IJAAF; Vol. 9, No. 4, Autumn 2025, Serial 33

Ferdowsi University of Mashhad

Iranian Journal of
Accounting, Auditing & Finance

Quarterly

RESEARCH ARTICLE

Digital Accounting Legitimacy Perspectives Based on the Need for More Developed Software Services

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How to cite this article:
Manafi, A. , Borhani, S. A. , Safari Gerayli, M. and Jahangirnia, H. (2025). Digital Accounting Legitimacy Perspectives Based on the Need for More Developed Software Services. Iranian Journal of Accounting, Auditing and Finance, 9(4), 149-181. doi: 10.22067/ijaaf.2025.46641.1523
https://ijaaf.um.ac.ir/article_46641.html

ARTICLE INFO

Article History
Received: 2024-12-19
Accepted: 2025-03-21
Published online: 2025-10-05

Keywords:
Digital Accounting, Legitimacy, Software Services

Abstract

The current study aims to outline the legitimacy perspectives of digital accounting in light of the increasing need for more advanced software services in Iran. A mixed-methods approach was employed, combining qualitative and quantitative analytical procedures to achieve the study's objectives. In the qualitative phase, grounded theory and Delphi analyses were conducted based on input from 14 experts and scholars familiar with the core phenomenon under investigation. In the quantitative phase, a futures studies approach was applied to identify potential scenarios that could define the legitimacy perspectives of digital accounting in the context of enhanced software service requirements in Iran. Based on the 14 interviews, the qualitative findings produced 282 open codes categorized into 33 conceptual themes, six core components, and three structural dimensions, forming the foundational framework for the legitimacy of digital accounting. Conversely, the quantitative results—through matrix analysis—identified four scenarios along two key axes: systemic mechanisms related to financial planning and those associated with the supply chain. According to the mathematical function matrix, the most probable scenario emerged at the intersection of high-impact systemic mechanisms associated with the supply chain and low-impact mechanisms related to financial planning. This scenario, termed the "Amadic Scenario," offers a more reliable justification for the legitimacy of digital accounting grounded in the advancement of software services in Iran's future. In interpreting these findings, it is important to note that achieving legitimacy for digital accounting—based on software service development requires logistical capabilities that enhance inventory and resource management within production systems, thereby ensuring higher computational capacity and operational efficiency.

https://doi.org/10.22067/ijaaf.2025.46641.1523

NUMBER OF REFERENCES
47

NUMBER OF FIGURES
8

NUMBER OF TABLES
16

Homepage: https://ijaaf.um.ac.ir
E-Issn: 2717-4131
P-Issn: 2588-6142

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1. Introduction

One of the most significant developments of the past decade has been the emergence of parallel-world platforms, which has fueled the rapid advancement of augmented reality technologies. These innovations have fundamentally reshaped key social functions (Santos, 2024). Consequently, the operation of social functions across diverse sectors such as healthcare, the economy, culture, and finance—has experienced substantial transformation within today's dynamic business environment (Liu et al., 2025). In other words, the digitalization of financial services has facilitated the creation of numerous tools derived from these transformations, enabling companies to enhance their capabilities in meeting stakeholder needs (Osuma, 2025). Therefore, earlier generations of financial technologies based solely on traditional accounting software may no longer be sufficient in light of advancements driven by artificial intelligence (Huy & Phuc, 2024).

Many commercial firms offering financial services through digital accounting startups increasingly strive to provide more advanced technological systems driven by artificial intelligence capabilities. These systems encompass broader financial computations and facilitate strategic planning, enabling firms to compete more effectively in the marketplace (Agyei-Boapeah et al., 2022). In other words, the financial systems dominant in previous generations of commercial companies faced inherent limitations in meeting stakeholders' informational needs due to constraints in computational infrastructure and challenges in evaluating financial events. The emergence of new generations of financial technologies powered by artificial intelligence and represented by innovations such as the metaverse and operational chatbots has not only addressed these shortcomings but also enhanced the reliability and accessibility of financial information for report users. During crises such as the COVID-19 pandemic, these technologies have demonstrated greater effectiveness in reinforcing organizational legitimacy and enabling firms to attain higher competitive advantages (Berger & Boot, 2024). Therefore, the fundamental structural distinction between these modern financial systems and their predecessors lies in their expanded forecasting and computational capabilities, which help companies establish more strategic and forward-looking roadmaps (Carè et al., 2025).

Thus, compared with the third generation of technological networking, the integration between accounting services and digital systems appears to have undergone more substantial transformations in computational capabilities (Wu & Pambudi, 2025). The rationale behind these changes lies in the fact that the accounting environment, due to its sensitivity to external challenges, must continuously evolve in implementing financial procedures within firms to effectively meet the informational needs of users (Qatawneh & Makhlouf, 2023). Recognizing this, international providers of digital accounting software have increasingly focused on developing customer-centric financial technologies. Their objective is to advance business services by integrating financial systems into interconnected, cloud-based networks—thereby enhancing computational speed and capacity through improved accessibility to financial data (Cochoy et al., 2017).

As Naser (1993) predicted, accounting functions have undergone substantial transformation in recent years due to technological advancements. These changes aim to enhance the capacity of accounting systems to meet stakeholders' informational needs, positioning accounting as a social product. Consequently, a critical question arises regarding the precise impact of digital technologies on advanced accounting systems. Today, commercial firms operating in this domain are improving the speed of information exchange by incorporating new features into financial platforms. These developments enable the real-time reflection of financial data to stakeholders, supporting more informed and higher-quality financial decision-making. This gap evident in previous generations of technologies such as traditional information systems—has now been bridged through the capabilities offered by current-generation financial technologies, allowing companies to attain a higher degree of legitimacy. Lombardi and Secundo (2021) argue that innovative technologies and data analytics can fundamentally transform corporate reporting processes, thereby improving stakeholders' decision-making capacity and fostering greater accountability and transparency. Moreover, the expansion of digital accounting services has endowed the accounting profession with a broader set of competencies—from forecasting and evaluation to financial estimation for investment decisions promoting greater integration among departments that depend on accounting functions (Yaftian et al., 2017). Additionally, these services, which include interactive modules and automated instructions designed to accelerate computational processes, enhance organizational decision-making efficiency within integrated information systems (Alsharari & Ikem, 2023). Consequently, the emergence of such software solutions has propelled digital accounting capabilities beyond the third generation. Whereas third-generation digital accounting primarily emphasized the output phase focusing on faster and more comprehensive financial disclosure—the emerging generations, developed by leading international firms, concentrate on building networked business services. These services function as strategic roadmaps for enhancing firms' competitive capabilities and ensuring long-term sustainability (Ayabei et al., 2023).

In addition to the current transformations taking place in financial markets, certain constraints such as the potential reduction in the confidentiality and security of financial systems can be identified as major challenges in developing accounting technology services, particularly in developing countries like Iran. These nations often face substantial gaps in adopting network-based financial business services due to various factors, including limited institutional oversight and the absence of effective scientific or technological cooperation with more developed economies. Emerging financial markets, given their limited preparedness to engage in new domains of financial transactions such as digital currencies, can no longer rely solely on the traditional functional boundaries of accounting systems. Instead, they increasingly require online services from international firms to ensure the security and reliability of financial exchanges. However, an issue overlooked in prior studies (e.g., Abikoye et al., 2024; Offiong et al., 2024; Nwoke, 2024), which primarily emphasized the efficiency of financial technologies, concerns the lack of adaptive alignment between the content of business software packages and the infrastructural functions of digital accounting systems. This misalignment has led to inconsistencies between firms' financial functions and the informational needs necessary to achieve greater legitimacy. Accounting systems, in disclosing financial performance, depend not only on institutional standards and regulatory frameworks but also on broader cultural, social, economic, and even political contexts. Therefore, achieving legitimacy for software-based accounting services—particularly in Iran—requires strategic attention to these operational and contextual factors. In light of these considerations and the theoretical gap identified, the following section presents the study's theoretical foundations, supported by relevant literature. Section Three explains the research methodology, Section Four provides the empirical analysis, and the final section offers an interpretive discussion and conclusion based on the study's findings.

2. Theoretical foundations

Owing to its long-standing role in information disclosure for users, accounting knowledge has undergone fundamental transitions from classical to neoclassical and, more recently, to postmodern approaches. Over the past few decades, the accounting profession has played a vital role in meeting the expectations of diverse stakeholders—including investors, managers, and shareholders—through its integration with information systems (Loo & Bots, 2018). In this context, Accounting Information Systems (AIS) have gathered data from external environments, processed it, and delivered reliable output information to stakeholders in the shortest possible time (Rakhshani et al., 2023). However, these systems, including earlier generations of accounting information technologies, still rely on traditional, well-defined processes grounded in the power and capacity of data banks. They are primarily regarded as tools for disclosing financial functions to satisfy stakeholders' expectations rather than mechanisms for generating higher competitive capabilities (Soleimani et al., 2024).

Digital accounting, as one of the core process mechanisms, is no longer regarded merely as a tool for tracking business financial activities or monitoring numerical and financial data to inform stakeholders—functions traditionally associated with Accounting Information Systems (AIS) (Antonini, 2024). Leveraging the technological capacities embedded in software packages such as QuickBooks, digital accounting systems have incorporated additional specialized functions, including planning, budgeting, and forecasting future financial changes (Laili et al., 2023). In this regard, digital accounting should not be viewed solely as a facilitator of information provision. Supported by institutionalized computational and estimation services, it demonstrates a higher degree of proactivity in generating value for stakeholders (Sadri et al., 2023). Accordingly, Table 1 presents a comparative summary of these two generations of technology in the accounting field, based on prior studies such as Prasetianingrum and Sonjaya (2024).

