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# The impact of ontology-based knowledge management on improving tax accounting procedures and reducing tax risks

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**Abstract**

This paper aims to investigate the impact of ontology-based knowledge management on improving tax accounting procedures and reducing tax risks, specifically focusing on the income tax system in a developing country. To achieve this objective, a mixed methodology approach was adopted, combining quantitative and qualitative data collection and analysis methods. The data were gathered through document analysis, interviews, and questionnaires administered to stakeholders in the Egyptian Income Tax Authority. The findings of this study hold significance for both academic researchers and accounting practitioners. The results demonstrate numerous advantages associated with the utilization of ontology in tax management. It has the potential to reduce costs in tax advisory services, minimize errors in tax calculations, and enhance tax revenue generation by promoting transparency and accountability. The empirical analysis further confirms a positive correlation between ontology-based knowledge management and improved accountability procedures, as well as a positive correlation with the reduction of tax risks. These statistically significant relationships ($r=0.85$, $p<0.01$ and $r=0.79$, $p<0.01$, respectively) provide empirical evidence of the actual effects of implementing ontology-based knowledge management in improving tax accounting procedures and mitigating tax risks.

**Keywords** Tax system, Tax risk, Knowledge management, Ontology, Tax accounting process, Tax accountability

## Introduction

Taxation is considered one of the most important sources of public revenues. Therefore, the country seeks to raise the efficiency and effectiveness of the tax system by providing an integrated database which leads to an increase in tax revenue. In developing countries, there are high rates of corruption and thus high levels of tax risk.

The tax system is one of the critical factors that determine the competitiveness of the enterprise, where it can create many opportunities that can maximize the values of the enterprise, but in turn can expose them to tax risks [1]. Although the concept of "tax risks" comes from taxation, it has not been well given yet in the tax legislation of the national economies in the world [2]. However, there are many essential problems in terms of data management in tax systems. Data management issues in tax systems further complicate matters, as taxation procedures often rely on tacit knowledge and expertise, leading to inconsistency and potential errors in judgement. To tackle tax risks, there is a need for a comprehensive information management framework. Ontological modelling has been studied extensively, but this paper specifically explores how ontology can reduce tax risks and enhance accountability procedures in tax accounting, ultimately leading to increased tax revenues [3].

Practically, taxation procedures frequently depend on the tacit knowledge and expertise of the practitioners. This leads to inconsistency in practice and possible

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human judgement errors and tax risks. Therefore, the combat between tax risk and tax legal relations is certain [2, 3]. There is often redundancy and inconsistency of data and processing functions. But still, there remains scope for strengthening the tax system and refining taxation procedures and modernizing tax authority [4]. A comprehensive information management framework can treat these issues more easily [5, 6]. Thus, there is a need for understanding how to reduce tax risks [3]. Notwithstanding an extensive repository of the literature available on ontological modelling but this paper is especially interested in the question of how ontology reduces tax risks and improves accountability procedures related to the tax accounting process which reflects increasing tax revenues.

The purpose of the paper is to contribute to this stream of research, providing further experimental evidence about the influence exerted by ontology on tax risks and improving the procedures of tax accounting through comprehensive management of information.

This research is a significant contribution to the accounting literature, as it serves as a starting point for addressing high levels of tax risk and corruption in developing countries by establishing an integrated database to boost tax revenue. The results of this study are valuable to academics, tax inspectors and accountants practitioners. These results suggest that there is a positive correlation between ontology-based knowledge management and reducing tax risk. Therefore, it is a vital tool to reduce tax risks and improve procedures of tax accounting. Therefore, using ontology can be considered a key component of knowledge management in the tax authority.

This study contributes to the accounting literature. This study provides a starting point for solving the high levels of tax risk and high rates of corruption especially in developing countries by providing an integrated database which leads to an increase in tax revenue.

This study is organized as follows: "Literature review" Section reviews the relevant literature on the risks associated with the tax. Section "Conceptual framework" reviews the conceptual framework. "Research methodology" section shows the research methodology. "Results" section presents the empirical results. "Discussion" section presents the discussion. Finally, the conclusion and future research are presented in "Conclusion" section.

## Literature review

To get an idea about the current state of research on ontology to reduce tax risk, a systematic literature search was conducted. Four online libraries were searched for publications Springer Link, ScienceDirect, ACM Digital Library and IEEE Xplore Digital Library. Furthermore, only publications were reviewed, which represent journal articles, book chapters or conference papers. Despite the relevance of the matter, especially in developing countries where there are high rates of corruption and thus high levels of tax risks. There are very few works have studied the ontology model in the tax system. Namely, it is from different aspects belonging to classical artificial Intelligence. They differed in the application domain, the goals and the target documents. Despite that, a review of previous works allows regarding some methodological considerations underlying the ontological approach that has been chosen to examine. Du and Zhou [7] established a taxonomy of data quality problems. Furthermore, a novel ontology-based framework is proposed to enhance the quality of online financial data. To assess the effectiveness of the framework, an empirical evaluation was conducted using real-world financial data from various firms. The results provide initial evidence supporting the efficacy of the proposed framework. Arogundade, Abayomi-Alli, and Misra [8] introduced a semantically enhanced model designed to enhance security management throughout the lifetime of an information system. The model enables continuous collection of identified threat behaviours from the intrusion detection system, followed by filtering and analysis of threats within a specific time snapshot. This study shows that through an Ontology-Based Security Risk Management Model for Information Systems, this approach supports management decision-making concerning security control selection and ensuring that security measures are maximally effective. While Leone, Di Caro, and Villata [9] assist both non-expert users and legal professionals in choosing the most suitable legal ontology for their requirements. Additionally, it aims to help them comprehend the unique characteristics of the selected model, enabling them to explore appropriate extensions to the chosen ontology effectively.

They show that Ontologies serve as the established method for modelling knowledge in particular domains, and this holds true for the legal domain as well. While Distinto, Guarino and Masolo [10] proposed an ontological framework for modelling the core notions of personal income taxes, as regulated by Italian law. As Sharipbaev, Omarbekova and Turmaganbetova [11] created the ontological model to provide corresponding operating conditions of the system and implement a web application to organize the process of implementation of the expert system of the tax system in Kazakhstan. An and Wilson [12] designed Corporate Tax ontology to extend tax software can explain its computation which reflects the structure and form of the U.S. Internal Revenue Code to define what the legal implications. While Qiu, Cheng and Alghazzawi [13] presented a framework using a middle-out method of modelling to build an ontology in Chinese tax domain and examined possible

opportunities and problems that may appear in applying ontology engineering techniques. While Guo, Wang, Montenegro-Marin, and García-Díaz [14] proposed a novel approach called Big Data Assisted Ontology-Based Blockchain Design (BDOBD) as an intelligent screening system for assessing job candidates through ontological mapping. The experimental findings demonstrated that this model significantly enhances the accuracy of job requirement evaluations for applicants in the competition. Bhatta, Ghimire, and Buranarach [15] presented a project to establish a knowledge repository for income tax in Nepal using domain ontology. They show that the developed ontology can serve as a valuable resource for the Inland Revenue Department, facilitating their journey towards knowledge management through ontology-based practices. Jiang, Wang, Liu, Xia, Skitmore, Nepal, and Ghanbaripour [16] demonstrate the capability of the risk ontology to capture crucial concepts and relationships relevant to PPP risk management. Consequently, it proves to be a valuable tool for facilitating knowledge reuse and storage, which contributes significantly to effective risk management in PPP projects.

