

Protocol Analysis Data Collection Technique Implemented for Artificial Intelligence Design

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Abstract— This article suggests that artificial intelligence (AI) can automate protocol analysis, a form of data analysis in cognitive psychology for inferring the information processes used by individuals from their verbal behavior while solving a problem. We propose a framework to employ think-aloud protocols (TaP) and thematic analysis in qualitative accounting research. Specifically, we use the TaP methodology to explore the impact of legal conflict and the lack of international financial reporting standards (IFRS) knowledge on implementing these accounting standards in a developing country (i.e., Iraq). The article analyzes 32 semi-structured in-depth phone interviews with external auditors, preparers, the capital market, national professional accounting and auditing associations, and academics. The results indicate that the lack of an AI framework, IFRS knowledge, and legislation conflict may adversely interact with standard implementation. This article explores how protocol analysis can benefit from AI support and provide design features. Protocol analysis can provide opportunities for future article, design, and action.

Index Terms— Artificial intelligence (AI), concurrent think-aloud, international financial reporting standards (IFRS), institutional theory (IT), protocol analysis, retrospective think-aloud.

I. INTRODUCTION

IT is becoming abundantly clear that artificial intelligence (AI) algorithms embedded in ubiquitous digital technology can encode societal biases, spread conspiracies, disseminate fake news, magnify echo chambers of public opinion, usurp our attention, and even impair our mental well-being [99]. One method that may abate biases encoded into algorithms is encapsulating protocol analysis into AI design. This paper presents protocol analysis as a tool for studying human behavior within an AI structure. Protocol analysis has been used extensively by researchers within the fields of psychology and AI. The goal is to build a detailed model of a person's cognitive rules by extracting such rules from verbal protocols and formalizing them in a computer algorithm [38, p. 470]. Therefore, protocol analysis may widen our understanding of cognitive processes by reaching into covert behavior. This

process allows for a more comprehensive structure for studying and understanding individuals' behavior since cognitive processes are expressed in scripts and different types of heuristics [97].

Further, protocol analysis is closely related to AI, and work has been performed to automate the analysis [77]. Protocol analysis can provide data on both external and internal search behavior. In addition, it provides an opportunity to discover the cognitive process implemented to generate a problem space. This procedure can be obtained by collecting data from the onset when a person is exposed to the task instructions until the person begins to work on the task [91, p. 110]. The link to AI is imperative since the analysis comprises extraction of meaning, inference from data, and induction of new sets of rules [100].

Moreover, protocol analysis opens new avenues for studying the decision-making and human creativity in management and cognitive psychology [102]. AI is defined as leveraging computers and machines to mimic the human mind's cognitive processes, problem-solving, and decision-making capabilities [101]. To this end, this study proposes a methodical protocol analysis process to record and analyze an individual's thought sequences for AI implementation [40]. This study informs the ongoing debate on the benefits of using AI-based research tools in science ([44], [52], [63]). Waterman and Newell [119] articulated that protocol analysis is a task for AI, which enables the essential problems to be highlighted, the task representations and the methods to be implemented for use.

Protocol analysis is one of the most efficient procedures for evaluating the usability of an AI system and targeting aspects of the system that should be changed to improve usability [119]. Protocol analysis increases the transparency of the methods and definitions applied to AI technology. Therefore, our study is motivated by protocol analysis as a form of data analysis, which has been used in the psychology of problem-solving ([16], [84]). Our analysis is based on the subject speaking while attempting to decipher a problem, their verbalizations are transcribed, and the underlying information processes are surmised from their content.

For example, natural language processing (NLP) is a subfield

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of AI, linguistics, and computer science concerned with the interactions between computers and human language. In addition, it is an effective tool for generating structured information from unstructured data. It is also a derivative of protocol analysis in that it endeavors to build AI-based computers and machines that understand and respond to text or voice data as well as respond with text or speech of their own in much the same way people do ([15], [24], [99]). Recently, Berdanier *et al.* [15] have used NLP in qualitative data analysis methods by analyzing a corpus of 54 interview transcripts investigating graduate engineering exhaustion. More recently, Caratozzolo *et al.* [24] provided evidence that using NLP tools could help instructors give better feedback, review oral and written communication skills, and provide personalized reports.

Our study builds on Johnson *et al.* [63] premise of the gradual adoption of AI-based research tools in business research and the augmentation of the typical research process steps until the full automation meets current standards. Our study provides a framework that shows how AI can assist in a step-by-step process (1) problem formulation, (2) literature search/screening process, quality assessment/ data extraction of think-aloud protocols, and finally, (3) our data analysis and interpretation as depicted by the results and conclusion (see Table I).

Our problem formulation is underlined by Newell and Simon [85], who developed an information processing model via psychological research that forms the foundation for the think-aloud protocol (TaP) data collection technique. Ericsson and Simon [43] and Jones [64] contended that verbalization reflects individuals' cognitive behavior and working memory's information stored in a current moment. Moreover, verbalization can facilitate the pattern recognition process, as depicted in AI apparatuses [98]. That is, verbal facilitation can describe supporting recognition patterns of several different facets of individuals' experience.

The literature search/screening process is formulated by asserting that TaP is extensively used in prior research: nursing and clinical ([62], [72], [74], [78], [105]); computer (e.g., [25], [110], [115]), education (e.g., [30], [116], [121]); sport [e.g., 120], Psychology (e.g., [9], [79]) and marketing (e.g., [14], [112]). This process allows us to better understand AI planning and implementation of design algorithms [101]. Furthermore, the AI process is enhanced by learning how protocols are recorded in manuscripts and through speech.