Table 1. Differences between accounting information systems and digital accounting

Criteria of Difference	Information Systems	Digital Accounting
In terms of goal setting	Based on internal structures	Based on external structures
In terms of operations	Static and fixed	Dynamic and automated
In terms of execution	Systematic rotation	Networked and structured
In terms of development	Focused on current affairs	Forward-looking and simulation-based

Referring to these distinctions, it becomes evident that information systems can only achieve effective goal-setting based on internal capabilities when the functional infrastructure within the financial domain enables efficient data sharing. In contrast, digital accounting primarily focuses on external requirements, where boundary-expanding environmental systems facilitate the dual reflection of informational flows—both internally and externally. From an operational perspective, earlier generations of financial technology systems were static and rigid, with operators and processors merely supporting decision-making processes. In the new generation, however, artificial intelligence (AI) agents, robots, and avatars contribute to a dynamic and automated flow of information. From an execution standpoint, previous generations of information systems primarily circulated data to meet strategic objectives. Conversely, digital accounting operates through networked, star-shaped information structures in which data circulates according to organizational needs. In terms of development, prior systems were mainly focused on current affairs, while digital accounting systems function within networked and simulation-based environments. The advancement of simulation tools and software packages has positioned digital accounting as a decisive factor in enhancing financial flexibility and reducing costs (Thottoli, 2021). A key aspect of sustaining these systems lies in the infrastructural transformation of corporate technologies, particularly regarding information flow. Such transformation allows users to access data and performance information through defined system identifiers (e.g., electronic identification numbers, or eIDs) (Valentinetti & Rea, 2024). Therefore, depending on the technological infrastructure utilized, digital accounting should be recognized as an integrated and alternative approach to traditional accounting methods, enabling real-time monitoring of financial information via mobile devices and other electronic tools (Dethier et al., 2024). These software-based systems provide users with predefined interfaces and analytical modules to process or evaluate specific categories of accounting procedures, tailored to their informational needs (Napisah et al., 2024). Today, many international financial technology firms offer software packages that align with the structure and services of digital accounting systems, as illustrated in Figure 1.

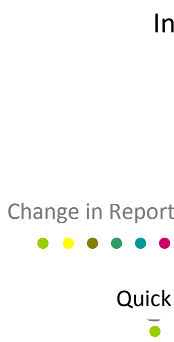

Figure 1. Features of commercial services in international software packages

By transforming traditional reporting methods and redefining input data flows, software packages aim to achieve rapid data processing and analysis while maintaining high levels of user security. These systems enable firms to request personalized financial disclosures from users, aligned with their operational strategies. Such capabilities enhance the uniqueness of financial computations, and with the support of online functionalities, companies can swiftly provide operational financial outputs to users. Consequently, the commercialization of digital accounting systems through international software providers has made it possible for businesses in various countries to enhance the transparency of their financial reporting. Despite this progress, however, the topic remains largely absent from contemporary financial reporting standards—particularly the International Financial Reporting Standards (IFRS). This omission can be attributed to several factors: the limited maturity and adoption of digital accounting norms within capital market systems, restricted access to financial technology infrastructure in many developing economies, insufficient investment flows in corporate technological initiatives, and the absence of dedicated evaluation committees or financial accelerators to support innovation. Collectively, these challenges have resulted in a notable gap within financial standards concerning this critical area of financial markets. At the same time, modern software packages increasingly emphasize the sustainable development of digital accounting across different regions (Lacy et al., 2019). In one such classification, Said and Aliu (2022) differentiated the operational processes of commercial financial software packages according to their functional scope and regional implementation contexts.

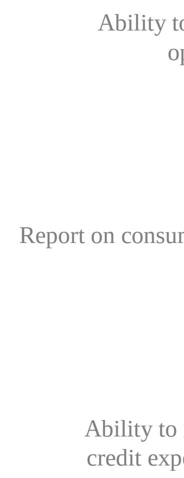

Figure 2. Operational processes of financial software business packages

As illustrated in Figure 2, digital accounting—facilitated through commercial software packages developed by international financial technology firms—enables the development of six operational phases across key areas, including cost management, inventory control, credit management, project costing, financial supply chain management, and investment project evaluation. These phases form the core foundations of supplementary reporting functions within financial statements, guiding them toward greater sustainability. By achieving higher levels of financial transparency, firms can gain substantial competitive advantages. Furthermore, the legitimacy of developing such technological mechanisms can be conceptualized through the framework proposed by Xiu et al. (2020), which identifies key dimensions of legitimacy that contribute to enhancing the effectiveness of corporate functions, as illustrated in Figure 3.

Moral Legitimacy **Adherence to stakeholder rights** **Adherence to individual rights**	**Practical Legitimacy** **Stakeholder promotion** **Management information systems**	**High**	**Stakeholder Value**
Selective Legitimacy **Organizational efficiency** **Resource management**	**Structural Legitimacy** **Social accountability** **Organizational transparency**	**Low**	
Exclusive	Competitive		
Social Norms			

Figure 3. General approaches to corporate legitimacy in the field of technology (Source: Xiu et al., 2020)

According to this matrix, and consistent with prior perspectives on the structure of legitimacy, stakeholder values (vertical axis) and social norms (horizontal axis) constitute the fundamental dimensions for establishing legitimacy in the new generation of digital technologies. The intersection of these two axes gives rise to four quadrants of organizational legitimacy—practical, moral, cognitive, and structural—each representing distinct functions and characteristics corresponding to its position within the matrix.

- *Practical Legitimacy*

Within this form of legitimacy, computational processes are oriented toward advancing stakeholders' interests. Information systems, grounded in shared values and social norms, provide meaning to the inter-organizational interactions between firms and their stakeholders. In essence, practical legitimacy represents the highest level of social benefit an organization can attain by internalizing societal values and transforming them into elements of organizational identity (Breakey, 2020).

- *Moral Legitimacy*

Within this form of legitimacy, the evaluation of positive social values forms the foundation for upholding stakeholders' social rights and the rights of human resources within organizations. Unlike practical legitimacy, moral legitimacy primarily represents adherence to resources and actions aligned with legal frameworks and established social norms. In this form of legitimacy, fewer innovative or emergent value norms are developed, as the emphasis remains on conformity and ethical compliance rather than innovation (Reinecke et al., 2017).

- *Structural Legitimacy*

Within this form of legitimacy, the direct emphasis on stakeholder values is relatively diminished, while social norms—grounded in an expanded framework of laws, accountability mechanisms, and transparency standards—become the primary basis for legitimacy creation. What matters most are the measurable values that can be assessed through specific performance metrics. In cognitive legitimacy, organizational values are shaped through competition and benchmarking among firms, with fewer benefits directly derived from stakeholders' subjective or perceptual evaluations (Lock and Schulz-Knappe, 2019).

- *Selective Legitimacy*

Within this form of legitimacy, only those values and norms that align with organizational interests are acknowledged. In other words, organizations, guided by the actionable expectations of their stakeholders, seek to enhance efficiency by emphasizing positive disclosures to their audiences. Owing to resource constraints, they attempt to minimize potential limitations and maximize access to emerging opportunities. Consequently, structural legitimacy reflects an approach of informational selectivity, whereby organizations communicate tailored information to stakeholders to build trust and maintain alignment with strategic objectives (Xiu et al., 2020).

Li et al. (2024), in their study on the design of an intelligent accounting system based on microcontrollers, emphasized that achieving digital legitimacy in accounting requires a higher degree of alignment between software functionality and hardware infrastructure. According to their findings, data-storage systems must be capable of creating central processing units within monitoring centers to facilitate the integration of input and output data analyses, thereby enabling the evaluation of larger volumes of information. Similarly, Gao (2024) investigated the development of startups among small and medium-sized enterprises (SMEs) in China to promote digital financial accounting. The study concluded that investment in digital accounting infrastructure significantly influences senior clients' intentions to adopt such systems. Moreover, the adoption of financial startups enables faster access to information, allowing users to make higher-quality and more legitimate financial decisions. In another related study, Pham and Vu (2022) examined the cost-effectiveness of digitalizing accounting information to enhance the added value of a sustainable innovation ecosystem within SMEs. Their findings revealed that as digitalization in accounting expands, the added value and sustainability of the innovation ecosystem are expected to increase accordingly.

A review of prior research reveals that previous studies have largely overlooked the specific needs of digital accounting in relation to available software packages. Recognizing this gap highlights the contribution of the present study and clarifies its position within the broader field of accounting knowledge. Given that modern digital accounting systems are increasingly essential for establishing financial identity within operational functions—and for enabling firms to deliver more comprehensive services to users of financial information—adopting a legitimacy-based framework can facilitate the preparation of more reliable and process-oriented financial information. Depending on firms' strategic orientations and competitive positions across industries and markets, the pursuit of legitimacy may manifest differently, making its achievement a distinctive process. Accordingly, this study aims to explore the integration of software service requirements with the sustainable development of digital accounting among companies listed on Iran's capital market. In other words, it seeks to assess the level of financial needs embedded in digital accounting functions with respect to future market prospects, thereby addressing the evolving expectations of stakeholders and information users. Based on these objectives, the research questions are formulated as follows:

First Research Question: What are the system requirements for the legitimacy of digital accounting based on software services development in Iran?

Second Research Question: What are the future perspectives for the legitimacy of digital accounting based on software services development in Iran?

Given the foresight-oriented nature of this study, the first phase involves conducting interviews with experts to identify the system requirements that can enhance the legitimacy of digital accounting through the use of software services. The insights obtained from these interviews will inform the analytical matrix sequencing process employed in the foresight analysis. Subsequently, an uncertainty questionnaire will be administered to identify potential driving forces related to the core phenomenon. Based on these drivers, probable scenarios influencing the future legitimacy of digital accounting—rooted in the use of software services within the Iranian context—will be developed and analyzed.

2.1. Literature review

Li et al. (2024) examined the hardware components of software systems based on data-storage sources controlled by a central processing chip for input data analysis. Their proposed intelligent accounting system is capable of evaluating larger volumes of data using predefined parameters. The findings indicate that expanding data sources and databases, as well as increasing the speed of financial computations through this microcontroller-based system, can provide more reliable information for managerial decision-making. In a separate study, Gao (2024) employed a quantitative methodology using a researcher-designed questionnaire. The findings revealed that facilitating investment in digital financial accounting infrastructure significantly influences senior clients' intentions to adopt such systems. Furthermore, leveraging financial startups allows users to access information more rapidly and make higher-quality financial decisions. Gao also found that promoting digital accounting through startup mechanisms can ensure greater stability and accountability to customers. Customer trust, in turn, can be strengthened by guaranteeing data security, ease of access, continuous system updates, and reliable program content.