It can be concluded from the above discussion that in previous studies, some studies (e.g. [10, 11, 12, 13, and 15] addressed ontological models in tax systems through the development of tax ontology knowledgebase. Nevertheless, these studies did not investigate the impact of using ontology-based knowledge management on improving accountability procedures and reducing the level of tax risks reflected on tax revenues increase. Hence, this paper aims to fill this gap where this study picks up these specific results. Therefore, this study is different from all the studies above, it investigates how the ontological model framework leads to improve tax accounting procedures and the reduction of tax risks. Moreover, our study also relies on interviews and surveys of a sample of academics, tax inspectors and accountants practitioners, in order to provide a critical analysis of the outcomes.

## Conceptual framework

The conceptual model given by this study has common features with prior provided ontology-based knowledge management and tax risks.

### Tax risk

The tax system aims to improve the Taxation Procedures' efficiency and effectiveness [4], which significantly contributes to refining the business climate. Therefore, the significant roles of the tax system include gathering data, sharing the information, and providing services to the taxpayers [17] So, tax reform is a continuous process. Consequently, the more strictly the tax procedures are administered, the more likely they are to pay attention to tax risks. The combat between tax risk and tax legal relations is certain. Given the high tax burden, it is not surprising that taxpayers are trying, by all means, to reduce their tax payments or escape payment, thereby expanding the "shadow" economy [2, 18]. Therefore, it is reasonable to consider the tax risks and how to reduce them in timely, effective ways. There is no specific definition of tax risk. Still, it can be defined as the difference between anticipated and actual tax proceeds due to many factors, for example, the judicial process, changes in the law, and changes in the business [3, 20, 22]. There are seven types of tax risk in terms of uncertainties associated with decisions, activities and operations of the organization as follows:

(a)

**Specific risk areas**

- **Transactional risk:** This concerns the risks connected with specific transactions embraced by a company. In any transaction, there may be uncertainty as to how the relevant tax law will apply, for instance, to preserve tax losses [21].
- **Operational risk:** This concerns the underlying risks of implement the tax laws, regulations, and decisions to the routine everyday business operations of a company. For example, there are greater tax risks associated with connected party cross border transactions transfer pricing issues [4, 22].
- **Compliance risk:** Compliance risk regards the risks associated with meeting an organization's tax compliance obligations. Besides, Compliance risk concerns the risks implicit in the systems, processes and procedures adopted by a company to prepare and submit its tax returns [23].
- **Financial accounting risk**: These risks come from changes in systems and policies accounting [21, 23].

(b)

**Generic risk areas**

- **Portfolio risk**: It concerns the overall total level of risk when looking at transactional, operational and compliance risks as a whole and considers the interaction of these three different specific risk areas. This is of certain concern to those organizations that are involved in several transactions [23].
- **Management risk:** The second generic area of tax risk is Management risk which comes from improper managing the various risks set out above [22].
- **Reputational risk:** this concerns the wider impact on the organization that might arise from an organization's actions. These risks will impact wider business interests [18].

Based on the foregoing it can be said, there are many tax risks face the tax system in a national economy which impacts on its revenues negatively. The lower is the tax risk, the more flourishing the economy is and the lower the cases of tax evasion. It is noticeable that poorly developed regions generate corruption, resulting in untimely tax payments. Therefore, it is important to work to reduce the level of tax risks.

#### An ontology-based knowledge management

Knowledge management (KM) is the process of creating, sharing, using and managing the information and knowledge of an organization. Knowledge is an asset that should manage. Even can achieve organizational goals by making the best use of knowledge. KM can manage and optimize knowledge resources in an organization by achieving the following [6, 19, 24]

- Improving decision-making through just-in-time intelligence,
- Growing innovation of products, services, and operations,
- Enhancing competency and competitiveness and
- Increasing responsiveness to customers.

Therefore, the demand for the use of information technology increases to enhance knowledge management. Ontology is a new intellectual tool for resources like Internet searching and a new technique of knowledge. It has been presented with a new definition by the artificial intelligence community to present queries and processing knowledge [25]. Ontology is described through five-body-array which are concepts or classes, relations, functions, axioms, and instances [9, 13]. It can accurately and effectively describe the data semantics for a certain subject domain. So, ontology is one of the standouts amongst existing methodologies of subject domain (SD) identification [6, 26]. Therefore, the ontological model can bring support for data and system interoperation at the semantic level.

Based on the foregoing, it can be said that one of the cutting edges of knowledge management is ontology. Instead of using databases that rely on storing information in the form of tables or reports, ontology can be used to achieve the association relations between these data and information and to understand the relationships between them. Thus, ontology is the nucleus of the knowledge management process. It works on the in-depth analysis of the knowledge organization and the retrieval of knowledge.

This study explores how using ontology-based knowledge management on improving the procedures of tax accounting and reducing the level of tax risks through knowledge management in the tax authority. The following figure shows the developing conceptual framework.

## Research hypotheses

Generally, the unemployment pace in poorly developing countries is high, and the individuals have almost no decision other than utilizing corrupt methods winning their living, therefore there is a significant level of tax risks.

Therefore, the focus of this study is on the study of the potential impact of ontology-based knowledge management on improving tax accounting Procedures reducing and tax risks for both tax authorities and taxpayers. Thus, this study proposes the following hypotheses:

*H1* There is a relationship between ontology-based knowledge management and improving the procedures of tax accounting.

*H2* There is a relationship between ontology-based knowledge management and reducing tax risks.

## Research methodology

The empirical study depends on a mixed methodology that involves collecting and analysing quantitative and qualitative data to understand the research problem comprehensively. To provide a deep understanding of the impact of ontology-based knowledge management on improving the procedures of tax accounting and reducing tax risks for both tax administration and taxpayers. The study focuses on developing countries through the Egyptian personal income tax as Egypt is one of the developing countries, which has high rates of corruption. To examine the tax ontology and tax risks in this study, a questionnaire, semi-structured interviews, and documentary analysis were used.

A documentary analysis of the Egyptian Income Tax Law No. 91 of 2005 and its executive regulations was carried out, in addition to the decisions of the President of the Republic published in the Egyptian Waqea gazette. Also, the Ministry of Finance website and what was raised in the Egyptian newspapers about these amendments.

The purpose of the questionnaire and interviews is to establish the perceptions and observations of the respondents regarding effects associated with the tax ontology and tax risks to the tax authority and the taxpayers and facilitate administrative procedures related to the tax accounting process in general.

#### Documentary analysis

Documentary analysis is a type of pragmatic qualitative approach. It relays on the analysis of documents that

include information about the phenomenon to be studied [27]. Documentary analysis was performed on both primary and secondary sources regarding the Egyptian Income Tax Law No. 91 of 2005 and its executive regulations.

#### *Sample*

The current study focuses on amendments to Law No. 91 of 2005 from 2005 to 2020 regarding the direction of the government towards digital transformation and the development of the tax system by using content analysis. In addition to the decisions of the President of the Republic, they were published in the Egyptian Waqea gazette and the Ministry of Finance website.

#### *Results of documentary analysis*

The documentary analysis revealed important information about the tax regulations and digital transformation initiatives in Egypt. According to Law 91 of 2005, direct taxes are imposed on various sources of income, including income from salaries, commercial or industrial activities, professional or non-commercial services, and real estate wealth. The law also applies to both residents and non-residents of Egypt, depending on their income generated within the country.

