A Principle-based Framework for Audit Analytics Implementation

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The Dissertation

A Principle-Based Framework for Audit Analytics Implementation

M.G. Ramadhan

A Principle-Based Framework
for Audit Analytics Implementation

by

M.G. Ramadhan

to be defended publicly
on Friday,
3 October 2025
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A Principle-based Framework for Audit Analytics Implementation

Dissertation

for the purpose of obtaining the degree of doctor
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to be defended publicly on
Friday, 3 October 2025 at 10:00

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Key words: Audit Analytics, Internal Audit, Implementation Principles, Implementation Framework, Challenges, MICMAC-ISM, Case Study, Mixed-Methods, Pragmatism

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A PhD is a tiny dot on the sphere of human knowledge,
yet, it can feel like an entire cosmos to the person making the journey.

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Table of Contents

List of Tables

List of Figures

List of Abbreviations and Acronyms

Presented in alphabetical order

Abbreviation/ Acronym	Full Term
AA	Audit Analytics
ACL	(Formerly known as) Audit Command Language
BPKP	*Badan Pengawasan Keuangan dan Pembangunan* (The Financial and Development Supervisory Agency)
CA	Continous Auditing
CAAT	Computer-Assisted Audit Technique
CAE	Chief Audit Executive
CAS	Complex Adaptive System
CCM	Continuous Control Monitoring
CGEIT	Certified in the Governance of Enterprise IT
CIA	Certified Internal Auditor
CISA	Certified Information System Auditor
CM	Change Management
CMQF	Conceptual Modelling Quality Framework
DG	Directorate General (Indonesian: *Direktorat Jenderal*)
EAM	Embedded Audit Module
FGD	Focused Group Discussion
GAS	Generalized Audit Software
IAF	Internal Audit Function
IIA	Institute of Internal Auditor
ISACA	(Formerly known as) Information Systems Audit and Control Association.
JFA	*Jabatan Fungsional Auditor* (Government Internal Auditors)

Abbreviation/ Acronym	Full Term
MADS	Multidimensional Audit Data Selection
MICMAC-ISM	*Matrice d'Impacts Croisés Multiplication Appliqués à un Classement* - Interpretative Structural Modelling
MOF	Ministry of Finance
MOFIG	Ministry of Finance – Inspectorate General
OJK	*Otoritas Jasa Keuangan* (Financial Services Authority)
RCM	Risk and Control Matrix
RM (IRM/FRM)	Initial/Final Reachability Matrix
SEC	Securities and Exchange Commission
SOE	State-Owned Enterprise
SSIM	Structural Self-Interaction Matrix
STS	Socio-technical System
TOE	Technology, Organization, Environment
TOGAF	The Open Group Architectural Framework

Summary

Audit analytics (*AA*) enables the improvement of the effectiveness and efficiency of the *internal audit function* (*IAF*). In this research, we follow Lambrecht et al.'s (2011, p.3) and define AA as "the process of identifying, gathering, validating, analyzing, and interpreting data using information and communication technology to further the purpose and mission of internal auditing". AA is an umbrella term encompassing various forms of technology-based audit approaches, from continuous auditing to advanced machine learning. Due to the increased effectiveness and efficiency, AA enables the IAF to provide proactive and ongoing assurance services instead of periodic assessment, expand the (internal) audit service areas with the same resources, enable larger samples or even the whole population for analysis, and can provide insight and foresight for its stakeholders, in addition to the hindsight of the (possibly) already occurred risks.

While the benefits of AA are widely regarded, its implementation is lagging behind expectations. The existing discourse often focuses on the technical aspects of AA within a single project. As there are typically multiple projects, such an approach leads to fragmented approaches and does not transform the IAF to foster the potential benefits. Transformation refers to the complete change of existing processes, structures, and relationships among actors of the organization. In contrast to the adoption of AA, the implementation issue should address socio-technical aspects and result in the internalization of AA as an integral part of IAF.

Research on AA-related topics ranges from designing AA projects and understanding the phenomena through conceptual analysis and various theoretical lenses to developing frameworks to understand the level of AA implementation or project-level guidelines to advocate AA implementation. A framework is a structured approach with concepts and components for understanding, analyzing, or solving a particular problem, which in the context of this research is AA implementation and the associated challenges. However, there is a void in the literature regarding AA implementation. First, while some (assumed) challenges are mentioned in the literature, there is a need for a structured overview of the challenges of AA implementation derived from practice. As existing research on AA implementation focuses primarily on technical issues of AA projects, the dependency among social and technical challenges of AA implementation is not addressed. Also, which challenges need to be addressed first is unclear. Finally, the transformational aspects are not addressed, whereas changes are needed, ranging from the technical to the organizational.

Existing research on IAF (as the setting for AA implementation in this research) is based on *Agency theory*. From this perspective, IAF serves as an intermediary to remedy the information asymmetry between the principal as the 'resource owner' and the agent as the 'resource user'. The Agency theory posits that there is possible tension between the principal and the agent, i.e., the agent aims to maximize its benefit, which may be against the principal's best interest. In this view, the IAF mediates this tension by providing assurance for the principal and

accountability for the agents. In reality, the situation is more complex. IAF deals with multiple stakeholders, roles and relationships are unclear, and a variety of data, applications, and systems can be used, which change and evolve. Hence, we will take the lens of Complex Adaptive Systems (CAS) and a broader Socio-technical Systems (STS) perspective. In this way, the evolving nature, the many interacting stakeholders, and the socio-technical elements will be considered when investigating AA implementation.

The aim of this research is to develop a principle-based framework for audit analytics implementation, which addresses the challenges of AA implementation and acknowledges its socio-technical complexities and interdependencies among challenges. This research complements the existing frameworks by outlining the key principles and guiding IAF to address the challenges and incorporate AA into internal audit practices from an organizational-level perspective. A principle-based framework provides high-level guidance to address the complex AA implementation challenges that are adaptable to various contexts and circumstances. The above objective is translated into the following research question:

"*How does a framework help the internal audit function to implement audit analytics to transform its internal audit practices?*"

The main question is detailed into several research questions as follows:

1) *What are the challenges of AA implementation by IAF?*
2) *What are the relationships among the challenges to be addressed in AA implementation by IAF?*
3) *What are the principles for addressing the challenges of AA implementation by IAF?*
4) *How do the proposed principles address the challenges to fostering the AA implementation by IAF?*

This research adopts a pragmatism philosophy to answer these research questions. This philosophy aligns with the research objective to explore real-world experience and develop a principle-based framework. This research relies *on mixed methods* to capture the phenomena from the research's participants through various approaches, i.e., MICMAC-ISM, case study, and interview with practitioners, with literature exploration as the starting point.

As the first step, this research explored the literature through a systematic literature review (SLR) to capture the contemporary discourses of audit analytics implementation in general and its challenges in particular. The literature review identified twenty-three challenges mentioned in the extant literature. These identified challenges are categorized as internal, regulation, data, information technology infrastructure, and audit practice aspects. This research found that challenges are intertwined and may simultaneously influence audit analytics implementation. Finally, the literature review suggested that different actors may perceive challenges differently, which will influence the developed framework to guide and address the organizational-level challenges of AA implementation.

In the next step, this research sought to theorize the interrelationships among challenges and how they influence audit analytics implementation. For this purpose, this research employed the *Matrice d'Impacts Croisés Multiplication Appliqués à un Classement* (MICMAC) - Interpretative Structural Modelling (ISM) (or MICMAC-ISM for short) method. This method captures quantified categorization of the relationships among challenges to develop structural relationships of notions (i.e., challenges in this research's context). This research also captures qualitative insights from practitioners and experts to understand the reasoning behind the chosen relationships and enrich the analysis.

We conducted two focused group discussions and compared the findings for the above purpose. The groups are an audit team experienced in developing and using audit analytics projects and a coordinating/innovation unit tasked to orchestrate audit analytics implementation in an internal audit function entity. Comparing the results from these groups calibrated and affirmed findings from one another, which resulted in similar themes. First, both groups were concerned with the resistance to implementing AA as one of the critical challenges. Furthermore, MICMAC analysis suggested that this challenge has a strong driving power and influences all other challenges, and ISM models indicated that at the foundational level, this challenge affects many other challenges that directly affect audit analytics implementation. Secondly, the subsequent layers of challenges focused on data-related issues, influencing organizational and regulation-related issues. Finally, the higher-level challenges consisted of technical challenges that directly hinder audit analytics use in internal audit activities.

