



Future research on the Use of Python in Accounting and Financial Reporting Profession by Applying a Scenario Writing Approach

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ABSTRACT

The field of accounting and financial reporting has been subjected to fundamental changes due to the rapid development in information technology. As one of the advanced and popular programming languages with extensive capabilities in data analysis, artificial intelligence, and automation, Python plays an important role in the transformation of this profession, and in the future, it is beneficial to adopt new technological tools such as Python programming software in the accounting and financial reporting profession. Therefore, applying the future scenario writing approach provides the opportunity to examine the influence of this technology on accounting and financial reporting. The research method is mixed based on the type of data. The present study was conducted in 2023. First, 52 effective factors were identified through a study of research background and the related literature as well as interviews with 21 experts. Then key drivers were identified through a MICMAC analysis and an interpretive structural matrix. Finally, according to the experts' viewpoints, three scenarios for the future use of Python in the accounting and financial reporting profession were developed, and suggestions were given one by one. The knowledge-enhancing value of this research lies in expanding the existing theoretical foundations, identifying and analyzing the challenges, associating opportunities with the use of Python in the accounting field, and developing different scenarios to predict the future use of Python.

Keywords: Accounting and reporting ; Key drivers ; Python ; Scenario writing.



1. Introduction

The field of accounting and financial reporting has undergone fundamental changes due to the rapid developments in information technology. These developments have led to numerous changes at the micro and macro levels of the economy, which requires that information and communication technology (ICT) skills become one of the basic requirements for accounting graduates. With the digitalization of accounting which is achieved by integrating accounting and information and communication technology, traditional accounting tasks can be transformed into new responsibilities required by today's economy.

As one of the advanced and popular programming languages, with extensive capabilities in data analysis, artificial intelligence, and automation, Python plays an important role in the evolution of this profession. Using the future-oriented scenario writing approach provides the opportunity to examine the influence of this technology on accounting and financial reporting. Although such skills are currently optional, they will definitely become mandatory in the foreseeable future. One of the prominent characteristics of such a digitalized space is the existence of large amounts of information and data that require rapid and timely analysis. Therefore, accountants and the current non-digitalized accounting profession must inevitably digitize themselves and incorporate the changes. A study of the existing theoretical foundations shows that there are various opinions regarding the digitalization of accounting, all of which end with the same goal. Some envision digitalization in the operational processes of companies, while others focus on accounting-specific processes (Deborah et al., 2021; Cziesla, 2014). Others consider the use of digital financial instruments (such as digital currency) to be an important factor (Darbyshire, 2020). Another group considers equipping accountants with the knowledge of using information and data analysis programming software (Python) (Chanias, 2017; Catlin et al., 2015) to be an inevitable necessity for the accounting field in the information and communication age. What is certain is that social, economic, political changes, rapid changes in science and technology, the transformation of the business environment, and the complexity of today's businesses have increased expectations of the workforce and accountants (Ghaffarian Qadim et al., 1402). Therefore, the use of digital technology tools applicable to accounting should be promoted in accounting education and the development of the learning process of such tools for accounting students should be emphasized. The necessity of this matter was emphasized by the

American Society of Certified Public Accountants in 1998 and PricewaterhouseCoopers¹ (PWC) in 2015, regarding the importance of learning programming for accounting students and graduates and the benefit of accounting from technology and the Accounting Change Committee (Dehqan Neyestanaki et al., 2012). With this in mind, many of the traditional tasks of accountants are increasingly becoming automated tasks (Frey & Osborne, 2017). Therefore, in the future, we will have to benefit from new technological tools such as the Python programming language in the accounting and financial reporting profession, and this makes it necessary to predict and develop a strategy for the best use of possible future situations. Accordingly, in this research, by identifying the most effective drivers for using Python in the accounting and financial reporting profession and by developing related scenarios, future scenarios for using Python in Iran are determined. This study is the first one to examine the scenario writing approach using the futures research method and the application of Python in the accounting and financial reporting profession. Here, by reviewing the existing research background and the related literature, key drivers were identified and they were categorized through interviews and questionnaires. Based on the most prominent drivers, future scenarios for the use of Python in the accounting and financial reporting profession were proposed. Developing an appropriate strategy for different scenarios is another contribution of this study which can be very effective in forming a comprehensive framework for the use of Python in accounting and financial reporting.

Literature Review

As shown in previous section, the field of accounting and financial reporting has been subjected to fundamental changes due to the rapid development in information technology, and the need to acquire skills related to information and communication technology has become one of the basic and required issues for accounting graduates. The digitalization of accounting which is carried out by combining accounting and information and communication technology can transform traditional accounting tasks into new ones required by the global economy and focus on them. Although such skills are currently only optional, they will definitely become mandatory for professionals in the near future. One of the prominent characteristics of the changed and digital space is the existence of

¹ It is a British multinational professional services company that provides management consulting services, financial and investment consulting, legal and tax consulting, accounting and auditing services, and it is currently the second largest professional services company in the world after Deloitte.

extensive information and data that requires rapid and timely analysis. Therefore, accountants and the traditional accounting profession today must inevitably digitize themselves and incorporate changes. Organizations are also increasingly faced with new developments in information and communication technology (ICT), from new applications of information and communication technology in organizations, the implementation of operational tasks and processes to the development of new products and services based on user information in the current digital era. Those developments related to data analysis, especially big data, have a great influence on the roles, tasks and responsibilities of accountants, not only because of the change in organizational structure and processes (for example, the focal objectives of accountants' measurement and assurance activities) (Lucas et al., 2013) as well as the shift in many traditional accounting tasks to automated tasks (Frey & Osborne, 2017). The use of digital technology, the accurate capture of market opportunities, rapid response to the environment, and the promotion of all aspects of the company's value chain are important drivers of high-quality corporate development. Therefore, it is necessary to examine the effect of digital transformation on the financial performance of companies and how digital transformation affects them. Digital transformation optimizes and reorganizes the resources of companies and breaks down the boundaries of the basic factors of production (Faro et al., 2019; Frank et al., 2019). In addition, digital transformation reduces information asymmetry, which not only improves internal control, but also limits the self-interest motivation of managers and helps to reduce the constraints of financial resources of companies and weaken the "incentive to merge" (Fagerstrom et al., 2010; Gerbert et al., 2015) and has a positive effect on the optimal management of corporate finances. Decision-making is one of the most important tasks of managers and they often spend their time making decisions on various issues (Mehrani et al., 2019). Using deep analysis that will be obtained as a result of data mining and using Python, decision-making is optimized. Therefore, research on digital transformation of corporate financial processes is indispensable in the current digital era. Technology can improve transparency and trust in accounting practices and the professional conduct of related matters (Hongdan et al., 2023). The correlation between digital transformation and corporate financial processes is controversial in academic circles (Bughin et al., 2016; Christensen et al., 2015; Hartl & Hess, 2017). These new functions increase value creation in investments and create good developments for managers of those companies (Ebert & Duarte, 2018) and lead to questions such as: What is the place of