The obligation to submit tax returns electronically took place in several stages where the Minister of Finance Decree No. 221 of 2018 was issued to compel legal persons to submit tax declarations electronically, and the system was launched experimentally in October 2018, then Ministerial Resolution No. 744 of 2018 was issued to compel the companies (Except for the companies of persons) to submit their tax returns electronically. In December 2018, Ministerial Resolution No. 695 of 2018 was issued obliging the VAT registrants to submit their monthly tax returns electronically. Then, in June 2019 Ministerial Resolution No. 358 of 2019 was issued to compel the companies'companies to submit the tax returns electronically As of January 2020, optional for the natural person.

The Minister of Finance issued a decision to amend Article 104 of the executive regulations of the Income Tax Law No. 91 of 2005, in the context of the government's plan for digital transformation; this contributes to facilitating the financiers and providing them with distinguished service.

The amendments included requiring "companies of persons" to submit the tax return through the e-government portal "income tax service for financiers", or any other electronic channel designated by the Ministry of Finance, as of 1 January 2020, where the taxpayer registers himself and obtains the secret password, and is considered responsible Whatever you give full responsibility by signing an acknowledgement of that when requesting to benefit from this service or to provide an authorized electronic signature from the Authority. A statement issued by the Ministry of Finance confirmed that the amendments obligated the taxpayer "to send the tax return electronically, as referred to". The statement clarified that submitting the tax return electronically is equivalent to submitting it to the competent tax office, noting that in all cases the taxpayer must present what is reported as payment. The tax due to the recognition of one of the approved payment methods stipulated in Article 82 of these regulations, or that the Ministry of Finance decides.

The analysis highlighted the transition towards electronic tax submission. Several ministerial resolutions and decrees were issued to enforce the electronic filing of tax returns. Ministerial Decree No. 221 of 2018 mandated legal entities to submit their tax declarations electronically, followed by Ministerial Resolution No. 744 of 2018, which obligated companies (excluding companies of individuals) to submit their tax returns electronically. Additionally, Ministerial Resolution No. 695 of 2018 made it mandatory for VAT registrants to submit their monthly tax returns electronically. Further, Ministerial Resolution No. 358 of 2019 required companies to submit their tax returns electronically starting from January 2020, while it remained optional for individuals.

Amendments to Article 104 of the executive regulations of the Income Tax Law were introduced to facilitate digital transformation. These amendments mandated "companies of individuals" to submit their tax returns through the e-government portal or other designated electronic channels. The taxpayer had to register and obtain a secret password, assuming full responsibility for the information provided. The Ministry of Finance emphasized that electronic submission of tax returns is equivalent to submitting them to the relevant tax office. The taxpayer must also fulfil the payment requirements using approved methods or as determined by the Ministry of Finance.

The Minister of Finance issued Decision No. 296 of 2020, amending certain provisions of the executive regulations of the Income Tax Law. This decision required individual taxpayers engaging in various activities, such as commercial, industrial, professional, real estate, or investment activities, to submit their tax returns electronically through the tax authority's website. Initially, electronic tax filing was optional for natural persons. Additionally, Law No. 151 of 2020 provided data protection for personal information processed electronically.

These findings from the documentary analysis highlight the government's efforts in promoting digital transformation and streamlining tax processes in Egypt. The shift

towards electronic tax filing aims to enhance efficiency, provide better services to taxpayers, and ensure the security of personal data.

It is important to note that the documentary analysis provides insights into the regulatory framework and government initiatives. However, the analysis does not capture the perspectives and experiences of taxpayers and tax examiners, which could further enrich the understanding of the challenges and effectiveness of these measures.

#### *Discussion of results*

The findings from the documentary analysis provide valuable insights into the tax regulations and digital transformation initiatives in Egypt. These findings have several implications for understanding the context and progress of tax procedures in the country.

Firstly, the analysis reveals that under Law 91 of 2005, direct taxes in Egypt are imposed on various sources of income, including salaries, commercial activities, professional services, and real estate wealth. This highlights the comprehensive nature of the tax system, covering different aspects of individuals' and entities' financial activities.

Moreover, the analysis indicates a significant shift towards electronic tax filing in Egypt. Several ministerial resolutions and decrees have been issued to enforce the mandatory electronic submission of tax returns. This transition aligns with global trends in digital transformation, aiming to enhance efficiency, accuracy, and transparency in tax processes. By implementing electronic tax filing, the Egyptian government seeks to streamline procedures and reduce administrative burdens for taxpayers.

The documentary analysis further highlights the gradual implementation of electronic tax filing requirements. Starting with legal persons, the government gradually expanded the scope to include companies, VAT registrants, and individuals engaging in various economic activities. This phased approach demonstrates the government's commitment to promoting digital transformation while considering the unique needs and capabilities of different taxpayer groups.

Furthermore, the findings emphasize the government's focus on data protection and privacy. Law No. 151 of 2020 specifically addresses the safeguarding of personal data processed electronically. This indicates the government's recognition of the importance of protecting sensitive taxpayer information in the digital age.

The findings from the documentary analysis underscore the positive impact of digital transformation on tax administration in Egypt. By embracing electronic tax filing, the government aims to enhance the accuracy and efficiency of tax processes, reduce the compliance burden on taxpayers, and improve overall transparency and accountability. However, it is important to consider the limitations of the documentary analysis. The analysis primarily focuses on the legal framework and government initiatives, providing a top-down perspective. The study does not capture the implementation challenges, practical experiences, or perspectives of taxpayers and tax examiners. Future research could complement these findings by conducting interviews or surveys to gather insights from stakeholders involved in the tax system. Such research could shed light on the effectiveness of digital transformation measures, potential barriers faced by taxpayers, and areas for further improvement.

In conclusion, the documentary analysis findings demonstrate the Egyptian government's commitment to digital transformation in tax administration. The mandatory electronic tax filing requirements and the focus on data protection reflect efforts to modernize tax processes, enhance efficiency, and ensure compliance. These findings contribute to the understanding of the evolving tax landscape in Egypt and provide a foundation for further research and analysis in this area.

### Interviews

Some questions were extracted from documentary analysis for use in interviews. The interview data analysis was conducted manually.

#### *Sample*

Twenty individuals were from stakeholders in Egypt: 10 tax examiners and 10 taxpayers. The results of documentary analysis and previous studies were presented as some questions have been concluded for use during interviews. A discussion was about improving tax accounting procedures and reducing tax risks.

#### *Interview procedure and analysis*

The interviews were performed at the interviewee's workplace. The interviews were undertaken face-to-face with the participants' consent in Arabic in Egypt and transcribed in full for analysis. An open discussion was held about the research. The interviews included an initial list of questions that serve only as a guide so that unexpected information can appear. Respondents were asked open questions. With the permission of the participants, the interviews were digitally recorded. The documents were analysed manually.

#### *Results of interviews*

The findings from the interview data indicate that some of the identified commonalities of responses for taxpayers and tax officers/ examiners that was positive about improving tax accounting procedures and reducing tax risks.

When asking participants about the importance and motives for submitting the electronic tax system. Taxpayers explained that there are many motivations, including achieving tax savings, avoiding penalties, and reducing compliance costs—as many taxpayers and tax examiners/ tax officers see the current tax system as complex and do not provide the necessary information about the tax due.

While tax examiners/ tax officers explained that the importance lies in trying to design a records group that meets the requirements of tax legislation.

One of tax officer said, "There are many problems in the mechanisms and procedures of the current tax system, about the inability of this system to provide the information necessary to make decisions easily, accurately and in a timely manner".

Also, one tax officer said, "Despite the government's tendency to digitize, otherwise, there is no good system that works to achieve the government's goals of achieving digital transformation".

Similarly, one taxpayer said, "There are many difficulties in the process of tax accountability, which result in a state of uncertainty and therefore the presence of many tax risks.