With regard to understanding the relationships among challenges, an exploratory case study was conducted to develop a principle-based framework for audit analytics implementation. The case study was performed in the Ministry of Finance-Inspectorate General (the MOFIG), the internal audit function of the Ministry of Finance Republic of Indonesia (the MOF). The MOFIG was chosen due to its revelatory characteristic, i.e., experiencing the emergence of audit analytics implementation as the phenomenon being studied. In the implementation effort, the MOFIG encounters and responds to various challenges.

Four audit analytics projects with different characteristics were selected as the units of analysis for this case study. Eighteen respondents were interviewed, some representing more than one role/position; for example, some auditors were involved in two selected projects. These respondents' selections targeted different actors to capture the complexities of the various roles. Hence, the respondents included auditors and audit managers as the main actors in audit analytics; internal audit executives involved in the strategic/high-level activities; supporting units, like information technology or the research and development division; and external actors, such as the audit clients, who may also have voices in audit analytics projects. The research also obtained relevant documents to complement the interview results.

The case study analysis resulted in four principles reflecting audit analytics as a digital transformation effort for IAF, beyond the notion of digitalization. First and foremost, the internal audit function must view audit analytics implementation as

a whole-organization approach instead of a series of siloed and ad hoc projects. This approach enables integrated efforts on all elements (e.g., skills, processes, and interrelationships). Second, given the fragmentation among involved actors in AA implementation, there must be mechanisms to clarify and determine each party's roles. Third, with the involvement of many actors and their different roles, audit analytics entails collaboration among various actors, and the internal audit function can utilize a dedicated team to connect all involved parties and foster collaboration. Finally, audit analytics requires a dedicated, reliable, and secure platform to satisfy all actors' concerns, such as infrastructure reliability or data security. The case study hints that the first principle is pivotal as it leads to the second principle and suggests combining the second principle with the other two principles. These principles are essential to address critical challenges, like mindset, data, and skills issues, and they result in a principle-based framework for audit analytics implementation. The combined principles and the associated challenges construct the prescriptive framework of AA implementation by IAF.

The developed framework theorizes the connection between the principles and critical challenges that hinder AA implementation. This finding complements the existing frameworks in the literature. For instance, while the current literature provides prescriptive frameworks to guide AA project development, these are project-level frameworks and miss the organizational level challenges, like how to internalize the skills of auditors or diverse interests among different stakeholders. Moreover, the existing literature also provides organizational-level frameworks that are descriptive and aimed at assessing implementation level or prescriptive, but are conceptual analysis and not based on empirical study, hence, disconnected from real-world challenges. Therefore, the resulting principle-based framework from this research enriches the literature by adding principles that guide the IAF in addressing the challenges of AA implementation based on an empirical study and fostering AA implementation at the organizational level. This principle-based framework complements the existing descriptive or project-level frameworks in the literature.

Furthermore, from a theoretical standpoint, the proposed framework (and the principles) extends the lens through which IAF and AA can be understood by acknowledging the complex interactions between IAF and its stakeholders. The framework also recognizes AA implementation's interwoven social and technical elements as integral to IAF's activities. Furthermore, the finding enriches the discourse of IAF, which mainly views IAF through a uni-dimensional role as an intermediary between the principal and the agent as conceptualized through the Agency theory. The agency theory suggests that the use of AA can be perceived as one of the IAF's efforts to fulfill its role. However, the principles of the framework show that IAF must better acknowledge the role of the whole of the organization, so that IAF and the organization can incorporate the social and technical aspects and co-evolve together to address the challenges of AA implementation, such as the fragmented AA projects, the risk of independence impairment, or the need for a shared infrastructure which satisfies all actors' concerns. This research offers an empirical account of socio-technical systems (STS) and complex adaptive systems (CAS) theories to understand AA implementation by IAF. This research reveals the

complexities of AA implementation and IAF's roles and relationships, which are influenced by socio-technical elements. The framework is aimed at being able to deal with the complex socio-tech nature and emerging properties. Therefore, these alternative lenses enrich the existing theoretical lenses in this research field.

The final facet of this research is to evaluate how the proposed framework contributes to addressing the challenges of audit analytics implementation. The evaluation includes assessing the framework's relevance, completeness, and accuracy in capturing the AA implementation as the phenomenon being investigated and its socio-technical complexities. Furthermore, the evaluation also examined the clarity of the framework to be applied and, by extension, its practical usability in addressing the challenges and fostering AA implementation by IAF.

The final research question examines how the proposed framework contributes to addressing the challenges encountered in AA implementation by IAF. For this purpose, this study used empirical and conceptual insights to evaluate the framework using the synthesized conceptual quality model (CMQF) with relevant professionals from two groups of respondents from diverse industries. First, this study evaluated the framework by clarifying to the respondents from the case study setting through group interviews to obtain feedback regarding their understanding of the framework and their views on the relevance, coherence, and practical value of the proposed principles. Secondly, this research evaluated the framework by interviewing eight internal audit professionals from various industries who are experienced in audit analytics to calibrate the results of the confirmation to the case study interviewees. The interview (with the eight professionals) consisted of scenario-based questions, reflecting the principles and how they address the challenges, and open-ended questions. The evaluation results from both groups suggested that the proposed framework satisfies the quality criteria, e.g., relevance, completeness, practical value, and usability, to assist IAF in implementing AA.

This study also enriches the discourses in AA and IAF literature. First, this study is the first to use an alternative approach to decompose the complex interrelationships among challenges of AA implementation through MICMAC-ISM. Furthermore, this study suggests a deeper nuance of some notions already discussed in the literature, like that AA transcends beyond the IAF and reaches the broader organization or that managerial skills are equally important as technical skills for audit analytics implementation. This study also complements the existing discourse by developing a framework that consists of principles that work at the organizational level based on real-world experience to address the critical challenges of AA implementation. Secondly, in investigating AA implementation, this study advances the existing methods. In the second phase, this research used FGD on two groups instead of a questionnaire on a single pool of respondents for MICMAC-ISM. This approach enriches the MICMAC-ISM analysis by uncovering in-depth and comparative insights instead of relying on quantified responses. The FGD enabled a deeper understanding of the relationships among challenges (compared to relying on questionnaire results), and the use of two groups allowed for 'calibrating' the resulting hierarchical models. This research also advances the method for evaluating a

framework by synthesizing the CMQF to evaluate the principles and their connection with the associated challenges. Third and most importantly, by viewing audit analytics as a digital transformation effort instead of a technology adoption issue, this study asserts the principles for AA implementation that consist of the need for an integrated approach, clarifying roles among actors, embracing collaboration, and devoting infrastructure that meets all actors' requirements.

Building on this study, future research can revisit the exploratory framework from this study using different methodologies to extend its generalizability. In a broader sense, the emergence of technology-based innovation of internal audits, such as blockchain or AI, offers fruitful avenues for future research, such as investigating if the proposed framework is applicable to these innovations, and what the implications are for the future digitalization of internal audits.

Samenvatting

Audit analytics (AA) maakt het mogelijk de effectiviteit en efficiëntie van de interne auditfunctie (IAF) te verbeteren. In dit onderzoek hanteren wij de definitie van AA zoals geformuleerd door Lambrecht et al. (2011, p. 3), namelijk: “het proces van identificeren, verzamelen, valideren, analyseren en interpreteren van gegevens met behulp van informatie- en communicatietechnologie om de doelstellingen en missie van interne auditing te ondersteunen”. AA is een overkoepelende term die verschillende technologie-gebaseerde auditbenaderingen omvat, variërend van continu auditen tot geavanceerd machinaal leren. Door de verhoogde effectiviteit en efficiëntie stelt AA de IAF in staat om proactieve en continue assurance-diensten te leveren in plaats van periodieke beoordelingen, de (interne) auditdienstverlening uit te breiden met dezelfde middelen, grotere steekproeven of zelfs de gehele populatie te analyseren, en naast inzichten in reeds opgetreden risico’s ook vooruit- en inzicht te bieden aan stakeholders.