Pham and Vu (2022) employed a three-dimensional methodology comprising a literature review, expert interviews, and a survey. Qualitative data were collected through a series of semi-structured, in-depth interviews, while quantitative data were obtained from a questionnaire administered to 583 respondents. The data were analyzed using covariance-based structural equation modeling (CB-SEM) via AMOS 26.0 software. The findings indicated that, although the model structures demonstrated a satisfactory fit, the digitization of accounting procedures can enhance the added value of sustainable innovation ecosystems within small and medium-sized enterprises (SMEs). Similarly, Sheikhi et al. (2023) identified three primary causal categories—individual, organizational, and environmental constructs—as well as three contextual categories: technology application, infrastructure enhancement, and improvement of accounting information systems. They also defined four strategic categories and two outcome categories, encompassing both positive and negative consequences related to the core phenomenon of the study. The results underscored the significance of adopting emerging technologies compatible with accounting information systems, alongside the necessity of regulatory oversight and managerial support during the implementation process. By emphasizing the positive implications of such technologies, organizations can better eliminate barriers and mitigate adverse outcomes. In a complementary study, Ghashghaei and Mashayekh (2019) proposed a five-level framework for process maturity within accounting units: (1) informal processes, (2) formalized processes, (3) integration and automation of core processes, (4) alignment of processes with strategic objectives while managing exceptions, and (5) continuous process improvement from good to excellent. They also outlined five levels of information technology (IT) maturity: (1) financial accounting or bookkeeping software, (2) financial, administrative, and commercial software solutions, (3) integrated software solutions, (4) Enterprise Resource Planning (ERP)-based systems, and (5) artificial intelligence (AI)-driven solutions.

A review of the existing literature reveals that prior studies have largely overlooked the assessment of digital accounting needs in relation to available software solutions. Recognizing this gap highlights the contribution of the present study, which seeks to advance accounting knowledge by providing a clearer understanding of digital accounting development and its legitimacy dimensions.

3. Methodology

In humanities-related research, methodology typically comprises three components: objective, outcome, and data type—each contributing to a clearer understanding of a scientific inquiry. First, in terms of the objective, this study is exploratory in nature, as it investigates an emerging phenomenon that, despite its significance for achieving sustainable development, has not been adequately examined within the national context. Accordingly, this section adopts the theoretical foundation of grounded theory to identify system-based needs for the effective development of digital accounting aligned with future software services. Second, regarding the outcome, the study is classified as developmental. From an epistemological standpoint, the focus on a single central phenomenon enables conceptual integration and contributes to the refinement of existing theoretical structures. Moreover, the study partially addresses the lack of conceptual coherence identified in previous research, thereby supporting the advancement of future studies in this area. Third, with respect to the data type, this research employs a mixed-methods approach, implementing both inductive and deductive reasoning to achieve the study's objectives. In the inductive phase, grounded theory and Delphi analyses are used to explore the systemic mechanisms underlying the central phenomenon, based on expert interviews and checklist-based evaluations. In the deductive phase, analytical matrices and uncertainty checklists are utilized to map prospective scenarios. An overview of this implementation process is illustrated in Figure 4.

In summary, following the expert interviews and Delphi analysis, linkage matrices were developed based on the mean values and consensus coefficients. These matrices were constructed using ordinal values of "1," "2," and "3," representing the strength and direction of impact relationships among the driving themes. By identifying the inputs and outputs, these relationships form the basis for constructing the MICMAC matrix. The MICMAC analysis classifies themes according to their influence and dependence, with those positioned in the independent quadrant serving as the foundation for scenario analysis. Each theme in this quadrant is then characterized in three potential states—"positive," "neutral," and "critical"—to establish the uncertainty checklist. Subsequently, a cross-impact matrix is developed to identify the relationships among these themes and to distinguish desirable, stable, and critical scenarios. Finally, each scenario is articulated through a detailed descriptive statement that outlines its defining characteristics and implications.

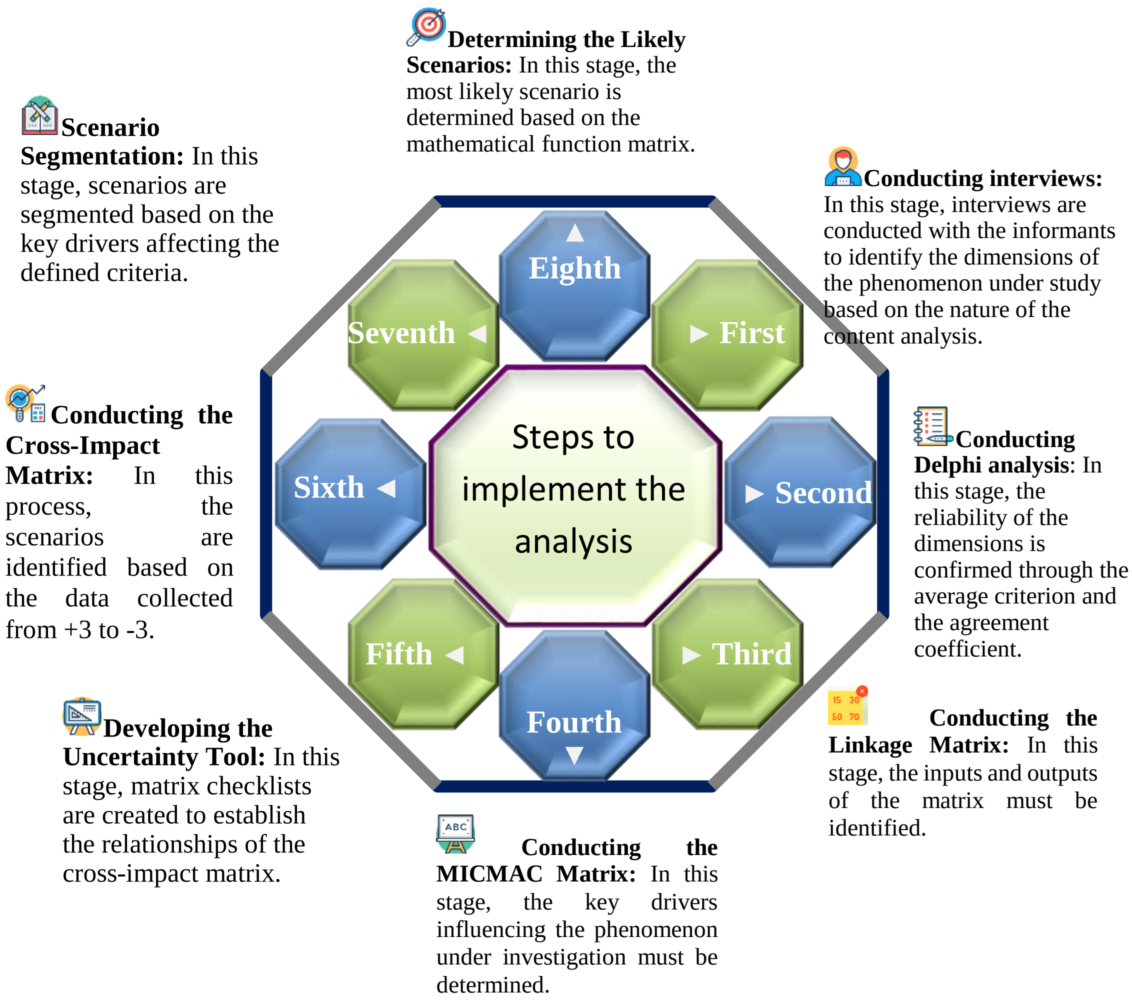

Figure 4. Overview of analytical implementation processes

3.1. Participants of the study

Given the mixed-methods design of this study, participants in the qualitative phase comprised experts in the field of accounting—particularly those with in-depth knowledge of systemic and software-related aspects of accounting practice. The sampling process combined purposive and snowball techniques. Data collection through interviews continued until theoretical saturation was achieved, meaning that no new concepts or relationships emerged from the data. During theoretical sampling, interviews were conducted iteratively to ensure that the primary themes were fully saturated. In the snowball sampling stage, additional participants were identified through referrals provided by initial interviewees. Expert selection was guided by the criteria of relevance, differentiation power, and contextual awareness, as well as interpretive understanding, following the recommendations of Henwood and Pidgeon (1992). The objective was to recruit experts with substantial theoretical knowledge and prior research experience in domains related to the central phenomenon under investigation. Accordingly, 14 experts meeting these criteria were interviewed, each demonstrating a high level of interpretive and analytical capability.

In the quantitative section of the present study, 23 financial managers and accountants with experience in capital market companies, who had a solid understanding of accounting system software, were selected through purposive and convenience sampling methods. The limited number of participants in this section was determined based on the guidelines for conducting system representation analysis, which, due to the number and complexity of participation processes, recommend an optimal range of 15 to 30 participants according to studies by Northcutt and McCoy (2004), Davis (2019), and Behling et al. (2022).

3.2. Data collection process of the study

The section below describes the study's data collection tools and provides a separate interpretation of each aspect of the analytical implementation process.

a) Data collection method based on Grounded Theory

As outlined in the methodology of this study, due to the lack of coherent and integrated dimensions related to this phenomenon, grounded theory and expert interviews were employed. Glaser's (1992) emergent approach to grounded theory analysis was applied in this process. After each interview, open, axial, and selective coding were performed sequentially. In this approach, the theory emerges from within the phenomenon under study, and researchers do not begin with rigid assumptions about the issue being investigated. Instead, they conduct in-depth and semi-structured interviews based on fragmented theoretical literature until theoretical saturation is achieved. A key feature of the emergent grounded theory strategy is that data analysis and coding occur concurrently with the interview process (Kalalian Moghadam et al., 2020).