In the same context, one taxpayer said, "The current system results in higher costs for tax consultants, many of the risks associated with reputation and compliance".

When asking participants about the challenges faced by the tax system. Most of the taxpayers and tax officers have made clear that there are many challenges (1) Availability of, and access to, records relating to taxation when needed; (2) prompt response to inspections and audits; (3) timely response to sudden and tax-related inspections and audits; (4) reducing the risks resulting from issuing false reports related to conducting operations manually; (5) data integration with other platforms and programmes within organizations; and (5) adherence to and compliance with tax legal systems. While the participants were asked about what they wanted in the tax system used to manage tax data. From there, they reported several requirements that must be met. Some participants reported processing a huge amount of detailed data; easy accessibility to documents which reduces administrative costs and costs.

Some of the tax examiners also indicated the need for central storage of all relevant documents; hierarchical tracking of reports and visual panels which includes trend analysis.; secure electronic archiving that considers user pre-defined access controls; the ability to prepare reports using advanced business intelligence, and the ability to represent data visually and customizable with a high degree of accuracy.

Likewise, one examiner said, "The existing system lacks databases capable of managing information well can make rational decisions.

According to the results of the documentary and interview analysis, the importance of the need to improve the procedures of tax accounting and reduce the level of tax risks through knowledge management in the tax authority is evident.

#### *The discussion of the interview findings*

The discussion of the interview findings reveals important insights into the perspectives of taxpayers and tax officers/examiners regarding tax accounting procedures and the reduction of tax risks. These findings contribute to a deeper understanding of the challenges faced by the current tax system and the requirements for improvement.

One key theme that emerged from the interviews is the motivation behind embracing the electronic tax system. Taxpayers expressed a desire to achieve tax savings, avoid penalties, and reduce compliance costs. This indicates that taxpayers recognize the potential benefits of digital tax filing, such as increased efficiency and reduced financial burden. On the other hand, tax officers/examiners highlighted the importance of designing a records group that meets the requirements of tax legislation. This suggests that tax officers recognize the need for an effective system that ensures compliance with tax regulations.

The interviews also shed light on the challenges faced by the tax system. Both taxpayers and tax officers/examiners identified common challenges, including the availability and access to taxation records when needed, prompt response to inspections and audits, and reducing risks associated with false reporting. These challenges highlight the need for a system that provides accurate and timely information, streamlines processes, and minimizes the potential for errors and non-compliance.

Furthermore, the interviews revealed specific requirements for an efficient tax system. Taxpayers emphasized the importance of processing a large amount of detailed data and easy accessibility to documents, which would contribute to reducing administrative costs and improving overall efficiency. Tax officers/examiners highlighted the need for central storage of documents, hierarchical tracking of reports, secure electronic archiving with access controls, advanced business intelligence for report preparation, and accurate data representation. These requirements align with the broader goal of leveraging technology to streamline tax processes, enhance data management, and facilitate decision-making.

The findings from the interviews also support the significance of knowledge management in the tax authority. The interviews highlighted the limitations of the current

tax system, such as the inability to provide timely and accurate information. This indicates a potential gap in knowledge sharing and utilization within the tax authority. By implementing knowledge management practices, including effective data management, information sharing, and decision support systems, the tax authority can improve tax accounting procedures and reduce tax risks.

However, it is important to acknowledge the limitations of the study. The interviews captured a specific set of perspectives from a limited sample size, and thus, the findings may not be fully representative of all taxpayers and tax officers/examiners in Egypt. Additionally, the study focused on the qualitative aspects of the interviews and did not incorporate quantitative measures or statistical analysis. Future research could consider a larger sample size and incorporate diverse perspectives to further validate and generalize the findings.

In conclusion, the interview findings provide valuable insights into the motivations, challenges, and requirements associated with tax accounting procedures and the reduction of tax risks. These findings underline the importance of improving the current tax system, leveraging digital technologies, and implementing knowledge management practices to enhance efficiency, transparency, and compliance. The findings contribute to the ongoing dialogue on tax administration and provide a foundation for further research and practical interventions in this domain.

## An ontology-based knowledge management framework for the Egyptian income tax authority

Tax reform efforts, especially the income tax in 2005 which was carried out by the Egyptian government, have significantly contributed to refining the business climate in Egypt [18]. Taxes are divided into two classes direct and indirect taxes. Although we think that the ontological model can be applied to different kinds of taxes, in this study, we shall focus on the Egyptian personal income tax which is an example of direct tax. Direct taxes are imposed on incomes, revenue from real estate possessions, salaries, and revenue from commercial and professional activity. Unlike indirect taxes, which are imposed when consumption or expenditures and other sorts of events that only indirectly reveal wealth, direct taxes are strictly based on the ability-to-pay principle. This is the necessary condition for tax application, therefore this implies that direct taxes have a progressive rate structure based on the overall personal situation. Thus, income tax is a financial obligation paid by the taxpayer legally to the state treasury according to the income or profits that he makes. The state shall provide public services for all, bearing in mind that there is no tax without law. The legislation gives the income-tax Investigator the authority to investigate and audit.

One of the major aims on the governmental level is to enhance mutual trust between the tax authority and the taxpayer. This requires managing tax information in such a way as to reduce the tax risks for both tax authorities and taxpayers [25].

According to ontology engineering, the design of an ontology-based knowledge management framework for income tax, illustrated in Fig. 1, is divided into two phases as follows:

- The first phase is a knowledge acquisition through the selection of the facts relevant to the tax.
- The second phase is working out process, which determines the actual tax position with respect to such tax based on the relevant facts through the definition of relations, constraints, data on tax deductions and exemptions.

Ontology can be considered a key component for knowledge management in tax authority and therefore is an important tool to reduce tax risks. This achieves as follows [6, 24]

- The ontological model does the simple collection of all the facts relevant to the given system. Where the selection is based on the essential properties of the facts it receives in the system inputs.
- Ontology can provide a common reference to interrelate IT-based informational resources to convert semi-structured and unstructured information to the structured knowledge base.
- The ontology-based knowledge management works to support the integration of relevant resources, searching the exact knowledge rapidly and avoiding much unrelated knowledges.
- Ontology-based knowledge management can be used for organizing information resources in the content repository.
- Ontology can be used to represent unified organizational schema which is important for data interoperability between systems. Therefore, it can provide better support for semantic interoperability and used by both the internal and the external entities.

## Constructing an ontology-based knowledge management for income tax

There are two manners to visualize the construction of ontology, the bottom-up approach and a top-down approach that is prevalent in disciplines where the domain consists of specific objects of the world [28].