Nonetheless, this process gained little attention in the accounting, information systems, and management literature; hence, the main objective of this study is to extend the qualitative accounting research by using TaP and protocol analysis to explore two of the main impediments (i.e., legal system and lack of knowledge) that encumber the implementation of IFRS in an emerging setting, (i.e., Iraq).

	as machine learning and deep learning.	and forest trees. Further, it enables fundamental problems to be better calibrated and addresses task representations and methods to be implemented for use.
Literature search	AI programs are automated by including extraction of meaning, inference from data, and induction of new rule sets.	The application of protocol analysis assists in opening the “black box” by labelling and addressing concepts in machine learning. Moreover, this process can overcome the limitations of the current knowledge in a determinate field to bridge a “knowledge gap.” Bringing something new in a scarcely explored field. Validating or nullifying previous results obtained in limited records by protocol studies in a broader population.
Screening for inclusion	Employing software is designated to speed up screening abstracts and titles with a minimum of papers to be read by a person with no or very few false negatives.	AI-generated software can lead to far more efficient processes by reviewing the protocols driving the machine’s learning apparatuses while displaying reasonable quality ([100], [101]).
Quality assessment	Employing TaP (concurrent and retrospective) and protocol analysis	Employing an Automated Detection of Implicit Theory (ADIT) technique of Larsen <i>et al.</i> [70] for researchers capable of designing and programming machine learning classifiers.
Data extraction	Protocol analysis procedures include data extraction requires researchers to identify relevant parts of qualitative and quantitative data and transfer them to a (seCi) structured coding sheet.	Utilize Robot Reviewer, a machine learning system that automatically assesses bias in experiments [113].
Data analysis and interpretation	From the protocol analysis, conveying insightful and profound interpretations of aggregated evidence or descriptive overviews.	Assessing the potential for future AI-based tools to support data analysis by considering various statistical and graphical technologies ([6], [69]).

TABLE I
AI-BASED TOOLS FOR STEPS OF THE TAP PROCESS

Steps	AI-Based Tools	Potential For AI-Support
Problem formulation	Protocol analysis assists with the design program for AI apparatuses such	Protocol analysis enables coding AI tools, such as machine learning, using decision

IFRS is a significant development in accounting professions that diminishes the divergence of financial statements [65] and constitutes a common global business language [17]. A large body of IFRS literature provides theoretical arguments and empirical evidence on the benefits of IFRS. For example, it is found that IFRS is associated with improved quality of financial statements (see, e.g., [28], [46], [55]), better disclosure and transparency [94], an improved financial statements comparability (e.g., [12], [23]), and an increased degree of convergence and harmonization (e.g., [2], [47], [53], [71], [83], [92], [95], [96]).

Nonetheless, a strand of literature challenges the view that the change to stricter accounting standards per se is sufficient to improve the quality of financial reporting (e.g., [10], [11], [22], [27], [32]). Our study argues that the institutional setting in which these standards are implemented is a crucial determinant that shapes the accounting system, fostering or hindering IFRS implementation. We accentuate the importance of other institutional factors when mandating IFRS, such as enforcement regimes and the ability of accountants to apply these standards.

Therefore, promoting IFRS as the ideal set of accounting standards that fits all countries' needs is challenged because not all economies or firms (users) have the same needs for accounting systems [118], which is mainly shaped by the institutional setting that it serves and the legal system that it is guided by. For example, in socialist-oriented economies, the legal system may resist IFRS to maintain the dominance of accounting standard-setting [1]. Daske *et al.* [33] find that the benefits of IFRS adoption are only apparent among firms with strong incentives to be transparent. Thus, our study addresses whether and how the legal system and lack of knowledge influence IFRS implementation in an emerging economy setting.

We use institutional theory (IT) as a primary theoretical basis that provides a clear insight into how the legal conflict and lack of IFRS knowledge affect IFRS implementation. IT investigates intra-organisational structures, strategies, and procedures that are primarily shaped by extra-organizational institutional environmental factors. IT also considers how rules, structures, norms, schemes, and routines are considered authoritative guiding ideologies for social behavior [108]. This theory is appropriate to our research because it explains the role of environmental factors in shaping IFRS implementation. Thus, it enhances our understanding of why IFRS is not implemented in some countries despite its benefits.

Pertaining to quality assessment/data extraction, we conducted thirty-two semi-structured in-depth phone interviews with external auditors, preparers, the capital market, national professional accounting and auditing associations, and academics. Using TaP (concurrent and retrospective) and protocol analysis to collect data, the results show that professional accountants and auditors lack the knowledge required to implement IFRS. In addition, the findings indicate that the overlapping and conflict between laws adversely affect the implementation of such accounting standards.

Protocol data analysis and interpretation are the processes of assigning meaning to the collected information and determining the conclusions, significance, and implications of the findings. That is, AI and data analytics are the capacities to analyze and learn about large amounts of protocol data from multiple sources and detect patterns to make future trend predictions. This process enables organizations to benefit from this type of "predictive analytics" to make decisions about production, marketing, and development [102]. Furthermore, a useful protocol analysis process to draw causal inferences from data could be divided into the following stages:

1. Find interesting patterns in the data.
2. Explain those patterns (e.g., using experimental manipulation to understand the link between cause and effect); and
3. Use those patterns and explanations.

