

# **Automatic Formulation of the Internal Control Report over Financial Reporting**

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## Abstract :

The evaluation of the internal controls over financial reporting is a difficult task which has to be learned over the years. Experience is a good teacher in this respect. So, education guided by experience may be expected to be fruitful. The purpose of this paper is to model, implement, and validate a knowledge-based system, called the "Auditor's Report on Internal Controls over Financial reporting" (ARICOFR), that is capable of formulating the opinion on the effectiveness of internal controls over financial reporting, as expressed in the auditor's report on internal controls over financial reporting. The main research questions studied in this study are: (1) can ARICOFR carry out the task of evaluating the internal controls over financial reporting equally as may be expected from an experienced auditor? If so, (2) how should ARICOFR be constructed and validated? And (3) to what extent is ARICOFR effective, efficient, and acceptable as a tool to help auditor evaluate the effectiveness of internal controls over financial Reporting? The knowledge used by ARICOFR is developed from the literature, and from qualified auditors through questionnaires and in-depth interviews. After putting into practice, the knowledge base is presented to experienced auditors for review. The ARICOFR performance is confirmed by test cases. From the consequences of the confirmation, we may conclude that ARICOFR is fruitful in performing the task of evaluating the internal controls over financial reporting.

### ملخص البحث :

تقييم الرقابة الداخلية علي التقارير المالية هي مهمة صعبة يجب تعلمها علي مر السنين. وتعتبر الخبرة معلم جيد في هذا الصدد. لذا من المتوقع أن يكون التعليم المسترشد بالخبرة مثمرا. الهدف من هذه الدراسة نمذجة واستخدام والتحقق من صحة نظام مبني علي المعرفة يسمي " تقرير المراجع عن الرقابة الداخلية علي التقارير المالية" (ARICOFR) يكون قادر علي صياغة الرأي حول فاعلية الرقابة الداخلية علي التقارير المالية كما ورد في تقرير المراجع حول الرقابة الداخلية علي التقارير المالية. الأسئلة البحثية الرئيسية التي تحاول هذه الدراسة الإجابة عليها هي : (١) هل يمكن ل ARICOFR أداء مهمة تقييم الرقابة الداخلية علي التقارير المالية علي نحو مماثل كما هو متوقع من مراجع متمرس؟ إذا كان الأمر كذلك ، (٢) كيف يتم إنشاء ARICOFR والتحقق من صحته؟ ، (٣) إلي أي مدي يكون ARICOFR فعال وكفاء ومقبول كأداة لمساعدة المراجع علي تقييم فاعلية الرقابة الداخلية علي التقارير المالية؟. يتم الحصول علي المعرفة المستخدمة من قبل ARICOFR من أدب المحاسبة والمراجعة ومن المراجعين ذوي الخبرة وذلك من خلال الاستبيانات والمقابلات المتعمقة. بعد التنفيذ يتم تقديم قاعدة المعرفة للمراجعين ذوي الخبرة وذلك للمراجعة. يتم التحقق من أداء ARICOFR من خلال حالات إختبار. أشارت نتائج التحقق الي أن ARICOFR ناجح في أداء مهمة تقييم الرقابة الداخلية علي التقارير المالية.

## 1. Introduction

Management is responsible for establishing and maintaining the entity's internal controls over financial reporting. According to Section 404 of Sarbanes-Oxley Act, management is also required to publicly report on the operating effectiveness of internal controls over financial reporting. In contrast, the auditor of a public company is required by Section 404 of SOX Act to attest management's report on the effectiveness of internal controls over financial reporting. Since 2004, larger public companies have been required by the SEC to annually obtain an auditor's report on internal controls over financial reporting (Lopez, Vandervelde & Wu, 2006; Institute of Internal Auditors, 2008; Romney & Steinbart, 2012; Arens et al., 2014). The PCAOB's protocol to require the Audit of the firm's Internal control over financial reporting (ICOFR) system and make that evaluation public information seems to be an excellent corrective (Gaber, Garas, Luck, 2019).

Standard unqualified audit report loses some credibility when it is combined with an adverse entity-level internal controls over financial reporting report as alleged by some users (Asare and Wright, 2012). Section 404 of the Sarbanes-Oxley Act stated that each annual report contains an internal control report, which shall (1) state the responsibility of management for establishing and maintaining an adequate internal control structure and procedures for financial reporting; and (2) contain an assessment of the effectiveness of the internal control structure and procedures of the issuer for financial reporting.

Since company managers and auditors depend on their personal judgments during the stage of evaluating the internal controls, this may lead to different company managers and auditors reaching different decisions on the effectiveness of internal controls over financial reporting, depending on, among others, their experience and expertise (Curtis and Hayes, 2002; O'Leary, 2003).

To formulate their opinions on the management's assessment of internal controls over financial reporting, auditors use a "personal-judgment" method. In performing so, they greatly depend on their own experience and expertise. Such a method may be ineffective and may cause different auditors coming to different decisions, developing an individual

bias, increasing/decreasing audit scope, and/or giving misleading judgments.

To overcome the deficiencies of a “personal-judgment” approach, auditors can do an electronic evaluation and formulation of the opinion of internal controls over financial reporting by a computer program, as a knowledge-based system (KBS). But the intriguing question is: can a computer program support the managers to evaluate the effectiveness of internal controls and to help auditors evaluate the management’s assessment on the internal controls over financial reporting? We can summarize the study problem by the following questions: (1) can ARICOFR perform the task of evaluating the internal controls over financial reporting equally as may be expected from an practiced auditor? (2) how could ARICOFR be constructed and confirmed? An (3) to what extent is ARICOFR effective, efficient, and acceptable as an instrument to help auditor evaluate the effectiveness of internal controls over financial Reporting?

A computer program, as a knowledge-based system (KBS), may be capable to evaluate the internal controls and formulate the opinion on internal controls over financial reporting and does so sufficiently will reduce the inconsistencies of the individual judgments (cf. Brown and Murphy, 1990; Flory, 1991; O’Leary, 2003). Hence, an electronic evaluation and formulation of the opinion of internal controls over financial reporting by a computer program, as a knowledge-based system (KBS), may provide five benefits: (1) preservation of expertise, (2) efficiency, (3) training, (4) effectiveness, and (5) improving an auditor’s ability (Wahdan, 2006). It may expedite auditors’ opinions on internal controls over financial reporting, thus expressing those opinions more dependable.

Moreover, a KBS for such a job could also be used as an internal training instrument at auditing firms to form the experience of junior auditors. It will help managers detect the weaknesses in their organizations’ internal controls more effectively and efficiently and prepare the assessment of internal controls as required by section 404 of SOX act. It may help the developing countries comply with international standards and apply the rules of Sarbanes Oxley act to decrease the fraud and corruptions in financial and managerial aspects. It will increase the likelihood that the auditors’ opinions on internal controls over financial reporting comply with

the International Standards on Auditing (ISA) (IFAC, 2010), components of COSO's internal control model, Sarbanes Oxley act (Krishnan & Visvanathan, 2007) or any other similar acts. This study examines to what extent it is possible to computerize the evaluation of the internal controls over financial reporting with a KBS. This KBS will help auditor to evaluate the management's evaluation on the internal controls over financial reporting according to SOX act.