Hoewel de voordelen van AA algemeen worden erkend, blijft de implementatie achter bij de verwachtingen. De bestaande discussie richt zich vaak op de technische aspecten van AA binnen een enkel project. Aangezien er doorgaans meerdere projecten zijn, leidt een dergelijke benadering tot gefragmenteerde implementaties en resulteert deze niet in een transformatie van de IAF om de potentiële voordelen volledig te benutten. Transformatie verwijst naar de algehele verandering van bestaande processen, structuren en de relaties tussen actoren binnen een organisatie. In tegenstelling tot de adoptie van AA dient het implementatievraagstuk sociaal-technische aspecten aan te pakken en te resulteren in de internalisering van AA als een integraal onderdeel van de IAF.

Onderzoek naar AA-gerelateerde onderwerpen varieert van het ontwerpen van AA-projecten en het begrijpen van de fenomenen via conceptuele analyses en diverse theoretische perspectieven tot het ontwikkelen van raamwerken die het implementatieniveau van AA of richtlijnen op projectniveau inzichtelijk maken. Een raamwerk is een gestructureerde benadering met concepten en componenten om een bepaald probleem te begrijpen, te analyseren of op te lossen, wat in dit onderzoek betrekking heeft op de implementatie van AA en de bijbehorende uitdagingen. De literatuur laat echter een lacune zien met betrekking tot AA-implementatie. Ten eerste, hoewel sommige (veronderstelde) uitdagingen in de literatuur worden vermeld, ontbreekt een gestructureerd overzicht van de implementatie-uitdagingen van AA zoals deze in de praktijk voorkomen. Aangezien bestaand onderzoek naar AA-implementatie zich voornamelijk richt op technische kwesties, blijven de afhankelijkheden tussen sociale en technische uitdagingen onderbelicht. Bovendien is onduidelijk welke uitdagingen als eerste moeten worden aangepakt. Tot slot worden de transformatieve aspecten onvoldoende belicht, terwijl veranderingen noodzakelijk zijn op zowel technisch als organisatorisch niveau.

Bestaand onderzoek naar IAF (als context voor de implementatie van AA in dit onderzoek) is voornamelijk gebaseerd op de Agency-theorie. Vanuit dit perspectief fungeert de IAF als een intermediair om de informatieasymmetrie tussen

de principaal (de 'eigenaar van de middelen') en de agent (de 'gebruiker van de middelen') te verminderen. De Agency-theorie stelt dat er een potentiële spanning bestaat tussen de principaal en de agent, aangezien de agent zijn eigen voordelen maximaliseert, wat mogelijk niet in het belang van de principaal is. In deze visie bemiddelt de IAF door assurance te bieden aan de principaal en verantwoording af te leggen aan de agenten. In de praktijk is de situatie echter complexer. De IAF heeft te maken met meerdere stakeholders, met onduidelijke rollen en relaties, en vele verschillende data, applicaties en systemen welke veranderen over tijd. Daarom hanteren wij het perspectief van Complexe Adaptieve Systemen (CAS) en een breder Sociaal-Technisch Systeem (STS). Hierdoor wordt bij de analyse van de implementatie van AA rekening gehouden met de evoluerende aard, de vele interacties tussen stakeholders en de sociaal-technische elementen.

Dit onderzoek heeft als doel een op principes gebaseerd raamwerk te ontwikkelen voor de implementatie van audit analytics, waarin de uitdagingen van AA-implementatie worden aangepakt en de sociaal-technische complexiteiten en onderlinge afhankelijkheden tussen de uitdagingen worden erkend. Dit onderzoek vult bestaande raamwerken aan door de belangrijkste principes te formuleren en de IAF te begeleiden bij het aanpakken van deze uitdagingen en het integreren van AA in interne auditpraktijken op organisatieniveau. Een principe-gebaseerd raamwerk biedt hoogstaande richtlijnen voor het omgaan met de complexe uitdagingen van AA-implementatie en is aanpasbaar aan verschillende contexten en omstandigheden. Deze doelstelling wordt vertaald in de volgende hoofdonderzoeksvraag:

"Hoe helpt een raamwerk de interne auditfunctie bij de implementatie van audit analytics om haar interne auditpraktijken te transformeren?"

Deze hoofdvraag wordt verder onderverdeeld in de volgende onderzoeksvragen:
1. Wat zijn de uitdagingen van AA-implementatie door de IAF?
2. Wat zijn de onderlinge relaties tussen de uitdagingen die bij AA-implementatie door de IAF moeten worden aangepakt?
3. Welke principes adresseren de uitdagingen van AA-implementatie door de IAF?
4. Hoe helpen de voorgestelde principes bij het overwinnen van de uitdagingen en het bevorderen van de implementatie van AA door de IAF?

Dit onderzoek hanteert een pragmatische filosofie om deze vragen te beantwoorden. Deze filosofie sluit aan bij de onderzoeksdoelstelling om praktijkervaringen te verkennen en een principe-gebaseerd raamwerk te ontwikkelen. Dit onderzoek maakt gebruik van een mixed-methods-benadering om de fenomenen onder de onderzoeksdeelnemers vanuit verschillende perspectieven te analyseren, met methoden zoals MICMAC-ISM, casestudy's en interviews met praktijkdeskundigen, waarbij literatuuronderzoek als uitgangspunt dient.

De eerste stap van dit onderzoek bestond uit een systematische literatuurstudie (SLR) om hedendaagse discoursen over audit analytics-implementatie en de bijbehorende uitdagingen in kaart te brengen. De literatuurstudie identificeerde 23 uitdagingen die in de bestaande literatuur worden genoemd. Deze uitdagingen werden gecategoriseerd in interne, regelgeving-, data-, IT-infrastructuur-

en auditpraktijk-gerelateerde aspecten. Dit onderzoek constateerde dat deze uitdagingen met elkaar verweven zijn en gelijktijdig van invloed kunnen zijn op de implementatie van audit analytics. Daarnaast suggereerde de literatuurstudie dat verschillende actoren uitdagingen anders kunnen waarnemen, wat invloed heeft op het ontwikkelde raamwerk om de organisatorische uitdagingen van AA-implementatie te adresseren.

In de volgende fase onderzocht dit onderzoek de onderlinge relaties tussen uitdagingen en hoe deze de implementatie van audit analytics beïnvloeden. Hiervoor werd de *Matrice d'Impacts Croisés Multiplication Appliqués à un Classement* (MICMAC) - Interpretatieve Structurele Modellering (ISM), oftewel MICMAC-ISM, toegepast. Deze methode categoriseert kwantitatief de relaties tussen uitdagingen om een structurele weergave van de onderlinge verbanden te ontwikkelen. Daarnaast werden kwalitatieve inzichten verzameld door middel van interviews met praktijkdeskundigen om de gepercipieerde relaties te begrijpen en de analyse te verrijken.

Wij hebben twee gerichte groepsdiscussies gehouden en de bevindingen met elkaar vergeleken om bovenstaande doelstelling te realiseren. De groepen bestonden uit een auditteam met ervaring in de ontwikkeling en toepassing van audit analytics-projecten en een coördinatie-/innovatie-eenheid die verantwoordelijk is voor de orkestratie van audit analytics-implementatie binnen een interne auditfunctie-entiteit. De vergelijking van de resultaten uit deze groepen diende ter kalibratie en bevestiging van de bevindingen, wat leidde tot overeenkomsten in de geïdentificeerde thema's. Ten eerste waren beide groepen bezorgd over de weerstand tegen de implementatie van AA, die werd beschouwd als een van de kritieke uitdagingen. Bovendien suggereerde de MICMAC-analyse dat deze uitdaging een sterke drijvende kracht heeft en invloed uitoefent op alle andere uitdagingen, terwijl de ISM-modellen aangaven dat deze uitdaging op fundamenteel niveau een groot aantal andere uitdagingen beïnvloedt die direct de implementatie van audit analytics beïnvloeden. Ten tweede richtten de daaropvolgende lagen van uitdagingen zich op data-gerelateerde problemen, die vervolgens organisatorische en regelgeving-gerelateerde vraagstukken beïnvloeden. Tot slot bestonden de uitdagingen op hoger niveau uit technische problemen die een directe belemmering vormen voor het gebruik van audit analytics binnen interne auditactiviteiten.