After the initial themes emerged from open coding, the interviews continued in both semi-structured and structured formats to differentiate components within broader categories until theoretical saturation was reached. It is important to note that during the interviews, the questions were continuously refined based on the interview conditions and the experts' responses, ensuring that the data coding process remained aligned with the main flow of the phenomenon under study. According to the interview protocol, open-ended questions were asked iteratively with the experts. At the end of each interview, efforts were made to categorize similar open codes within a single component in the first classification layer. Subsequently, through axial coding, similar components were grouped into higher-level categories. A critical point in this process was the scientific consideration of the timing for completing the interviews. For this purpose, the theoretical saturation procedure was applied—after each interview, open coding and, to some extent, axial coding were conducted to identify emerging concepts and overlaps, thereby clarifying the categorization of components and categories within a theoretical framework. By combining data collection methods, including unstructured and semi-structured interviews, theoretical notes were taken during and immediately after each interview to ensure the reliability of the identified themes. This approach helped minimize potential coding bias resulting from the interviewers' mental preparedness from prior sessions. Through this process, 14 interviews were conducted. Theoretical saturation was approximately achieved after the eighth interview due to the depth of responses. Subsequent interviews focused on balancing and validating the identified codes through additional semi-structured discussions. By the fourteenth interview, it became evident that no new or divergent concepts were emerging. Accordingly, data collection was concluded, and axial and selective coding were initiated.

b) Implementation process of Delphi Analysis in determining reliability and consensus Thresholds for key themes

Once the main themes derived from the core phenomenon in the grounded theory analysis were identified, fuzzy Delphi analysis was employed to assess the reliability of the dimensions identified in the qualitative phase. Given the matrix-based nature of the quantitative analysis in this study, the use of fuzzy Delphi analysis provided a more practical approach for measuring reliability. Due to its reliance on fuzzy linguistic scales, this method offers strong validity for generalizing the identified criteria to the study context. Therefore, fuzzy analysis was applied to determine reliability, taking into account the potential dispersion of theoretical perceptions regarding the dimensions identified in the qualitative process. The Triangular Fuzzy Number (TFN) scale, which incorporates linguistic criteria, was utilized in this analysis.

c) Implementation process of scenario development

As a foresight-oriented research technique, scenario development commonly employs matrix-based methods to identify the key driving forces that emerge from the initial exploration of the studied phenomenon. Accordingly, the linkage matrix is applied to determine the principal drivers derived from the components identified in the qualitative phase of the study. During the pairwise comparison process—where each relationship between row i and column j is examined—the relative position and influence of each main theme are established. These relationships are then represented in the MICMAC matrix, as illustrated in Figure 5.

Indicating Output (Influence Power)	*Independent Quadrant**	Linkage Quadrant
	Autonomy Quadrant	Dependent Quadrant
	Indicating Input (Dependency Power)	

Figure 5. MICMAC reference matrix

As illustrated, the MICMAC matrix comprises four quadrants formed by the intersection of two indicators: output (influence power) and input (dependency power). Each key component is positioned within the matrix based on the pairwise comparison of row i and column j in the linkage matrix, which determines its relative level of influence and dependence. According to participants' scores in the matrix checklists, two key components located in the independent quadrant were identified as the primary drivers of the central phenomenon under investigation. Subsequently, an uncertainty questionnaire was developed using the values "+3," "0," and "–3," representing the "positive," "neutral/constant," and "negative" states, respectively. This instrument served as the foundation for constructing the uncertainty matrix, which facilitated the identification of potential scenarios for the future development of effective digital accounting services within Iran's software service industry.

3.3. Data validation process

Since the first phase of this study aims to identify the legitimacy mechanisms of digital accounting systems with an emphasis on the development of software services in Iran, it is essential to validate the collected data to ensure that the identified dimensions of the framework can be appropriately generalized to the study context. To achieve this, the triangulation method was employed in this phase of the research. The validation process evaluated the robustness of the identified constructs across four dimensions: data source triangulation, researcher triangulation, methodological triangulation, and theoretical triangulation. Establishing these four forms of validation enhances the credibility and trustworthiness of the generated codes, thereby ensuring their suitability for expansion in the second phase of the study and minimizing potential interviewer bias. The results presented below illustrate the degree of data validity derived from the interview findings within the thematic analysis process.

Triangulation of data sources: The objective of this triangulation component was to engage knowledgeable individuals who possessed both theoretical and practical expertise related to the central phenomenon. At this stage, a multi-stage expert selection process was implemented to ensure the participation of individuals with higher levels of subject-matter awareness. Consequently, this triangulation dimension was confirmed in terms of content alignment, verifying that the selected participants were well-suited to contribute meaningfully to the study's objectives.

Triangulation of researcher collaborators: This triangulation dimension aimed to assess the credibility of the generated codes through peer evaluation. In this study, efforts were made to validate the analytical sequence of the data coding process by engaging other faculty members and doctoral students who had previously conducted, or were currently conducting, similar research. The feedback received from these peer reviewers confirmed the consistency and rigor of the coding procedures employed in this study.

Triangulation of methods: This triangulation dimension aimed to assess how theoretical saturation was achieved during the interview process. By comparing the coding procedures of this study with those reported in previous qualitative research, the methodological implementation was validated.

Triangulation of Theory: This triangulation dimension established the linkage between key components and structural categories, facilitating the transition from axial to selective coding. Adherence to grounded theory principles in defining justifiable titles during the selective coding phase ensured theoretical consistency. Consequently, the validity confirmed through this form of triangulation provided a solid foundation for content alignment and reinforced the conceptual integrity of the emerging framework.

4. **Findings**

In this study, the findings are presented separately according to the type of analysis employed in data collection and interpretation.

In the first part, grounded theory analysis was conducted in alignment with the data collection process and the methodological framework. To this end, three stages of coding—open, axial, and selective—were carried out to identify the dimensions of the phenomenon under investigation and to develop the corresponding theoretical framework. Based on the data obtained from the interviews, Table 2 presents the results of this three-stage coding process, illustrating the progression from initial concepts to core categories.

Table 2. Legitimacy mechanisms of digital accounting based on the development of software services

Main Codes **Open Coding** **Conceptual Themes**	**Axial Coding** **Core Components**	**Selective coding categories**	**Theoretical Codes** **Main class**
Estimation of Annual Human Resources Premiums Estimation of Fair Overtime Hours for Human Resources Estimation of Continuous and Non-continuous	Systemic mechanisms related to wages and salaries	The system needs within the accountin	The legitimacy of digital accountin g based on the

Benefits for Human Resources		
Estimation of Base Seniority for Human Resources		
Estimation of Legal Deductions for Human Resources		
Planning for Selecting an Investment Plan and Project	Systemic mechanisms related to financial planning	
Planning for Resource Budgeting and Avoiding Redundancy		
Planning for Securing Required Financial Resources		
Planning for Optimal Allocation of Financial Resources to Projects and Plans		
Planning for Determining the Capital Recovery Period		
Planning for Managing the Execution Costs of Projects and Plans		
Determining the Inventory Needed for the Production Line According to the Scheduled Program	Systemic mechanisms related to the supply chain	Systemic needs of competitive strategies of the accounting unit
Determining the Reserve of Raw Materials for Production		
Determining the Costs Related to Securing Inventory from Order to Warehouse Entry		
Determining the Inventory Turnover Based on Logistical Assessment		
Determining the Overhead Costs from the Supply Chain to the Production Line		
Determining the Relative Expiration of Inventory through Data Mining (DEA)		
Access to Customer Hierarchy from Wholesale to Retail in the Customer Tab	Systemic mechanisms related to customers	
Quick Access to Categorized Customer Invoices		
Access to Customer Categories Based on Type of Service and Product Requests		
Access to Customer Prepayments and Service Sequences for Customers		
Access to Customer Purchase Orders and Categorizing Customers Based on Service and Product Types		
Estimating Net Profit Margin in Company Financial Strategies	Systemic mechanisms related to profitability	Accounting unit infrastructure system needs
Estimating Operating Profit Margin in Company Financial Strategies		
Estimating Return on Equity in Company Financial Strategies		
Estimating Return on Assets in Company Financial Strategies		
Estimating Owner's Return on Company Financial Strategies		
Evaluating Tax Exemptions	Systemic mechanisms related to evaluation	
Evaluating Payable Taxes		
Evaluating the Progress of Investment Projects and Plans		
Evaluating the Revenues from the Implementation of Investment Projects and Plans		
Evaluating Market Conditions for Determining Competitive Strategies		
Evaluating Competitors in Terms of Financial Efficiency		

Through the three-stage coding process conducted via expert interviews, three main categories were identified. These categories were developed to ensure conceptual alignment with the fragmented theoretical foundations related to the studied phenomenon. The definitions and descriptions of each category are briefly summarized in Table 3, as presented below.

Table 3. Definitions of main categories

Identified Categories	Definition
Intra-structural Systemic Needs of the Accounting Unit	The first category encompasses a set of systemic processes embedded within the organizational structure of accounting units. Considering the potential of digital accounting systems to leverage business services offered by financial software providers, this category focuses on enhancing the integration and utilization of accounting software for functions such as payroll calculations and financial planning. Strengthening these processes contributes to the formulation of future corporate strategies related to financial policies and market positioning. On one hand, this category promotes dynamism and balance in payroll management—particularly in the estimation of insurance liabilities and other legally mandated benefits. On the other hand, it stabilizes corporate financial planning through the efficient allocation of resources, the selection of investment projects, and the determination of payback periods within a coherent systemic framework.
Strategic Systemic Needs of the Accounting Unit	The second category encompasses a set of systemic processes related to the competitive strategies of accounting units. Drawing on the needs assessment of digital accounting in utilizing business services offered by financial software vendors, this category assists companies in formulating operational strategies aimed at expanding market share—both in sourcing raw materials for production and in reaching a broader customer base. Within this systemic process, firms typically establish supply chain mechanisms to monitor inventory levels, safety stock, and turnover rates up to the production line. This continuous cycle within the digital accounting system helps prevent excessive holding costs and ensures efficient resource management. Furthermore, in the customer domain, the digital accounting needs assessment emphasizes developing analytical capabilities that distinguish between major and minor clients and identify discrepancies in sales invoices. These analytical functions can be further enhanced through advanced software tools integrated into future business service platforms.
Extra-structural Systemic Needs of the Accounting Unit	The third category encompasses a set of systemic processes related to the extra-structural functions of accounting units. This category addresses the informational needs of stakeholders—from institutional and investment perspectives—by providing insights into corporate profitability and financial performance evaluation. With respect to profitability mechanisms, digital accounting needs assessments seek to deliver comprehensive reports that incorporate key financial ratios as supplementary information for stakeholder decision-making, leveraging future advancements in financial software. Regarding performance evaluations, the findings highlight that business services offering digital accounting solutions should provide integrated reports—complementary to financial statements—that assess corporate performance from tax, investment, project, and market competitiveness perspectives. Such accessible reporting enhances the company's transparency and can improve its credit rating with regulatory authorities.

Based on the definitions presented in Table 3, the identification of the main themes derived from open coding, the components obtained through axial coding, and the categories identified in selective coding led to the development of a multidimensional framework describing the systemic legitimacy mechanisms of digital accounting in relation to the development of software services in Iran.

According to the theoretical framework of the study (Figure 6), this framework comprises three categories, six components, and 33 conceptual themes. As shown in Table 4, the distribution and frequency percentages associated with the three-stage coding process are specified.