In our examination, we established a KBS called the "Auditor's Report on internal controls Over Financial Reporting" (ARICOFR), which is able to evaluate the internal controls over financial reporting. ARICOFR contains all knowledge associated with the auditor's opinion on both the effectiveness of internal controls and the management's assessment on the internal controls over financial reporting. ARICOFR is directed in particular to the auditing practice in Egypt. This nation may have only a limited number of qualified auditors who are sufficient in evaluating the internal controls, in particular in E-Commerce environment (Wahdan, et al., 2005; Wahdan, & Van den Herik, 2012).

To progress ARICOFR, knowledge was collected from the literature and from a suitable set of qualified auditors through questionnaires and in-depth interviews. The initial validation consequences acquired from qualified auditors in Egypt, using investigation cases and in-depth interviews, indicate that ARICOFR successfully achieves the task of evaluating the effectiveness of internal controls over financial reporting.

The outline of the paper is as follows. Section 2 deals with literature review. Section 3 presents the research methodology. Section 4 describes the conceptual model of ARICOFR. Section 5 deals with the actual implementation of ARICOFR. Section 6 shows the validation and evaluation. Section 7 discusses the research limitations. Section 8 illustrates our main conclusions and point at forthcoming study.

## **2. Literature Review**

KBS has been applied to an abundance of decision problems in financial and production domains, such as for supporting investments decisions (see Poh, 2000), for performance measurement (Ammar, Duncombe, Jump, & Wright, 2004; Khan & Wibisono, 2008; Wang, Huang, & Lai, 2008), for

formulating budget planning - which is called Knowledge-based Intelligent Decision Support System or KIDSS system (Wen et al., 2005), for supporting business in small financial institutions (Chung & Pak, 2006), for supporting decision on credit granting - which is called Moody's KMV Risk Advisor™ or MRA (Kumra et al., 2006), for formulating the auditor's opinion - which is called Auditor Report EXpert or AREX (Wahdan, 2006), for optimising portfolio management (Bao & Yang, 2008), for measuring logistic performance - which is called knowledge-based logistics performance measurement system or KLPMS (Choy et al., 2008), for financial knowledge management (Shiue et al., 2008; Cheng et al., 2009), for evaluating the credit worthiness of customers using balance scorecard strategic planning opinions - which is called BSC knowledge-based system or BSCKBS (Huang, 2009), for selecting supplier/customer with the consideration of benefits, opportunities, costs, and risks (Lee, 2009), for determining cost-volume-profit analysis (Yuan, 2009), for determining (pro)-performance appraisal (Chen & Chen, 2010), for obtaining customer-buying patterns (Jayanthi & Vishal, 2011) and for clarifying financial ratios (Gunawan, 2012), for assessing materiality level at the audit planning stage Materiality Expert (MEX) (Wahdan & Hassan, 2019).

While organizations develop information systems, auditors must adapt their approaches to comply with the fast evolution of these systems. Auditors need computerized tools and techniques to improve the audit process (Egerdahl, 1995). The need for KBSs in different areas, in particular in auditing, is one avenue for improving an organization's competitive edge with less cost and lower risk (Mattei, 2001; Killingsworth, Hayden, and Schellenberger, 2001; Gunawan, 2012). The audit is a decision process. It can be divided into four categories namely: (1) an information acquisition decision, (2) a design activity, (3) an opinion decision or choice, and (4) an action (cf. Jacob and Bailey, 1991; Brown and Eining, 1997; Wahdan, 2006; Gunawan, 2012).

The audit process includes 4 phases: (1) planning and designing an audit method, (2) performing tests of controls, (3) performing analytical procedures and tests of details of transactions and balances, and (4) completing the audit and issuing the auditor's report (Arens et al., 2014). In terms of functional areas, Brown and Murphy (1990) & Vinze and Karan

(1991) differentiate 3 areas where a KBS can enhance the audit process: (1) the audit program development, (2) the internal control assessment and risk analysis, and (3) the technical support.

In this research, we remark that previous KBSs in auditing are classified into four categories, which correspond to four audit phases: (1) audit planning (audit phase 1), (2) internal-controls evaluation (audit phase 2), (3) going-concern uncertainties (audit phase 4), and (4) auditor's opinion (audit phase 4). These systems are briefly presented as follows. (1) Audit planning systems that relate to the first audit phase include (1a) AUDITPLANNER (Steinbart, 1987) and (1b) CAPEX (Boritz and Wensley, 1992, 1996) (1c) Materiality Expert (MEX) (Wahdan & Hassan, 2019). (2) Internal-controls evaluation systems that relate to the second audit phase and include (2a) EDP-XPERT (Hansen and Messier, 1992), (2b) INFAAUDITOR (Akoka and Comyn-Wattiau, 1996, 1997), and (2c) INTERNAL CONTROL KNOWLEDGE (Changchit, Holsapple, and Viator, 2001). (3) Going-concern uncertainties systems that relate to the final audit phase include (3a) GC ADVISOR (Lenard et al., 1998) and (3b) HYBRID GC ADVISOR (Lenard et al., 2001). (4) The auditor's opinion systems that relates to the final audit phase are: (4a) AOF (Hegazy, 1992), (4b) AUDPORT (Smith and McDuffie, 1996) and (4c) AREX (Wahdan, 2006).

Consistent with Auditing Standard No. 5, (Asare, et al. 2013) delineate five phases of the ICOFR audit: (1) planning; (2) scoping; (3) testing; (4) evaluation; and (5) reporting. With regarding to Internal-controls evaluation systems (our main concern), there are three systems as follows.

#### (2a) EDP-XPERT

In 1992, Messier and Hansen continued the evaluation of EDP-XPERT developed by them in 1986 (EDP-XPERT is an expert system for assisting computer audit specialists' judgements on the reliability of controls in advanced computer environments). The results of that evaluation indicated that EDP-XPERT performed well on test cases but its performance declined on actual audits (Messier and Hansen, 1992).

#### (2b) INFAAUDITOR

Fifteen years ago, Akoka and Comyn-Wattiau (1996, 1997) presented the INFAAUDITOR to aid the auditor in auditing management information

systems. The knowledge base consists of the characteristics of the enterprise, its information system, and the audit objectives. The rule bases encompassed the criteria, the general audit tree, and the rules of customization. INFAAUDITOR was successfully applied to several real-life situations.

#### **(2c) INTERNAL CONTROL KNOWLEDGE**

Changchit, Holsapple, and Viator (2001a) developed an expert system to facilitate the transfer control knowledge to management. The findings of the study indicated that the expert system could help managers to detect the weaknesses in their organizations' internal controls more effectively and efficiently. Changchit, Holsapple, and Madden (2001b) developed another study for the same purpose with results similar to the former. Both studies have two restrictions arising from their limited scope. First, they concentrate only on the evaluation of controls commonly found in the sales and collection cycle in the merchandising industry. Second, the knowledge of this system is based on one auditor's experience (expert specific).

Hwang et al.(2004) presented a prototype design support model called "CRAS-CBR" using case-based reasoning to help auditors making their professional judgments on the control risk assessment of the accounting systems in the manufacturing industry. The results of the experiment indicated that CRAS-CBR outperforms staff auditor performance and a statistical model. However, this study depends only on a small sample size.