Om de onderlinge relaties tussen uitdagingen beter te begrijpen, werd een exploratieve casestudy uitgevoerd om een op principes gebaseerd raamwerk voor de implementatie van audit analytics te ontwikkelen. De casestudy vond plaats bij het Ministry of Finance-Inspectorate General (MOFIG), de interne auditfunctie van het Ministry of Finance van de Republiek Indonesië (MOF). MOFIG werd geselecteerd vanwege zijn revelatoire karakter, aangezien deze entiteit de opkomst van audit analytics-implementatie als bestudeerd fenomeen ervaart. In zijn implementatieproces wordt MOFIG geconfronteerd met diverse uitdagingen en reageert hierop.

Voor deze casestudy werden vier audit analytics-projecten met verschillende kenmerken geselecteerd als analyseeenheden. Er werden achttien respondenten

geïnterviewd, waarvan sommigen meerdere rollen of posities vertegenwoordigden; bijvoorbeeld, sommige auditors waren betrokken bij twee geselecteerde projecten. De selectie van respondenten was gericht op verschillende actoren om de complexiteit van de uiteenlopende rollen binnen audit analytics te begrijpen. De respondenten bestonden uit auditors en auditmanagers als de primaire actoren binnen audit analytics; interne auditbestuurders die betrokken waren bij strategische en beleidsmatige activiteiten; ondersteunende afdelingen, zoals de IT-afdeling of de onderzoeks- en ontwikkelingsdivisie; en externe actoren, zoals auditcliënten, die mogelijk ook een stem hebben in audit analytics-projecten. Daarnaast zijn relevante documenten verzameld om de interviewresultaten aan te vullen.

De analyse van de casestudy resulteerde in vier principes die audit analytics positioneren als een digitale transformatie-inspanning binnen de IAF.

1. Integrale benadering van audit analytics-implementatie: De interne auditfunctie dient de implementatie van audit analytics te beschouwen als een organisatiebrede aanpak in plaats van een reeks geïsoleerde en ad-hoc projecten. Deze geïntegreerde aanpak maakt gecoördineerde inspanningen mogelijk op alle relevante gebieden, zoals vaardigheden, processen en onderlinge relaties.
2. Duidelijkheid en rolverdeling: Gezien de gefragmenteerde betrokkenheid van verschillende actoren bij AA-implementatie, dienen mechanismen te worden ontwikkeld om de rollen van alle betrokken partijen te verduidelijken en vast te stellen.
3. Samenwerking en verbinding tussen actoren: Gezien de participatie van meerdere actoren met verschillende rollen vereist audit analytics samenwerking tussen diverse partijen. De interne auditfunctie kan hiervoor een toegewijd team inzetten om de betrokken partijen met elkaar te verbinden en samenwerking te bevorderen.
4. Betrouwbaar en veilig platform: Audit analytics vereist een toegewijd, betrouwbaar en veilig platform om tegemoet te komen aan de zorgen van alle betrokken actoren, zoals de betrouwbaarheid van de infrastructuur en de beveiliging van gegevens.

De casestudy suggereert dat het eerste principe fundamenteel is, omdat het leidt tot het tweede principe, en dat het tweede principe vervolgens moet worden gecombineerd met de andere twee principes. Deze principes zijn essentieel voor het aanpakken van kritieke uitdagingen, zoals problemen met de mindset, data en vaardigheden, en vormen de basis voor een op principes gebaseerd raamwerk voor de implementatie van audit analytics. De gecombineerde principes en bijbehorende uitdagingen vormen samen het prescriptieve raamwerk voor de implementatie van AA door de IAF.

Het ontwikkelde raamwerk theoretiseert de verbinding tussen de principes en de kritieke uitdagingen die de implementatie van AA belemmeren. Deze bevinding vult de bestaande raamwerken in de literatuur aan. Enerzijds bieden bestaande prescriptieve raamwerken richtlijnen voor de ontwikkeling van AA-projecten, maar deze zijn op projectniveau en laten organisatorische uitdagingen buiten beschouwing, zoals de internalisatie van auditorvaardigheden of de diversiteit aan belangen van verschillende stakeholders. Anderzijds bieden bestaande organisatieniveau-raamwerken descriptieve kaders om de implementatiefasen te beoordelen of zijn zij

prescriptief, maar gebaseerd op conceptuele analyses in plaats van empirisch onderzoek, waardoor zij niet goed aansluiten bij de praktijk. Daarom verrijkt het in dit onderzoek ontwikkelde principe-gebaseerde raamwerk de literatuur door principes toe te voegen die de IAF ondersteunen bij het aanpakken van de uitdagingen rondom AA-implementatie op basis van empirisch onderzoek en die de implementatie van AA op organisatieniveau bevorderen. Dit raamwerk vormt een aanvulling op de bestaande descriptieve of projectniveau-raamwerken in de literatuur.

Bovendien breidt het voorgestelde raamwerk, vanuit theoretisch perspectief, de lens uit waarmee de interne auditfunctie (IAF) en audit analytics (AA) kunnen worden begrepen, door de complexe interacties tussen de IAF en haar stakeholders te erkennen. Het raamwerk onderkent daarnaast dat de implementatie van AA wordt gekenmerkt door verweven sociale en technische elementen die integraal onderdeel uitmaken van de activiteiten van de IAF. Daarnaast verrijkt deze bevinding de academische discussie over de IAF, waarin deze functie veelal wordt benaderd vanuit een eendimensionale rol als intermediair tussen de principaal en de agent, zoals gedefinieerd in de Agency-theorie. Volgens deze theorie kan het gebruik van AA worden beschouwd als een manier waarop de IAF haar rol vervult. De principes van het voorgestelde raamwerk tonen echter aan dat de IAF niet alleen haar rol binnen de organisatie moet erkennen, maar dat zij ook in samenwerking met de gehele organisatie de sociale en technische aspecten moet integreren. Dit stelt zowel de IAF als de organisatie in staat om gezamenlijk te evolueren en de uitdagingen rondom AA-implementatie aan te pakken, zoals gefragmenteerde AA-projecten, het risico op aantasting van de onafhankelijkheid of de behoefte aan een gedeelde infrastructuur die tegemoetkomt aan de belangen van alle actoren. Dit onderzoek biedt een empirische bijdrage aan de toepassing van socio-technische systeemtheorieën (STS) en complexe adaptieve systemen (CAS) om de implementatie van AA binnen de IAF te begrijpen. In dit opzicht onthult dit onderzoek de complexiteit van AA-implementatie en de rol- en relatiedynamiek binnen de IAF, die beïnvloed worden door sociaal-technische factoren. Het voorgestelde raamwerk is specifiek ontworpen om de complexe sociaal-technische aard en emergente eigenschappen van AA-implementatie te adresseren. Daarom dragen deze alternatieve theoretische perspectieven bij aan de verdere verrijking van de bestaande academische kaders binnen dit onderzoeksveld.

De laatste facet van dit onderzoek betreft de evaluatie van de bijdrage van het voorgestelde raamwerk aan het aanpakken van de uitdagingen bij de implementatie van audit analytics. De evaluatie omvat een beoordeling van de relevantie, volledigheid en nauwkeurigheid van het raamwerk bij het vastleggen van AA-implementatie als onderzocht fenomeen en de daarbij behorende sociaal-technische complexiteiten. Daarnaast werd in de evaluatie onderzocht in hoeverre het raamwerk helder en toepasbaar is, en in welke mate het bijdraagt aan de praktische bruikbaarheid bij het aanpakken van uitdagingen en het bevorderen van AA-implementatie binnen de IAF.

De laatste onderzoeksvraag richt zich op de wijze waarop het voorgestelde raamwerk bijdraagt aan het adresseren van de uitdagingen die zich voordoen bij de

implementatie van AA door de IAF. Om deze vraag te beantwoorden, heeft deze studie zowel empirische als conceptuele inzichten gebruikt om het raamwerk te evalueren aan de hand van het **Synthesized Conceptual Quality Framework (CMQF)**, in samenwerking met relevante professionals uit twee groepen respondenten afkomstig uit diverse sectoren. Ten eerste werd het raamwerk geëvalueerd door middel van groepsinterviews met respondenten uit de casestudy-setting, om feedback te verkrijgen over hun begrip van het raamwerk en hun perceptie van de relevantie, samenhang en praktische waarde van de voorgestelde principes. Ten tweede werd het raamwerk beoordeeld aan de hand van interviews met acht interne auditprofessionals uit verschillende sectoren, die ervaring hebben met audit analytics. Deze interviews dienden ter kalibratie van de bevindingen uit de groepsinterviews. De interviews met deze acht professionals bestonden uit scenario-gebaseerde vragen, die de principes en hun toepassing op uitdagingen weerspiegelden, evenals open vragen om aanvullende inzichten te verkrijgen. De evaluatieresultaten uit beide groepen suggereerden dat het voorgestelde raamwerk voldoet aan de kwaliteitscriteria, zoals relevantie, volledigheid, praktische waarde en bruikbaarheid, en dat het de IAF ondersteunt bij de implementatie van AA.

