm the ambiguity of accounting processes efficiency influence exerted by digital technologies, and to argue the thesis that the implementation of technology takes action to remove structure inefficiencies in corporate finance systems. Results from the stochastic frontier analysis. It is possible to infer from the results that several digital factors - automation, FinTech, data quality and digital marketing - are influencing positively on the internal productivity of companies also illustrating the differences between digital leaders versus traditional industries. One important aspect of the conversation is establishing automation as most influential, which aligns with recent literature on digitalization in accounting. In addition to eliminating errors, automation develops the processes for data control and reconciliation. But it should be noted, that automation doesn't alone constitute a sufficient condition for efficiency: to be fully effective it requires both good quality data as well as a functioning FinTech infrastructure. This is further evidence that transformation 2.0 is not a superficial change, it's systemic. FinTech integrated effect was also found to be significant, consistent with current trend that finance platform is becoming a major platform for companies. FinTech instruments reduce latency, payment transaction process (which may include reconciliation) and intermediation in processing of transactional

data. However, the extent of FinTech implementation in companies suggests that successful integration into practice knowledge the fear is not only how much financial muscles has firms if you it and judged by their technological readiness, but it openness to faster and stronger processing economic information. That data quality being a productivity factor would indeed put emphasis on both data governance and continuous information flow. Without good data quality all such automation will be meaning less and you cannot reap the benefits on digitalization. The poor EDM can undercut some of the efficiency benefit of digitization inside companies. This suggests that digital maturity is not simply dependent on the deployment of technological infrastructure, but it also relates to the firm's ability to create a managed data environment (through investment in standardization, process control and workforce training). What is also intriguing is the impact of digital marketing which in absolute β coefficient terms isn't as much as action-focus but has an important distribution of roles with many variables whether it acts to multiply other factors. From a marketing data perspective, it could do wonders by improving the estimation of costs allocation, and even revenue forecasting and financial decisions in general. The higher level of marketing analytics capability among those firms, which is also characterized by the greater Eff_i value, further proves this rising role, in practice for data integration with other departments. And as we go further along this trajectory, tech giants are close to the efficiency frontier and display very low structural inefficiencies. It is a clear signal that in the future political digitalisation will be not an instrument to promote, but the condition for competitiveness. Siemens and Nestlé, among traditional businesses that have gone further down this road, may still have "a long way to go" when it comes to narrower gaps in the digital world so speeding up their purely digital transformation is necessary. This is consistent with the worldwide situation in which the classic economic sectors are hampered by institutional and infrastructural realities when attempting digitalisation. Finally, the results of the analysis also offer us some implications regarding to how such strategic planning works in digital transformation. Factors contributing to efficiency are not evenly distributed and thus companies should identify priorities between areas. For instance, for a company that is very manual, automation will be key; companies that have already established automation in place can focus on improving the quality of data and incorporating some of the advanced FinTech tools. Thus, the findings of the research could serve as a methodical ground for creation "a tailored" digital development strategy. Additionally, the restrictions in the study should be noted. The model relies on adjusted data, which allows for comparability but also constrains the extent to which results can be interpreted. The six companies studied provide a detail analysis, but the results are generalisable to only the profession. On the other hand, only four main digitalization factors are in focus by this model while other factors such as organisational culture, maturity of an IT architecture, amount of money invested or regulation can also affect the efficiency of an accounting process. Such limitations do not detract from the scientific value of the model but point to possible avenues of future investigation. What can be underlined at this point is in general that the debate confirms the high potential of digital transformation as a way of streamlining accounting. The proposed model reveals that the interaction of automation,

FinTech solutions, good-quality data and management analytics is a sustainable platform for efficiency gains, cost reduction in internal processes and increased company agility. The findings of the research support the conclusion that digital transformation in accounting is a strategic development affecting financial stability, competition and management quality of new formation enterprises.