Our data analysis and interpretation add to the information systems and research methodology studies in two ways. First, although prior research has generated a wealth of insights about TaP, it provides a less clear framework for its implementation. Second, little attention has been paid to exploring the challenges that may encumber its implementation of protocol analysis in emerging AI settings. In this study, we use TaP with protocol analysis to explore the performance and progress of participants' cognitive processes for problem-solving issues and identify the causes of the problem based on their perspectives [80]. We are unaware of any published work in management that uses both concurrent and retrospective TaP when collecting the data. Our study advances the literature by proposing a framework for applying TaP in qualitative research and provides an approach for applying both concurrent and retrospective TaP useful in AI research. Second, Johnson *et al.* [63] and Wanger *et al.* [117] show how AI can be integrated with the research steps. Our study extends this line of research and provides a framework that shows how AI can assist in the typical steps of the research process.

The remainder of this paper proceeds as follows: Section 2 provides background about AI and think-aloud protocols and the theoretical base of the paper. Section 3 explains the research methodology, while Section 4 discusses the empirical findings and concludes the paper.

II. BACKGROUND

A. AI and think-aloud protocols

Newell was one of the founders of AI and a pioneer in using computer simulations in psychology, a prelude to AI. In collaboration with Cliff Shaw and Herbert Simon, Allen Newell developed the first list-processing programming language and the earliest computer programs for simulating human problem-solving. First, the task to be automated requires an AI program, which includes extraction of meaning, inference from data, and induction of new sets of rules. Further, the task of protocol analysis in AI represents a scientific process in experimental psychology. Nonetheless, protocol analysis does not reflect a more formal approach in AI [85]. Unlike many AI tasks currently holding a central stage, protocol analysis reveals a

lack of formality and an inherently inductive character that characterizes many other scientific activities.

Examples of tasks utilized by protocol analysis include puzzles, cryptarithmic, elementary logic problems, chess, binary-choice sequence prediction, geometry proofs, word problems in mathematics, concept identification for the induction of various logical and sequential concepts [43], and various understanding tasks such as NLP [99].

A protocol is an oral procedure, voiced aloud, that discloses the systematic evolution of an individual's problem-solving and decision-making behavior [64]. However, this description of verbal protocols may not respond sufficiently to inquiries related to the nature of cognitive thought raised by philosophers during the 17th, 18th, and 19th centuries whereas most philosophers of introspective analysis reflected their thought based on their self-analysis ([40], [41]).

TaP is an approach to human behavior analysis through verbal reports founded by Lewis [73] and advanced by Ericsson and Simon [43]. Think-aloud techniques are built on two assumptions: cognitive processes and a two-memory system. The cognitive process is the process of categorizations and sequences of internal situations converted by processing an information system ([8], [39]). The two-memory systems include long-term memory, which is responsible for storing and retrieving information, and short-term memory, which is immediately accessible and has a temporary storage capacity ([9], [41], [42]). The foremost differences between the two memories relate to their capacity and accessing features [78]. Short-term memory has a small capacity (i.e., temporary storage), and its content is immediately accessible, while long-term memory has a larger size (i.e., permanent storage) with intermediate duration [43].

Some studies consider working memory, which transfers data from short-term to long-term memory and retrieves information and vice versa, as a memory between long-term and short-term memories [78]. Linden [76] claims that short-term memory and working memory, to some extent, have the same functional neuroanatomy, capacity limitations, and cognitive architecture that partially overlap with long-term memory. This cognitive process is the principal of the think-aloud technique; TaP is best employed by transferring participants' information stored in long-term memories to short-term memories before the verbalization process. TaP is acknowledged as a valid and reliable data collection method [104] that helps gain insights into participants' cognitive processes [54], and neither requires a large sample size nor highly skilled participants [86].

Prior studies distinguish between concurrent and retrospective think-aloud protocols ([2], [56], [115]). Concurrent TaP is the action of asking participants to perform a task and then verbalizing whatever crosses their minds for the duration of the task performance [59]. However, in the retrospective TaP, a researcher videotapes/audiotapes the interview and then verbalizes participants' thoughts only after the performance (e.g., [19], [115]). Concurrent TaP is more popular than retrospective TaP, which collects information through observation and interaction between the interviewer

and the interviewees. We assert that TaP is the outcome of participants' brainstorming that uses restored information from long-term memory to short-term memory and the cognitive process required to answer specific questions raised by the interviewer.

Some studies raised concerns about the reliability and validity of TaP. For example, Li [75] questions the investigation's engagement limitation and sterile environments. Nisbett and Wilson [87] also highlighted the challenges of stimulating participants to reach the cognitive process's peak. Lundgrén-Laine and Salanterä [78] claim that preparing a careful data collection plan, providing short practice sessions before the interviews, advising participants, and imposing sampling selection criteria are meaningful in overcoming reliability and validity concerns.

Crutcher [31] discusses three critical issues regarding verbal protocol analysis. (a) the extent to which the verbal protocol accurately reflects participants' thoughts, (b) whether participants alter their views, and (c) whether the data could be processed as objectively as other human behavioral data. Russo *et al.* [104] propose that the reactivity exam is the definitive tool to test the validity of TaP by comparing silent control and contemporary protocols. Ericsson and Simon [43] advise researchers to keep interviewees talking without interruption. However, this practice is challenged by some studies. For example, Boren and Ramey [19] and Yang [123] encourage scholars to interconnect with interviewees and engage with them, but this should be guided by the research design. See Table II for a summary of some TaP studies used in various disciplines.