Deze studie verrijkt ook de discoursen in de AA- en IAF-literatuur. Ten eerste is deze studie de eerste die een alternatieve benadering gebruikt om de complexe onderlinge relaties tussen uitdagingen van AA-implementatie via MICMAC-ISM te ontleden. Bovendien suggereert deze studie een diepere nuance van enkele begrippen die al in de literatuur zijn besproken, zoals dat AA verder gaat dan de IAF en de bredere organisatie bereikt of dat managementvaardigheden even belangrijk zijn als technische vaardigheden voor de implementatie van auditanalyses. Deze studie vult ook het bestaande discours aan door een raamwerk te ontwikkelen dat bestaat uit principes die op organisatieniveau werken op basis van ervaringen uit de echte wereld om de kritieke uitdagingen van AA-implementatie aan te pakken. Ten tweede, bij het onderzoeken van AA-implementatie, ontwikkelt deze studie de bestaande methoden verder. In de tweede fase gebruikte dit onderzoek FGD op twee groepen in plaats van een vragenlijst op een enkele groep respondenten voor MICMAC-ISM. Deze benadering verrijkt de MICMAC-ISM-analyse door diepgaande en vergelijkende inzichten te onthullen in plaats van te vertrouwen op gekwantificeerde antwoorden. De FGD maakte een dieper begrip van de relaties tussen uitdagingen mogelijk (vergeleken met het vertrouwen op vragenlijstresultaten), en het gebruik van twee groepen maakte het mogelijk om de resulterende hiërarchische modellen te 'kalibreren'. Dit onderzoek verbetert ook de methode voor het evalueren van een raamwerk door de CMQF te synthetiseren om de principes en hun verband met de bijbehorende uitdagingen te evalueren. Ten derde en het belangrijkste, door auditanalyses te zien als een digitale transformatie-inspanning in plaats van een technologie-acceptatieprobleem, bevestigt deze studie de principes voor AA-implementatie die bestaan uit de noodzaak van een geïntegreerde aanpak, het verduidelijken van rollen tussen actoren, het omarmen van samenwerking en het toewijzen van infrastructuur die voldoet aan de vereisten van alle actoren.

Voortbouwend op deze studie kan toekomstig onderzoek het verkennende kader van deze studie herzien met behulp van verschillende methodologieën om de

generaliseerbaarheid ervan uit te breiden. In bredere zin biedt de opkomst van op technologie gebaseerde innovatie van interne audit, zoals blockchain of AI, vruchtbare wegen voor toekomstig onderzoek, zoals om te onderzoeken of het voorgestelde kader van toepassing is op deze innovaties en wat de implicaties zijn voor de toekomstige digitalisering van interne audits.

Ikhtisar

Penggunaan ***Audit analytics*** **(AA)** dalam kegiatan audit intern meningkatkan efektivitas dan efisiensi fungsi audit intern (*Internal Audit Function*/IAF). Penelitian ini mengadopsi definisi dari Lambrecht et al. (2011, hlm. 3) dengan sedikit modifikasi berupa penekanan pada teknologi, yaitu AA sebagai *"proses mengidentifikasi, mengumpulkan, memvalidasi, menganalisis, dan menginterpretasi data dengan menggunakan teknologi informasi dan komunikasi guna mendukung tujuan dan misi audit intern"*. AA merupakan istilah umum yang mencakup berbagai pendekatan audit berbasis teknologi, mulai dari audit berkelanjutan hingga penggunaan teknologi *machine learning*.

AA memungkinkan IAF untuk melaksanakan tugas dan fungsi audit intern secara proaktif dan berkelanjutan, alih-alih dengan pendekatan tradisional fokus pada data historis dan *ad hoc*. AA juga memungkinkan perluasan area layanan audit intern dengan sumber daya yang sama, penggunaan sampel yang lebih besar atau bahkan seluruh populasi untuk dianalisis, serta memberikan wawasan (*insight*) dan pandangan ke depan (*foresight*) bagi para pemangku kepentingan, di samping evaluasi retrospektif (*hindsight*) terhadap risiko yang telah terjadi.

Meskipun manfaat AA telah banyak diakui, implementasinya masih belum memenuhi harapan. Diskusi yang ada umumnya berfokus pada aspek teknis AA dalam konteks AA sebagai proyek (termasuk proyek penugasan audit intern). Dalam praktiknya, penerapan AA dapat mencakup banyak proyek individiual, sehingga pendekatan yang terfragmentasi tersebut tidak mendorong transformasi IAF secara menyeluruh untuk meraih manfaat potensial AA. Transformasi dalam hal ini merujuk pada perubahan menyeluruh terhadap proses, struktur, dan hubungan antaraktor dalam organisasi. Berbeda dengan adopsi AA, isu implementasi seharusnya mencakup aspek sosial dan teknis (*socio-technical*) dan menghasilkan internalisasi AA sebagai bagian integral dari IAF.

Penelitian mengenai AA meliputi berbagai topik, mulai dari perancangan proyek AA, pemahaman fenomena melalui analisis konseptual dan teoretis, hingga pengembangan kerangka kerja untuk memahami tingkat implementasi AA atau panduan penilaian tingkat kematangan proyek guna mendorong implementasi AA. Penelitian ini berfokus pada kerangka kerja (*framework*), yang merupakan pendekatan terstruktur yang terdiri dari konsep dan komponen untuk memahami, menganalisis, atau menyelesaikan suatu permasalahan tertentu, yang dalam konteks penelitian ini adalah implementasi AA dan tantangan yang menyertainya.

Namun demikian, terdapat kekosongan dalam literatur terkait implementasi AA. Pertama, meskipun cukup banyak tantangan atau hambatan penerapan AA (yang diasumsikan) disebutkan dalam literatur, masih diperlukan tinjauan yang terstruktur mengenai tantangan implementasi AA yang berasal dari praktik nyata. Penelitian yang ada cenderung berfokus pada isu teknis dalam proyek AA, sehingga keterkaitan

antara tantangan sosial dan teknis belum dibahas secara memadai. Selain itu, belum jelas tantangan mana yang perlu diatasi terlebih dahulu. Terakhir, aspek transformasional belum banyak mendapat perhatian, padahal perubahan yang diperlukan mencakup aspek teknis hingga organisasional secara menyeluruh.

Penelitian-penelitian yang ada mengenai fungsi audit internal (IAF)—khususnya dalam konteks implementasi AA pada penelitian ini—umumnya berlandaskan pada teori agensi (*Agency Theory*). Dari perspektif ini, IAF berperan sebagai perantara untuk mengatasi asimetri informasi antara prinsipal sebagai 'pemilik sumber daya' dan agen sebagai 'pengguna sumber daya'. *Agency theory* menyatakan bahwa terdapat potensi 'friksi' antara prinsipal dan agen, di mana agen cenderung berupaya memaksimalkan kepentingannya sendiri, yang mungkin bertentangan dengan kepentingan terbaik prinsipal. Dalam hal ini, peran IAF adalah untuk memediasi perbedaan tersebut dengan menyediakan layanan *assurance* bagi prinsipal serta memastikan akuntabilitas bagi para agen.

Namun, kenyataan di lapangan jauh lebih kompleks. IAF berinteraksi dengan berbagai pemangku kepentingan, memiliki peran dan hubungan yang tidak selalu jelas, serta menggunakan beragam data, aplikasi, dan sistem yang terus berubah dan berkembang. Oleh karena itu, penelitian ini menggunakan pendekatan *Complex Adaptive Systems* (CAS) dan perspektif yang lebih luas dari *Socio-technical Systems* (STS). Dengan demikian, karakteristik institusi dan IAF yang terus berkembang, banyaknya aktor yang saling berinteraksi, serta elemen sosial dan teknis dapat dipertimbangkan secara holistik dalam menganalisis implementasi AA oleh IAF.