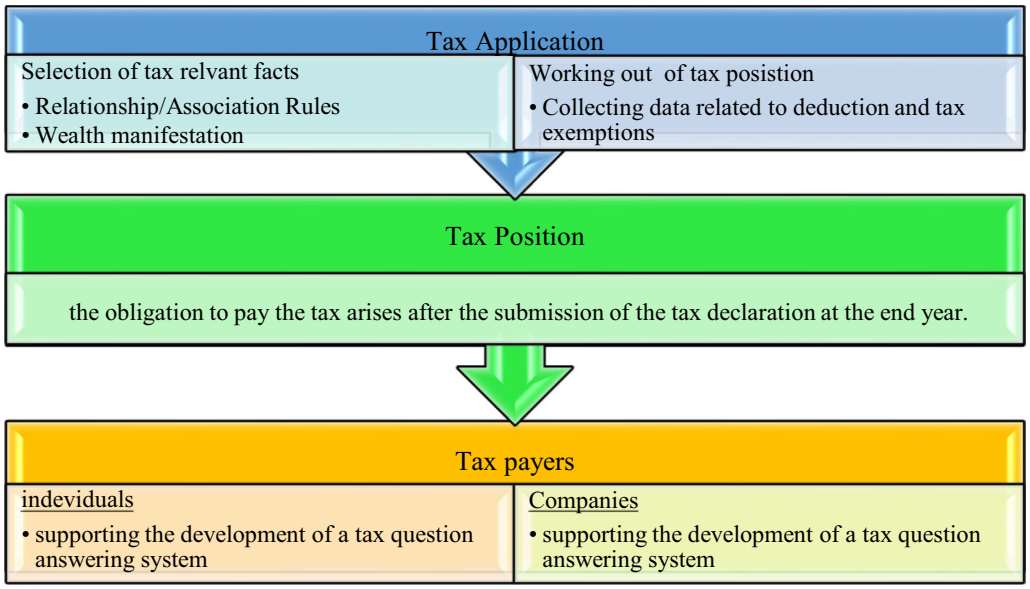


**Fig. 1** The design of an ontology-based knowledge management framework for income tax

This study depended on the top-down methodology. The object language for a domain is given then specify the relations between the predicates on the basis of their actual use through appointing the discourse domain, determine a primary vocabulary and set the by intentional and extensional definitions [6].

The protégé tool has been used to turn into the tax case to the ontology format. Before starting to create tax ontology, we identified web space which tax officers and taxpayers can use. It can be sharing data across organizations through RDF (Resource Description Framework) format to facilitate the data reuse and integration, as shown in Fig. 2.

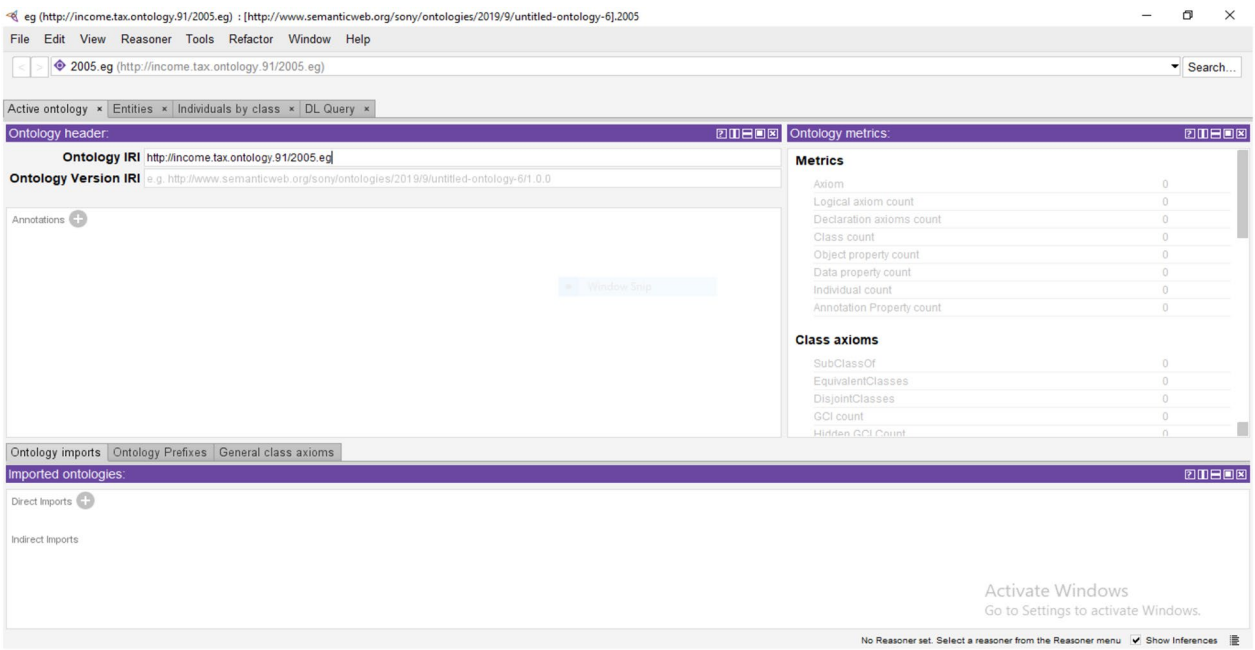


**Fig. 2** Identify web space through RDF format

Then, it is helpful to list all terms that it would be liked either to make statements about or to introduce explanation to a user, through answer these questions what are the terms, we would like to talk about? What properties do those terms have? What would we like to say about those terms? It is important to get a comprehensive list of terms without worrying about the overlap between concepts they represent, relations among the terms, or any properties that the concepts may have. Therefore, classes and subclasses were made to clarify the relationships between terms as shown in Fig. 3.

After creating a class hierarchy for each branch of the taxonomy appropriate descriptions in the kinds of income when adding object properties and data properties. Object properties describe the relationship between two instances or two class, whereas data properties describe the relationship between instances and data values into Protégé (Figs. 4 and 5).

Then, the Linked Open Data (LOD) portal is used to support using and sharing of tax data based on the linked open government data concept. Where it extends the functions typically found in open government data portals, e.g. Data.gov, by enriching the data for restful access and reference by applications [24, 29]. Access to the published RDF data in the portal and retrieval is normally provided via a SPARQL endpoint, which supports data integration by URI referencing mechanism. The data will be transformed into the RDF format based on the classes and properties defined in the enterprise ontology [24].

