Journal of Technological Information, Management & Engineering Sciences (2025),6(2), 17-31

DOI : https://doi.org/10.5281/zenodo.24002568

The Role of Microsoft Excel in Data Analysis and Decision-Making: An Integrative Review of Capabilities, Evidence, and Risks

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How to cite this article:

Ali, M., & Khurshid, H. (2025). Blockchain-Enabled Smart Contracts and Their Influence on Corporate Governance and Transaction Transparency. *Journal of Technological Information, Management & Engineering Sciences , 6*(2), 17-31.

Received	Accepted	Published
28 July 2025	16 Oct 2025	22 Dec 2025

Abstract

Microsoft Excel is a popular tool for organizing, analyzing, and communicating data, but the evidence of its utility in decision making is scattered throughout information systems, software engineering, accounting, economics and life-science research. This paper reviews 16 scholarly sources, along with one textbook and one vendor documentation to explore the role Excel plays in data analysis, the relationship between data-driven analysis and decision quality, and the associated risks. The sources have been identified using targeted searches, followed by screening for explicit inclusion criteria, verification with the publisher or repository records, and thematization. The findings suggest that the wide range of functions Excel offers and its ease of use are why the product has remained so viable even in small and medium-sized businesses as well as that data-driven decision-making has been linked to improved firm performance. It is times and again found in these papers that other mistakes usually occur, there is no formal quality control and as a consequence analytical failures, but also that the advantages of a decision depends on the organizational competency and not only on the tool itself. The paper states that Excel should be considered as a very useful but conditionally reliable decision support tool which requires testing, governance and user skill and that 'scripted or database-based tools' should be used for large data sets or if the consequences are significant. There were no primary data gathered.

Keywords: *Microsoft Excel; spreadsheets; data analysis; decision-making; spreadsheet errors; decision support; data-driven decision-making.*

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Introduction

Increasingly, managers are required to be able to justify decisions based on data. A survey of 179 large firms by Brynjolfsson et al. (2011) does not specifically deal with any one software item, but their findings indicate that companies that put more emphasis on data-driven decision making gained 5%–6% more output and productivity than might otherwise be expected, based on the rest of their investments and information technology usage. There is a middle ground between raw data and the managerial decision, and a lot of commonplace analysis happens in that middle ground, which is a spreadsheet. Microsoft Excel is a program that includes capabilities for entering, calculating, visualizing and modeling data without requiring formal training in programming. A wide range of analysis tools are outlined in the textbook, such as PivotTables, descriptive statistics, regression, exponential smoothing, sensitivity analysis, Solver-based optimization, and Monte Carlo simulation (Winston, 2017).

However, reliability is not the same as accessibility. As in the famous economics study, errors in coding, exclusion of data available, and weighting used in the computations resulted in a quoted average growth rate of −0.1% for high-debt countries, while the appropriate growth rate for these countries was 2.2% (Herndon et al., 2014). In the PubMed Central database, 30.9 % of articles that provided Excel gene lists showed gene-name errors when scanned for supplementary material (Abeysooriya et al., 2021). These cases indicate that Excel's very strengths – flexibility, immediacy, and simplicity of entry – are also the elements that can lead to errors.

The purpose of this paper is to examine the role of Excel in data analysis and decision-making and when it is helpful. It is an integrative review based on the synthesis of the already existing scholarly evidence and not on new findings. The paper summarizes the literature, outlines the gap in research, sets objectives, outlines the method, presents results of synthesis, discusses implications, and concludes.

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Literature Review

Be known as a successful End-User Analytical Environment

Spreadsheets are end-user programming tools: people who are not professional programmers create their calculations and models and traditional software quality assurance is rarely used for the results (Jannach et al., 2014). The Enron email archive, for example, shows how Excel has become part of the organizational analysis. It has revealed that over 15,000 spreadsheets were extracted from it, 10% of the emails sent or referenced spreadsheets, and that these emails frequently referred to errors in and updates to spreadsheets (Hermans and Murphy-Hill, 2015). They also said there was little functional diversity: 76% of the spreadsheets were the same 15 functions. So, although there is a much greater repertoire available in Excel, practical analysis seems to be based on a compact functional core (Winston, 2017).

This is confirmed by the evidence of smaller organisations. In this practitioner survey Church et al., (2022) concluded that small and medium businesses (SMEs) still use Excel for their main accounting functions, and were less advanced with the use of data analytics technology, raising the question: Is Excel a "golden hammer"? Microsoft's documentation then outlines how to use Power Query to bring in the external data and then analyze using Python within Excel using the =PY function (Microsoft, n.d.). This documentation is by the vendor and therefore demonstrates ability, not effectiveness.