After identifying the qualitative aspects of the study and determining the frequency distribution for each dimension of the central phenomenon, the next step involved applying the fuzzy Delphi method to assess the reliability of the identified core components. The Delphi analysis served as a bridge connecting the qualitative and quantitative phases of the research. Evaluating the reliability of the dimensions within the developed model enabled the formulation of research instruments for the target population in the quantitative phase. In this study, the fuzzy Delphi analysis was employed to verify the reliability of the primary components of the proposed model. To conduct this analysis, triangular fuzzy numbers (TFN) were utilized, based on a five-point linguistic scale, as presented in Table 5.

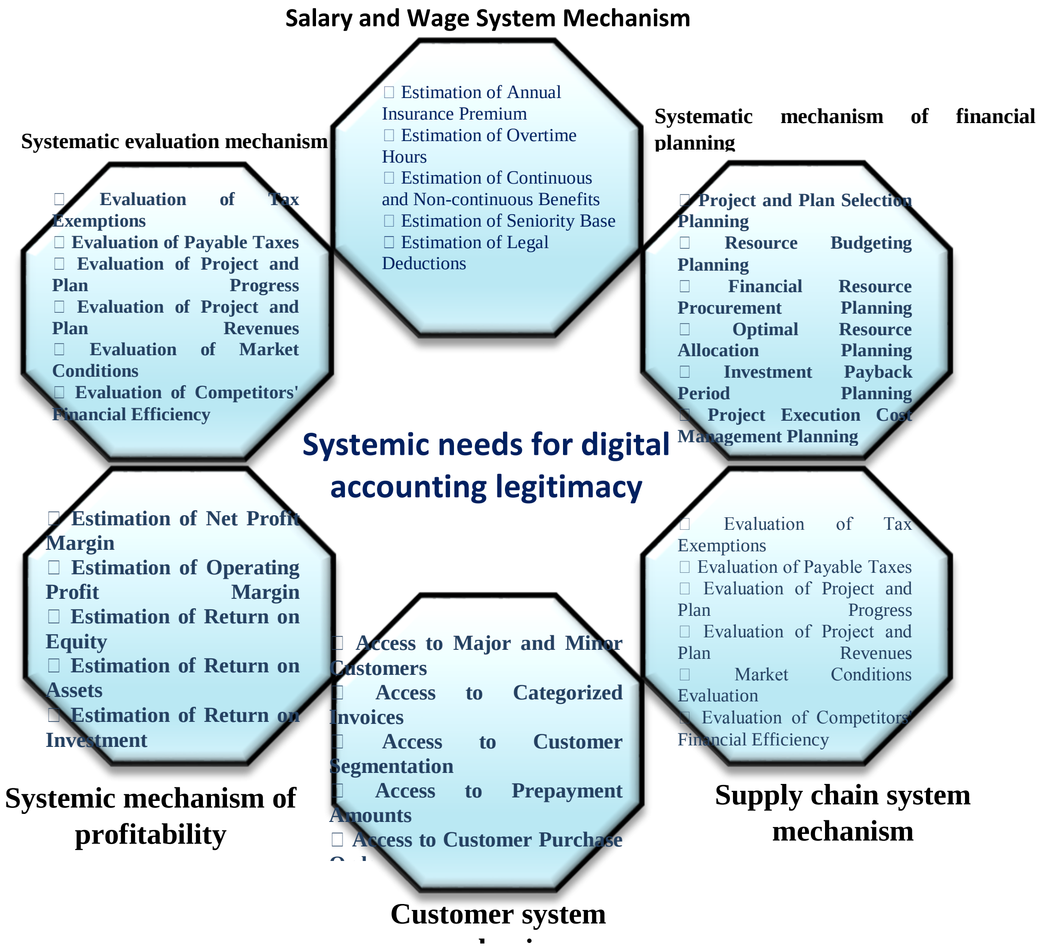

Figure 6. The framework of digital accounting legitimacy mechanisms based on software service development (Source: Research findings)

Table 4. Breakdown of codes generated from conducted interviews

Identified Categories	Identified Components	Identified Themes	Number of Open Codes	Frequency Percentage
Intra-structural Systemic Needs of the Accounting Unit	Systemic Mechanisms Related to Payroll	5	92	32.62%
	Systemic Mechanisms Related to Financial Planning	6		
Strategic Systemic Needs of the Accounting Unit	Systemic Mechanisms Related to the Supply Chain	6	103	36.52%

Extra-structural Systemic Needs of the Accounting Unit	Systemic Mechanisms Related to Customers	5	87	30.86%
	Systemic Mechanisms Related to Profitability	5		
	Systemic Mechanisms Related to Evaluation	6		
Column Total	Six Identified Components	33	282	100%

Table 5. Triangular fuzzy numbers scale

Linguistic Scale	Linguistic Expressions	Fuzzy Numbers U	M	L
1	Very High	10	7	9
3	High	9	7	5
5	Medium	7	5	3
7	Low	5	3	1
9	Very Low	3	1	0

Subsequently, an appropriate fuzzy scale was developed to collect and evaluate experts' opinions, which were expressed and recorded in fuzzy linguistic terms. In this method, experts typically articulate their judgments using three parameters—the minimum value, the most likely value, and the maximum value—represented as triangular fuzzy numbers (TFNs). In the next step, the experts' opinions were aggregated using the fuzzy averaging method, which consolidates the individual assessments into a single representative value. The fuzzy average of n triangular fuzzy numbers—reflecting the aggregated opinions of n experts—is calculated according to Equation (1).

$$F_{AVE} = \left(\frac{\sum l}{n}, \frac{\sum m}{n}, \frac{\sum u}{n}\right) \quad \text{Equation (1)}$$

Following the fuzzy aggregation of experts' opinions, a defuzzification process was performed to obtain a crisp value for each indicator. In other words, this step converts the aggregated fuzzy values into definitive numerical representations that reflect the collective judgment of the experts. To achieve this, the defuzzification formula presented in Equation (2) was applied.

$$DF_{ij} = \frac{\lfloor (u_{ij} - l_{ij}) + (m_{ij} - l_{ij}) \rfloor}{3} l_{ij} \quad \text{Equation (2)}$$

According to Equation (2), i denotes the number of experts, and j represents the number of evaluation criteria. The parameters, u_{ij}, m_{ij}, and l_{ij} correspond to the minimum, most probable, and maximum evaluation values for the j-th criterion, respectively. In the final stage of the analysis, a tolerance threshold was applied to filter and confirm the influential indicators. Consistent with the approach adopted by Boluo et al. (2019), this study employed a threshold value of 0.7. The determination of the threshold level may vary across studies, depending on the analytical design and researchers' methodological perspectives. In the present study, a defuzzified value equal to or greater than 0.7 was considered acceptable, while values below 0.7 were excluded from the final model.

Table 6. Reliability derived from fuzzy delphi analysis

Core Components	Abbreviation	u	m	l	Defuzzified Value (Mean)	Outcome
Systematic mechanisms related to wages	X_1	0.830	0.780	0.690	0.740	Approved
Systematic mechanisms related to financial planning	X_2	0.860	0.810	0.730	0.770	Approved
Systematic mechanisms related to the supply chain	X_3	0.900	0.860	0.780	0.820	Approved

Systematic mechanisms related to customers	X_4	0.870	0.830	0.740	0.780	Approved
Systematic mechanisms related to profitability	X_5	0.920	0.880	0.810	0.820	Approved
Systematic mechanisms related to evaluation	X_6	0.890	0.850	0.770	0.800	Approved

Based on the defuzzified sectional means of each dimension derived from the research framework— all exceeding the threshold value of 0.7—it was determined that the identified qualitative dimensions possess sufficient reliability for further analysis. Accordingly, these validated dimensions were extended to the systematic representation evaluation in the quantitative phase of the study. Subsequently, and in line with the study's second research question, the foresight analysis was applied to identify the key driving forces, as presented in Table 7, using the linkage matrix. This matrix operates along contextual axes, where its input and output relationships are used to determine the relative influence of each driving factor. In this framework, the directional arrows represent the flow of influence between components: an arrow pointing to the right (⟶) indicates the direct influence of the core component in row i on column j, whereas an arrow pointing to the left (⟵) denotes the reverse influence of the core component in row j on row i.

Table 7. Implementation of the bond matrix process

Row indicator	$j \leftarrow i$ ←	$j \rightarrow i$ →	$j \neq i$ ⃠	Column indicator	Frequency
Level 1 / Bonding relationships of system mechanisms related to wages and salaries with other criteria					
System mechanisms related to wages and salaries	-	→	-	System mechanisms related to financial planning	20
System mechanisms related to wages and salaries	-	-	⃠	System mechanisms related to the supply chain	19
System mechanisms related to wages and salaries	-	-	⃠	System mechanisms related to customers	16
System mechanisms related to wages and salaries	←	-	-	System mechanisms related to profitability	18
System mechanisms related to wages and salaries	-	-	⃠	System mechanisms related to evaluation	19
Level 2 / Bonding relationships of system mechanisms related to financial planning with other criteria					
System mechanisms related to financial planning	-	→	-	System mechanisms related to the supply chain	19
System mechanisms related to financial planning	←	-	-	System mechanisms related to customers	19
System mechanisms related to financial planning	←	-	-	System mechanisms related to profitability	21
System mechanisms related to financial planning	-	→	-	System mechanisms related to evaluation	20
Level 3 / Bonding relationships of system mechanisms related to the supply chain with other criteria					
System mechanisms related to the supply chain	-	→	-	System mechanisms related to customers	18
System mechanisms related to the supply chain	←	-	-	System mechanisms related to profitability	17
System mechanisms related to the supply chain	←	-	-	System mechanisms related to evaluation	19
Level 4 / Bonding relationships of system mechanisms related to customers with other criteria					
System mechanisms related to customers	-	→	-	System mechanisms related to profitability	19
System mechanisms related to customers	←	-	-	System mechanisms related to evaluation	20
Level 5 / Bonding relationships of system mechanisms related to profitability with other criteria					

System mechanisms related to profitability	-	→	-	System mechanisms related to evaluation	19

The results of the bond (linkage) matrix, derived from the pairwise comparisons, are presented in Table 7. Considering the frequency of responses from participants in the quantitative phase, these results provided the input–output structure of the central phenomenon, as shown in Table 8, which served as the foundation for constructing the MICMAC matrix. The frequency scores indicate the degree of consensus among participants for each pairwise comparison, reflecting the strength and direction of relationships between the variables positioned in the rows and columns of Table 8.