TABLE II
PROTOCOL ANALYSIS LITERATURE

Author	Field of study	Think-aloud technique
Austin and Delaney [9]	Psychology	Concurrent
Benbunan-Fich [14]	Marketing	Concurrent
Boren and Ramey [19]	Computer	Retrospective vs. concurrent
Chandrashekar <i>et al.</i> [25]	Computer	Concurrent
Cooke [29]	Communication	Concurrent
Cotton and Gresty [30]	Education	Concurrent
Li [75]	Linguistics	Retrospective vs. concurrent
Lundgrén-Laine and Salanterä [78]	Clinical	Concurrent
Magliano and Millis [79]	Psychology	Concurrent
Schrauf [106]	Clinical	Concurrent
Van Den Haak <i>et al.</i> [115]	Computer	Retrospective vs. concurrent
Yang [123]	Humanities	Concurrent
Whitehead <i>et al.</i> [120]	Sport	Concurrent
Tanner <i>et al.</i> [112]	Marketing	Retrospective
Marco-Ruiz <i>et al.</i> [80]	Clinical	Concurrent
Johnsen <i>et al.</i> [62]	Nurse' clinical	Concurrent
Laukvik <i>et al.</i> [72]	Nurse	Concurrent
Siddiq and Scherer [110]	Computer	Concurrent
Vandeveldt <i>et al.</i> [116]	Education	Concurrent
Willey and Tanimoto [121]	Education	Concurrent
Li <i>et al.</i> [74]	Clinical	Concurrent

B. Institutional Theory

The institutional theory extends organizational theory and social change [35], linking organizational legitimacy, organizational practices, and society's values. Legitimacy may be a commonly acceptable perception or an assumption that an entity's actions are acceptable within a socially constructed system's values, beliefs, and norms [49]. Scott [109] provides a valuable framework to investigate the consequence of a higher-level institutional environment on lower-level institutions (entities). He divides the framework into three levels of institutional setting: global and social institutions (at the highest level of the analysis hierarchy), Governance Structures (at the middle level), and entities (at the lowest level). A critical assumption of IT is that every level seeks legitimacy, leading to convergence and isomorphism ([51], [67]).

DiMaggio and Powell [35] distinguish between three isomorphism types: coercive, mimetic, and normative. The isomorphism pressure, which stems from the government and authorities' regulations, is less superficial and less prone to organizations' resistance ([107], [108]). Normative isomorphism, which arises mainly from the profession and professional organizations, refers to norms and social beliefs influencing organizational behavior [34]. The mimetic isomorphism may arise when an organization models its practices on other successful counterparts [34]. Mimetic pressure strives to boost legitimacy by adopting a common structure of reference.

III. METHODOLOGY

A. Pilot study

For the pilot study, data extraction and analysis are paramount in employing Tap for AI purposes (see steps 5 and 6 in Table I). Previous literature provides unclear guidance on collecting data using TaP. Lundgrén-Laine and Salanterä [78, p. 567] explain: "In all of the studies, researchers used retrospective data collection and asked the participants to talk aloud after their performance. Most of the articles do not explicitly discuss the challenges faced by using the various research methods but, instead, merely present individual studies that have used the various methods." Among the references, Lundgrén-Laine and Salanterä [78] found only one article dealing with the research methods in a decision-making study.

Due to the lack of detailed guidance on implementing TaP, we believe conducting a pilot study is inevitable. The pilot study helps revise and reword interview questions and observe other salient factors. Moreover, it helps the interviewer exercise TaP, receive feedback about the interview procedures and test communication mediums. Hence, we emailed seven interviewees asking them to study the interview questions and the consent letter. We also asked the interviewees to determine a suitable date and time for a pilot phone interview. Following the interviews and the comments raised by the interviewees, we deleted, added, or reworded some research questions accordingly.

B. Sample selection

Thirty-two semi-structured phone interviews have been conducted with high-ranking representatives of national professional accounting and auditing associations, experienced external auditors, preparers, the capital market, and academics with significant experience with IFRS. We used a purposive sampling technique to conduct the interviews to ensure data saturation, reached when the thematic analysis revealed no new themes or ideas in the data ([21], [45], [89]). Our initial analysis was performed using ten participants from a diverse sample of experienced participants. After analyzing this data, we modified the interview guidelines for subsequent in-depth interviews to reflect the distinct themes that have been observed. We found that 86% of the codes were identified within the first ten interviews, while 100% were generated after conducting two additional sets of ten interviews. We tested the stopping criteria suggested by Francis *et al.* [45] and the approach suggested by Guest *et al.* [50] by conducting two additional successive interviews to reach data saturation. After these additional interviews, we found that collecting further data was unnecessary since data was becoming redundant. Therefore, we decided not to interview additional participants since no new themes, ideas, or insights emerged from participants' responses ([45], [50]).

TABLE III
INTERVIEWEES' DETAILS

Interviewee Code	Position	Gender	Experience (years)	Date	Duration (Minutes)
1. FM1	ACAD	Male	18	Sep-20	30
2. A1	PREP	Male	11	Sep-20	41
3. CPA1	AAA	Male	26	Sep-20	45
4. CPA2	AUD	Male	22	Sep-20	48
5. A2	PREP	Male	43	Sep-20	50
6. A3	PREP	Male	17	Sep-20	50
7. CPA3	AASS	Male	24	Sep-20	35
8. FM2	ACAD	Female	28	Sep-20	35
9. CPA4	AAA	Male	42	Sep-20	53
10. CPA5	AAA	Male	20	Sep-20	45
11. FM3	ACAD	Male	22	Sep-20	56
12. CPA6	AASS	Male	41	Sep-20	33
13. CPA7	AUD	Male	23	Oct-20	34
14. FM4	AUD	Female	25	Oct-20	30
15. FM5	ACAD	Male	23	Oct-20	30
16. A5	PREP	Male	28	Oct-20	48
17. CPA8	AUD	Male	11	Oct-20	40
18. CPA9	AUD	Male	14	Oct-20	32
19. CPA10	AUD	Male	21	Oct-20	43
20. FM6	ACAD	Male	17	Oct-20	45
21. FM7	ACAD	Male	22	Oct-20	32
22. FM8	ACAD	Male	17	Oct-20	30
23. A6	PREP	Male	16	Oct-20	40
24. FM9	ACAD	Male	9	Oct-20	38
25. CPA11	AUD	Male	18	Oct-20	48
26. FM10	ACAD	Male	14	Oct-20	27
27. CPA12	AUD	Male	22	Nov-20	30
28. A7	PREP	Male	25	Nov-20	40
29. FM11	ACAD	Male	24	Nov-20	38
30. CPA13	ISC	Male	33	Nov-20	53
31. FM12	ACAD	Female	26	Nov-20	30
32. A8	PREP	Male	28	Nov-20	45