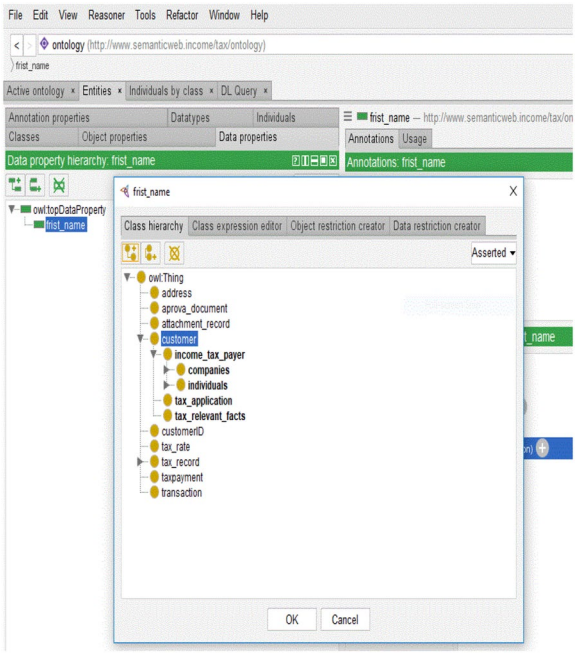


**Fig. 4** Adding object properties

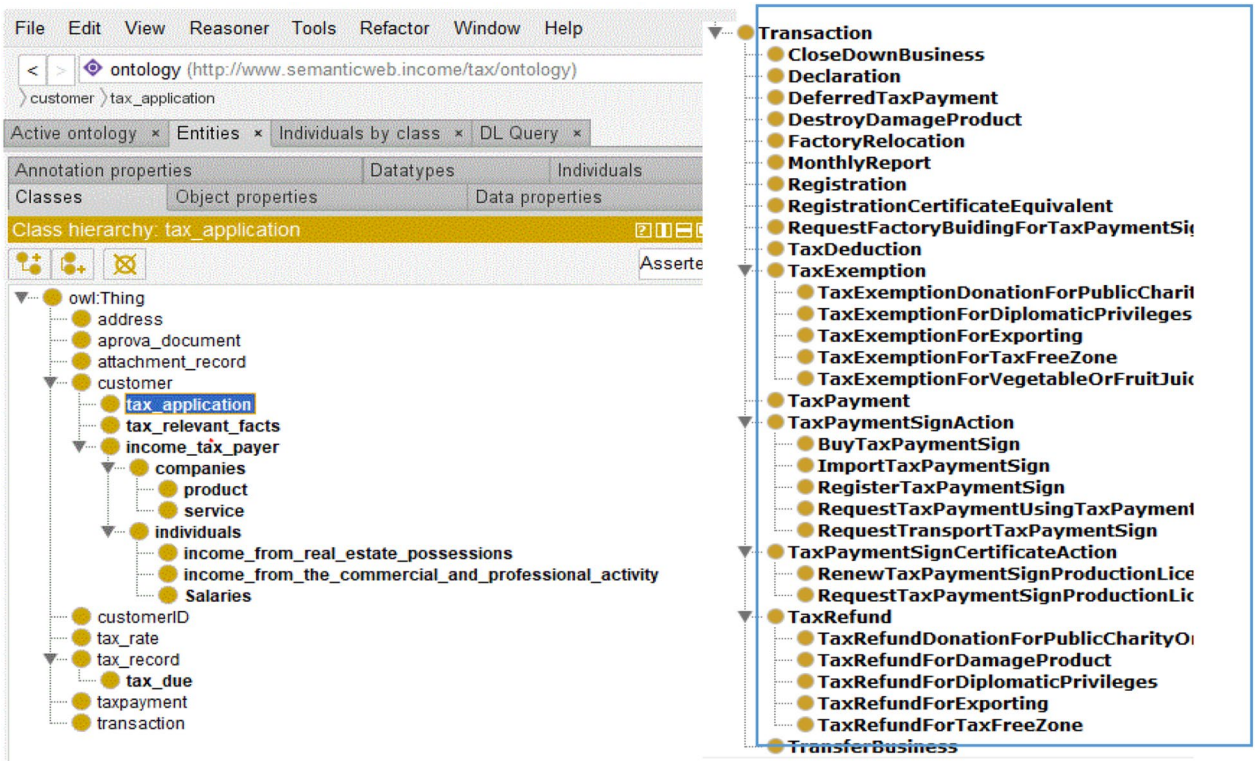


**Fig. 3** Creating a class hierarchy of tax ontology

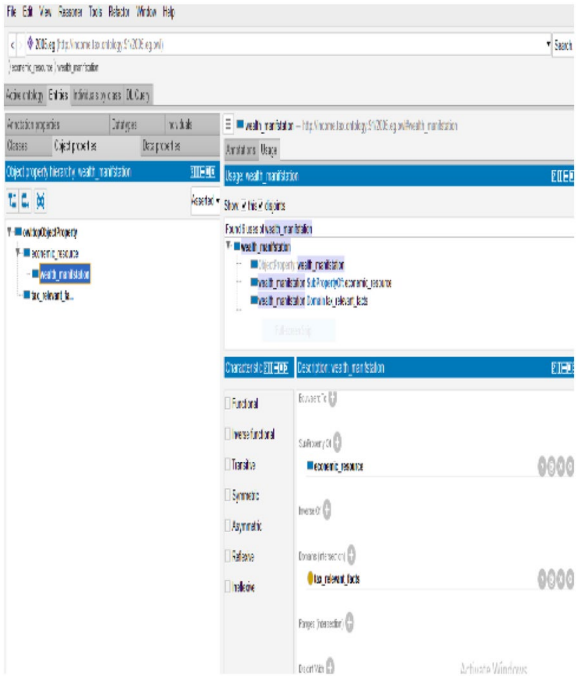

**Fig. 5** Adding data properties

According to [26], the usage of the ontological model decreases the time of computation and information retrieval and get better the efficiency of existing knowledge usage. Ontology can support the development of a tax question-answering system and refine the sharing of information [6].

### Survey

The survey was made after constructing ontology-based knowledge management to investigate the impact of using the ontology model in the Egyptian Income Tax Authority.

#### *The selection of respondents and measurement instrument*

The collected data are based on qualitative questionnaires which were obtained through a questionnaire provided to academics from tax accounting professors, income taxpayers and tax officers from Egyptian income-tax authority. The survey was made after constructing ontology-based knowledge management. The internet, as well as telephone directories, were used to identify possible respondents at random for this study. The respondents were contacted by telephone to outline the purpose of the study and to enquire whether the prospective respondent would be willing to participate. If a respondent agreed to participate, the questionnaire was sent via electronic mail to the respondent. Therefore, we distributed (100) questionnaires including (20) questionnaires for academics from tax accounting professors, (30) questionnaires for Egyptian income taxpayers on persons and (50) questionnaires for tax investigators at the Egyptian income-tax authority. All the completed questionnaires that were returned were analysed using specialized statistical software. These instruments were chosen because they provide sufficient data as well as ensure the validity and reliability of the study.

#### *Data analysis*

The Statistical Package for Social Science (SPSS) version 24.0 was used to analyse the data from the questionnaire. Various statistical methods were applied to the questionnaire. The study employed Harman's single-factor test was conducted to define the presence of common method bias (CMB). Also, the study employed alpha Cronbach to assess the validity and reliability of measurement scales. In addition, variables were used that meet the acceptable standard of validity and reliability analysis in testing the hypothesis. Then, we used Pearson correlation and chi-square tests to test the relationship between variables of the study to test its hypotheses. Statistical significance is determined by considering the respective p values, where a p value of below 0.01 indicates statistical significance at a 99% level.

## Results

### Common method bias

It is major to account for common method bias for studies based on surveys. So, therefore, the Harman individual factor test was performed to determine the presence of common method bias. Harman's single-factor test explains the presence of common method bias in the dataset when a single factor appears, or one-factor accounts for more than fifty per cent of the item variance in factor analysis [30] Results of Harman's single-f factor test results extract 20.097 per cent of the total variance. Therefore, it is so far less than 50 per cent that it has shown that no factor represents more than fifty per cent of the variance. Therefore, it can be concluded that common method bias was not a menace in the present data set.

### Validity and reliability analysis

To ensure the validity and reliability of the study, the respondents were chosen from different environments (university and professional sector). The study relied on the method of direct delivery and receipt. One hundred questionnaires were distributed but a number of invalid questionnaires (14). Accordingly, the questionnaires were valid for statistical analysis (86). Alpha Cronbach was used as a method to test the validity and reliability of the study's questionnaire. Alpha Factor Cronbach`s for

**Table 1** Descriptive statistics for using ontology's variables *Source*: Author's calculations using SPSS

| ID | Statements | Disagree | | Neutral | | Agree | | Strongly agree | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Freq | % | Freq | % | Freq | % | Freq | % | |
| Q1 | The knowledge can be managed using An Ontology Instead of using databases | 0 | 0 | 12 | 14.3 | 25 | 29.8 | 47 | 56 | 4.4167 |
| Q. 2 | Ontology-based knowledge management is better at supporting the integration of relevant resources, searching for the exact knowledge rapidly, and avoiding unrelated knowledge | 6 | 7.1 | 29 | 34.5 | 35 | 41.7 | 14 | 16.7 | 3.6786 |
| Q.3 | Ontology can be used to represent a unified organizational schema | 0 | 0 | 32 | 38.1 | 45 | 53.6 | 7 | 8.3 | 3.7024 |
| Q.4 | The usage of the ontological model decreases the time of computation and information retrieval | 0 | 0 | 10 | 11.9 | 33 | 39.3 | 41 | 48.8 | 4.3690 |
| | Total average | | | | | | | | | 3.671 |

variables of study is (0.868), which means they are valid and highly reliable.