Table 8. Inputs and outputs of pairwise evaluation of core components

Core Components	Abbreviation	X_1	X_2	X_3	X_4	X_5	X_6	Output	Input
System mechanisms related to wages and salaries	X_1	0	←	–	–	↑	–	1	1
System mechanisms related to financial planning	X_2	↑	0	←	↑	↑	←	3	2
System mechanisms related to the supply chain	X_3	–	↑	0	←	↑	↑	3	1
System mechanisms related to customers	X_4	–	←	↑	0	←	↑	2	2
System mechanisms related to profitability	X_5	←	←	←	↑	0	←	1	4
System mechanisms related to evaluation	X_6	–	↑	←	←	↑	0	2	3

As presented in Table 8, the output values indicated by the upward arrow (↑, purple) and the input values indicated by the leftward arrow (⟵) were identified and classified. Based on these results, the relative placement of each evaluated contextual axis is illustrated in Figure 7. Within the MICMAC matrix, the output values derived from the pairwise comparison represent the driving power of the variables, whereas the input values correspond to their dependency power. This relationship enables the identification of key driving and dependent factors shaping the systemic structure of the phenomenon under study.

	Linking Quadrant		**Independent Quadrant**		
4					**Influence Power** (Total score of paired evaluation outputs)
3			X_2	X_3	
2		X_6	X_4		
1	X_5			X_1	
	4	3	2	1	
	Dependent Quadrant		**Autonomous Quadrant**		
	Dependency Power (Sum of Pairwise Comparison Input Scores)				

Figure 7. MICMAC matrix

By positioning each core component within the four quadrants of the MICMAC matrix, it was determined that two components—systemic mechanisms related to payroll systems (X_1) and systemic mechanisms related to customer management (X_4)—are located in the autonomous quadrant. These components exert minimal influence on other variables and are, in turn, only marginally affected by them. Conversely, systemic mechanisms related to evaluation systems (X_6) and systemic mechanisms related to profitability (X_5) fall within the dependent quadrant, indicating a higher level of susceptibility to external influence. These dimensions tend to vary in response to changes in the components situated within the independent quadrant. Finally, two pivotal components—systemic mechanisms related to financial planning (X_2) and systemic mechanisms related to the supply chain (X_3)—occupy the independent quadrant, signifying strong influence over other variables within the system. These components were therefore identified as the key driving forces and serve as the foundation for scenario analysis. From the perspective of digital accounting legitimacy and the evolution of software services, these two core components highlight that the future trajectory of digital accounting will likely depend on the development of AI-driven financial programs, surpassing the capabilities of existing operational software systems.

Table 9. Redefinition of key drivers influencing the core phenomenon

Core Components	Conceptual Themes	Core Components	Conceptual Themes
Systemic mechanisms related to financial planning (X_2)	Planning for the selection of an investment plan or project	Systemic mechanisms related to the supply chain (X_3)	Determining the required inventory for the production line according to the scheduled plan
	Planning for resource budgeting to prevent redundancies		Determining the safety stock level of raw materials for production
	Planning to secure necessary financial resources		Determining the costs associated with inventory procurement, from ordering to warehouse entry
	Planning for the optimal allocation of financial resources to plans and projects		Determining inventory turnover rates based on logistical evaluations
	Planning to determine the payback period		Determining overhead costs from the supply chain to the production line
	Planning to manage the implementation costs of plans and projects		Determining the relative expiration rate of inventory through data mining (data envelopment analysis)

Table 10. Delphi analysis process for determining the reliability of key influential criteria

		(First Delphi Round)		(Second Delphi Round)		
	Core Themes	**Mean**	**Agreement Coefficient**	**Mean**	**Agreement Coefficient**	**Result**
Supply Chain Systemic Mechanisms	Determining the required inventory for the production line according to the scheduled plan	10.6	85.0	30.6	90.0	Confirmed
	Determining the safety stock level of raw materials for production	40.5	70.0	60.5	77.0	Confirmed
	Determining the costs associated with inventory procurement, from ordering to warehouse entry	00.6	80.0	10.6	85.0	Confirmed
	Challenges related to the fair value assessment of cryptocurrencies	00.4	40.0	Removed		
	Determining overhead costs from the supply chain to the production line	40.5	70.0	60.5	77.0	Confirmed
	Determining the relative expiration rate of inventory through data mining (data envelopment analysis)	50.5	70.0	00.6	80.0	Confirmed
Financial Planning	Planning for the selection of an investment plan or project	15.6	88.0	30.6	94.0	Confirmed

Systemic Mechanisms	Planning for resource budgeting to prevent redundancies	30.5	65.0	50.5	70.0	Confirmed
	Planning to secure necessary financial resources	15.5	60.0	35.5	67.0	Confirmed
	Planning for the optimal allocation of financial resources to plans and projects	30.5	65.0	50.5	70.0	Confirmed
	Planning to determine the payback period	50.5	75.0	00.6	80.0	Confirmed
	Planning to manage the implementation costs of plans and projects	50.3	35.0	Removed		

These AI-driven programs will need to accurately shape future financial supply chains through effective and adaptive financial planning. Given that the two identified components—systemic mechanisms related to financial planning (X_2) and systemic mechanisms related to the supply chain (X_3)—represent the most influential factors in establishing the legitimacy of digital accounting through software service development, the next stage of the research involves addressing the second research question through scenario development.

As outlined in Table 9, each conceptual theme related to these key components was redefined to construct the uncertainty questionnaire. To ensure the generalizability of these dimensions within the study context, the reliability of the conceptual themes—in alignment with their corresponding core components—was reassessed using the classical Delphi method. The results of this analysis, presented in Table 10, are based on two validation criteria: the mean value and the agreement coefficient.

Based on the findings of the two-stage Delphi analysis, which examined the reliability of the conceptual themes associated with the core components, out of twelve criteria proposed for scenario analysis, two were eliminated, while ten criteria (five per core component) were confirmed. Subsequently, as shown in Table 11, each conceptual theme was defined under three possible states—Positive, Neutral/Stable, and Negative—to facilitate the design of the uncertainty questionnaire. This questionnaire then serves as the foundation for the cross-impact matrix analysis, which identifies and structures potential future scenarios.

Table 11. Definition of possible states of key practical components

Core Components	Conceptual Themes	State	State name
System Mechanisms Related to Supply Chain "X_3"	Determining the inventory level required for the production line according to the schedule "X_3^1"	X_3^{11}	Legitimacy of digital accounting based on leveraging computational capacities to determine the production line's required inventory.
		X_3^{12}	Neutrality of the impact of leveraging software-based calculations of inventory required for the production line on the legitimacy of digital accounting**.**
		X_3^{13}	Insignificance of software-based calculations of inventory required for the production line on the legitimacy of digital accounting**.**
	Determining the safety stock level for raw materials for production "X_3^2"	X_3^{21}	Legitimacy of digital accounting based on leveraging software capacities for determining the safety stock level for production inventory.
		X_3^{22}	Conditional impact of inventory management policies on leveraging software capacities for determining safety stock levels on digital accounting.
		X_3^{23}	Neutrality of the impact of leveraging software capacities for determining the safety stock level on digital accounting**.**
	Determining the cost associated with supply inventory from order placement to warehouse entry "X_3^3"	X_3^{31}	The impact of developing software capacities in calculating inventory supply costs on the legitimacy of digital accounting.
		X_3^{32}	The appropriateness of the impact of developing software

			capacities in calculating inventory supply costs on the legitimacy of digital accounting.
		X_3^{33}	Neutrality of the impact of developing software capacities in calculating inventory supply costs on the legitimacy of digital accounting.
	Determining the overhead cost from the supply chain to the production line "X_3^4"	X_3^{41}	Conducting software-based calculations of supply chain overhead costs as an effective driver of the legitimacy of digital accounting.
		X_3^{42}	Focusing on software-based calculations of supply chain overhead costs to validate the current basis for digital accounting.
		X_3^{43}	Lack of impact of software-based calculations of supply chain overhead costs on the legitimacy of digital accounting.
	Determining the relative expiration rate of inventory through data mining "X_3^5"	X_3^{51}	The influence of data mining computations in advanced financial software for predicting inventory expiration time on the legitimacy of digital accounting.
		X_3^{52}	Appropriateness of financial policymaking in data mining computations for predicting inventory expiration time on the legitimacy of digital accounting.
		X_3^{53}	Neutrality of the impact of data mining computations in advanced financial software for predicting inventory expiration time on the legitimacy of digital accounting.
System Mechanisms Related to Financial Planning "X_2"	Planning for the selection of an investment project or scheme "X_2^1"	X_2^{11}	Strengthening software capabilities in selecting investment projects as the basis for the legitimacy of digital accounting.
		X_2^{12}	Conditional reliance on software capabilities in selecting investment projects based on appropriate financial support as the basis for the legitimacy of digital accounting.
		X_2^{13}	Neutrality of the impact of software capabilities in selecting investment projects as the basis for the legitimacy of digital accounting.
	Planning for resource budgeting and preventing redundancies "X_2^2"	X_2^{21}	Strengthening software capabilities in resource budgeting as the basis for the legitimacy of digital accounting.
		X_2^{22}	Conditional reliance on software capabilities in resource budgeting based on appropriate financial support as the basis for the legitimacy of digital accounting.
		X_2^{23}	Neutrality of the impact of software capabilities in resource budgeting as the basis for the legitimacy of digital accounting.
	Planning for the provision of required financial resources "X_2^3"	X_2^{31}	Strengthening software capabilities in forecasting the provision of required financial resources as the basis for the legitimacy of digital accounting.
		X_2^{32}	Conditional reliance on software capabilities in estimating the provision of required financial resources based on high financial leverage is the basis for the legitimacy of digital accounting.
		X_2^{33}	Neutrality of the impact of software capabilities in estimating the provision of required financial resources as the basis for the legitimacy of digital accounting.
	Planning for optimal allocation of financial resources to projects and schemes "X_2^4"	X_2^{41}	Developing software capabilities for optimal allocation of financial resources to investment projects as the basis for the legitimacy of digital accounting.
		X_2^{42}	Neutrality of the development of software capabilities for optimal allocation of financial resources to investment projects as the basis for the legitimacy of digital accounting.
		X_2^{43}	Lack of impact of developing software capabilities for optimal allocation of financial resources to investment projects as the basis for the legitimacy of digital accounting.
	Planning to determine the investment payback period "X_2^5"	X_2^{51}	Developing software capabilities for forecasting the investment payback period as a practical function of digital accounting.
		X_2^{52}	Conditional reliance on software capabilities on managerial ability in forecasting the investment payback period as a practical function of digital accounting.
		X_2^{53}	Neutrality of the impact of software capabilities in forecasting the investment payback period as a practical function of digital accounting.