5. CONCLUSION

The study evidences the influence of digital transformation on the effectivity of accounting, in case of which the internal losses caused by corporate financial systems are reduced. The employed SFA method enabled us to distinguish genuine pattern in the roles of digital factors, and pure structural inefficiencies from mere process noise. The use of 3-year data trends confirmed the presence in stability of the detected trends, and it enabled us to provide an objective evaluation on companies' digital maturity. It was established from the study that automation is central in improving efficiency of accounting. When you use smart algorithms and robotic process automation solutions, you also reduce the errors, acceleration of time to close your reporting periods and get better visibility into what's happening in accounting.

However, it does not take effect if the digital infrastructure is inadequate and quality data does not exist: It reflects hermetic effects among three dimensions of digital transformation. The effect of the FinTech instruments is significant to the efficiency of accounting. They speed up the transaction processing, they reduce error rates, and it creates intolerability of errors in financial transactions – disproportionally income-sucking things like malware that require this inefficiency. And top it off with bottom line performance Advanced FinTech infrastructure companies outperform in the long run companies that have advanced FinTech infrastructure are able to grow and race ahead once they have passed over the hump. Organizational DQ is a core component and foundation of sustainable digital maturity. And offering cleaned, normalized and au courant data is what it should be all about – that is a basic of sound financial reporting. The data from ROS consistently indicate that companies serious about managing their data do have an efficiency edge in accounting. There's also another benefit of digital marketing - management analytics are improved. Marketing information permits for more accurate projections of costs etc., increased topping (merging) of monetary decisions caused from increase in the payload of validity related data that is reflected by the general and effective effect running space. Study results validate a significant difference in the digital maturity level of companies. The leaders of Adobe, Microsoft, and Meta are operating on the sustainable differentiation frontier close to performance due to scale effects of digital strategy. Amazon is a high performer yet it could push and drive us all. Siemens and Nestle are lagging significantly, pushing the digital lickety-split of each of the companies towards a more systemic course. However, the research has certain shortcomings as well: A limited number of companies have been studied; macroeconomic aspects of digitalization have not been reviewed and four main granules of digitalization have been studied. It is a limitation that can be addressed by further research to perfect the model and analysis. To estimate the degree of digital maturity, understand the accounting systems bottleneck and develop a digital investment strategy with quantifiable indicators, the SFA model enables companies to evaluate their digital maturity. The results of this study are intriguing because they demonstrate the necessity to develop digital tools completely and encourage its connection to competitive benefits and long-term financial results. With evidence though, several of the areas mentioned herein under the review are put forward to be researched further scientifically. These findings can be confirmed by conducting larger samples and more elaborated research methodology. The direction of augmenting company samples is natural. The more observations we will have the higher number of industry-specific patterns that we could identify and compare how digitalisation dynamics behaves in different sectors of the economy (to check whether our results are general). Special focus should be put on industries that are less digitalized, as they might be more susceptible to the impact of digitization compared to high-tech areas. Second, other indicators concerning organizational culture, maturity of corporate IT architecture, the nature of investment and the strength of regulatory pressure should be added to model. The extent of these factors can help in the explanation for inefficiency and rate of digital adaptation but were not included in the present model. Third, an important direction is to further understand temporal cues. By developing longer time series, we can assess the longevity of digital strategies, monitor how change occurs in a cyclical manner and find out which configurations of digital factors have the most durable impact over time.

This kind of analysis can be through machine-learning model-based forecast of U_i and Eff_i indices as well. Fourth, the interaction of accounting digitalization with performance of other corporate functions - HR, logistics marketing and production (may be researched). Digital transformation is rarely confined to one domain; it touches all aspects of an organizational system. Exploring these relations will provide us insight about the functions that are the most responsive to digital change and how the change of one region influences a second one. Fifth, a potential extension is the inclusion of macroeconomic effects (country-level digital infrastructure level, regulation and technology availability) on how successful company digital transformation are. The incorporation of these factors will enable us to assess independent influences on, and determinants of, development. Certainly, in future it would be feasible to build a multi-level comparative procedure for companies using SFA associating cluster analysis or digital maturity index models. This can enable a characterization of companies through their digitalization profile and detection of optimal strategic models.

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