Tujuan dari penelitian ini adalah untuk mengembangkan sebuah kerangka kerja berbasis prinsip (*principle-based framework*) untuk implementasi audit analytics, yang tidak hanya merespons tantangan implementasi AA, tetapi juga mengakui kompleksitas sosial-teknis serta saling ketergantungan antar tantangan yang dihadapi. Penelitian ini melengkapi kerangka kerja yang telah ada dengan merumuskan prinsip-prinsip utama dan memberikan panduan bagi IAF untuk menghadapi tantangan serta mengintegrasikan AA ke dalam praktik audit intern dari perspektif tingkat organisasi. Kerangka kerja berbasis prinsip menawarkan panduan tingkat tinggi (*high-level direction*) yang dapat disesuaikan dengan berbagai konteks dan kondisi, guna menjawab tantangan implementasi AA yang kompleks.

Tujuan tersebut dituangkan ke dalam pertanyaan penelitian sebagai berikut:

"Bagaimana sebuah kerangka kerja membantu fungsi audit intern dalam mengimplementasikan audit **analytics untuk mentransformasi praktik audit intern?"**

Pertanyaan utama tersebut dijabarkan ke dalam beberapa pertanyaan penelitian berikut:

1. Apa saja tantangan (dan hambatan) implementasi AA oleh IAF?

2. Bagaimana hubungan antar tantangan (dan hambatan) yang perlu diatasi dalam implementasi AA oleh IAF?
3. Apa saja prinsip-prinsip untuk mengatasi tantangan implementasi AA oleh IAF?
4. Bagaimana prinsip-prinsip dimaksud menjawab tantangan, mengatasi hambatan, dan mendorong implementasi AA oleh IAF?

Penelitian ini menggunakan **filosofi pragmatisme** untuk menjawab pertanyaan-pertanyaan penelitian yang telah dirumuskan. Filosofi ini selaras dengan tujuan penelitian, yaitu untuk mengeksplorasi pengalaman aktual dan mengembangkan sebuah kerangka kerja berbasis prinsip berdasarkan pengalaman actual tersebut. Penelitian ini menggunakan pendekatan **metode campuran** (***mixed methods***) untuk menangkap fenomena yang diamati dari para partisipan penelitian melalui berbagai pendekatan, yakni MICMAC-ISM, studi kasus, dan wawancara dengan praktisi, dengan eksplorasi literatur sebagai titik awalnya.

Sebagai langkah pertama, penelitian ini melakukan eksplorasi literatur melalui ***systematic literature review*** **(SLR)** untuk menangkap diskursus teraktual mengenai implementasi AA dan tantangannya. Reviu literatur tersebut mengidentifikasi dua puluh tiga tantangan/hambatan yang disebutkan dalam literatur yang telah ada. Tantangan-tantangan tersebut dikategorikan ke dalam lima aspek, yaitu aspek internal, regulasi, data, infrastruktur teknologi informasi, dan praktik audit. Penelitian ini menemukan bahwa tantangan-tantangan tersebut saling terkait dan dapat secara simultan memengaruhi implementasi AA. Selain itu, tinjauan literatur juga menunjukkan bahwa aktor yang berbeda dapat memiliki persepsi yang berbeda terhadap tantangan-tantangan tersebut, yang pada akhirnya memengaruhi kerangka kerja yang dikembangkan untuk menangani tantangan implementasi AA pada tingkat organisasi.

Pada tahap berikutnya, penelitian ini berupaya untuk mengembangkan pemahaman teoretis mengenai keterkaitan antar tantangan dan bagaimana keterkaitan tersebut memengaruhi implementasi AA. Untuk tujuan ini, penelitian menggunakan metode ***Matrice d'Impacts Croisés Multiplication Appliqués à un Classement (MICMAC)*** dan ***Interpretative Structural Modelling (ISM)*** (disingkat **MICMAC-ISM**). Metode ini digunakan untuk mengklasifikasikan hubungan antar tantangan secara kuantitatif guna membangun struktur hubungan antar gagasan (dalam konteks penelitian ini, yaitu tantangan). Penelitian ini juga mengumpulkan wawasan kualitatif dari para praktisi dan pakar untuk memahami alasan di balik keterkaitan tersebut dan memperkaya analisis.

Tahap kedua ini dilaksanakan melalui dua diskusi kelompok (*focused group discussions*) dan membandingkan temuan dari kedua kelompok tersebut. Kelompok pertama merupakan tim audit yang memiliki pengalaman dalam mengembangkan dan menggunakan proyek AA, sedangkan kelompok kedua adalah unit koordinasi/inovasi yang bertugas mengorkestrasi implementasi AA di dalam entitas IAF. Perbandingan

hasil dari kedua kelompok tersebut memperkuat dan mengkalibrasi temuan satu sama lain, yang menghasilkan tema-tema yang serupa.

Pertama, kedua kelompok menyoroti resistensi terhadap implementasi AA sebagai salah satu tantangan kritis. Selanjutnya, analisis MICMAC menunjukkan bahwa tantangan ini memiliki kekuatan pengaruh (*driving power*) yang tinggi dan memengaruhi hampir seluruh tantangan lainnya. Model ISM mengindikasikan bahwa pada tingkat paling dasar, tantangan ini memengaruhi berbagai tantangan lain yang secara langsung berdampak pada implementasi AA. Kedua, lapisan tantangan berikutnya berfokus pada isu-isu yang berkaitan dengan data, yang selanjutnya memengaruhi tantangan pada tingkat organisasi maupun regulasi. Terakhir, tantangan pada tingkat lebih tinggi terdiri dari tantangan teknis yang secara langsung menghambat pemanfaatan AA dalam aktivitas audit intern.

Dalam rangka memahami hubungan antar tantangan, penelitian ini melakukan studi kasus eksploratif untuk mengembangkan kerangka kerja berbasis prinsip dalam implementasi AA. Studi kasus dilakukan di **Inspektorat Jenderal Kementerian Keuangan (Itjen Kemenkeu)**, yang merupakan unit audit intern di lingkungan **Kementerian Keuangan Republik Indonesia (Kemenkeu)**. Itjen Kemenkeu dipilih karena karakteristiknya yang bersifat *revelatory*, yakni sedang atau telah mengalami implementasi AA dengan berbagai dinamikanya sebagai fenomena yang menjadi obyek penelitian. Dalam proses ini, Itjen Kemenkeu menghadapi dan merespons berbagai tantangan tersebut.

Empat proyek AA dengan karakteristik berbeda dipilih sebagai unit analisis dalam studi kasus ini. Dalam studi aksus ini, sebanyak delapan belas responden diwawancarai, di mana beberapa responden mewakili lebih dari satu peran atau posisi; misalnya, beberapa auditor terlibat dalam dua proyek yang dipilih. Pemilihan responden diarahkan untuk mencakup berbagai aktor guna menangkap kompleksitas peran yang beragam. Oleh karena itu, responden meliputi auditor dan manajer audit sebagai aktor utama dalam AA; pimpinan audit intern yang terlibat dalam aktivitas strategis atau *high-level*; unit pendukung seperti teknologi informasi atau penelitian dan pengembangan; serta aktor eksternal seperti klien pengawasan, yang juga dapat memiliki peran dalam proyek AA. Penelitian ini juga mengumpulkan dokumen relevan untuk melengkapi hasil wawancara.

Analisis studi kasus menghasilkan empat prinsip yang mencerminkan AA sebagai bagian dari upaya transformasi digital oleh IAF, yang melampaui sekadar digitalisasi. Pertama dan yang paling utama, fungsi audit intern harus memandang implementasi AA sebagai pendekatan organisasi secara menyeluruh, bukan sekadar kumpulan proyek yang berjalan secara terpisah dan *ad hoc*. Pendekatan ini memungkinkan adanya integrasi upaya terhadap seluruh elemen (misalnya, keterampilan, proses, dan hubungan antaraktor). Kedua, mengingat adanya fragmentasi antaraktor yang terlibat dalam implementasi AA, perlu ada mekanisme

untuk memperjelas dan menetapkan peran masing-masing pihak. Ketiga, dengan keterlibatan banyak aktor dan peran yang berbeda-beda, implementasi AA membutuhkan kolaborasi antaraktor, di mana fungsi audit intern dapat memanfaatkan tim khusus untuk menghubungkan seluruh pihak yang terlibat dan mendorong kolaborasi tersebut. Terakhir, implementasi AA memerlukan platform yang andal, aman, dan didedikasikan untuk menjawab berbagai kekhawatiran para aktor, seperti keandalan infrastruktur atau keamanan data.