ACAD = Academic, AUD = External auditor, PREP = Preparers, AASS = Accounting and auditing standards-setters, AAA = Association of Chartered Accountants, Iraqi Union of Accountants and Auditors, Iraqi Association of Certified Accountants, ISC = Chairman of the Iraqi Securities Commission.

To be informed, invitation letters were sent to all interviewees, explaining the research aim and factors proposed to be explored. We also obtained written approval and consent from interviewees before the interviews and permission to audio record the interview. In addition, we guaranteed participation was voluntary and that the interviewees had the right to refuse to answer any questions and withdraw from the study without any negative consequences. We then requested the interviewees to choose a convenient date and time to set up the interview. We ensured the confidentiality of the data collected and the interviewees' anonymity. A copy of the transcript has been sent to the interviewees to confirm the accuracy of the content of the interview.

About 25% of the interviewees were external auditors, 34% were academic (75% working in public universities and 25% in private universities), and 22% were preparers (i.e., CFOs). As for the interviewees' occupations, 33% of the auditors were heads of auditing companies, 44% were partners in auditing companies, and 23% were owners of auditing bureaus. The interviewees were highly experienced, with 63% having more than 20 years of experience. In contrast, only 6% had 10 years or less. Also, the maximum (minimum) duration was 48 (27) minutes, whereas the average duration was 37 minutes; see Table III for more details about the interviewees. Most interviewees sometimes hold multiple roles (e.g., some academics work as auditors and/or accounting and auditing standards-setters board members). Specifically, 53% of the interviewees hold one role, 32% have two, and 16% hold three positions. However, we consider only the dominant position when interviewing participants with several roles to have a diverse sample.

C. Stages of think-aloud protocols (Problem Formulation)

The first step involves identifying and labelling variables, which are at the heart of AI machine-learning apparatuses ([99], [113]). Therefore, in the following section, we propose a three-stage framework for conducting TaP and combining concurrent and retrospective TaPs to collect qualitative data.

The first stage: sending invitation letters (retrospective TaP)

This stage reflects quality assessment by employing retrospective TaP and protocol analysis (see step 4 in Table I). In the first stage, we employed a retrospective TaP by sending the interview questions via email, allowing the interviewees to study the questions in advance to decide if they wanted to participate. In this stage, the interviewees answer the questions by retrieving information from long-term memory and restoring it to short-term memory. As such, if interviewees were interested and had enough time, they would accept the invitation and confirm their willingness to participate or decline it otherwise. They are also well-prepared to take notes and organize their cognitive thinking before the interview.

This stage is practically and ethically crucial. Practically, participants who accepted the invitation are assumed to be interested in the interview and informed to answer the research questions. Ethically, sending the interview questions in advance to the interviewees avoids causing any harm, embarrassment,

or discomfort. If the participants were interested, they would accept the email invitation or decline it otherwise.

The second stage: conducting the interviews (concurrent TaP)

Quality assessment is instrumental in this stage (see step 4 in Table I). In the second stage, we asked the questions using the same wording and order as the invitation letter. We avoided expressions of (dis)agreement with their responses and pauses between questions. Specifically, we took a series of procedures before and during the interviews to implement the concurrent TaP.

Before commencing each protocol, we allocated a specific code for each interviewee and printed a protocol sheet that included the interview date and the starting and ending times of each protocol. The average time of the interviews was 43 minutes, with a maximum duration of 64 minutes and a minimum of 22 minutes. In addition, we ensured sound quality and tested their preferred communication facility (i.e., JSM network, WhatsApp, Viber, IMO, Tango, Skype).

During the interview, the interviewer introduced himself to the interviewees, acknowledging their participation and repeating all points stated in the invitation letter. Then, the interviewers sought permission to quote responses or audio record the interview where possible. Notes or audio recordings served as a reference tool for the transcription and translation stage. The interviewee also used a professional demeanor and pleasant tone of voice that kept the interviewees focused, avoiding curiosity or debating. The interviewer let participants talk and provided enough explanations and evidence as much as possible, refraining from giving any suggestions and answers or influencing the interviewees' opinions.

The third stage: confirming transcripts' accuracy (retrospective TaP)

In the third stage, we applied retrospective TaP once the interviewees received transcripts and compared verbal reports transcripts with their thoughts, which is necessary for quality assessment (see step 4 in Table I). This cognitive process allows participants to refine and compare the interview content with their beliefs and views, verifying the validity and reliability of the research findings.