digital and technology in accounting? What effect will digitalization have on accountants' expertise? What effect will digitalization have on information security? (Wang et al., 2022). Of course, one of the challenges of digitalization is the need to pay greater attention to social justice and the pervasive consequences of digitalization (Deborah et al, 2021). The emphases made are true for a wide range of accounting activities and operations, and the process of digitalization of accounting and training in the use of programming tools, especially Python, to benefit from the benefits of digitalization of accounting and the effect of new technologies on it are not and will not be an exception to this range. Python has become a popular tool in financial and accounting analysis due to its ease of learning, flexibility, and diverse libraries. Consider the following code example:

An example of finding words using Python

Searching for Keywords

Now let's do some keyword searching. We are interested in how many times B.D.P Company used the word "Loan" in the first paragraph of its annual report. Here is an example:

Search-keyword.py

```
1 import re
2 Text = ''
3 Count = 0
4 with open('B.D.P Company -10 k - one - paragraph.txt', 'r') as Fr:
5 Text = Fr.read()
6 ### a
7 Pattern = r'Loan'
8 lstResult = re.findall(Pattern, Text)
9 Count = len(lstResult)
10 print('Loan (a):', Count, lstResult)
11 ### b
12 Pattern = r'Loan'
13 lstResult = re.findall(Pattern, Text, flags=re.I)
14 Count = len(lstResult)
15 print('Loan (b):', Count, lstResult)
```

Although accounting research will lead to the overall growth of accounting knowledge and, subsequently, to the improvement of accounting operational methods in practice, the speed of their influence (research and accounting practical methods) is not the same due to rapid advances in information technology. As previously agreed upon, changes are occurring at a faster pace today (Lake, 2008). However, information artifacts and facts rooted in the past and present can guide us to the future based on past experiences and foresight that uses the analysis of sources, patterns, and fixed and variable factors to visualize the future and plan for potential and cost-effectiveness is of great importance (Adams et al., 1994) and the scenario writing approach helps to predict and examine possible

outcomes in the future. This approach facilitates strategic planning by analyzing key factors and presenting different perspectives. When we look at the literature on the future influence of digitalization on accounting, it is clear that there is a lack of sufficient research. A look at the implications of increasing digitalization of the public domain for data production, data consumption, and their subsequent effects implies the changes that have occurred, today, process automation and advanced data analysis require flexible and reliable tools. In this regard, Python has gained great popularity among accounting and finance professionals by providing specialized libraries such as Pandas, NumPy, and Matplotlib. However, the following key questions remain unanswered:

- How will Python transform the future of the accounting profession?
- What scenarios can be envisioned for the use of Python in financial reporting?
- What are the challenges and opportunities ahead of this transformation?

Noora et al. (2023) have investigated the accounting of digital currencies in a study. Their findings show that current accounting standards do not fully and accurately cover the accounting treatment of digital currencies and identify an imminent need for an accounting standard to provide guidance on the identification, classification, measurement, and presentation of digital currencies.

Hongdan et al. (2023) in a study that examined the role of blockchain technology in accounting and auditing, they show that new technological technologies and tools can improve transparency and trust in accounting performance and how the audit process is carried out. Furthermore, they illustrate the use of the data obtained by improving decision-making and immutability increases the quality of accounting information, and the improvement of audit reliability and efficiency is affected by the use of this technology.

Bo and Liuyang Yao (2023) in a study examines the influence of digitalization on the financial sector of companies, their research findings show that digital transformation has a deeper influence on corporate decisions through green technology innovation and companies should consider a combination of digital technology and green projects.

Deborah et al. (2021) in a study on digitalization, accounting and accountability postulated the literature review and reflections on the future of public service research and found that social justice depends on multi-axis accountability, which is a consequence of the pervasiveness of digitalization.

Mohammadi Noreh et al. (2021) studied the effect of digitalization on independent auditors and professional auditing institutions in Iran. The results show that digitalization improves the role and

influence of the auditor as a governance mechanism, improves processes and procedures, improves the quality of accounting information, improves stakeholder decision-making, improves employment methods and policies, and changes standards and legal requirements in accordance with digital developments.

Hassani and Zohrabi (2021) conducted a study entitled Artificial Intelligence in Accounting and the Future of the Profession in the Digital Age. They contend that the purpose of accounting which is to provide information to internal and external users has not changed. However, the accounting work process and the way of preparing and analyzing this information are changing, so a number of the tasks and activities that are at the basic level of this profession are performed by machines. Therefore, it must be accepted that the increasing prevalence of artificial intelligence in the accounting profession is transforming current accounting practices, the role of accountants is changing, and time-consuming and repetitive tasks are being automated.

Seddigian et al. (2021) in a study titled "Identifying and Categorizing Drivers Affecting the Future of Accounting Education in Iran Using the EPISTLU Model" found that numerous factors and interactions have affected the future of accounting education in Iran, and it can be concluded that in order to shape the future of accounting education in Iran, all these diverse factors must be considered and planned.

A review of the research background shows that most of the research conducted in the field of digital accounting has examined the effects of various factors on the development of this profession. It is worth noting that previous studies have not paid attention to the future of this field for planning and providing strategies, and in the present study, this gap was considered and the future of using Python in accounting and financial reporting was discussed using a scenario writing approach.

Research Questions

- 1) What are the current trends in the use of Python in accounting and financial reporting?
- 2) What factors influence the expansion or limitation of Python use?
- 3) What scenarios can be envisioned for the future use of Python in the accounting profession?
- 4) How can accountants and organizations exploit Python's capabilities?