Marand and Bayaz (2015) purposed to discover the impact of computerized accounting systems on the auditing risk management in listed firms of Tehran stock exchange. The results of the study indicated that the computerized accounting system has a positive impact on the inherent risk in forms of reducing the internal control weakness, reducing the risk of sampling related to tests of controls and providing with a suitable method to assess the inherent risk.

Han et al. (2015) dealt with the association between information technology (IT) and audit risk. They found that the IT complexity generates challenges for auditors in evaluating the effectiveness of internal control and detecting accounting irregularities. However, IT decreases the audit risk by improving operations and internal control effectiveness which may decrease the inherent and control risks.

Davis et al. (2017) described a case approach for teaching internal control evaluation in sales and cash receipts cycles using Excel spreadsheet

tool. The case and spreadsheet application provide students an opportunity to deeply understand and analyse the accounting processes, the internal controls, and the interrelationships between the processes and controls. The finding of the study indicated that the students were significantly increased their abilities to evaluate internal controls by completing the case (their average score increased from 44% to 62%).

There are 3 main restrictions related to previously established KBSs made for an auditing area. They are: (1) the knowledge bases indicate only the expertise of a single practitioner, so the capability to generalize the system's conclusions is constrained (Changchit, Holsapple, & Viator, 2001), (2) the KBSs do not indicate any real decision-making in auditing firms – they achieve well on examination cases but their performance decreases on actual audit cases (Smith and McDuffie, 1996; Collier, Leech, & Clark, 1999; Lenard, Alam, Booth, & Madey, 2001; Lenard, 2003), and (3) they do not deal with the audit process as a whole, but concentrate instead on limited sides of the auditor's concern within a definite cycle (they do not consider the following sides: understanding internal controls environment, investigating management integrity, investigating control procedures, walking-through of significant accounts, tests of controls, and internal controls over financial reporting). Also, preceding studies disregarded the role of users in evolving a knowledge base and building an description facility (Akoka and Comyn-Wattiau, 1996; Mak, Schmitt, & Lyytinen, 1997; Bayraktar, 1998; Changchit et al., 2001a).

So far, a whole KBS for expressing the auditor's opinion on internal controls over financial reporting received little attention in the literature. To the best of our knowledge, previous research has failed to deal adequately with the complexities of the task of evaluating the internal controls over financial reporting. Up till now, no single KBS has been developed which executes this task in practice, as we established during a survey among local and international auditing firms in the Middle East (a pilot study by the author).

### **3- Research methodology**

To progress ARICOFR, knowledge was attained from the literature and from a proper set of qualified auditors through questionnaires and in-depth interviews, using the Knowledge Acquisition and Design Systems (KADS)

method (cf. Schreiber, Wielinga, & Breuker, 1993; Post, Wielinga, & Schreiber, 1997). ARICOFR is applied using the Knowledge Representation Objects Language (KROL) (Shalan, Rafea, & Rafea, 1998). After application, the knowledge base was confirmed by qualified auditors. The auditors were determined relying on at least one of the following 3 items: (i) the number of years of experience (at least 10 years), (ii) the level of education (at least a bachelor degree of accounting and auditing), and (iii) some work performed in international auditing firms. A preliminary study was carried out to examine the clarity and validity of the questions in all questionnaire lists.

Part of the study is based on the two surveys conducted: (i) to elicit knowledge from auditors, and (ii) to validate and evaluate ARICOFR by Egyptian auditors and students. Our study was divided into the following seven steps.

1. The knowledge needed to build ARICOFR was learned from the literature.
2. The first questionnaire (knowledge elicitation) coupled with in-depth interviews, using the KADS methodology as a model-driven approach, was used to elicit the knowledge from experienced auditors in the audit firm.
3. The acquired knowledge was confirmed by allowing the auditors review the consequences of the knowledge-acquisition process. Differences between two or more auditors were first given to a small sample of the auditors for determination. If they could not reach agreement, the leading expert made the last decision.
4. A prototype of ARICOFR was constructed and implemented, using the KROL language, based upon the knowledge collected and elicited in the steps one and two, and reviewed in step three.
5. A primary confirmation of ARICOFR was approved in Egypt. A questionnaire was distributed to 40 auditors. The questionnaire contained mainly of twelve auditing cases that needed to be handled by the auditors as test cases. The test cases were handled by ARICOFR too, and the opinions of ARICOFR were compared to the auditors' opinions. In addition, five auditors who used the

ARICOFR in hypothetical cases expressed their opinions on the performance of ARICOFR.

6. A final version of ARICOFR was implemented based on the findings of the preliminary validation, and an additional revision of the knowledge acquired in the first three steps, including the pilot study, and the first survey.
7. ARICOFR was run and was processed on test auditing cases by Master students. In addition, the questionnaire number 2 and in-depth interviews were used to evaluate the effectiveness, efficiency, and acceptance of ARICOFR.

## **4. Conceptual Model OF ARICOFR**

This section presents the evaluation of the internal controls (4.1), the internal controls over financial reporting (4.2) and the conceptual model of ARICOFR (4.3).

### **4.1 Evaluation of the internal controls**

A company's manager is mainly concerned with presenting the results of the company's operations as acceptable as possible. This concern may conflict with the aim of preparing accounts to present a reasonable opinion. The auditor's report gives credibility to financial reports by confirming the methods and procedures used to report the company's findings (Guy, Carmichael, & Lach, 2003; Arens *et al.*, 2014). The auditor is responsible for examining the compliance with GAAP and for attesting that financial reports are fairly presented (Whittington and Pany, 2003; PCAOB, 2007; Hayes, Dassen, Schilder, & Wallage, 2005; Boynton and Johnson, 2006). To do so, the auditor performs many tasks; from these tasks the evaluation of internal controls (ISA, 400) to determine the audit scope, as the auditing standard (ISA 400) requires that the auditor obtains adequate understanding of internal controls. If the auditor is convinced that the auditee has appropriate and adequate internal controls, the amount of audit evidence will be less than when internal controls are inadequate (Manson and Zaman, 2001; Locatelli, 2002; IFAC, 2010).

So, any program for examining control will aim at determining the control risk (CR), which seeks to determine internal controls' reliability and

the amount of audit evidence required to support the assessment of the control risk. To assess the effectiveness of the internal controls for planning audit evidence, auditors need to understand the key internal controls and assess the control risk according to COSO's internal control model (IFAC, 2010; Arens et al., 2014).

#### **4.2 The internal controls over financial reporting**

According to some recent corporate scandals the Sarbanes-Oxley Act of 2002 (SOX) is issued. This Act required the disclosure of three new reports related to the effectiveness of a company's internal controls: (1) The management's report on the effectiveness of the internal controls, (2) the auditor's opinion on the management assessment of the effectiveness of internal controls (the auditor will issue an unqualified opinion on the management's assessment of internal controls if he agrees with management's assessment, and will issue an adverse opinion if he does not agree with the management's assessment), and (3) the auditor's opinion on the effectiveness of internal controls (the auditor will issue an unqualified opinion on the effectiveness of internal controls if there are no material weakness in the internal controls, and will issue an adverse opinion if there are material weakness in the internal controls) (Lopez, Vandervelde, & Wu, 2006). After SOX was passed, the management must: (a) base its evaluation on COSO's internal control model, (b) disclose all material internal controls weaknesses, and (c) conclude that a company does not have effective financial reporting internal controls if there are material weaknesses (Romany & Steinbart, 2012). The five interrelated components of COSO's internal control model are Control environment, risk assessment, Control activities, information and communication, and monitoring (Arens, et al., 2014; Romany & Steinbart, 2012). PCAOB auditing standard 5 requires the audit of internal control to be integrated with the audit of the financial statements (See figure 1). However, the auditor may choose to issue separate report or a combined report (PCAOB, 2007; Arens, et al., 2014).