Studi kasus ini menunjukkan bahwa prinsip pertama bersifat krusial karena menjadi dasar bagi prinsip kedua, dan prinsip kedua dalam pelaksanaaanya dikombinasikan dengan dua prinsip lainnya. Prinsip-prinsip ini penting untuk menjawab tantangan-tantangan kritis seperti resistensi, data, dan keterampilan, serta menghasilkan kerangka kerja berbasis prinsip untuk implementasi AA. Kombinasi prinsip-prinsip tersebut dan tantangan-tantangan yang relevan membentuk kerangka kerja preskriptif implementasi AA oleh IAF.

Kerangka kerja yang dikembangkan dalam penelitian ini membangun kerangka teoretis mengenai hubungan antara prinsip-prinsip dan tantangan-tantangan kritis yang menghambat implementasi AA. Temuan penelitian ini memerkaya kerangka kerja yang telah ada dalam literatur. Sebagai contoh, meskipun literatur saat ini telah menyediakan kerangka kerja preskriptif untuk memandu pengembangan proyek AA, kerangka-kerangka tersebut berfokus pada tataran proyek dan belum mencakup tantangan-tantangan pada tataran organisasi, seperti bagaimana menginternalisasi keterampilan auditor atau menangani beragam kepentingan dari berbagai pemangku kepentingan. Selain itu, literatur yang ada juga menyediakan kerangka kerja deskriptif pada tingkat organisasi yang bertujuan untuk menilai tingkat implementasi, atau kerangka kerja preskriptif yang bersifat analisis konseptual namun tidak berbasis pada studi empiris, sehingga kurang terhubung dengan tantangan aktual di lapangan.

Oleh karena itu, kerangka kerja berbasis prinsip yang dihasilkan dari penelitian ini memperkaya literatur dengan menambahkan prinsip-prinsip yang dapat memandu IAF dalam mengatasi tantangan implementasi AA secara empiris, serta mendorong implementasi AA pada tingkat organisasi. Kerangka kerja ini bersifat melengkapi, bukan menggantikan, kerangka kerja deskriptif maupun yang berfokus pada tingkat proyek yang telah ada dalam literatur.

Lebih lanjut, dari sisi teoretis, kerangka kerja yang diusulkan (beserta prinsip-prinsipnya) memperluas pemahaman terhadap IAF dan AA dengan mengakui adanya interaksi kompleks antara IAF dan para pemangku kepentingannya. Kerangka ini juga mengakui bahwa elemen sosial dan teknis dalam implementasi AA saling terkait dan menjadi bagian integral dari aktivitas IAF. Temuan ini turut memperkaya diskursus mengenai IAF, yang selama ini lebih banyak dipahami secara kaku sebagai perantara antara prinsipal dan agen, sebagaimana dikonseptualisasikan dalam

kerangka *Agency theory*, yang dalam konteks teori ini, penggunaan AA dipandang sebagai salah satu upaya IAF dalam menjalankan perannya. Namun, prinsip-prinsip dalam kerangka kerja ini menunjukkan bahwa IAF perlu mengakui secara lebih menyeluruh peran organisasi secara keseluruhan, sehingga IAF dan organisasi dapat mengintegrasikan aspek sosial dan teknis serta berkembang bersama dalam menjawab tantangan implementasi AA—seperti terfragmentasinya proyek AA, risiko terhadap independensi, atau kebutuhan akan infrastruktur bersama yang dapat menjawab kekhawatiran berbagai aktor.

Penelitian ini menyajikan bukti empiris untuk mendukung pendekatan teoretis berbasis **socio-technical systems (STS)** dan **complex adaptive systems (CAS)** dalam memahami implementasi AA oleh IAF. Penelitian ini mengungkap kompleksitas implementasi AA serta peran dan relasi IAF yang dipengaruhi oleh elemen sosial-teknis, khususnya dalam penerapan AA. Kerangka kerja yang dikembangkan menangkap karakteristik dan kompleksitasi interaksi sosial dan teknikal IAF dengan lingkungannya. Dengan demikian, lensa alternatif yang digunakan dalam penelitian ini memperkaya lensa-lensa teoretis yang telah ada dalam penelitian terkait IAF.

Tahap terakhir dari penelitian ini adalah mengevaluasi sejauh mana kerangka kerja yang dikembangkan (dari penelitian ini) berkontribusi dalam mengatasi tantangan implementasi AA. Evaluasi ini mencakup penilaian atas relevansi, kelengkapan, dan ketepatan kerangka kerja dalam menangkap fenomena implementasi AA yang diteliti, beserta kompleksitas sosial-teknis yang menyertainya. Selain itu, evaluasi juga menilai kejelasan kerangka kerja dalam penerapannya serta, secara lebih luas, kegunaan praktisnya dalam menghadapi tantangan dan mendorong implementasi AA oleh IAF di dunia nyata.

Pertanyaan penelitian terakhir berfokus pada bagaimana kerangka kerja yang diusulkan berkontribusi dalam mengatasi tantangan yang dihadapi dalam implementasi AA oleh IAF. Untuk tujuan ini, penelitian ini menggunakan pendekatan empiris dan konseptual dalam mengevaluasi kerangka kerja melalui ***conceptual model quality framework*** **(CMQF)**, bersama para profesional yang relevan dari kelompok responden lintas industri.

Pertama, penelitian ini mengevaluasi kerangka kerja dengan melibatkan kembali responden dari studi kasus melalui wawancara kelompok guna memperoleh umpan balik atas persepsi mereka atas kerangka kerja (yang disusun berdasarkan studi kasus di unit mereka) serta pandangan mereka mengenai relevansi, koherensi, dan nilai praktis dari prinsip-prinsip yang dikembangkan. Kedua, penelitian ini juga melakukan evaluasi kerangka kerja melalui wawancara dengan delapan profesional audit intern dari berbagai industri yang memiliki pengalaman dalam AA, dengan tujuan mengkalibrasi hasil konfirmasi dari responden studi kasus.

Wawancara dengan delapan profesional tersebut menggunakan pendekatan berbasis skenario, yang memuat prinsip-prinsip dalam kerangka kerja dan bagaimana prinsip-prinsip tersebut menjawab tantangan yang ada, serta dilengkapi dengan pertanyaan terbuka. Hasil evaluasi dari kedua kelompok menunjukkan bahwa kerangka kerja yang diusulkan memenuhi kriteria kualitas, seperti relevansi, kelengkapan, nilai praktis, dan kegunaan, untuk membantu IAF dalam mengimplementasikan AA.

Penelitian ini juga memperkaya khazanah dalam literatur AA dan IAF. Pertama, penelitian ini merupakan yang pertama menggunakan pendekatan alternatif untuk mengurai kompleksitas hubungan antar tantangan dalam implementasi AA melalui metode **MICMAC-ISM**. Selain itu, penelitian ini menawarkan gagasan baru, dibandingkan dengan yang telah dibahas dalam literatur, seperti bahwa AA tidak hanya berada dalam lingkup IAF, melainkan juga menjangkau organisasi secara lebih luas; atau bahwa keterampilan manajerial sama pentingnya dengan keterampilan teknis dalam implementasi AA. Penelitian ini juga melengkapi diskursus yang ada dengan mengembangkan sebuah kerangka kerja berbasis prinsip yang beroperasi pada tingkat organisasi dan dibangun berdasarkan pengalaman nyata untuk mengatasi tantangan-tantangan kritis dalam implementasi AA.