D. Data Analysis process

Step six of data analysis (see Table I) emphasizes protocol analysis, which conveys insightful and more profound interpretations of the protocol analysis [113]. Schryen *et al.* [106] advocated that different tools can be implemented for knowledge-building activities. In this study, we used thematic analysis to analyze the data. Braun and Clarke [21] define thematic analysis as identifying, analysing, and reporting meaning patterns. It is the procedure of searching for themes which emerge from careful re-reading of the dataset to analyze and interpret statements in qualitative research ([61], [103]). The theme includes a combination of different codes in a meaningful way. It is a precise pattern of meaning abstracted from the dataset by coding, categorizing, and reflective analysis. Thematic analysis is a theory-flexible analysis that is neither linked to pre-existing theoretical frameworks nor

epistemological approaches [21].

Nonetheless, thematic analysis lacks concise implementation guidelines [5]. In particular, Braun and Clarke [21, p.10] questioned, “What counts as a pattern/theme, or what size does a theme need to be?” A more frequent pattern/theme does not imply that a particular theme is more critical than others that occur less frequently because it relies not on quantifiable measures but on a researcher’s judgement.

Two contrary approaches to thematic analysis are suggested: inductive (data-driven) and deductive (theory-driven). The former could be useful when “investigating an under-researched area or with participants whose views on the topic are unknown” [21, p.11]. The latter is where the researchers provide a more accurate and detailed account of a particular theme(s) related to a specific question(s) within the dataset. The researchers offer “less a rich description of the data overall, and more a detailed analysis of some aspect of the data” [21, p. 12]. This approach, which is followed in our study, is mainly driven by the theoretical research framework and is “explicitly analyst-driven”. Thus, the coding process might evolve research question(s) by focusing on data coding features.

E. Transcription and translation

Since Arabic was the mother tongue of all interviewees, translation was necessary. All audio recordings and notes must be transcribed before conducting a thematic analysis [21]. Transcription provides the researcher with a deep understanding of the dataset ([18], [21]). All content-confirmed transcripts were first translated into English by a professional proofreader and then translated back into Arabic to ensure the accuracy of interview content before performing the analysis.

F. Steps of analysis

We employed an inductive thematic analysis and followed the six-step guidance recommended by Braun and Clarke [21]. In the first step, we familiarised ourselves with the data until we deeply understood each transcript’s content. The transcription and translation advanced our knowledge of the dataset. Thus, we have explored patterns and meanings, considering the interviewees’ backgrounds, ideologies, positions, occupations, and qualifications. We acknowledge what each participant said, their background, position, qualification, focus, ideology, and occupation. Moreover, the notes taken, and the ideas marked for coding assisted the formal coding process.

In the second step (coding), the dataset was coded and supported by the notes taken and the ideas generated during the interviews, transcription, and translation. In this step, we use a pre-coding process by organizing the dataset into meaningful groups based on the interview questions. During pre-coding, a provisional list of codes is created based on the key variables of the study, which are established from a conceptual framework, research questions, and research hypotheses ([13], [81]). Then, several further codes emerged from the dataset. In the third step (searching for themes), we employed QSR-NVIVO software to identify unique themes and their connected codes. This step helped determine the associations among key themes, sub-themes, and codes and draw the analysis map.

We refined and reviewed the candidate themes in the fourth step (reviewing themes). During the review and refinement process, we retained only themes adequately supported by the data. Any themes that lacked sufficient support were discarded. We also identified themes with overlapping or related components and reorganized them by merging or dividing them into multiple categories. This approach helped ensure that the themes accurately reflected the patterns and insights from the analysis. To guide the integration and split of themes, we use criteria proposed by Patton [90] for external (i.e., themes should be distinct) and internal homogeneity (i.e., the data related to each theme should be coherent, identifiable, and transparent). After carefully reviewing and refining the coded data extracts associated with each theme, we sought to determine if they demonstrated a clear and coherent pattern. We then considered the final themes that accurately reflected the patterns and insights that emerged from the data to be included in the thematic map.

In the fifth step, themes were given concise and meaningful names that reflected the data that they captured and the themes they represented [21] (see Table IV). The naming process involves organizing the themes into an internally consistent and coherent account, with an accompanying narrative to identify and explain what is interesting in these themes and why. Finally, we wrote a coherent, concise, engaging, and logical report.

TABLE IV
CODEBOOK

Code	Theme
The legal system	The mandatory implementation of UAS Conflict of laws Lack of harmony between the UAS with IFRS
Lack of Knowledge	Alignment of UAS with the socialist political regime Political instability Lack of education Lack of training Lack of experience

IV. FINDINGS

Despite substantial economic and legal reforms, the Iraqi economy is not yet well integrated with the global economy, in part, due to the non-implementation of IFRS [88]. All Iraqi and foreign companies operating in Iraq, except private banks, must follow the Iraqi Unified Accounting System (IUAS) when preparing their financial statements.

Although some of the principles and assumptions adopted by IUAS are consistent with IFRS, the Keeping Accounting Records Regulation 2 of 1985, which mandates the Iraqi Generally Accepted Accounting Principles (GAAP), mostly conflicts with IFRS. Several institutions and organizations push private banks to implement IFRS, including the World Bank (WB), International Monetary Fund (IMF), Central Bank of Iraqi (CBI), Iraqi Association of Certified Public Accountants (IACPA), Council of Profession Monitoring and Auditing of Accounting in Iraq (CPMAAI), and corresponding banks.

However, the lack of IFRS knowledge and the conflict inherent in the legal system stand as barriers to implementing IFRS. In the following sections, we discuss the pressures for and against implementing IFRS in Iraqi private banks.

A. Coercive pressures

WB and IMF requested that borrowing countries apply IFRS to guarantee the settlement of their loans. WB and IMF present the countries applying IFRS as fertile grounds and well-regulated avenues for international investment (e.g., [3], [4], [7], [57], [60], [68], [82], [122]). However, IFRS implementation does not solely guarantee that these countries are fertile avenues for international investments; it also depends on a country's institutional environmental factors and settings that facilitate or expedite this implementation. The legal system plays a vital role in shaping accounting practices and standards.