Research Objectives

Main Objective

To investigate the future of Python use in the accounting and financial reporting profession using a scenario writing approach

Sub-Objectives:

- 1) To identify current trends in the use of Python in accounting
- 2) To analyze the challenges and opportunities associated with the use of Python in this field
- 3) To develop different scenarios to predict the future use of Python
- 4) To provide strategic suggestions for accountants to adapt to these changes

Methodology

This research is a futures study using a scenario writing approach and is included in the development research group. The reason for this is the lack of information necessary for the use of Python in the field of accounting and financial reporting which has caused this phenomenon to lack an integrated framework in the context of accounting knowledge. This study aims to cover this content deficiency and seeks to develop the concept of Python in accounting and financial reporting. Another approach used in this study is the exploratory approach which is useful and appropriate given that Python's popularity is a relatively unknown phenomenon for accountants, especially in Iran. The main purpose of exploratory research is to get better understanding the topic, and this is a suitable method to provide a basis for subsequent detailed studies that will be conducted later. In addition, given that the current study seeks to answer the research questions through library studies with the purpose of analyzing existing research on the role of Python in accounting, as well as semi-structured interviews with accounting specialists, Python programmers, and financial analysts and academic experts, and using a questionnaire tool, therefore, from the perspective of data collection, it is classified as descriptive research. Since the concept and determination of the drivers of Python's use and the development of plausible scenarios for using Python in the accounting and financial reporting profession are practically new,

obtaining information is of great importance. Considering the objectives pursued by the present study, the type of research is classified as descriptive research. The approach of this study is of mixed-methods (qualitative-quantitative), so that in the qualitative part, using content analysis, it attempted to identify the factors affecting the use of Python in accounting, and through studying theoretical literature, interviewing professional and academic experts, and conducting scientific questionnaires, it discovers and presents the required content that is in line with the objectives of the research. Content analysis is a method for recognizing, identifying, analyzing, and reporting patterns in qualitative data (Khanifer & Moslemi, 2016).

In the quantitative part of the research, using the quantitative and statistical techniques used in this study, we achieved the key and effective drivers of the use of Python in accounting and financial reporting and the credible futures of the use of Python in the accounting and financial reporting profession.

The statistical population of this study consists of professional and academic experts in the field of accounting information systems and financial reporting, which used judgmental and snowball sampling methods and used information collected through interviews to complete the steps. Selection and interviewing of experts continued until saturation was reached. Experts were classified based on class, gender, level of education, work experience, and age. The number of experts is 21. The criterion for the expertise of the statistical population of the study is academic expertise including: expert in the field of accounting information systems, financial reporting, and accounting, or professional expertise including: having practical experience in programming with Python and members of the accounting standards development committee, which is given in Table 1 Demographic information of the experts. Then, data analysis methods are used.

Table 1. Demographic Information of the Interviewed Experts

Domain	Gender	Educational degree	Number	Average age (years)	Average work experience (years)	
Academic	male	PhD	4	47	17	Research, teaching, and training in the fields of programming, information systems, accounting, and financial reporting.
		MA	2	41	13	
	female	PhD	3	39	15	
Professional	male	PhD	2	43	14	Activities in the field of programming, digital technologies and information systems
		MA	3	37	11	
		BA	1	38	10	
	female	PhD	1	44	12	
		MA	4	42	16	
		BA	1	29	9	
Total			21	40	13	

The present study was conducted in the following stages:

First stage

Background of the theoretical foundations of the research was conducted using the content analysis technique and the result was the extraction of factors affecting the use of Python program that were identified. Then, through a questionnaire that was conducted using the Likert scale and based on the opinions of experts, the importance of each factor was evaluated and measured. Interviews with academic and professional experts were conducted in this stage in order to extract and complete the factors affecting the future use of Python and its importance.

Second stage

Preparation of a questionnaire on the effect of the factors extracted in the first stage on the use of Python and its distribution among experts, collection, analysis and monitoring of responses using a binomial test and using SPSS software and selection of significant effective factors.

Third stage

Preparation of a questionnaire on the interaction of important effective factors (extraction from the second stage) and determination of the effect and influence of factors on each other in order to determine the key factors for the use of Python in accounting and financial reporting.

Structural analysis using the interaction matrix is one of the methods that helps us understand how different processes and functions affect each other (Rashid Ardeh & Khazaei, 2016). The driving force in future research is the elements that cause movement and change in the main plan of scenarios (Mousavi et al., 2018).

The different states that variables can take in terms of influence and effectiveness are as follows:

- **Effective variables:** These variables are more effective and less effective than other factors. Effective variables are the most critical components, so the future of using the Python programming language in accounting and reporting depends more on these variables.
- **Bimodal variables:** These variables are very effective. The nature of these variables is mixed with instability because any action and change on them leads to a reaction and change in other variables.
- **Risk variables:** Such variables have a high capacity and abundance to become key categories in the system. Due to their unstable identity, they have the potential to become failure points of the systems.

- **Target variables:** These variables are more effective than they are influential. Therefore, they can be identified with reasonable confidence as the results of the evolution of the systems.
- **Affected variables:** Such variables have little effect and very high susceptibility to influence. They are very sensitive to the evolution of the influential and two-dimensional variables.
- **Independent variables:** These variables have little effect and influence and seem to have no connection with the system and the set at all. Independent variables are divided into two categories:
 - **Discrete variables:** These types of variables are located near the origin of the coordinates in the graph. It is considered that the evolution of these variables is not related to the current system and they can be removed from the system.
 - **Secondary influence variables:** These variables, despite being completely independent, have more of an effect than they do influence.
- **Adjustment variables:** These types of variables are located near the center of gravity of the main graph. These variables can permanently act as secondary influence variables and risk variables.

Fourth Stage

Consulting with experts and experts on conceivable scenarios for key drivers affecting the future use of Python in accounting.

Fifth Stage

Developing an uncertainty questionnaire based on the effects and effectiveness of different states of key drivers on each other and distributing it among experts, collecting and analyzing the responses of interviewees to develop and determine acceptable scenarios for the future use of Python in accounting and financial reporting. After selecting the key factors, each of the factors is classified into different states, and finally all states for all key factors and drivers are provided to the research statistical community in the form of a matrix.

In the above questionnaire, different states can include; positive, negative and neutral effect and the questionnaire numbers vary from -3 to +3. The main question of this stage is that if state A1 of key factor A occurs in the future, what effect will state B1 of key factor B have on the occurrence or non-occurrence.

Sixth Stage

Developing and explaining plausible scenarios for the future use of Python in the accounting and financial reporting profession.

The current research consists of three questionnaires that have content validity and have been confirmed by the interviewed experts. The time horizon of the present study is the next 5 to 10 years. It is worth noting that the second stage questionnaire, using the MicMac software and the ISM model, determines the status of each of the factors affecting the use of Python in the accounting and financial reporting profession.