### Descriptive analysis

The questionnaire was divided into three groups. The first group posed questions to the respondents regarding the use of ontology. This group included four questions to demonstrate the positive impact of the use of ontology. The second group posed four questions to demonstrate the impact of using ontology-based knowledge management on improving accountability procedures. The third group posed seven questions to the respondent regarding reducing tax risks. The respondents were asked to express their views on these questions by selecting one of the items presented within the Likert pentagram. Tables 1, 2 and 3 show the descriptive analysis of study variables for these groups by analysing the questionnaires of the survey that were distributed.

From Table 1, it is clear that most of the respondents (85.8 per cent) believe knowledge can be managed using an ontology instead of using databases. Only 14.2 per cent of the respondents were Neutral to this statement. Fifty-nine per cent of the respondents believe ontology-based knowledge management is better at supporting the integration of relevant resources, searching the exact knowledge rapidly, and avoiding unrelated knowledge. Only 7 per cent of the respondents had an opposing viewpoint.

Sixty-one per cent of the respondents believe ontology can be used to represent a unified organizational schema. Thirty-eight per cent of the respondents were Neutral with this statement. Most of the respondents (88.1 per cent) believed the usage of the ontological model decreases the time of computation and information retrieval. Only 11.9 per cent of the respondents were Neutral to this statement.

From Table 2, it is clear that all the respondents believe the usage of the ontological model refines the sharing of information and semantics.

63 per cent of the respondents believed the usage of the ontological model can support the development of a tax question answering system and 36.9 per cent of the respondents were Neutral with this statement.

Most of the respondents (91.7 per cent) believe that ontology-based knowledge management can improve tax revenue hold various with a high degree of transparency and accountability. Only 8.3 per cent of the respondents were Neutral with this statement. Most of the respondents (85.8 per cent) believe the ontology-based knowledge management Framework can help the users in decreasing the cost of tax advisors and reducing errors. Only 14.2 per cent of the respondents were Neutral to this statement. Therefore, it can be said that the general tendency of respondents is towards approval that using ontology in knowledge management is better at supporting the integration of relevant resources, searching for the exact knowledge rapidly and avoiding unrelated knowledge. In addition, it achieves many benefits such as decreasing the time of computation and information retrieval, sharing of information and semantics, and improving tax revenue hold various with achieving a high degree of transparency and accountability. The second group of questions were posed to the respondents regarding people's views in terms of reducing tax risks issues; their responses are indicated in Table 3.

From Table 2, it is clear that most of the respondents (83.5 per cent) believe ontology-based knowledge management can reduce transactional risk. Only 16.7 per cent of the respondents were Neutral to this statement.

85.9 per cent of the respondents believe ontology-based knowledge management can reduce operational risk. Only 14 per cent of the respondents had an opposing viewpoint. Also, 85.9 per cent of the respondents believe An ontology-based knowledge management can reduce Compliance risk and it can reduce financial accounting risk can reduce Portfolio risk. Only 14 per cent of the respondents had an opposing viewpoint. In addition, 94.1 per cent believe ontology-based knowledge management can reduce Management risk. Only 6 per cent of the respondents were Neutral. Many of the respondents (88.1 per cent) believe ontology-based knowledge management can reduce Reputational risk. Only 11.9 per cent of the respondents were Neutral to this statement.

Therefore, it can be said that the general tendency of respondents is towards approval on that using ontology in knowledge management can contribute to reducing tax risks.

### Testing the Study Hypotheses

To test the hypotheses of the study, Pearson correlation and Chi-Square tests were performed. The results are given in Table 4.

As described in Table 4, the results of testing the Pearson correlation and Chi-Square show important findings. ontology-based knowledge management leads to improving accountability procedures and reduces tax risks positively. Where there are significantly correlated between ontology-based knowledge management and accountability procedures H1: ($r=0.85$, $p<0.01$) Therefore, H2: (There is a relationship between ontology-based knowledge management and improving accountability procedures) was accepted. Also, there are significantly correlated between ontology-based knowledge management and reducing tax risks H2: ($r=0.79$, $p<0.01$). Therefore, hypothesis H2: (There is a relationship

**Table 2** Descriptive statistics for accountability procedures' variables *Source*: Author's calculations using SPSS

| ID | Statements | Disagree | | Neutral | | Agree | | Strongly agree | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Freq | % | Freq | % | Freq | % | Freq | % | |
| Q.5 | The usage of the ontological model refines sharing of information and semantics | 0 | 0 | 0 | 0 | 25 | 29.8 | 59 | 70.2 | 4.7024 |
| Q. 6 | The usage of the ontological model can support the development of a tax question-answering system | 0 | 0 | 31 | 36.9 | 42 | 50 | 11 | 13.1 | 3.7619 |
| Q.7 | An ontology-based knowledge management can improve tax revenue with a high degree of transparency and accountability | 0 | 0 | 7 | 8.3 | 25 | 29.8 | 52 | 61.9 | 4.5357 |
| Q.8 | ontology-based knowledge management Framework can help users in decreasing the cost of tax advisors and errors | 0 | 0 | 12 | 14.3 | 26 | 31 | 64 | 54.8 | 4.4048 |
| | Total average | | | | | | | | | 3.571 |

**Table 3** Descriptive Statistics for Tax risks' variables *Source*: Author's calculations using SPSS

| ID | Statements | Disagree | | Neutral | | Agree | | strongly agree | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Freq | % | Freq | % | Freq | % | Freq | % | |
| Q.9 | An ontology-based knowledge management can reduce Transactional risk | 0 | 0 | 14 | 16.7 | 26 | 31 | 44 | 52.4 | 4.3571 |
| Q.10 | An ontology-based knowledge management can reduce Operational risk | 0 | 0 | 12 | 14.3 | 25 | 29.8 | 47 | 56 | 4.4167 |
| Q.11 | An ontology-based knowledge management can reduce Compliance risk | 0 | 0 | 12 | 14.3 | 25 | 29.8 | 47 | 56 | 4.4167 |
| Q.12 | An ontology-based knowledge management can reduce Financial accounting risk | 0 | 0 | 12 | 14.3 | 25 | 29.8 | 47 | 56 | 4.4167 |
| Q.13 | An ontology-based knowledge management can reduce Portfolio risk | 0 | 0 | 12 | 14.3 | 19 | 22.6 | 53 | 63.1 | 4.4881 |
| Q.14 | An ontology-based knowledge management can reduce Management risk | 0 | 0 | 5 | 6 | 23 | 27. 4 | 56 | 66.7 | 4.6071 |
| Q.15 | ontology-based knowledge management can reduce Reputational risk | 0 | 0 | 10 | 11.9 | 25 | 29.8 | 49 | 58.3 | 4.4643 |
| | Total average | | | | | | | | | 4.167 |

between ontology-based knowledge management and reducing tax risks) was accepted.

## Discussion

In order to assess the impact of ontology-based knowledge management on mitigating tax risks and enhancing accountability procedures, an empirical study was conducted. The study involved the development of a tax ontology to test the research hypotheses. Various instruments were employed, including documentary analysis, interviews, and surveys utilizing questionnaires. The sample consisted of Egypt, a developing country characterized by high corruption rates and significant tax risks.

The research instruments encompassed a questionnaire, interviews, and documentary analysis. A survey was conducted to validate the experimental study. Data from the questionnaire were analysed using SPSS version 24.0. Descriptive statistics, Pearson correlation, and Chi-Square tests were utilized to test the hypotheses and examine the relationships between the variables under investigation.