Data Analysis, Decision Quality and Performance

Case for Analytical Tools is based on Data-To-Decision. The relationship between data-driven decision-making and performance was also present for asset utilization, return on equity and market value, and the instrumental-variable tests did not indicate reverse causality, according to Brynjolfsson et al. (2011). Based on survey data from managers in 133 U.S.-based firms, Ghasemaghaei (2019) found that the impact of data analytics use on decision quality was fully mediated by knowledge sharing, and that the impact of knowledge sharing on decision quality

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was dependent on data analytics competency. Both studies suggest that the tools are most effective for decisions when the organization understands and communicates the results of the tools.

However, in the case of field evidence on spreadsheets, it is more reserved. The researchers, Caulkins et al. (2007), conducted interviews with 45 executives, senior managers, and analysts from a variety of sectors. Nearly all reported that spreadsheet inaccuracies occurred frequently, and close to all could cite examples where they made losses or poor decisions due to inaccuracies, while quality control was mostly non-existent. Many members thought that checking as it happens was adequate as a checker would see gross errors.

Understand the risk of errors in a spreadsheet and how to avoid them.

After a review of the literature on spreadsheet errors, Powell et al. (2008) found that knowledge regarding the types, causes, detection and prevention of errors was limited, and that errors were widely accepted as being prevalent and capable of causing poor decision making and significant financial losses. Rates are reported, depending on definitions and methods. A review of 50 operating spreadsheets identified between 0.8% and 1.8% of the formula cells as incorrect, depending on the definition of error used (Powell et al., 2009a), and a follow-on review indicated that 1%–5% of the formula cells in these spreadsheets were incorrect, with some being harmless and others fatal (Powell et al., 2009b). In a survey of 25 spreadsheets from five organizations, many of the errors were nonsignificant, and some of the errors had a significant quantitative impact on key results (Powell et al., 2009c). In the Enron corpus, 24% of the spreadsheets containing at least one formula had Excel errors (Hermans & Murphy-Hill, 2015); and in an Irish healthcare case study, over 90% of the spreadsheets analysed contained bottom-line errors, with an average cell-error rate of 13% (Dobell et al., 2018). Based on human error research, Panko (2007) noted that spreadsheet errors are not a problem of the spreadsheet itself and that it is very difficult to reduce the spreadsheets' errors.

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This article examines the key issues associated with QA and the limitations of spreadsheets.

Two reviews have been published that catalogue responses to the error problem. Jannach et al. (2014) categorized automated quality assurance methods broadly as visualization, static analysis, quality reports, testing and support and model-based development. Poon et al. (2024) found that there is 35.5 years of journal literature (January 1987 - June 2022) and 10.5 years of conference literature and it is concluded that the quality of the spreadsheet should be addressed during its whole life cycle, and there are more studies on testing and debugging than there are on specification, modelling and design. According to Panko (2008), at that time no other technique has been shown to be effective, except for code inspection done on a cell-by-cell basis. The boundaries of tools have also been clearly marked. Abeysooriya et al. (2021) found that spreadsheets are not appropriate for large genomic datasets and that using Python or R notebooks would be better suited for this analysis, after finding gene-name errors in 30.9% (3,436 of 11,117) of articles with supplementary Excel gene lists published between 2014-2020.

Research Gap

Four gaps emerge. First, the evidence is scattered: errors in spreadsheets, data-driven decision making, and the use of Excel in small organisations are examined in different research areas, and none of the sources found for this review report on all three areas. Second, the evidence for decision quality is predominantly indirect as the large-sample studies focus on analytics in general and the studies for Excel focus on errors, but not outcomes. Third, error research goes back a long time before Power Query and Python integration in Excel were available, and the sources mentioned here do not perform empirical evaluations of their effects. Fourth, the studies included are mostly conducted in North American, European, Australian and East Asian context; none have been conducted in South Asia, meaning transferability to these contexts is untested. The first three gaps will be

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closed by integrative synthesis and the fourth as a restriction and future research direction.

Research Objectives

The purpose of this study is to integrate the knowledge gained from scholars in the field of the role of Microsoft Excel in data analysis and decision making. It has the following specific objectives:

To explain the analytical functions that can be used to facilitate data analysis in an organisation using Excel.

2. To evaluate the evidence for the correlation between spreadsheet-based and data-driven analysis and the quality of decision and performance.

3. To review evidence of errors in the use of Excel as an analysis tool and the effects of these errors.

To identify implications based on evidence for decision-making using Excel.

The following goals are related to three research questions. RQ1: What are the uses of Excel in organization data analysis? RQ2: How do the evidence-based relationships between such analysis and decision outcomes? RQ3: What risks exist and how can they be addressed?

Methodology

Research Design

This study is an integrative review, which is a type of research that enables the integration of various empirical and theoretical data to provide an overall view of a phenomenon (Whittemore & Knafl, 2005). Work was organized into the five stages suggested by Whittemore and Knafl (problem identification, literature search, data evaluation, data analysis, and presentation). The review is not a systematic review and is not exhaustive.