Prior research distinguishes between two legal systems: code- and common law. Countries with a common-law system have, in general, higher levels of transparency and better corporate governance than those in a civil- or code-law; they are more likely to follow IFRS with fewer obstacles and restrictions on the switch [124]. As a result, emerging countries that belong to civil- or code-law may resist IFRS implementation, possibly because the legal system in these countries conflicts with IFRS, such as that in Romania [3], Belgium [66], Egypt [37], and Tunisia [111]. There might also be resistance to IFRS implementation because national accounting standards sufficiently meet the national accounting and disclosure needs, or these countries preserve national sovereignty and secrecy inherent in national accounting standards and accounting practices [1].

Our findings show that international organizations, such as the WB and IMF, at the global level, exercise coercive pressures on the Central Bank of Iraq (CBI) at the governance level to oblige private banks at the lowest level of institutional context to implement IFRS to assure the settlement of CBI loans. All interviewees agreed that the World Bank and IMF exerted coercive pressure on CBI to legitimize and impose IFRS as a prerequisite for financial assistance, as shown. For example, interviewee one believed that "... the pressures by the World Bank and IMF on the CBI to adopt IFRS resulted from the significant borrowing during the economic crisis that hit Iraq in 2015." In the extract below, interviewee twelve also expressed that adopting IFRS was mainly a response to comply with the requirements of WB.

"The World Bank pushed towards implementing IFRS to meet its borrowing requirements and improve disclosure and transparency in Iraq."

Interviewee thirty emphasized the role played by global organizations in enforcing IFRS implementation:

"I believe that IFRS is imposed by IMF, WB, the International Committee of Basel, the Arab Monetary Fund (Abu Dhabi), the Monitoring Committee Arab Banks (Abu Dhabi), the Committee on Financial Stability, and other international organizations. This implementation aims to integrate Iraq with the global economy and meet international organizations' requirements."

Similar pressure from the World Bank and capital markets on the United Arab of Emirates to adopt IFRS is documented by Irvine [58]. Similarly, Albu *et al.* [3] claim that the World Bank forced large companies to adopt IFRS as a prerequisite for financial assistance in 1997-1998.

Interviewee nineteen highlighted some laws favouring IFRS, including the Banking Law (94/2004, the Iraqi Central Bank Law (56/2004, and the anti-money laundering and counter-terrorism Law (37/2016. However, all interviewees argued that the Banking Act (94 /2004 conflicts with several current laws. For instance, interviewee four explained that "the Taxation Authority only accepts financial statements prepared according to IUAS." Also, interviewee six added, "The Iraqi Tax Law does not recognize some expenses or losses that IFRS recognizes." Interviewee four indicated that the Department of the Registrar of Companies prohibited the implementation of IFRS and issued binding instructions to private companies, including private banks, to follow IUAS. Interviewee seventeen explained that IFRS also conflict with Company's Act, and interviewee nine noted that:

"Many laws conflict with IFRS, including the Taxation Act, Companies law, and Keeping Accounting Records Regulation. This conflict necessitates several changes to legislation in force before implementing IFRS."

However, all legislation issued after 2003 did not have the same power as previous laws and had no time limit for their applications. Interviewee eighteen argued that the application of IUAS was never repealed, as explained below:

"It is worth noting that the laws and legislations issued post-2003 that impose IFRS did not have the same power as those issued pre-2003 due to the lack of sanctions that create a legal obligation. In addition, no time limit for the application was specified."

B. Normative pressures

In many capitalist countries, such as the UK, Germany, and France, accounting practices are controlled by national professional organizations. Greenwood *et al.* [48] and Judge *et al.* [67] asserted that professional organizations play a vital role in theorizing changes and endorsing innovations and accounting practices. Guerriero *et al.* [49] added that, at the national level, professional organizations provide professional training that assists accountants in using IFRS. The normative pressure to adopt IFRS in Iraq stems from the Council of Profession Monitoring and Auditing of Accounting (CPMAAI) and the Iraqi Association of Certified Public Accountants (IACPA). Interviewee three argued that:

"As a first stage, IACPA and CPMAAI obligated private banks to switch to IFRS, and if the transition is successful, all domestic and foreign listed companies would also be required to follow IFRS."

However, there is an agreement among interviewees that the role of IACPA and CPMAAI in promoting IFRS remains inadequate. For example, interviewee three, the secretary of the IACPA and a member of the Iraqi Board of Accounting and Auditing Standards (IBAAS), asserted that despite their efforts to promote IFRS, the steps taken by IACPA and IBAAS to

educate and train accountants to gain IFRS knowledge still primitive. Most interviewees agreed that “professional accountants, in general, resist implementing IFRS because they lack the knowledge and training needed to apply these new set of accounting standards.” Interviewee fourteen added: “... IFRS learning materials covered at the university level are shallow.” Interviewee twenty-three explained, “... professional accountants need many workshops to know how to implement and be familiar with IFRS.” Furthermore, there is unclear guidance on IFRS implementation in private banks, as articulated by interviewee seven. The transitional committee has not yet agreed on the shape of IFRS implementation, as argued by several interviewees:

“The plan is to adopt all international accounting standards as one package is unrealistic because there are some international standards that contradict the Iraqi law that is in force.” (Interviewee Three)

“... I suggest that some international accounting standards be customized to suit the Iraqi environment, and, in parallel, the level of some of the local accounting standards need to be revised to match the quality of IFRS.” (Interviewee Seven)

A counter-normative pressure arises from IBAAS that obligates IUAS, ingrained in the accounting and tax systems and dominated by professional accountants’ beliefs and accounting practices, to keep national sovereignty, as stated by interviewees Nine and Twenty-Seven.