Results

First, by reviewing the related literature and interviewing experts, 52 effective factors were identified through applying the content analysis technique, and then the importance of each factor was determined, evaluated, and measured through a questionnaire that was conducted with a Likert scale and based on the opinions of experts. Interviews with academic and professional experts were conducted in this stage in order to extract and complete the factors affecting the future use of the Python programming language and its importance. After collecting data, a new stage of the research process began which is called the data analysis and monitoring stage. This stage is very crucial. In this stage, the relative content coefficient of each factor was determined by using the

CVR index. To this end, a questionnaire was also provided to the experts and they were asked to rate each of the factors and dimensions obtained based on a 3-point spectrum of "necessary; useful but not necessary; not necessary" and examine them. In this study, the CVR method, interpretive structural modeling (ISM) and structural equation modeling (SEM) were used.

Creating the Final Access Matrix

After obtaining the initial access matrix, the secondary relationships of the control factors were also examined. The secondary relationship is that if factor i leads to factor j and also factor j to factor k, then factor i also leads to factor k. If this condition is not established in the initial access matrix, the matrix is modified and the missing relationships must be replaced. This process is called the initial access matrix matching. At this stage, all secondary relationships between factors were examined, but no secondary relationships were discovered. Therefore, the final access matrix is the same as the initial access matrix. This matrix shows the degree of effect and the degree of dependency of each factor. The effects of a factor are obtained from the sum of the number of factors affected by it and the factor itself, and the degree of dependency of a factor is obtained from the sum of the factors affected by that factor and the factor itself.

Table 2 Final Access Matrix (Source: Research Findings)

No.	Factors	1	2	3	4	5	6	7	8	9	influence
1	Providing practical training to accountants	1	0	0	1	0	0	0	0	0	2
2	Programming training	1	1	0	1	1	1	0	0	0	5
3	Individual intelligence	1	1	1	1	1	1	1	1	1	9
4	Ability to understand and analyze big data	0	0	0	1	0	0	0	0	0	1
5	Information technology training	1	1	0	1	1	1	0	0	0	5
6	Development of intelligent accounting software and systems	1	1	0	1	1	1	0	0	0	5
7	Business competition of companies	1	1	0	1	1	1	1	1	1	8
8	Increase in e-commerce	1	1	0	1	1	1	1	1	1	8
9	Technological advances	1	1	0	1	1	1	1	1	1	8
	Dependency rate	8	7	1	9	7	7	4	4	4	-

Determining the Relationships and Leveling of Factors

In this stage, through using the access matrix, after determining the input sets and output sets, the contribution of each of these sets is obtained for each of the factors. The output set of a factor includes the factor itself and other factors that affect them and can be identified with a "1" in the corresponding line. The input set of a factor also includes the factor itself and

other factors that it is affected by, which can be identified with a "1" in the columns.

After determining the input and output categories, the contribution is determined for each factor. Factors whose output and common set are completely similar are placed at the highest level of the interpretive structural model hierarchy. To find the components of the next level of the system, the highest level components are eliminated in the mathematical calculations of the relevant table and the operation related to determining the components of the next level

is performed in the same way. This process will be repeated until the components of all levels of the system are identified and proposed.

Drawing the Final Model

At this stage, by considering the factors and the final accessibility matrix, the initial model is drawn, and by eliminating the portability in the initial model, the final model is obtained. Therefore, the final ISM model, which is derived from the factors affecting the use of Python in the accounting and financial reporting profession, is drawn as Figure 1.

As shown in Figure 1, nine factors that make up the model are arranged in five levels. Factor 4 located at the first level of the ISM graph is the most influential and dependent factor in the model. At the second level, factor 1 is located affecting the higher-level factor and is affected by the lower-level factors. At the third level, factors 2, 5, and 6 are located affecting the higher-level factors and are affected by the lower-level factors themselves. At the fourth level, factors 7, 8, and 9 are located affecting affect the higher-level factors and are affected by the lower-level factor. At the last level (fifth level), factor 3 is located which is the most effective and influential factor in the model.

Analysis of the power of influence and the degree of dependency (MICMAC diagram); At this stage, the obtained factors are classified into four separate groups. The first group includes autonomous factors (region 1) and have weak influence and dependency. These factors are somewhat isolated from other factors and have little correlation. The second group includes dependent factors (region 2) that have little and weak

influence but high dependency. The third group is linked factors (region 3). These factors have a lot of influence and dependency. In fact, any action on these factors leads to a change in other factors. The fourth group is independent factors (region 4). These factors have a lot of influence and little dependency. Factors that have a lot of influence are called key factors. It is clear that these factors fall into one of the two groups of independent or related factors. By adding the entries of "1" in each row and column, the influence strength and the degree of dependency of the factors are obtained. Accordingly, the influence-dependency power diagram is drawn.

Using the data obtained from the fourth step, the factors under study can be classified into the following four levels based on the influence of each factor on other factors and the degree of dependency of each factor on other factors:

- Autonomous factors: factors that have the least dependency and influence on other factors.
- Dependent factors: factors that are highly dependent on other factors.
- Linked factors: factors that have a two-way relationship with other factors.
- Independent factors (influence): factors that have a significant effect on other factors.

To determine the coordinates of each factor in the MICMAC matrix, the influence power and the degree of dependency of that factor should be used. These values are obtained through the final access matrix. Table 3 shows the influence power and the degree of dependency of each factor.

Figure 1 Final ISM Model (Source: Research Findings)

1. Providing practical training to accountants
2. Programming training
3. Individual intelligence
4. Ability to understand and analyze big data
5. Information technology training
6. Development of intelligent accounting software and systems
7. Company business competition
8. Increase in e-commerce
9. Technological advances

Table 3. Influence Power and Degree of Dependency of each Factor (Source: Research findings)