<p><b>FORM</b></p> <ol style="list-style-type: none"> <li>1. Title</li> <li>2. Addressee</li> <li>3. Date of the report</li> <li>4. Name of specific location where the auditor maintains an office</li> <li>5. Auditor’s signature</li> </ol> <p><b>CONTENT</b></p> <p><b>Introductory Content</b></p> <ol style="list-style-type: none"> <li>1. Identification of the financial statements audited</li> <li>2. Identification of the definition of internal control over financial statements</li> <li>3. Identification of the date and period covered by the financial statements</li> <li>4. Statement that: maintaining effective internal controls over financial reporting and assessing its effectiveness are the responsibility of management and that the responsibility of the auditor is to express an opinion thereon</li> <li>5. Statement that: preparing the financial statements are the responsibility of management and that the responsibility of the auditor is to express an opinion thereon</li> <li>6. [Identification of the framework used to evaluate the internal controls]</li> </ol> <p><b>Scope</b></p> <ol style="list-style-type: none"> <li>1. Identification of the relevant national auditing standards or practices</li> <li>2. Statement that: the audit was planned and performed to obtain reasonable assurance about whether the financial statements are free from material misstatements</li> <li>3. Description of the audit as examining, on a test basis, the evidence to support the financial statement amounts and disclosures</li> <li>4. Description of the audit as assessing the accounting principles used in the preparation of the financial statements</li> <li>5. Description of the audit as assessing the significant estimates made by management in the preparation of the financial statements</li> <li>6. Description of the audit as evaluating the overall financial statements presentation</li> <li>7. Statement that: the audit provides a reasonable basis for an opinion</li> <li>8. [Statement that: the audit of the internal controls over financial reporting includes obtaining an understanding of internal control, evaluating an assessment of management, and evaluating the design and operating effectiveness of the internal controls over financial reporting]</li> <li>9. [Identification of the inherent restrictions of the internal controls over financial reporting]</li> </ol> <p><b>Opinion</b></p> <ol style="list-style-type: none"> <li>1. Clear statement of opinion as to whether the financial statements are fairly presented in all material respects</li> <li>2. Clear statement of opinion as to whether the financial statements are prepared in accordance with the financial reporting framework</li> <li>3. Clear statement of opinion as to whether the financial statements comply with statutory requirements, if applicable</li> <li>4. Clear statement of which country’s accounting principles have been used</li> <li>5. [Clear statement of opinion as to whether an assessment of management on the internal controls over financial reporting is fairly stated]</li> </ol>
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**Figure 1: Elements of the auditor’s report according to the ISA 700 and [Section 404].**

The latter ones are given in square brackets [ ]

Sources: PCAOB (2007) adapted.

### 4.3 Conceptual Model Structure

Our conceptual model structures the process of examining and determining the control risk (CR), which seeks to determine internal controls reliability and amount of audit evidence required to support the assessment of the control risk. To assess the effectiveness of the internal controls for planning audit evidence, auditors need to understand the key internal controls and assess the control risk. It is common practice that if the auditors rely on the internal controls, they will reduce the amount of substantive tests, which they have to execute (Arens et al., 2012). A common approach used by auditors, to determine the reliability of the internal controls, consists of three stages: (1) obtaining an understanding of the internal controls at a detailed level, (2) assessing the control risk and identifying the possibility of reducing it, and (3) testing the effectiveness of the internal controls. An auditor may not conclude that the control risk is low before completing all these three stages (Locatelli, 2002; Guy et al., 2003; Arens et al., 2014, Wahdan, 2018).

To complete the test of evaluating internal controls, the conceptual model of ARICOFR distinguishes many sub-models (see Figure 2). Figure 2 illustrates the steps required to evaluate the effectiveness of internal controls and assess the control risk. The arrows in Figure 2 indicate that the output from one of the submodels is used as input for the other. For example, the output of the submodel of understanding internal controls forms the input of the following submodels: assessing management integrity, examining documents and records, and investigating management attitude.

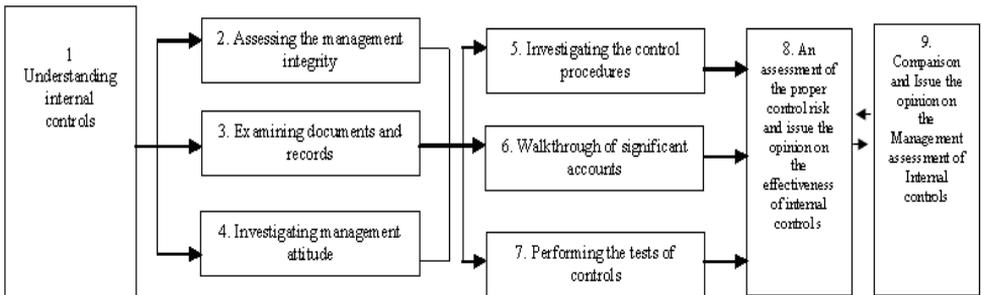


Figure 2: The conceptual model of ARICOFR.

We list the nine sub-models together with a short explanation as the following:

- (1) The submodel of *understanding internal controls* provides an *understanding* of the control environment and accounting system sufficient to set up the audit plan of financial statements (Guy et al., 2003; Boynton and Johnson, 2006; Arens et al., 2012). They have to be concerned with the controls regarding the reliability of financial reporting to comply with the second GAAS fieldwork, the SAS 78 (Lenard, 2003), the ISA 330, and the ISA 400 (IFAC, 2010). The SAS 78 and ISA 400 require the auditor to obtain an understanding of the internal controls for every audit. In obtaining an understanding of internal controls, the auditor should consider two issues, viz. the design of controls and their placement in operation (Arens et al., 2014). Auditors can use five procedures to evaluate the design of controls and placement in the operation: (1) updating and evaluating an auditor's previous experience with the company, (2) making inquiries of the auditee personnel, (3) reading an auditee's policy and systems manuals. (4) Examining documents and records, (5) observing the company activities and operations (PCAOB, 2007; Arens et al., 2014). The transaction walk-through can combine observation, documentation, and inquiry. The auditor selects a representative sample of documents for the initiation of a transaction type and traces them through the entire accounting process in the transaction walk-through (Ernst and Young, 2002; Arens et al., 2014) (See Figure 5 and information available from the authors).
- (2) The management integrity submodel contributes to assess whether the financial statements are auditable. For example, in figure 5 (middle), the management integrity are affected by many factors. Some factors indicate a lack of management integrity, including the presence of one or a few individuals dominating management of the enterprise, improper accounting system, improper internal controls, false earnings, poor reputation, considerable turnover in senior positions, taking unusual risks, or poor relationships with auditors, customers, stockholders, and/or employees. If management integrity is questionable, false representations cause the auditor to rely on unreliable evidence.