By defining the potential states of each foundational theme under three conditions—Positive, Neutral/Stable, and Negative—a total of 30 evaluable scenarios were generated. Subsequently, experts were asked to complete a 30 × 30 uncertainty matrix questionnaire, specifying the relationship between each state according to three attributes: Reinforcing, Neutral, and Constraining, using a scale ranging from +3 to −3. The completed matrix was processed using the Scenario Wizard software to identify the most probable and internally consistent scenarios. This software performs complex calculations on the interrelationships among the identified drivers, allowing the extraction of a spectrum of scenarios characterized by varying levels of probability and internal coherence—namely, high-probability, possible, and high-consistency scenarios. Within this analytical framework, the Mode index—defined as the most frequently assigned score by experts—was used as the primary criterion for determining the dominant patterns within the cross-impact structure. The aggregated data sets were then entered into the Scenario Wizard for processing. Accordingly, this analytical technique in scenario planning facilitates the identification of a comprehensive range of potential futures based on the structured matrix relationships among the key drivers. Table 12 presents the uncertainty matrix questionnaire used for the cross-impact evaluation of the key influencing drivers.

Table 12. Mutual evaluation matrix checklist

	X_2^{11}	X_2^{12}	X_2^{13}	X_2^{21}	X_2^{22}	X_2^{23}	X_2^{31}	X_2^{32}	X_2^{33}	…	…	…	X_3^{41}	X_3^{42}	X_3^{43}	X_3^{51}	X_3^{52}	X_3^{53}
X_2^{11}				☐	☐	☐	☐	☐	☐	⋮	⋮	⋮	☐	☐	☐	☐	☐	☐
X_2^{12}				☐	☐	☐	☐	☐	☐	⋮	⋮	⋮	☐	☐	☐	☐	☐	☐
X_2^{13}				☐	☐	☐	☐	☐	☐	⋮	⋮	⋮	☐	☐	☐	☐	☐	☐
X_2^{21}	☐	☐	☐				☐	☐	☐	⋮	⋮	⋮	☐	☐	☐	☐	☐	☐
X_2^{22}	☐	☐	☐				☐	☐	☐	⋮	⋮	⋮	☐	☐	☐	☐	☐	☐
X_2^{23}	☐	☐	☐				☐	☐	☐	⋮	⋮	⋮	☐	☐	☐	☐	☐	☐
X_2^{31}	☐	☐	☐	☐	☐	☐				⋮	⋮	⋮	☐	☐	☐	☐	☐	☐
X_2^{32}	☐	☐	☐	☐	☐	☐				⋮	⋮	⋮	☐	☐	☐	☐	☐	☐
X_2^{33}	☐	☐	☐	☐	☐	☐				⋮	⋮	⋮	☐	☐	☐	☐	☐	☐
⋮	…	…	…	…	…	…	…	…	…				…	…	…	…	…	…
⋮	…	…	…	…	…	…	…	…	…		⋰		…	…	…	…	…	…
⋮	…	…	…	…	…	…	…	…	…				…	…	…	…	…	…
X_3^{41}	☐	☐	☐	☐	☐	☐	☐	☐	☐	⋮	⋮	⋮				☐	☐	☐
X_3^{42}	☐	☐	☐	☐	☐	☐	☐	☐	☐	⋮	⋮	⋮				☐	☐	☐
X_3^{43}	☐	☐	☐	☐	☐	☐	☐	☐	☐	⋮	⋮	⋮				☐	☐	☐
X_3^{51}	☐	☐	☐	☐	☐	☐	☐	☐	☐	⋮	⋮	⋮	☐	☐	☐			
X_3^{52}	☐	☐	☐	☐	☐	☐	☐	☐	☐	⋮	⋮	⋮	☐	☐	☐			
X_3^{53}	☐	☐	☐	☐	☐	☐	☐	☐	☐	⋮	⋮	⋮	☐	☐	☐			

Based on the aggregate scores obtained from the cross-impact matrix, four distinct future scenarios were identified for the legitimacy of digital accounting in relation to the development of software services in Iran. These scenarios were analyzed under three evaluative conditions: Optimal, Static, and Critical. The outcomes of this analytical process are summarized in Table 13.

Table 13. Status of each basic theme based on possible scenarios

	State	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Determining the inventory level required for the production line based on the schedule "X_3^1"	X_3^{11}	-	-	Optimal State	Optimal State
	X_3^{12}	Static State	-	-	-

	X_3^{13}	-	Critical State	-	-
	X_3^{21}	-	-	Optimal State	Optimal State
Determining the safety stock level for raw materials for production "X_3^2"	X_3^{22}	Optimal State	-	-	-
	X_3^{23}	-	Static State	-	-
	X_3^{31}	-	-	Optimal State	Optimal State
Determining the cost associated with supply inventory from order placement to warehouse entry "X_3^3"	X_3^{32}	Optimal State	-	-	-
	X_3^{33}	-	Static State	-	-
	X_3^{41}	-	-	*Optimal State*	*Optimal State*
Determining the overhead cost from the supply chain to the production line "X_3^4"	X_3^{42}	*Static State*	-	-	-
	X_3^{43}	-	*Critical State*	-	-
	X_3^{51}	-	-	*Optimal State*	*Optimal State*
Determining the relative expiration rate of inventory through data mining "X_3^5"	X_3^{52}	*Optimal State*	-	-	-
	X_3^{53}	-	*Static State*	-	-
	X_2^{11}	-	-	*Optimal State*	*Optimal State*
Planning for the selection of an investment project or scheme "X_2^1"	X_2^{12}	*Optimal State*	-	-	-
	X_2^{13}	-	*Static State*	-	-
	X_2^{21}	-	-	*Optimal State*	*Optimal State*
Planning for resource budgeting and preventing redundancies "X_2^2"	X_2^{22}	*Optimal State*	-	-	-
	X_2^{23}	-	*Static State*	-	-
	X_2^{31}	-	-	*Optimal State*	*Optimal State*
Planning for the provision of required financial resources "X_2^3"	X_2^{32}	*Optimal State*	-	-	-
	X_2^{33}	-	*Static State*	-	-
	X_2^{41}	-	-	*Optimal State*	*Optimal State*
Planning for optimal allocation of financial resources to projects and schemes "X_2^4"	X_2^{42}	*Static State*	-	-	-
	X_2^{43}	-	*Critical State*	-	-
	X_2^{51}	-	-	*Optimal State*	*Optimal State*
Planning to determine the investment payback period "X_2^5"	X_2^{52}	*Optimal State*	-	-	-
	X_2^{53}	-	*Static State*	-	-

The future scenarios for the legitimacy of digital accounting in relation to the development of software services in Iran—categorized in Table 14—are defined under three primary conditions: Optimal, Static, and Critical. These conditions constitute the analytical foundation for determining the potential future configurations of the core phenomenon. The positioning of each core component within these three states enables the delineation of probable scenario paths. Accordingly, based on the distribution of the core components across these defined conditions, a total of 40 possible scenarios were identified and analyzed, as summarized in Table 14.

The results indicate that, out of 40 projected scenarios, 27 were classified as favorable, 10 as static, and three as critical. This distribution suggests that the state of digital accounting in Iran is not functionally critical, and that a relatively straightforward trajectory for the development of financial software can be outlined based on the favorable scenarios. Consequently, in shaping future perspectives on the legitimacy of digital accounting grounded in software service development, particular attention should be directed toward the two most favorable scenarios. To construct these scenarios, a two-axis matrix was developed, incorporating system mechanisms related to financial planning (X_2) and supply chain mechanisms (X_3) as the main dimensions. Using mathematical function computation techniques, four matrices were generated to evaluate the 17 conceptual themes identified within the favorable scenarios. Each participant was asked to assign a score—on a 10-point scale (ranging from 0 to 10)—to the criteria defined for these scenarios. The scenario with the highest priority was determined based on the expected value associated with each matrix score. The mathematical function scenario with the greatest weight encompassed four defined cases within the quadrants of the two-axis matrix, labeled as the Identity Scenario, Sinusoidal Scenario, Bracket Scenario, and Logarithmic Scenario. These were evaluated according to mathematical function criteria and their corresponding expected values. Considering the participation of 14 experts in the scenario development process and the 10-point scoring scale, the mode index was applied to calculate the scores for the 17 favorable base themes, as presented in Equation (1).

Table 14. Differentiation of potential states in developing future scenarios

Scenario	**Optimal State**		**Static State**		**Critical State**		**Total Scenarios**	
	Count	**Frequency %**	**Count**	**Frequency %**	**Count**	**Frequency %**	**Count**	**Frequency %**
Scenario 1	7	25.94%	3	30%	-	-	10	25%
Scenario 2	-	-	7	70%	-	-	7	17.5%
Scenario 3	10	37.03%	-	-	3	-	13	32.5%
Scenario 4	10	37.03%	-	-	-	100%	10	25%
Column Total	27	100%	10	100%	3	100%	**40**	**100%**
Row Total	27	67.5%	10	25%	3	7.5%	**40**	**100%**

$$\mathbb{E}[X] = \left[\left(\frac{1}{\mathrm{N}} \times \gamma\right)^4\right] \qquad \text{Equation (1)}$$

In this context, $\mathbb{E}[X]$ represents the expected value of the mathematical functions applied to the four matrices—Identity, Sinusoidal, Bracket, and Logarithmic. N denotes the number of participants involved in evaluating the favorable core themes, and γ indicates the frequency distribution derived from the total scores. Since the expected value (v) is calculated based on probability theory, which assesses random variable states according to the average frequency of their occurrence, the scores assigned by 23 participants to each core theme yielded an average expected value of 4.88. This result implies that the minimum expected value calculated for the matrices should be no less than 4.88.