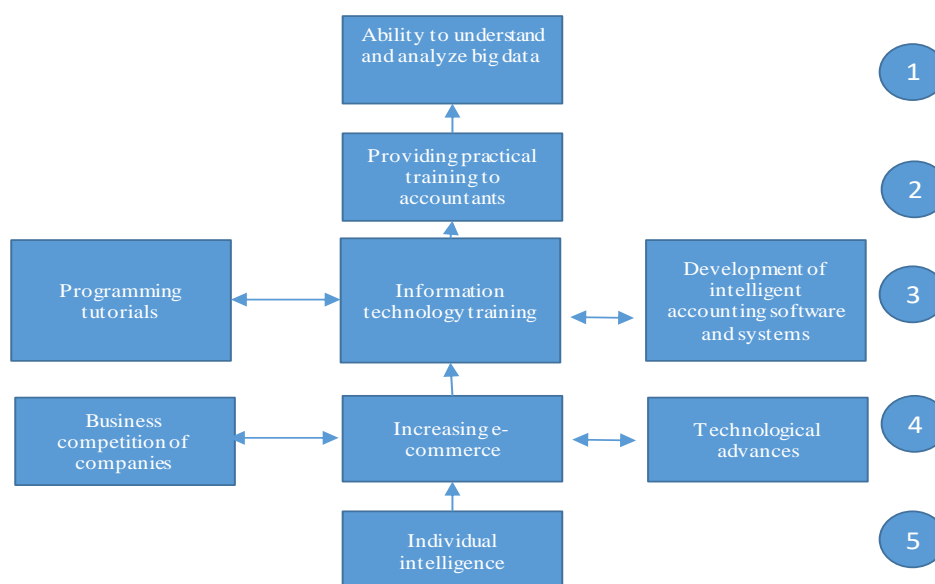
No.	Factors	Dependency	influence
1	Providing practical training to accountants	8	2
2	Programming training	7	5
3	Individual intelligence	1	9
4	Ability to understand and analyze big data	9	1

No.	Factors	Dependency	influence
5	Information technology training	7	5
6	Development of intelligent accounting software and systems	7	5
7	Company business competition	4	8
8	Increase in e-commerce	4	8
9	Technological advances	4	8

Drawing the final model; At this stage, the initial model is drawn according to the factors and the final access matrix, and by eliminating the transferability in the initial model, the final model is obtained.

Therefore, the final ISM model, which is derived from the factors affecting the development of Python tools in the accounting and financial reporting profession, is drawn as Figure 2.

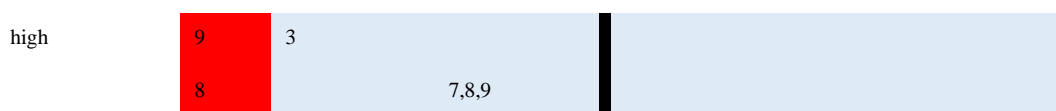
Figure 2 Final ISM model (Source: Research findings)

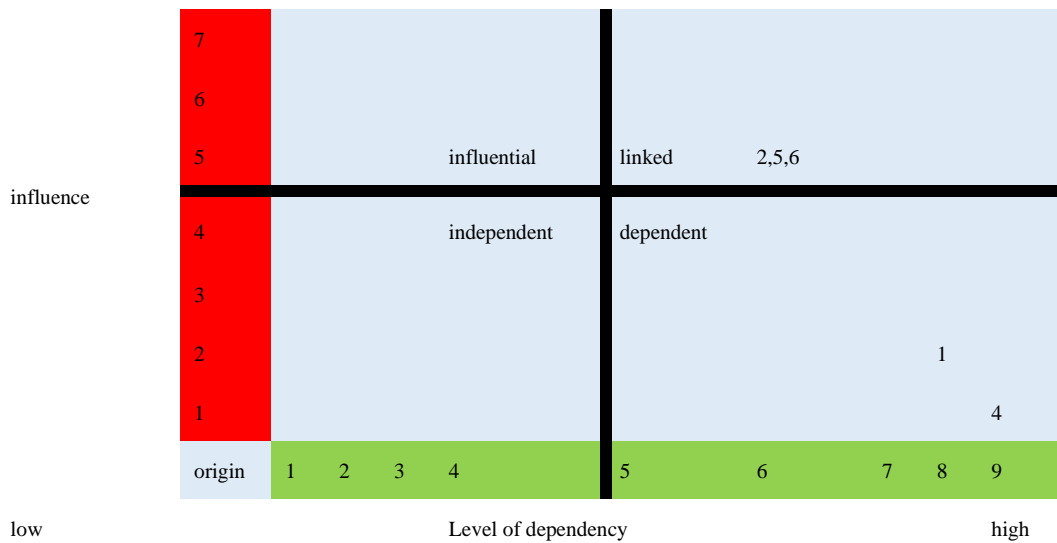


By using the factor coordinates given in Table 3, the MICMAC matrix is formed (Figure 3). As can be seen in the MICMAC matrix (Figure 3), factors 1 and 4 are in the dependent region, meaning they have low influence but are highly dependent compared to other factors. Factors 3, 7, 8, and 9 are in the influence region, meaning they have high influence

and low dependency on other factors. Factors 2, 5, and 6 are also in the linkage region. These factors have relatively high influence and high degree of dependency. These factors play a key role in the model because they establish a relationship between independent and dependent factors.

Figure 3 MICMAC Matrix (Source: Research findings)





Understanding the Model (ISM)

Before the scenario writing stage, some key points from the ISM model are reviewed as follows.

Level 1 (Ability to understand and analyze big data)

This factor serves as the foundation for using Python in accounting. Without a complete understanding of data, effective use of Python is not possible.

Level 2 (Providing practical training to accountants)

Proper training of accountants to use Python is a key factor in accelerating this process.

Level 3 (Programming training, development of intelligent accounting software and systems, IT training)

These factors are interrelated and indicate that the development of software and technical infrastructure is essential for the use of Python in accounting.

Level 4 (Commercial competition of companies, increase in e-commerce, technological advances)

These factors act as external drivers and increase the demand for the use of Python in accounting. Level 5 (Individual intelligence and intelligence)

This factor is at the highest level and indicates that ultimately, success in using Python depends on the ability and creativity of individuals.

Proposed Scenarios

According to this model, various scenarios can be predicted for the future. Here are some examples of proposed scenarios as follows.

Scenario 1

Python's widespread influence on accounting

Reason: Increased awareness of Python's benefits, companies investing in personnel training, developing user-friendly tools, and increasing computing power.

Features: Complete automation of many accounting processes, extensive use of machine learning for forecasting and data analysis, creating advanced interactive dashboards, and personalizing financial reports.

Challenges: The need for standardization, data security, and a shortage of skilled labor.

Scenario 2

Gradual and limited growth

Reason: Resistance to change, high training and implementation costs, and lack of appropriate infrastructure in some organizations.

Features: Using Python in some specific tasks, developing simple and practical tools, and focusing on specific parts of accounting.

Challenges: Maintaining competitiveness with organizations that use Python more widely.