- (3) The submodel of assessing the adequacy of documents and records contributes to assess whether the financial statements are auditable, if the accounting records (source of the audit evidence) are unreliable and/or inadequate, the audit evidence may not be accessible. When the auditor concludes that the financial statements are not auditable, the engagement is withdrawn or a disclaimer of opinion is issued (Arens et al., 2014).
- (4) The submodel of investigating management attitude (control environment) checks actions, policies, and procedures that affect management attitudes with respect to internal controls. The auditor should understand the control environment to assess the management's attitude and awareness regarding the controls importance (Colbert, 2000; Munter, 2003; IFAC, 2010).
- (5) The submodel of control procedures tests efficiency of controls activities. As shown in figure 5, control activities include adequate segregation of duties, proper authorisation of transactions and accounts, adequate documents and records, safeguarding controls, and independent checks on performance (Changchit, and Holsapple, and Viator, 2001, Arens et al., 2014), if management gives less attention to internal controls, the control activities may be unreliable and the control risk should be at the maximum.
- (6) The submodel of walk-through of significant accounts tests whether the results of investigating the significant accounts supports the low assessment of control risk (Ernst & Young, 2002; Arens et al., 2014).
- (7) The tests of controls submodel evaluates whether the internal controls are designed and operated as contemplated in the preliminary assessment of control risk (Arens et al., 2014). The auditor should obtain audit evidence through tests of controls to support any assessment of control risk below the maximum. The lower the assessment of control risk, the more support the auditor should obtain that internal controls are suitably designed and effectively operated.
- (8) The control risk submodel assesses the proper control risk after collecting the outputs from all the above submodels. If the auditor identifies the assessed level of control risk as the maximum, the conclusion should be documented. However, if it is below the maximum, the bases and reasons of that conclusion should be documented (Guy et

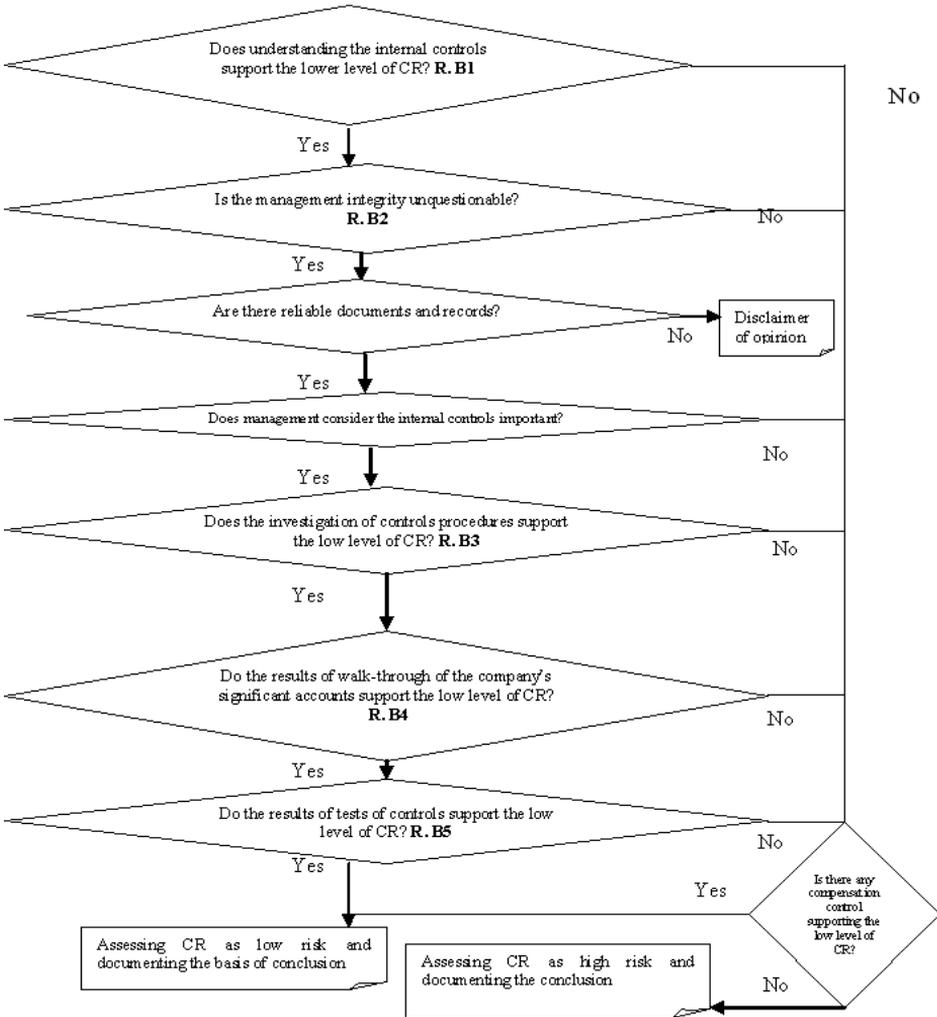
al., 2003; Boynton and Johnson, 2006; Arens et al., 2014) (See figures 3 and 5).

- (9) The auditor's opinion on management assessment submodel assesses whether the auditor agrees with the management assessment of internal controls. This submodel compares the output of submodel (8) with the management assessment of the effectiveness of internal controls and formulates the opinion on internal controls over financial reporting (See figures 2, 4 and 5).

## **5. ARICOFR Implementation**

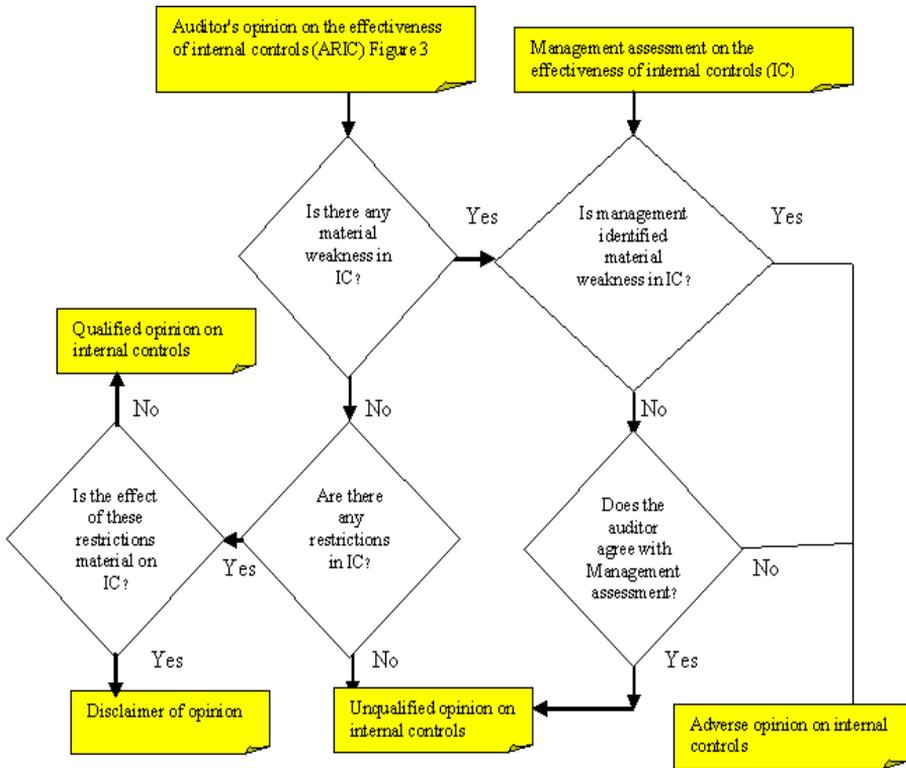
Knowledge acquiring is the extraction of knowledge from experts. It is a primary bottleneck to the development of dependable and practically usable KBSs (Jones and Miles, 1998). Therefore, the knowledge needed to construct ARICOFR was attained from the literature on ISA (IFAC, 2010), academic resources, journals, and from the qualified auditors. The knowledge acquisition process was designed according to the KADS methodology, using the submodels specified in the preceding section. In the development phase, knowledge was elicited from 40 qualified auditors during interviews. Questionnaire No. 1 (available from the authors) was designed to acquire the qualified auditors' knowledge and classified into nine parts, each covering one submodel. The attained knowledge was confirmed and differences between the auditors were resolved.