C. Mimetic pressures

Mimetic isomorphism may play a significant role in the absence of laws and professional organizations that organize accounting practices and determine accounting standards [50]. Thus, entities can imitate their successful or influential counterparts [20]. Albu *et al.* [3] indicate that mimetic pressure emanates from accepting the widely used accounting practices for legitimacy. Therefore, entities may replicate peers’ accounting practices that offer a reliable benchmark. According to interviewee ten, mimetic isomorphism for IFRS implementation in the Iraqi banking sector emerges from correspondent banks. However, an opposite mimetic isomorphism against IFRS implementation stems from national trade partners who prefer IUAS, which meets stakeholders’ needs. As such, the counter-mimetic pressure to continue using IUAS is greater than applying IFRS. Interviewee Ten explained: “We are facing strong pressure from corresponding banks to apply IFRS, especially after their investments in almost all Iraqi private banks. However, there is counter pressure from internal trade partners to continue with IUAS. Therefore, some banks prepare two sets of financial statements to meet both needs, although at a high cost.”

V. DISCUSSION AND CONCLUSION

Developments in AI-based protocol analysis have profound influences on our daily lives. They also pose challenging but exciting questions regarding implementing and training AI machine learning and deep learning applications, especially in NLP. Nonetheless, they also present novel opportunities for studying human innovation and creativity. Entirely new

experiments can be devised from protocol analysis beyond the simple tasks generally implemented for studying accounting systems and new approaches to problem-solving.

While several non-accounting studies used TaP (e.g., [62], [110], [116]), they provided an indistinct framework for its implementation. Prior literature either employed concurrent and retrospective think-aloud protocols alone or compared their results ([26], [115]); our study uniquely employed both protocols. Moreover, our view of retrospective TaP is the participants’ cognitive process in verbalizing their thoughts to answer specific questions. In other words, the outcomes of participants’ brainstorming use restored information from long-term to short-term memory raised by the interviewer. Whereas previous literature viewed retrospective TaP as the interviewers’ videotape/audiotape, whereby they verbalized inter’ thoughts after the performance, this procedure reflects (e.g., [115]). However, we employed a unique form of TaP within three phases: Retrospective → Concurrent → Retrospective. Also, we present a guideline for each phase to frame TaP practices.

Several studies also provided theoretical and empirical evidence on the benefits of IFRS (e.g., [12], [28], [47], [93], [96]). Nevertheless, very few studies have paid attention to the obstacles that may hinder IFRS implementation. Although adopting IFRS in private banks was taken in 2015, these international standards have not been implemented. Therefore, the main objective of this study is to present a framework that employs TaP and protocol analysis implemented for Artificial intelligence design. We explore whether and how the lack of knowledge to apply IFRS and the conflict between laws in force hinder the application of IFRS in Iraqi private banks. To do so, we provided a systematic approach combining concurrent and retrospective think-aloud techniques to guide researchers when collecting qualitative accounting data.

We conducted thirty-two interviews with accountants and auditors representing national regulatory accounting and auditing bodies, professional organizations, and academics. We find that WB and IMF (at the global level of IT hierarchy) practice a coercive isomorphism on the CBI (at the governance level of IT hierarchy) to obligate private banks (at the entities level of IT hierarchy) to apply IFRS. However, the legal conflict (at the Governance level of IT hierarchy) between the Banking Act and other laws, such as the Taxation Act, Keeping Accounting Records regulation, and Company’s Law, presents a coercive counter-pressure against the implementation of IFRS in the banking sector. Also, the lack of IFRS knowledge (at the entities level of IT hierarchy) presents a normative counter-pressure that arises from IBAAS, which is dominated by accounting practices and professional accountants’ beliefs to keep national sovereignty.

Therefore, adopting IFRS alone is insufficient to increase transparency and is unlikely to improve financial reporting quality because these high-quality standards require the knowledge, training, and experience that professional accountants lack. Two features of professionalization are significant bases of isomorphism: the cognitive base produced by professional training institutions and universities [49] and

the development of professional and organizational networks [34]. Hence, normative pressures may leave professional accountants to play a role in developing the knowledge needed to apply IFRS at the governance level of IT [82].

Accountants and auditors prefer long-standing IUAS over IFRS because they are understandable with clear guidance, easy to apply, and sufficiently meet the domestic stakeholders' needs. The costly switch to IFRS will likely add to the resistance to using these standards. Thus, the transition to IFRS should occur following a comprehensive training program that assists in applying these standards correctly and eliminates the inherent conflict within the legal system. Therefore, imposing IFRS on countries and ignoring institutional settings may lead to resistance and low compliance from countries [82].

One implication of our protocol analysis findings is that IFRS must be an integral part of the national legal framework rather than a label to mimic developed countries that adopted IFRS. The implementation of IFRS also needs profound knowledge and understanding, and professional accountants need to use inductive reasoning rather than a previous intuitive experience to apply these standards ([36], [114]). Imposing IFRS on emerging countries without a preamble infrastructure required to apply these high-quality accounting standards could lead to a distorted hybrid accounting system that harms accounting development. We recommend that future research scholars investigate the institutional environmental forces and AI technology that enhance or hinder IFRS adoption in developing transitional settings. Another avenue for future research is examining the impact of national settings (at the national level) on the quality of financial statements post-IFRS implementation.

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