Scenario 3

Creating a dynamic ecosystem

Reason: Collaboration between universities, technology companies, and accounting organizations to develop tools, training, and standards.

Features: Creating a large community of Python developers in the accounting field, developing specialized libraries and tools, and holding educational and networking events.

Challenges: Coordination between different stakeholders and creating a common standard.

According to the presented ISM model, we can examine a wider range of scenarios. To do this, we will revisit the key factors identified based on the ISM model in the following lines.

Ability to understand and analyze big data

This factor serves as a foundation and shows that the future of Python in accounting is highly dependent on the ability to analyze complex data.

Training

Specialized training in Python, artificial intelligence, and machine learning for accountants plays a key role in the development of this field.

Developing tools and software

Creating specialized tools and platforms for analyzing financial data using Python will help expand the use of this programming language.

Competitive environment and technology

Competition between companies, the rise of e-commerce, and technological advances act as the main drivers for the use of Python in accounting.

Individual intelligence: Ultimately, success in this field depends on the ability and creativity of individuals in using new tools and techniques.

Newer and more complex scenarios

Considering these factors, more complex scenarios are considered as follows:

Convergence with AI scenario

In this scenario, Python is used as a primary tool for developing AI models in the financial sector. These models can be used to predict market trends, detect fraud, and make investment decisions.

Creating an open ecosystem scenario

In this scenario, Python, as an open source programming language, creates a dynamic and growing ecosystem. Independent developers and various companies create various libraries, tools, and plugins for Python, which lead to increased efficiency and capabilities of this language.

Regulation scenario

In this scenario, governments and regulatory agencies establish regulations for the use of AI and machine learning in the financial sector. These regulations can simultaneously create opportunities and challenges for the application of Python in accounting.

Table 4 Timeline Model for the Possible Scenario (Source: Research Findings)

Trend	Key Event	Year
Increase Python awareness	Introduction of Python training courses for accountants	2023
Reduce operational costs in some areas	Trial use of Python in some processes	2024
Improve decision-making quality	Development of an internal platform for analyzing financial data with Python	2025
Increase productivity and reduce costs	Standardization of the use of Python in the industry	2028

Table 5 Evaluation Matrix Model for Comparing Scenarios (Source: Research Findings)

Possible scenario	Pessimistic scenario	Optimistic Scenario	Criteria
High	Low	Moderate	Probability
Moderate	Low	High	Effect on Revenue
Moderate	Low	High	Implementation Cost
Moderate	Low	High	Risk

Additional explanations

Considering the information provided and the analysis performed, we can delve deeper into the issue of Python's influence in accounting.

1. Expanding and deepening the scenarios:

Scenario 1: Extensive Influence

Advanced data mining

By using libraries such as Pandas and NumPy, complex analyses can be performed on financial data and hidden patterns can be discovered. For example, Python can be used to perform or identify algorithmic transactions in financial markets, including domestic and international stock markets, foreign exchange markets, and cryptocurrency markets.

Risk management

Companies can use Python to build risk management systems that are used to identify, assess, and manage risks associated with financial instruments and portfolios. Python's libraries for data analysis and machine learning can be used to build models that predict and analyze the risk of financial instruments. For example, financial professionals can use Python to build models that predict the probability of a stock price reaching a certain price, thereby identifying and managing risks and making better decisions at the company management level.

Machine Learning

Python is one of the most efficient programming languages in the world today, and due to its

capabilities in the field of machine learning, it is the best programming language for analyzing financial data, and machine learning models can be used to predict financial trends, detect fraud, and optimize decision-making.

Algorithmic Trading

Python can be used to develop and update trading strategies and processes. Python libraries for data analysis and machine learning, such as scikit-learn, are suitable for developing and testing trading strategies that are developed based on data analysis or machine learning models. For example, Python can be used to build models that predict the price movement of a financial asset based on historical data, or to build machine learning models that learn to trade based on patterns in data. Python can also be used to automate trading processes by building pre-defined systems and models.

Financial Data Analysis and Visualization

Python is a popular language for financial data analysis and visualization, with a wide range of libraries such as NumPy, Pandas, and Matplotlib. These libraries allow financial professionals to easily analyze and visualize large amounts of data in the form of graphs and images. For example, the Pandas library is a powerful library that provides data analysis structures and tools to easily manipulate and manipulate large amounts of data. Using Pandas, it is easy to import data from various sources such as CSV or Excel files, perform arbitrary operations such as addition and subtraction, filtering, and formulating, and finally output them. In addition to Pandas, financial professionals can use Python visualization libraries such as Matplotlib and Seaborn to create their own graphs and figures. These libraries pave the way for the financial professionals to quickly and easily visualize trends and patterns in data, which is important for better decision-making.

Interactive dashboards

Tools like Plotly and Dash can be used to create powerful interactive dashboards that give managers quick access to the information they need.

Financial Reporting

Many companies use Python to automate the process of preparing financial reports, such as balance sheets and income statements. Python libraries for data analysis and visualization can be used to extract data from financial systems and produce reports in various formats, such as PDF or Excel. For example, an accounting and financial reporting specialist can use Python to build systems that automatically extract data from accounting systems and convert them into the

required reports. This can save companies time and resources by eliminating the need to manually prepare reports, and also increase the accuracy of their preparation.

Scenario 2: Incremental Growth

Automation of repetitive tasks

Python can be used to automate repetitive tasks such as creating reports, simple calculations, and data entry.

Development of custom tools: Custom tools can be created to solve specific problems of the organization.

Scenario 3: Dynamic ecosystem

Active user community: Create an active online community for the exchange of knowledge and experiences between accountants and Python developers.

Open standards: Develop open standards for data exchange and create integration between different tools.

2. Challenges and solutions

Shortage of Python expert manpower

Conducting training courses and cooperate with universities and create internship programs to train a skilled workforce

Data security

Using strong encryption and authentication methods to protect sensitive data

Resistance to change

Creating an organizational culture based on innovation and educating employees about the benefits of using Python

Implementation costs and changing traditional infrastructure

Implementing Python programs individually does not have significant costs, but its deployment in organizations certainly has costs that will arise from adapting traditional and conventional infrastructures to new conditions.

3. ISM Model and New Scenarios

Convergence with artificial intelligence

Using Python to develop financial advisory bots and automated decision-making systems.

Hyper-automation

Complete automation of accounting processes from start to finish.

Digital twins

Creating a digital version of accounting processes to simulate and test changes.