It is observed that knowledge engineers are using shells and devoted AI languages (Van den Herik, 1988) that contributes to accomplish the task. Thus, we use KROL (Shalan, et al., 1998) to represent the ARICOFR knowledge. KROL combines object and rule processing. This combination allows the task of expressing the auditor's opinion on internal control over financial reporting to be classified into appropriate frameworks for more effective programming and system operation. To represent the ARICOFR knowledge, we used concepts, properties, prompts, values, and value sources.



**Figure 3: The model of examining controls.**

R.B1, 2,3,4,5 means Relations B1, 2,3,4,5 (from the authors)



**Figure 4: The Auditor's opinion on internal controls over financial reporting**

The ARICOFR expertise framework differentiates between three kinds of knowledge:

First, the area knowledge comprises the knowledge needed for preparing the auditor’s report on internal control over financial reporting. The ARICOFR area knowledge is kept in a concept hierarchy comprising of items with their relations. Questionnaire no 1 (available from the author) is used to acquire knowledge from the experienced auditors. Figure 5 depicts the ARICOFR concept hierarchy.

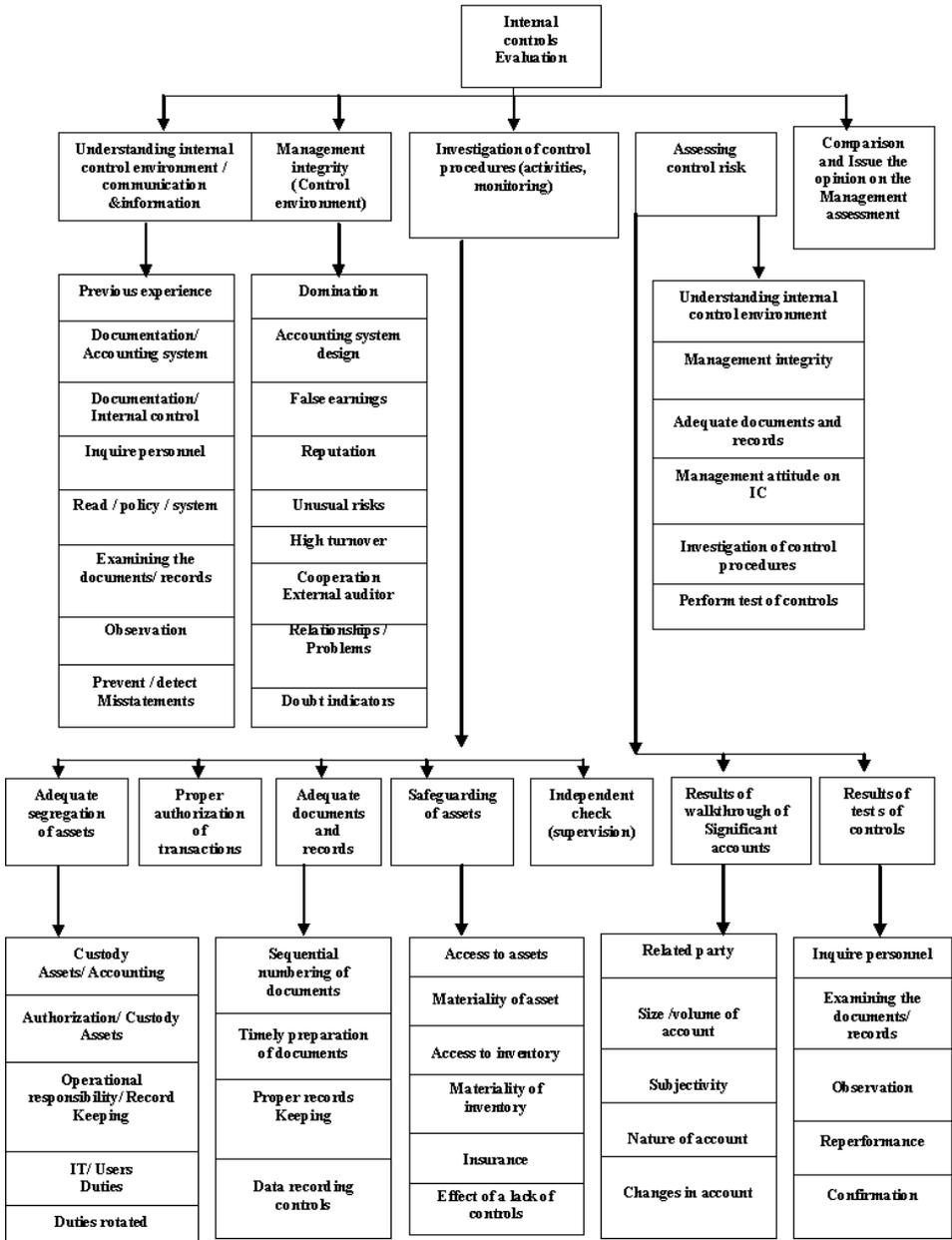


Figure 5: ARICOFR concept hierarchy.

Second, the interpretation knowledge includes knowledge that is used in the reasoning process (Brown and O’Leary, 1995). We used programmed rules. ARICOFR produces the appropriate auditor’s opinion on internal control over financial reporting by implementing user-supplied facts to the programmed rules. Third, the task knowledge is knowledge on the expressing of the auditor’s opinion on internal control over financial reporting and the appropriate activities. In ARICOFR, the nine sub-models are used to construct the information that the user must supply. Table 1 shows the main concepts and sub-concepts. Each concept has properties, prompts (questions), values, and value sources.