The results of the documentary analysis revealed the government's overall direction and successful implementation of the comprehensive development plan of the Egyptian Tax Authority. Ministry of Finance Statement No. (296) for the year 2020 emphasized the importance of digitization and automated processes, ensuring swift tax examination procedures and the provision of accurate and immediate information. The government is committed to modernizing the tax system, simplifying procedures, and introducing automation. Resolution No. (296) for the year 2020 completed the electronic tax returns system, enabling the submission of all tax returns electronically, regardless of the taxpayer's legal or natural person status.

The findings derived from semi-structured interviews conducted with both taxpayers and tax examiners shed light on numerous challenges and requirements faced by the current tax system. These challenges include the availability and accessibility of tax-related records when needed, prompt response to inspections and audits, secure electronic archiving with predefined user access controls, and the ability to generate reports using advanced business intelligence. These challenges contribute to the existence of various tax risks and highlight the need for improving tax accounting procedures. These findings provide substantial evidence supporting the necessity of enhancing tax accounting procedures and reducing tax risks.

The empirical analysis findings indicate a positive correlation between ontology-based knowledge management and the improvement of accountability procedures ($r = 0.85$, $p < 0.01$). Furthermore, a positive correlation was observed between ontology-based knowledge management and the reduction of tax risk ($r = 0.79$, $p < 0.01$).

The findings of this study have several implications in the context of existing research on ontology-based knowledge management, tax risks, and accountability procedures. Firstly, the positive correlation between ontology-based knowledge management and the improvement of accountability procedures aligns with prior studies that emphasize the significance of knowledge management in enhancing organizational processes and transparency. This suggests that leveraging ontologies can effectively contribute to strengthening accountability mechanisms within the tax system.

Secondly, the positive correlation between ontology-based knowledge management and the reduction of tax risk reinforces previous research that highlights the role of knowledge management in mitigating risks and improving compliance. By employing ontologies to manage tax-related information and facilitate automated processes, organizations can minimize the

**Table 4** Outcomes of testing the study hypothesis *Source*: Author's calculations using SPSS

| ID | Hypothesis | Pearson correlation | Chi-square |
|---|---|---|---|
| H1 | There is a relationship between ontology-based knowledge management and improving the procedures of tax accounting | 0.85 | 0.00 |
| H2 | There is a relationship between ontology-based knowledge management and reducing tax risks | 0.79 | 0.00 |

occurrence of errors, identify potential risks more efficiently, and enhance overall tax compliance.

Furthermore, the study's findings shed light on the specific challenges faced by the current tax system in Egypt, such as record availability, prompt response to inspections, secure electronic archiving, and advanced business intelligence capabilities. These challenges resonate with existing literature, emphasizing the importance of addressing these issues to improve tax accounting procedures and reduce tax risks. The study thus contributes to the existing body of knowledge by providing empirical evidence of these challenges within the Egyptian tax context.

Despite the valuable insights gained from this study, there are several limitations that should be acknowledged. Firstly, the research focused on a specific developing country, Egypt, and its findings may not be directly generalizable to other countries or regions with different socio-economic and institutional contexts. Replicating the study in other countries would provide a more comprehensive understanding of the relationship between ontology-based knowledge management, tax risks, and accountability procedures.

Secondly, the sample size of the study might limit the generalizability of the findings. Although Egypt was selected due to its high corruption rates and significant tax risks, the sample's representativeness may be a concern. Future research could aim for larger and more diverse samples to enhance the external validity of the study. Additionally, the reliance on self-reported data through questionnaires and interviews introduces the potential for response biases. Participants may provide socially desirable responses or inaccurately report their experiences and perceptions. Combining self-reported data with objective measures, such as tax compliance records or financial indicators, would strengthen the robustness of the findings.

Lastly, the study focused on the impact of ontology-based knowledge management on accountability procedures and tax risk reduction without considering other potential factors or interventions that could influence these outcomes. Future research could explore additional variables and control for confounding factors to provide a more comprehensive understanding of the relationships examined in this study.

Overall, while the findings of this study contribute to the existing literature, it is crucial to consider the limitations outlined above and further explore these research areas to strengthen the validity and applicability of the findings.

## Conclusion

This study has explored the impact of ontology-based knowledge management on improving tax accounting procedures and reducing tax risks, with a specific focus on the income tax system in a developing country. By adopting a mixed methodology approach and gathering data through document analysis, interviews, and questionnaires, valuable insights have been obtained.

The findings of this study hold significance for both academic researchers and accounting practitioners. The results have revealed several advantages associated with the utilization of ontology in tax management, including cost reduction, error reduction, and improved transparency and accountability in tax revenue handling. The empirical analysis has further confirmed a positive correlation between ontology-based knowledge management and improved accountability procedures, as well as a positive correlation with the reduction of tax risks. These findings provide empirical evidence of the actual effects of implementing ontology-based knowledge management in enhancing tax accounting procedures and mitigating tax risks. The results of this study are in line with the studies of Distinto, Guarino and Masolo [10], An and Wilson [12], and Bhatta, Ghimire, and Buranarach [15] that using ontology can be considered a key component for knowledge management in the tax authority. Therefore, it is an important tool to reduce tax risks and improve accountability procedures. It achieves many benefits such as decreasing the cost of tax advisors, reducing errors, increasing sharing of information and semantics, avoiding irrelevant knowledge and improving tax revenue. The results of this study support findings from Qiu, Cheng, and Alghazzawi [13] and Bierbrauer, Boyer, and Hansen [4] that there are many benefits such as decreasing the time information retrieval. The results of the current study agree with the results of previous studies that dealt with the advantages of utilizing ontology in knowledge management [e.g. 9, 14, 15, 16] such as achieving

data integration, accurate and consistent knowledge representation, and facilitation of decision-making.

By demonstrating the potential benefits of ontology-based knowledge management in tax administration, this study contributes to the existing body of knowledge. It highlights the value of adopting ontology models to optimize tax processes and improve overall efficiency and compliance. The findings also emphasize the importance of knowledge management practices in tax authorities, particularly in developing countries where there may be unique challenges and risks associated with tax administration.

Both academics and accounting practitioners can benefit from the insights provided by this study. The findings offer valuable guidance for researchers exploring the intersection of knowledge management and tax administration and can inform the development of practical strategies and interventions to enhance tax accounting procedures and reduce risks.

Despite the study's contribution, it has some limitations that offer promising opportunities for future research. Firstly, the research focused on a specific developing country and may not be fully generalizable to other contexts. Secondly, this study investigates one type of direct tax which is a tax on individuals' income and did not address the other taxes. Thirdly, the data were only taken one time during the duration of this study. Therefore, it did not capture the developmental issues such as changes in individuals, and restrictions of rules to participants. Additionally, a simplified of ontology-based knowledge management framework was created that does not contain all the tax data of the Egyptian income-tax authority. Finally, there is a need to know the role of ontology-based knowledge management in the Integration of tax authorities. The significance of these issues needs to be further explored in the future research.

**Abbreviations**

| | |
|---|---|
| KM | Knowledge management |
| LOD | The linked open data |
| RDF | Resource description framework |
| SD | The subject domain |
| CMB | Common method bias |
| SPSS | The Statistical Package for Social Science |

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## Declarations

**Ethics approval and consent to participate**
Not Applicable.

**Consent for publication**
I am hereby giving acceptance for publication of my manuscript.

**Competing interests**
There are no competing interests.

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## Publisher's Note