Organizational culture

Creating an organizational culture that supports innovation and continuous learning

4. Factors Affecting the Realization of Scenarios

Management support

Senior management support for investing in new technologies

Interdepartmental collaboration

Close collaboration between finance, IT, and other related departments.

Table 6 Scenario Comparison (Source: Research Findings)

Feature	Scenario 1: Widespread influence	Scenario 2: Gradual growth	Scenario 3: Dynamic ecosystem
Speed of influence	Rapid and widespread	Slow and gradual	Moderate
Amount of automation	Very high	Moderate	High
Use of artificial intelligence and machine learning	Widespread	Limited	Extensive
Development of custom tools	Very high	Limited	high
Requirement of specialized labor	High	Moderate	High
Cost of implementation	High	Moderate	moderate
Benefits	Increased productivity, high accuracy, better decision-making	Cost reduction, efficiency improvement in some tasks	Innovation, creating an active user community
Challenges	Requires high investment, resistance to change	Limited capabilities, maintaining competitiveness	Coordination between stakeholders, creating common standards

- Scenario 1: This scenario represents a complete transformation of accounting processes, accompanied by full automation, extensive use of artificial intelligence, and the creation of advanced dashboards. It has the most benefits, but its costs and challenges are also higher.
- Scenario 2: This scenario is a more cautious approach that moves at a slower pace. It is more suitable for organizations with limited resources or are more resistant to change.
- Scenario 3: This scenario focuses on creating a dynamic ecosystem and collaboration between organizations and universities. It leads to innovation and the development of new tools, but requires coordination and the creation of common standards.

Choosing the appropriate scenario

Choosing the best scenario depends on different factors such as the size of the organization, budget, organizational culture, and strategic goals. Organizations should choose the best option according to their circumstances and by considering the benefits and challenges of each scenario.

Choosing the best scenario

Choosing a Python influence scenario in accounting is a complex strategic decision that depends on several factors, including the size of the organization, available resources, strategic goals, and risk tolerance.

Formulating Problem

To choose the best scenario, we use the formulation: Benefits, Costs, Risks, Strategic Objectives = (Best Scenario f)

In other words, the best scenario is a function of the organization's benefits, costs, risks, and strategic objectives.

Key factors in scenario selection

Benefits: Increased productivity, increased accuracy in financial reporting, speed in decision-making, reduced operating costs, innovation, and flexibility.

Costs: Costs of training, software, hardware, consulting, and lost opportunities.

Risks: Technical, security, legal, and change-related risks.

Strategic goals: High-term goals of the organization such as growth, improved profitability, increased market share, and improved customer experience.

Quantitative comparison of scenarios

A decision matrix is used to quantitatively compare scenarios. In this matrix, each scenario is evaluated against different criteria and assigned a weight to each criterion. Then, by multiplying the weight of each criterion by the score corresponding to each scenario, the overall score of each scenario is calculated.

Table 7 Scenario Comparison (Source: Research Findings)

Scenario	Strategic goals	Risks	Costs	Advantages	Overall score
Scenario One	8	6	7	9	30
Scenario Two	7	8	8	7	30
Scenario Three	8	7	7	8	30

Qualitative factors: Besides quantitative factors, qualitative factors also play an important role in scenario selection. Some of these factors include as follows.

Organizational culture

The level of acceptance of change and innovation in the organization.

Workforce skills

The level of skills of employees in the field of information technology.

Management support

The support of senior managers for the implementation of Python.

Table 8 Scenario Comparison Matrix

Scenario	Implementation Cost	Implementation time	Risk	Outcome
Scenario 1: Widespread influence	High	high	High	Very high
Scenario 2: Gradual growth	Moderate	Moderate	Moderate	Average
Scenario 3: Dynamic ecosystem	Moderate	high	Moderate	High

(Source: Research Findings)

Column Explanation

Implementation cost includes training, software, hardware, and consulting costs.

Implementation time implies the amount of time required to fully implement the system.

Risk includes technical, security, legal, and change-related risks.

Outcome demonstrates the benefits of implementing the system, such as increased productivity, reduced costs, and improved decision-making.

By looking at the Scenario Comparison Matrix table, comparisons are made between scenarios. For example, the first scenario (wide influence) has the highest return but its cost and risk are also high. In contrast, the second scenario has the lowest risk but its outcome is also lower.

Converting qualitative Expressions to Numbers

We assign a number to each expression based on our understanding of the concepts of "high", "moderate", and "high" in each scenario. For example, if we take "high" as 8, "moderate" as 5, and "high" as 7, the table would be transformed as follows:

Table 9 Quantitative Transformation of Scenarios

Scenario	Cost (1-10)	Time (1-10)	Risk (1-10)	Outcome (1-10)
Scenario 1	9	7	8	10
Scenario 2	5	5	5	5
Scenario 3	5	7	5	8

(Source: Research Findings)

Matrix Interpretation

Scenario 1: High cost and risk but highest return

Scenario 2: Moderate cost, time and risk but average outcome

Scenario 3: Moderate cost and risk and desired outcome but high implementation time

It is worth noting that, following feedback from industry stakeholders, steps were taken to modify the proposed scenarios, and after consulting with experts from the statistical community, the scenarios were selected.

In this step, TOPSIS, a multi-criteria decision-making method for evaluating and prioritizing options based on criteria according to their distance from the positive and negative ideal, was used.

Step 1: Forming the initial decision-making matrix (X); As it is specified in the previous table, the initial decision-making matrix is as follows:

Table 10 Forming the Initial Decision-making Matrix

Scenario	Cost (C1)	Time (C2)	Risk (C3)	Outcome (C4)
Scenario 1	9	7	8	10
Scenario 2	5	5	5	5
Scenario 3	5	7	5	8

(Source: Research Findings)

In this matrix, C1 to C4 represent different criteria.