Identify and select sources.

In October 2026, targeted searches of various combinations of the terms excel, spreadsheet, errors, decision-making, data analytics, and quality assurance were conducted, and candidates' records were found by publisher, indexing, and repository pages. Sources were considered if they were (a) peer-reviewed articles,

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conference papers, established working papers or a recognized textbook; (b) spreadsheet or Excel analysis or spreadsheet errors or quality assurance, or relationship between analytics and decision quality; (c) written in English; and (d) verifiable using a publisher or repository record. News reports, blogs, and secondary summaries were not included, nor were any sources where it was not possible to confirm bibliographic information. Studies from 2007–2015 were retained due to the fact that many of the studies in the field audit results are from these years and studies from 2018-2024 were added for current data. The final set included 16 scholarly sources, one textbook and one vendor documentation (which served for describing features).

A student's guide to the analysis and evaluation of data.

All sources were evaluated for design, sample, setting and relevance and were categorized as Excel, spreadsheet, or analytics. Key findings were derived and inductively coded and codes were aggregated into themes using the approach of Braun and Clarke (2006) for thematic analysis. The quantitative results are presented as published and credited to their sources. Not pooled due to differences in definitions of error, samples, and methods (Powell et al., 2008). This was done without human participants and without new data being collected, so that the Results section is not reporting original measurements, but rather a synthesis of the results.

Results

The main evidence is summarized in Table 1. Four themes were generated during the synthesis process.

Table 1

The evidence from the selected literature has been summarized for inclusion in the review.

SourceContext Key reported findingFocus

Brynjolfsson et al. (2011) surveyed 179 large public companies and found that data-driven decision-making was correlated with 5%–6% more output and productivity than predicted, on average—analytics generally.

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Ghasemaghaei (2019) Survey of managers, 133 U.S. firms Effect of analytics use on decision quality fully mediated by knowledge sharing Analytics generally

Caulkins et al. (2007) 45 interviews with executives, managers, analysts Errors reported as common; most could mention losses or bad decisions; quality control was informal, mainly in the form of spreadsheets

The information was extracted from 50 operational spreadsheets, and errors that were identified in the formula cells were as high as 1.8% (Powell et al. 2009a), depending on definition.

Hermans & Murphy-Hill (2015) over 15,000 Enron spreadsheets 24% had an excel error; 76% of those spreadsheets had 15 of the same functions.

Dobell et al. (2018) Irish healthcare case study More than 90% had errors at the bottom line; Average cell-error rate 13% Spreadsheets

Abeysooriya et al. 2021 11,117 articles retrieved from PubMed Central with gene lists provided in Excel format, and 3,436 articles had gene-name errors (30.9%) Excel

Church et al. (2022) Practitioner survey of SMEs Lags behind analytics adoption by SMEs; still doing leading accounting tasks in Excel

Herndon et al. (2014) Replication of published economic analysis, corrected by 2.2% growth, compared to –0.1%, due to coding errors, data exclusion and weighting Spreadsheet-based

Briggs et al. (2011) Systems integration literature review, 1987-2011 More work on testing & debugging than on specification & design Spreadsheets

Note. Numbers are presented as given by the original authors. Definitions, samples and methods vary and figures are not directly comparable.

Theme 1: Accessibility and Functional Breadth: Support Excel's Role.

When it comes to the role, across sources Excel is about accessibility and breadth. It has been integrated into daily business communication (Hermans & Murphy-Hill, 2015), is the dominant means of fundamental accounting processes in SMEs (Church et al., 2022) and has analytical capabilities ranging from PivotTables to

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simulation (Winston, 2017), and, again according to the vendor documentation, is linked to Power Query and Python (Microsoft, n.d.). But observed use focuses on a limited number of functions.

Theme 2: Decision Value is Conditional

The positive relationship between data driven decision making and its impact on firm performance (Brynjolfsson et al., 2011), but the improvement of the decision quality as a result of the use of data-based analytics rely on sharing knowledge and the competency of data based analytics (Ghasemaghaei, 2019). The evidence for decision consequences that is contained in spreadsheets is qualitative: Typically, managers can identify spreadsheet mistakes that led to losses or bad decisions (Caulkins et al., 2007). There were no included studies that measured decision outcomes specifically to Excel.

Theme 3: Errors are common but not of equal impact

In a healthcare case study, the reported rate of formulas with errors is 13% of all formula cells (Dobell et al., 2018); 24% of all spreadsheets used by the energy company Enron have formulas and contain an Excel error (Hermans & Murphy-Hill, 2015); and 0.8%–1.8% of formula cells in a general worksheet are reported to be erroneous (Powell et al., 2009a). These all point in the same direction but they are not directly comparable. The impact is uneven, with many errors having a negligible quantitative effect, but a few having a significant effect on key outputs (Powell et al., 2009b, 2009c). According to Panko (2007), error is more of a human phenomenon than a tool-specific phenomenon.