**Table 1: model of examining controls**

Concept	Property	Prompt	Value	Source_of_Value
control_risk	controls_design_operation_advice	Understanding of internal control	Supports the low level of control risk / does not support the low level of control risk	Derived / relation B1/ understanding_internal_controls
	management_ingerity_advice	The management integrity	Was questionable / Was unquestionable	Derived / relation B2 / management_Performance
	a-reliable_documents_records	Are there reliable documents and records?	Yes / No	User
	b-management_attitude	Does management consider internal control important?	Yes / No	User
	control_procedures_Advice	Control procedures	Support the low level of control risk / does not support the low level of control risk	Derived / relation B3 / investigation_control_procedure
	walk-through_significant_processes	Walk-through of Significant processes	Supports the low level of control risk / does not support the low level of control risk	Derived / relation B4/ significant_accounts

**Table 1: model of examining controls**

Concept	Property	Prompt	Value	Source_ of_ Value
control_ risk	test_controls_support_low	Tests of controls	Support the low level of control risk / do not support the low level of control risk	Derived /relation B5 / tests of controls results
	c_compensation_controls	Is there any compensation control supporting the low level of control risk?	Yes / No	User
	Advice		Level of control risk is	maximum, document the conclusion / below the maximum, document the basis of conclusion
The auditor is advised to formulate his opinion as			Disclaimer of opinion, auditor is not independent / withdraw from audit process, unreliable documents and records	
Auditor's opinion on internal controls	a.management_assessment	Are the internal controls effective?	Yes / No	Management report
	b.auditor's opinion	Is the any agreement between the management assessment and the auditor assessment of internal controls	Yes/no	Derived/ submodel 8/ control risk & submodel 9 / management_ assessment

Interaction with ARICOFR occurs through a user interface and an description facility. By the user interface, users can source ARICOFR with information in two different methods. The first method is by sequential questions posed by ARICOFR, i.e., ARICOFR queries the user on needed information. The second method is by sheet screens. The user can select the values and/or the order of values, which he/she would like to allocate to

assets, and can so acquire information on how the system works, why assets are needed, and how middle conclusions are derived. It provides the possibility of removing any inappropriate items, of printing conclusions and their reasoning (See Table 2), of stopping the program, and of going to the preceding and next submodels (see Figure 6). As will as, the help screen of ARICOFR, shown in Figure 7, illustrates more description to the user concerning how ARICOFR operates and explains its conclusion.

**Table 2: The value of the input and the output attributes.**

‘A model of examining controls (Investigation of control procedures)’

Concept	Property	Value
control_procedures	a_effective_supervision_controls_internal_auditors	yes
control_procedures	b_separation_custody_assets_accounting	yes
control_procedures	c_separation_authorisation_custody_assets	yes
control_procedures	d_separation_operational_responsibility_record_keeping	yes
control_procedures	e_separation_IT_users_duties	yes
control_procedures	f_duties_rotated	yes
control_procedures	g_pre_sequential_numbering_documents	yes
control_procedures	h_timely_preparation_documents	yes
control_procedures	i_proper_records_keeping	yes
control_procedures	j_controls_data_recording	yes
<b>Output:</b> Investigation of control procedures: ‘supports the low level of control risk’		

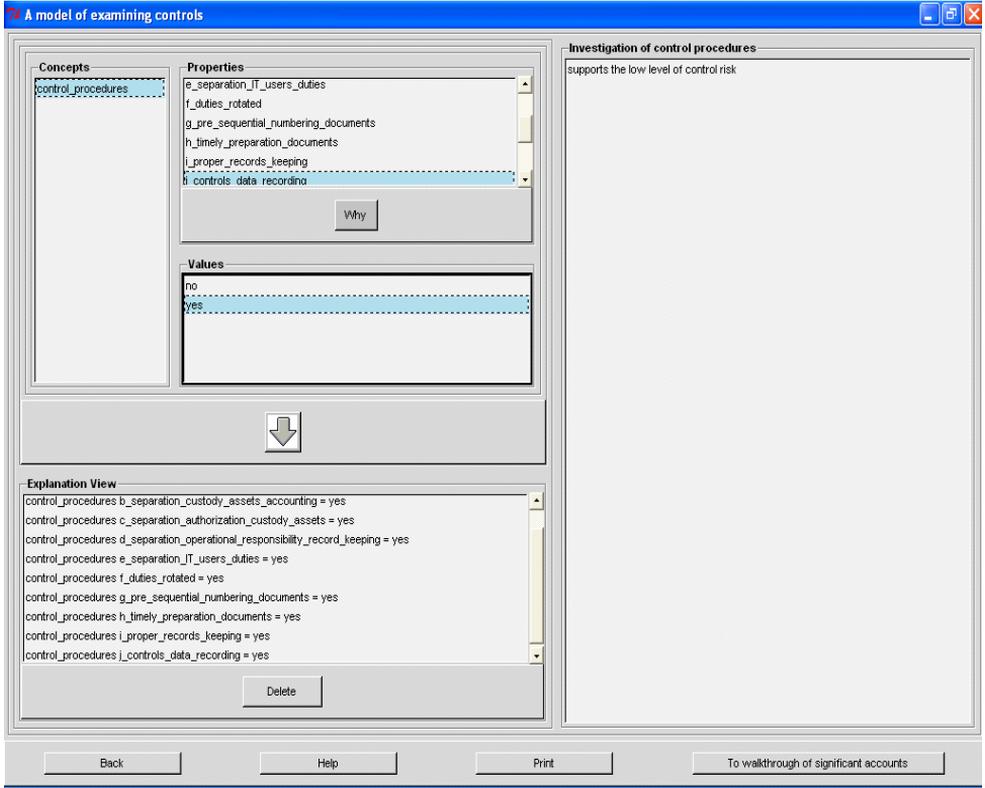


Figure 6: Sheet screen.

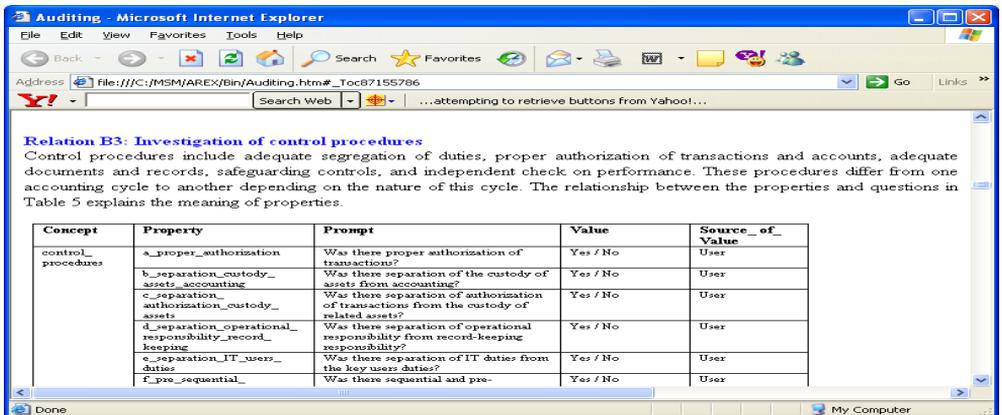


Figure 7: The help screen in ARICOFR.

## 6. Validation and Evaluation

In the following we illustrate the validation and evaluation of ARICOFR. It begins with a primary validation (6.1), followed by an auditors' evaluation (6.2).

### 6.1 Preliminary Validation

Validation is an essential concept in the development, realisation, and implementation of a model (cf. Kumra et al., 2006). In particular, we may state that the validation process is crucial as we would like to know whether ARICOFR is functioning "as intended" (cf. Khan & Wibisono, 2008). A primary validation of ARICOFR was achieved in Egypt as follows. *First*, questionnaire No. 2 (available from the authors) was distributed on 40 auditors. It consisted of twelve auditing cases that required to be handled by the auditors as assessment cases. These assessment cases were handled by ARICOFR too. *Second*, the results produced by ARICOFR were compared to the auditors' results. The results of the comparison showed that there was severely some 15% of differences in decisions between ARICOFR and the auditors. We discussed the reasons of the different decisions with the auditors. After discussion, we conclude that ARICOFR achieved better than the auditors; the auditors reviewed their decisions according to ARICOFR's results. Furthermore, we make some changes and improvements in ARICOFR. *Third*, five auditors were attracted to use the ARICOFR example in their own assumed cases. The results showed that ARICOFR achieved the task of assessing the internal controls in a manner identical to their own assessment.