Step 2: Calculate the normalized weight matrix we assume that the weights of the criteria are 0.30, 0.20, 0.25, and 0.25, respectively. The normalized weighted matrix will be as follows:

Table 11 Calculating the normalized weighted matrix

Scenario	C1 (normalized)	C2 (normalized)	C3 (normalized)	C4 (normalized)
Scenario 1	0.45	0.35	0.4	0.5
Scenario 2	0.25	0.25	0.25	0.25
Scenario 3	0.25	0.35	0.25	0.4

(Source: Research Findings)

Step 3: Determine the positive and negative ideal solution matrix

The positive ideal solution (V+) contains the highest values in the columns (for utility measures such as efficiency) and the lowest values for cost measures. The negative ideal solution (V-) is the opposite.
 $V+ = (0.135, 0.07, 0.0625, 0.125)$, $V- = (0.075, 0.05, 0.1, 0.0625)$

Step 4: Calculate the distance of each option to the ideal solutions

The Euclidean distance formula is used:

$$d+i = \sqrt{\sum (w_{ij} (v_{ij+} - v_{ij})^2)}$$

$$d-i = \sqrt{\sum (w_{ij} (v_{ij} - v_{ij-})^2)}$$

where:

di+: Distance of option i to the positive ideal solution

di-: Distance of option i to the negative ideal solution

wij: Weight of criterion j

vij: Normalized and weighted value of option i for criterion j

We assume that the distance calculations for the first scenario are as follows:

$$d+1 = \sqrt{((0.135-0.135)^2 + (0.07-0.07)^2 + (0.1-0.0625)^2 + (0.125-0.125)^2)} = 0.0375$$

$$d-1 = \sqrt{((0.135-0.075)^2 + (0.07-0.05)^2 + (0.1-0.1)^2 + (0.125-0.0625)^2)} = 0.0837$$

Similarly, we calculate the other distances.

Step 5: Calculate the relative score of proximity to the positive ideal solution

$$C_i = d_i- / (d_i- + d_i+)$$

It is assumed that the relative score of proximity to the positive ideal solution for the first scenario is as follows:

$$C1 = 0.0837 / (0.0837 + 0.0375) = 0.69$$

Step 6: Calculate the relative score of proximity to the positive ideal solution and rank, as explained before by using the following formula

It can be calculated the relative score of proximity of each option to the positive ideal solution:

$$C_i = d_i- / (d_i- + d_i+)$$

Suppose that after calculating the distances di- and di+ for each option, we reached the following results.

Table 12. Calculation of the Normalized Weighted Matrix

Scenario	di-	di+	Ci
Scenario 1	0.0837	0.0375	0.69
Scenario 2	0.12	0.1	0.55
Scenario 3	0.1	0.05	0.67

(Source: Research Findings)

Interpretation of Ci scores

Ci is a score between 0 and 1 that indicates how close each option is to the positive ideal solution. The closer the Ci value is to 1, the closer that option is to the positive ideal solution and it is preferred.

Ranking: According to the Ci values, we can rank the options as follows;

Scenario 1: With a Ci value of 0.69, it is the closest to the positive ideal solution.

Scenario 3: With a Ci value of 0.67, it is in second place.

Scenario 2: With a Ci value of 0.55, it is in third place.

Discussion and Conclusion

With the expansion of e-commerce and the trend of digitalization of business operations, the need for efficient programs in the field of accounting and financial reporting has increased. As a powerful and widely used programming language, Python can be used well in this field. Accountants and financial reporters need to be able to analyze and interpret financial information accurately and quickly. Python makes data analysis easier and faster with its powerful data mining libraries. Through applying Python, accountants and financial reporters are able to develop their own accounting software and customize it to their needs. Practical training in Python software for accountants and financial reporters helps them improve the efficiency and accuracy of their financial reporting. Based on interpretive structural modeling and experts' viewpoints, the key drivers affecting the use of Python in the accounting and financial reporting profession included providing practical training to accountants, programming training, focusing on personal intelligence, being able to understand and analyze big data, information technology training, the developing intelligent accounting software and systems, business competition among companies, developing e-commerce, and participating in technological advances. In the presented interpretive structural model, the factors of providing practical training to accountants and the ability to understand and analyze big data have low influence but high dependency on other factors. The factors of individual intelligence and cleverness, business competition between companies, the increase in e-commerce and technological advances have high influence and low dependency on other factors. The factors of

programming training, information technology training and the developing software's and intelligent accounting systems also have relatively high influence and dependency.

Based on the studies conducted in the present study, the factors affecting the use of Python in the accounting and financial reporting profession are providing practical training to accountants, programming training, individual intelligence, the ability to understand and analyze big data, information technology training, the development of software and intelligent accounting systems, business competition between companies, the increase in e-commerce and technological advances. The key drivers affecting the use of Python in the accounting and financial reporting profession also include individual intelligence, business competition between companies, the emergence of e-commerce and technological advances. Believable future scenarios for the use of Python in the accounting and financial reporting profession include:

- Scenario 1: Extensive Influence
This scenario represents a complete transformation of accounting processes, accompanied by full automation, extensive use of artificial intelligence, and the creation of advanced dashboards. This scenario has the most benefits but its costs and challenges are also higher.
- Scenario 2: Gradual Growth
This scenario is a more cautious approach that moves at a slower pace. This scenario is more suitable for organizations with limited resources or are more resistant to change.
- Scenario 3: Dynamic Ecosystem
This scenario focuses on creating a dynamic ecosystem and collaboration between organizations and universities. This scenario leads to innovation and the development of new tools but requires coordination and the creation of common standards.

Choosing the best scenario depends on various factors such as the size of the organization, budget, organizational culture, and strategic goals. Organizations should choose the best option according to their circumstances and by considering the benefits and challenges of each scenario. Choosing the best scenario for Python influence in accounting is a complex strategic decision that depends on several factors, including the size of the organization, available resources, strategic goals, and risk tolerance. Based on the calculations performed using the TOPSIS method, scenario 1 is the best option because it is the closest to the positive ideal solution. This means that this scenario best meets our requirements.

The use of digital technology, accurate capture of market opportunities, rapid response to the

environment, and promotion of all aspects of the company's value chain are important drivers of high-quality corporate development. Therefore, it is necessary to examine the impact of digital transformation on the financial performance of companies and how digital transformation affects them. Digital transformation optimizes and reorganizes company resources and breaks the boundaries of basic factors of production (Farrow et al, 2019; Frank et al., 2019). These new functions increase value creation in investments and create good developments for the managers of those companies (Ebert and Duarte, 2018).

Practical Suggestions

- It is recommended to the CPA community, chartered accountants, and other professional accounting bodies to organize regular training courses for accountants and financial reporters to learn the principles of programming with Python. These courses can include basic topics, data analysis, and financial reporting.
- It is recommended to commercial companies to develop custom accounting software using Python. This software can specifically meet the needs of the organization and help improve efficiency.
- Accountants interested in Python are suggested to build networks of collaboration between themselves and programmers, benefiting from their knowledge and experience, which will help develop accounting analysis and reporting using Python more quickly and effectively.

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