Theme 4: Failures Concentrate Where Scale, Complexity, and Weak Review Coincide

Highly publicized economic analyses were replicated, with discrepant results due to code errors, data exclusion and weighting (Herndon et al., 2014), and gene names were converted to dates and other data types remained in 2014-2020 in supplementary excel files (Abeysooriya et al., 2021). Prevention research focuses on testing and debugging, rather than early-stage design (Poon et al., 2024), and

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only one method—cell-by-cell inspection—was found to be effective at the time of Panko's (2008) review.

Synthetic against the research questions

The evidence for RQ1 suggests that Excel is operating as a general-purpose, end-user analytical environment, and that its observed use focuses on what is essentially a limited set of functions, and is central in SMEs. Data-driven decision making supports better performance and is linked to organizational knowledge sharing and competency, but for RQ2, there is indirect evidence: Excel-specific decision outcomes have not been measured. Errors are common and have varying consequences in RQ3, and are not easily reduced by individual vigilance; literature suggests life-cycle quality assurance, independent inspection, and appropriate tool selection as the key controls.

Discussion

Interpretation of Findings

The synthesis provides a conditional perspective of the role of Excel (RQ1–RQ3). It is becoming ubiquitous because of its ability to reduce the analysis cost — users can go from data to a model or chart without the need to write specialized programs, explaining its presence in SMEs (Church et al., 2022) and corporate workflows (Hermans & Murphy-Hill, 2015). However, this reachability also puts analysis in the hands of the end user, whose work is rarely subjected to the traditional approach of software quality assurance (Jannach et al., 2014). If errors are primarily human in nature (Panko, 2007), changing tools would not be enough to eliminate errors, and process controls are of importance, but for certain types of errors, like type conversion errors in a big genomic list, a new tool is valid enough to eliminate the type conversion errors (Abeysooriya et al., 2021).

The rule of evidence also supports this: analytics makes a difference most of all when there is knowledge sharing across the organisation, and when they have analytical capability (Ghasemaghaei, 2019). So, an Excel model should be considered a step in a socio-technical decision process, rather than the answer

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itself. However, the impact of error is variable (Powell et al., 2009c) and risk-based, proportionate controls seem more realistic than blanket review of all workbooks.

There are two tensions to highlight. First, the most powerful feature of Excel, that it is directly controlled by the end-user, is also its most significant limitation: controls are dependent on user discipline and not mandatory process as would be in a formal quality control system, echoing the informal quality control reported by Caulkins et al. (2007). Second, the fact that firms benefit from data-driven decision making (Brynjolfsson et al., 2011) does not imply that some particular tool is endorsed: it implies that firms benefit from analysis, but the error literature addresses the issue of the reliability of one common vehicle for this practice. Reconciliation of these two aspects—whether analysis is performed and how—is a matter that needs attention.

Practical Implications

Use appropriate tools: if you have a large amount of data or a large and complex dataset, use scripted tools or database tools (Abeysooriya et al., 2021).

Scale controls to stakes: Independently inspect and test high consequence workbooks at the level of the cell (Panko 2008; Poon et al. 2024).

Concentrate on quality in specification and design, not just during final debugging (Poon et al., 2024).

Use formal review processes instead of informal checking (Caulkins et al., 2007).

Investing in analytical competency and sharing knowledge in addition to the tool (Ghasemaghaei, 2019).

Limitations and Future Research.

This review is not comprehensive, and therefore some studies may have been omitted and there may be selection bias. The evidence relating to evidence of decision outcomes is indirect, in that many of the studies included prior to the current features in Excel, and large-sample studies include analytics as a whole. Error measures vary from study to study and vendor documentation is not independent evidence. Further research is needed on (a) measuring decision outcomes in an Excel-based process directly, (b) testing if Power Query, Python

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integration, and other related features decrease error rates, and (c) studying the practices of Excel in South Asian organizations that are not covered in the literature included.

Conclusion

Because Excel allows analysis to be performed on any data and is highly flexible, it takes a significant and enduring place in the landscape of data analysis and decision-making. The evidence reviewed indicates that making decisions based on data is correlated with improved firm performance, and that decision-making based on data will only benefit the firm if the firm has the competence to do so; spreadsheet errors are common, unevenly distributed, and sometimes significant. The rules for using Excel should therefore be: it is OK to use for moderate scale analysis that is backed up with testing, review, and governance, it is not OK to use as the only means of making high stakes or large scale analysis. This is a secondary synthesis paper and the conclusions drawn are therefore limited by the evidence available, and currently no direct measurement of the impact of Excel on decision outcomes is possible.

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