Table 15. Determining the most significant mathematical function matrix

Scores	***Identity Scenario (Quadrant IV)***	***Bracket Scenario (Quadrant III)***	***Sinusoidal Scenario (Quadrant II)***	***Logarithmic Scenario (Quadrant I)***
	40.39	***49.75***	***51.17***	***68.56***

Expected Value	*4.92*	*5.27*	*5.11*	*5.05*
Priority Ranking	*4th*	*1st*	*2nd*	*3rd*

Based on the assigned scores, the most significant scenario in shaping the future outlook for the legitimacy of digital accounting—grounded in software service development in Iran—is the Bracket Scenario, located in the third quadrant of the matrix illustrated in Figure 8. This scenario is concisely referred to as the Amadic Scenario. To better understand the structure of this matrix, it is important to consider its two primary axes: system mechanisms related to financial planning and system mechanisms related to the supply chain. These axes constitute the foundation for constructing and interpreting the scenario framework.

Figure 8. Matrix scenarios for the future outlook on the legitimacy of digital accounting based on the development of software services

Therefore, based on this matrix and the intersections of the two primary axes, the dimensions of each scenario are presented in Table 16. An important consideration in scenario planning is the selection of descriptive titles that are conceptually aligned with the central phenomenon yet distinctive or uncommon. Such titles enhance readers' engagement and deepen their understanding of the phenomenon under study.

The explanatory descriptions provided for each scenario in Table 16 serve to conceptually align theoretical frameworks with the corresponding thematic constructs that define the scenarios. By emphasizing a distinctive title grounded in the ontological foundations of relevant theories or related terminology, these descriptions effectively convey the key evaluative dimensions of each scenario. Accordingly, the subsequent sections present a detailed account of each scenario.

- ***Arvik scenario***

Arvik—an Armenian term meaning "light"—has been selected as the explanatory title for the first-quadrant scenario, positioned at the intersection of systemic mechanisms related to financial planning and those associated with the supply chain. The rationale behind this designation lies in the idealized legitimacy of future digital accounting, grounded in software-based needs assessments. In this scenario, the future legitimacy of digital accounting depends primarily on mechanisms linked to financial software development. Through advanced analytical capabilities, such software enhances the predictability of accounting outcomes and supports the efficient allocation of financial resources for investment projects aligned with predetermined budgets. Furthermore, the advancement of AI-driven financial applications equips digital accounting systems with the capacity to evaluate a company's supply chain comprehensively—from the entry stage to the production line. Predicting inventory expiration timelines, in turn, enables firms to minimize financial costs associated with material procurement and production processes.

Table 16. Breakdown of scenarios related to the future outlook on the legitimacy of digital accounting based on software service development

Scenario Title	***Descriptive Statement***	***Evaluation Factors***
Identity Mathematical Function	*Arvik Scenario*	*- Strengthening software capabilities in forecasting required financial resources as a basis for the legitimacy of digital accounting.* *- Impact of data mining calculations in advanced financial software to predict inventory expiration, supporting digital accounting legitimacy.* *- Enhancing software capabilities for selecting investment projects as a basis for the legitimacy of digital accounting.* *- Influence of developing software capacities in calculating inventory supply costs on digital accounting legitimacy.*
Sinusoidal Mathematical Function	*Biometric Scenario*	*- Conditionality of software capabilities in budgeting resources based on appropriate financing as a foundation for the legitimacy of digital accounting.* *- Strengthening software capabilities in resource budgeting as a basis for digital accounting legitimacy.* *- Developing software capabilities for the optimal allocation of financial resources to investment projects as a foundation for digital accounting legitimacy.* *- Enhancing software capabilities in forecasting payback periods as a practical function of digital accounting.* *- Conditionality of software capabilities in selecting investment projects based on appropriate financing as a basis for digital accounting legitimacy.*
Bracket Mathematical Function	*Amadic Scenario*	*- Legitimacy of digital accounting based on leveraging computational capacities to determine the required inventory for production lines.* *- Legitimacy of digital accounting based on utilizing software capacities to determine reserve stock levels for production.* *- Performing software-based calculations of overhead supply chain costs as a significant driver for digital accounting legitimacy.* *- Necessity of financial policy alignment with data mining calculations to predict inventory expiration, reinforcing digital accounting legitimacy.*
Logarithmic Mathematical	*Neotic Scenario*	*- Software capacity development is necessary to calculate inventory supply costs on digital accounting legitimacy.*

Function	*- Conditionality of software capabilities in estimating required financial resources based on high financial leverage as a foundation for the legitimacy of digital accounting.* *- Conditional impact of inventory management policies on utilizing software capacities for determining reserve stock levels in digital accounting.* *- Dependence of software capabilities on managerial skills in predicting payback periods as a practical function of digital accounting.*

- ***Biometric scenario***

Beyond its specialized meaning in biology, the term "biometric" broadly refers to an evaluative scale that relies on measurable data for forecasting and planning purposes. This explanatory label has been adopted for the scenario situated at the intersection of strong systemic mechanisms related to financial planning and weak systemic mechanisms associated with the supply chain. The rationale for this designation stems from the envisioned legitimacy of digital accounting supported by the development of analytically capable financial software. In the future, such capabilities are expected to facilitate long-term accounting and financial planning by enabling more effective budgeting, optimized resource allocation, forecasting of investment return periods, and the selection of investment projects within the framework of dynamic financial management.

- ***Amadic scenario***

Amadic—an interpreted term meaning "logistics" in the context of the supply chain—has been selected as the title for the scenario positioned in the third quadrant, representing the intersection of weak systemic mechanisms related to financial planning and highly influential systemic mechanisms associated with the supply chain. This scenario emphasizes the computational capacities of next-generation financial software that underpin the legitimacy of digital accounting. Analytical operations in this scenario are grounded in micro-level processes, enabling artificial intelligence to assist production line managers in estimating optimal inventory levels and aligning them with precautionary reserves. Through predictive mechanisms that forecast inventory expiration timelines, overhead costs in the supply chain for raw materials can be minimized using data-mining techniques. Furthermore, improved financial policy frameworks within this scenario are expected to strengthen managerial discipline and reduce the likelihood of resource wastage.

- ***Neotic sscenario***

Neotic—meaning "logical reasoning"—has been selected as the explanatory term for the scenario located in the fourth quadrant. This quadrant represents the intersection of weak systemic mechanisms related to financial planning and the low impact of systemic mechanisms associated with the supply chain in shaping the future of digital accounting based on financial software development. The explanatory term chosen for this scenario reflects a form of pragmatic realism that balances existing capacity constraints with the analytical potential that accounting software can attain through artificial intelligence. Accordingly, the analytical requirements associated with calculating inventory supply costs and determining precautionary reserves—through effective inventory management—alongside the conditional capabilities for securing financial resources via leverage and forecasting investment return periods, can collectively help sustain the stability of digital accounting in the future while minimizing potential disruptions.

5. Discussion and conclusion

This study aimed to develop a developmental outlook for software services in achieving the legitimacy of digital accounting in Iran. Specifically, it sought to identify the future requirements of digital accounting based on AI-driven software capabilities. To accomplish this, the grounded theory methodology was employed to determine the areas of influence of systemic mechanisms within digital accounting. Through three stages of coding, 282 open codes were identified and subsequently categorized into 33 conceptual themes, six core components, and three structural dimensions, forming the foundation of the theoretical framework for digital accounting legitimacy. These categories—grouped into intra-structural, strategic, and supra-structural levels—illustrated the future needs of digital accounting in developing AI-based software services to enhance legitimacy. In the quantitative phase, using a foresight approach, the study addressed the second research question: defining the developmental trajectory of digital accounting legitimacy based on software service advancement in Iran. Scenario-planning analyses identified four distinct scenarios, as detailed in the findings section. Among these, the mathematical function matrix revealed that the most probable pathway for achieving digital accounting legitimacy—through the development of AI-driven software services—was represented by the third-quadrant scenario, designated by the explanatory term "Amadic."

In interpreting this scenario, the operational logistics capabilities of digital accounting are deemed essential for achieving legitimacy through the future development of software-based services. These capabilities enhance computational efficiency in managing inventory and production line resources. By enabling such functions, digital accounting systems can effectively forecast precautionary reserves, reducing the risk of spoilage or expiration of raw materials and minimizing future financial costs associated with the supply chain. Within this framework, practical legitimacy in digital accounting requires software systems that, unlike earlier generations of financial service providers, can conduct operational calculations while simultaneously offering strategic guidance for financial policymaking units. Such systems improve supply chain forecasting in today's competitive capital markets, allowing firms to undertake timely and informed actions. Consequently, the Amadic Scenario can be regarded as a pathway through which AI-driven software services achieve higher legitimacy in digital accounting. Owing to enhanced computational capacities, this scenario enables firms—particularly accounting units—to address supply chain challenges alongside traditional accounting functions. Through advanced software applications, artificial intelligence facilitates the policymaking processes necessary for accurate forecasting, thereby preventing production line disruptions under critical conditions such as energy shortages, equipment depreciation, international sanctions restricting raw material imports, and technological knowledge gaps in production operations. These measures collectively ensure the sustained efficiency of accounting functions while minimizing production overhead costs. When aligning these findings with previous research, it is noteworthy that this study focused on the practical future-oriented needs of digital accounting development. Given the rapid influence of AI on software service advancement, accounting departments within industries must proactively adapt to meet growing expectations in increasingly competitive markets. Therefore, direct comparison with prior studies is not feasible; instead, content-based analogies may be drawn with works such as Xiu et al. (2020), Gao (2024), and Pham and Vu (2022).

First, knowledge-based firms engaged in software service development are encouraged to integrate artificial intelligence into the computational and operational functions of accounting. Beyond the traditional role of recording financial events within earlier generations of management accounting information systems, future financial tools should extend their functionality beyond information disclosure. Guided by analytical needs assessments that identify higher-level functions of digital accounting, these firms should design more instrumental features for professional users and practitioners—particularly in industrial companies listed on the capital market—to strengthen the strategic capabilities of the accounting profession within a software-based framework, thereby enhancing its legitimacy in meeting informational expectations. Second, policymakers are advised to normalize the institutional focus on the legitimate functions of digital accounting and to issue regulatory guidelines that facilitate the adoption of software services across industries. Moreover, incentive policies—such as tax exemptions, export privileges, or other supportive measures—should be considered to help firms transition toward AI-based accounting systems. Finally, companies operating as financial startups should account for the current economic conditions of the country and provide software services that meet institutional standards and oversight requirements. Delivering advanced, supervised, and high-capability digital accounting tools will support companies in achieving compliance and operational efficiency within an evolving technological landscape.

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