### 6.2 Auditors' Evaluation

After the auditors had processed test auditing cases and review the logic of ARICOFR through ARICOFR flowcharts of the nine submodels, we choose a sample of twenty students who study a Master degree at Faculty of Commerce, Menoufia university in 2012 (their field is accounting and auditing). The students processed the test cases using ARICOFR. We examine their attitudes by questionnaire No. 3 (available from the authors) using five-point Likert scales (ranging from strongly agree = 5 to strongly disagree = 1). The examined data contain the students' assessment of

ARICOFR's effectiveness (6.2.1), its efficiency (6.2.2), and its acceptance (6.2.3). A summary of the results is given in Table 3.

**Table 3: Students' evaluation of ARICOFR**

Part 1: Statements – Effectiveness	SA %	A %	N %	D %	SD %	Agreement Frequent %
1. ARICOFR is useful in practice	50	35	10	5	0	85
2. ARICOFR is valuable as a training device for new auditors	45	45	5	5	0	90
3. ARICOFR's logic is sound	60	30	5	5	0	90
4. ARICOFR approached the task of formulating the auditor's opinion on the effectiveness of internal controls in the same manner I would	65	25	5	5	0	90
5. ARICOFR helps auditors better understand the way they formulate their opinions on the effectiveness of internal controls	45	45	5	0	5	90
6. ARICOFR helps auditors formulate their opinions on the effectiveness of internal controls according to COSO's internal control model	70	25	5	0	0	95
7. ARICOFR provides guidelines for auditors and management as to the required procedures to express their opinions on the effectiveness of internal controls	60	25	5	5	5	85
8. ARICOFR provides the auditors with the appropriate auditor's opinion on the effectiveness of internal controls	55	30	5	5	5	85

<b>Part 2: Statements - Efficiency</b>	<b>SA %</b>	<b>A %</b>	<b>N %</b>	<b>D %</b>	<b>SD %</b>	<b>Agreement Frequent %</b>
1. ARICOFR decreases the time required for expressing the auditor’s opinion on financial reports	55	15	15	10	5	70
<b>Part 3: Statements – Acceptance</b>	<b>SA %</b>	<b>A %</b>	<b>N %</b>	<b>D %</b>	<b>SD %</b>	<b>Agreement Frequent %</b>
1. It is easy to follow the logic of ARICOFR	65	20	5	5	5	85
2. ARICOFR’s advice may be trusted	70	20	5	5	0	90
3. ARICOFR’s advice is professionally accepted	45	40	10	5	0	85
4. ARICOFR needs improvements	20	5	30	35	10	40

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree.  
 Agreement Frequent % = SA % + A %

**6.2.1 Effectiveness**

Effectiveness concerns with the influence of ARICOFR on the decision quality, and high accuracy (Baldwin-Morgan and Stone, 1995; Changchit et al., 2001a). The effectiveness of ARICOFR contains both user-friendliness, which is the system’s ability to explain questions and conclusions, and probable usefulness, which is the system’s ability to meet an auditor’s needs (Baldwin-Morgan and Stone, 1995). From Table 3, part 1, we may conclude that ARICOFR is effective in accomplishing the task of assessing the effectiveness of internal control over financial reporting (Agreement percentage is not less than 85%).

**6.2.2 Efficiency**

Efficiency may be determined by the time needed to achieve a task or by the number and administrative levels of individuals involved in the task (Back, 1993-1994; Changchit et al., 2001a). From Table 3, part 2, we may

conclude that the use of ARICOFR may increase the individual productivity (Agreement percentage is equal to 70%).

### 6.2.3 Acceptance

The auditors' acceptance of ARICOFR is affected by the auditors' confidence in the ARICOFR's recommendations and the ease of using ARICOFR (cf. Boritz and Wensley, 1992). From Table 3, part 3, we may conclude that the users have confidence in ARICOFR logic and conclusions (Agreement percentage is not less than 85%) and ARICOFR still needs some improvements ((Agreement percentage is equal to 25%).

Lastly, the dependability of the students' answers determined by internal constancy (Coefficient Alpha is 0.787). This means that there is a high constancy among the students' answers on the questions in questionnaire No. 3. During and after the validation, it was clear that the auditors and students were influenced by the result of ARICOFR and by its properties. Furthermore, five experienced auditors proposed several points of how to improve the application of ARICOFR to help auditor formulate the opinion on the internal control over financial reporting and to help management assess the effectiveness of internal controls.

## 7. Research Limitations

The main research limitations are presented below.

- The changes in components of COSO's internal control model will affect the knowledge base of ARICOFR. Therefore, the ARICOFR knowledge base should be continuously updated.
- The knowledge elicitation of ARICOFR is confined to the Egyptian auditors, in particular Egypt does not apply Sarbanes Oxley act.
- The response scale of ARICOFR is restricted to yes or no responses, which may affect the user's attitude in interacting with the system.
- An experimental study should be done to test the impact of ARICOFR (i) on training and educating novices, (ii) on the time required to evaluate the effectiveness of the internal controls, and (iii) on the ease of use.
- The research results depend on Master students' points of view to serve as substitutes for auditors in the evaluation stage. However, if we depend on the auditors within auditing firms, the evaluation results may be different from what had in section 6.

- Using test cases only may affect the effectiveness of the ARICOFR; the test cases are designed by the researcher and reviewed by auditors, so some bias may be expected. Using actual auditing cases should be done and may provide different results.

## **8. Conclusions and Future Research**

This study describes how we model, implement, and validate of ARICOFR. It answers the questions: (1) can ARICOFR accomplish the task of assessing the internal controls over financial reporting likewise as may be expected from an qualified auditor? If so, (2) how should ARICOFR be built and validated? And (3) to what extent is ARICOFR effective, efficient, and acceptable as an instrument to help auditor assess the effectiveness of internal controls over financial Reporting? From our application, tests, and validations we may conclude two main conclusions: (1) ARICOFR is successful in preparing the auditor's report on internal control over financial reporting, and (2) the nine sub-models embodied in ARICOFR are correct.

More definitely, the students' assessment of the effectiveness, efficiency, and acceptance of ARICOFR are quite positive, i.e., they scored well on our scales. From the reviews of 5 highly qualified auditors in local and international auditing firms in Egypt, we may conclude that the following statements are true: (1) the task of formulating the auditor's opinion on internal control over financial reporting can be achieved by a KBS, and (2) ARICOFR is appropriate and acceptable to express the auditor's opinion on internal control over financial reporting.

Being able to produce a proper auditor's opinion on internal control over financial reporting there are three issues for future study. First, the auditor's requirements should be examined and substantiated. Second, auditors should list a number of recommendations to include in ARICOFR in order to improve the performance any further. Third, ARICOFR should be tested using actual auditing cases.

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