Kedua, dalam menelaah implementasi AA, penelitian ini turut memperkaya metode penelitian yang digunakan. Pada fase kedua, penelitian ini menggunakan diskusi kelompok terfokus (**FGD**) pada dua kelompok responden, alih-alih kuesioner tunggal kepada satu kelompok responden sebagaimana lazim digunakan dalam methode MICMAC-ISM. Pendekatan ini memperkaya analisis MICMAC-ISM dengan menggali informasi dan nuansa yang mendalam dan bersifat komparatif, alih-alih semata-mata mengandalkan hasil kuantifikasi dari survei terhadap responden penelitian. FGD memungkinkan pemahaman yang lebih utuh atas hubungan antar tantangan, dan penggunaan dua kelompok responden memberikan kesempatan untuk mengkalibrasi model yang dihasilkan.

Penelitian ini juga mengembangkan metode evaluasi kerangka kerja dengan menyintesis **CMQF** untuk mengevaluasi prinsip-prinsip yang diusulkan beserta kaitannya dengan tantangan-tantangan yang relevan. Ketiga, dan yang paling penting, dengan memandang AA sebagai suatu upaya **transformasi digital**, bukan sekadar persoalan adopsi teknologi, penelitian ini menegaskan pentingnya prinsip-prinsip dalam implementasi AA, yaitu perlunya pendekatan yang terintegrasi, kejelasan peran antaraktor, penerimaan terhadap kolaborasi, serta penyediaan infrastruktur yang mampu menjawab kebutuhan semua pihak yang terlibat.

Berdasarkan temuan ini, penelitian selanjutnya dapat mengevaluasi kembali kerangka kerja eksploratif ini dengan menggunakan metodologi yang berbeda guna memperluas generalisasi hasilnya. Secara lebih luas, munculnya inovasi audit intern berbasis teknologi seperti *blockchain* atau *artificial intelligence (AI)* membuka

peluang riset lanjutan, misalnya untuk menyelidiki apakah kerangka kerja yang diusulkan ini juga relevan diterapkan pada inovasi-inovasi tersebut, serta apa implikasinya terhadap masa depan digitalisasi audit intern?

Foreword

Alhamdulillahirabbil 'aalamiin.

A PhD is a challenging enterprise, and I feel grateful to be able to embark on this adventure. However, it is evident that this effort entails a multitude of direct and indirect supports and helps. To quote another PhD: "It takes a community to complete a PhD". Therefore, I dedicate this section to those having contributed to this quest. For this, I have to apologize. First, because this will be quite a long list, and second, it may still not capture all involved people (otherwise, it will be an endless list).

First and foremost, a PhD is about learning to be an independent researcher and seek knowledge to benefit society. In this regard, mentorship is of paramount importance to sustain the energy fuelled by the curiosity for this journey. For this, I want to dedicate my gratitude to my supervisory team, **Marijn** and **Haiko**.

It was an afternoon with a heavy monsoon Indonesian rain in early 2019. I was very nervous to meet you (Marijn) in person. I prepared for any kind of tough academic questions, which I was afraid not to give a satisfying enough answer. It turned out that you were very approachable and warm-hearted while sharply digging into my scientific curiosity. After a warm conversation and nice dinner, I was grateful you were willing to guide me through this challenging yet empowering quest; thank you for your wisdom, support, guidance, and trust in me! Throughout the PhD process, your questions and challenges on the subject sharpened the research direction and, eventually, the outcoming results. Your meticulous attention to detail helped me to realize all the possible misdirections of this scientific inquiry and how to rectify them. You poured your unshakeable commitment in guiding me, even at the event of unfortunate circumstance you must endure. At times, I was worried that I might not be good enough to be your protégé, yet you kept guiding me with your wisdom, support, and patience. Thank you for all your wisdom to help me finish this journey with a trace of your utmost dedication to further science and knowledge.

At the beginning of this journey, I felt stranded: a practitioner with a background in social sciences among high-profile scientists and engineers in one of the best research institutions in the world. Fortunately, I was provided with the opportunity to present my research proposal to the faculty members in search of a co-promotor for my PhD. I was glad to have the discussion with you (Haiko), one of the social scientists at this technical university, who eventually became my co-promotor. You warned me that this would not be a straightforward journey; yet you guide me not only to find a path in this labyrinth but also to enjoy the 'puzzle'. You walk the talk, by showing your flexibility in adapting to an unanticipated situation despite your other demanding roles, keep 'walking' with me to weather the bump. I remember some of your remarks, like "I want you to make mistakes" or "You have to choose", which then I felt confused and against my nature as a practitioner. However, your approach helped to translate the scientific and engineering language to my practical and social sciences mindset, especially at the beginning of my PhD. This approach not only empowered me but also honed me, both personally and professionally.

I cannot thank both of you enough for the unwavering support, for challenging and encouraging me, for being the best supervisors on this arduous yet rewarding adventure, and for your patience with all my shortcomings and ineptitude. I also thank both of you for your warmth beyond the academic talks, like the Brazillian coffee from the conference, or the 'struggle' between chocolate and dates. *"Nobody said it was* (or will be) *easy"*; yet your presence and guidance were integral in paving the way for this journey.

My sincere gratitude to the members of my doctoral committee: **Prof. Nitesh Bharosa** (TU Delft), **Dr. Zenlin Roosenboom-Kwee** (TU Delft), **Prof. Jose Hilario Canós Cerdá** (Universitat Politècnica de València, Spain), and **Prof. Jamaliah Said** (Universiti Teknologi MARA, Malaysia). I am grateful for the time and effort you invested in reviewing this research output, as well as for your constructive and supportive feedback. The quality of my dissertation has been substantially improved as a direct result of your insightful comments.

This PhD was made possible with the tangible and intangible support I received. Thanks to Pak **Lutfi** for facilitating my meeting with Marijn and for your insights on how to navigate family and PhD matters. Particularly, I have immense gratitude to my sponsor, LPDP, and special thanks to **Merzi**, Mbak **Shera**, Mbak **Rani**, Mas **Budi** (Okta), Mas **Isnendi**, and Pak **Lukman.**

Of course, a PhD journey transcends beyond the periodic meeting with the supervisory teams. For that, I was grateful to be part of ESS-ICT! First, although she is no longer in the ICT, I want to thank **Laura** for the critical help at the beginning of this process, especially in finding accommodation, which was surprisingly troublesome. Warm welcome notes from **Mark** and **Anneke** gave a soothing experience, knowing that this is both a high-achieving and a welcoming and friendly environment. **Nitesh** and **Wendy**, for the early discussions that gave me a glimpse of the nuance of the group, section, and department, and helped me acclimate to the academic setting. **Boriana**, for helping me prepare for the Go/No Go meeting. **Jolien**, for your always warm smile in the hallway (and the Hungarian cookies and paprika!). **Nico**, for your always fast and helpful responses, even when I inadvertently disrupt your 'me time'. **Ellen**, **Fanny, Charelle,** and **Minaksie**, thank you for your compassionate and helpful assistance! To quote Antra: "I cannot imagine navigating my PhD without you". You answered all my questions and assisted with all my requests to ensure a smooth process for my PhD. But beyond that, your helping hands put me at ease in broader matters that made this journey easier!

As a PhD student, I enjoyed the flexibility in doing the research. While I loved the tranquillity of working in solitude, at times, I also benefitted from both serious discussion and casual talk with other faculty members. For this, I thank Mas **Aga** and **Dewant** for being the perfect office mates for these past four years! A big thanks to Mas **Antra** for your mentorship and my role model for an ideal PhD candidate. Thank you to all ESS-ICT friends and beyond, to name a few: **Ini, Sem, Kathleen, Fernando, Fransesca, Ezra, Luba, Aaron, Zenlin, Julien, Veerle, Annamarie,** and **Louis.** Special thanks to **Roel** and **Stefan** for your enthusiasm and hospitality in sharing your expertise with our faculty's guests!

In a broader setting, I was also fortunate to be exposed to a variety of academic discourses in information systems and accounting. I enjoyed the opportunity to discuss with **Arif Perdana** and **Sandy Arief** and be invited as one of the panel sessions' speakers with **Eugene Sieuw** and Prof. **Juliana Sutanto** in the 3rd International Conference by the Journal of Information Systems (JIS). I was also privileged to contribute as a reviewing committee member in one of the I3E Conferences. I thank **Ricardo** from the 22nd I3E Conference and **Samaneh** and **Debbie** from the 23rd I3E Conference. I was also grateful for the opportunity to facilitate visits from the Malaysian delegation, during which I interacted with Bang **Taufik**, Prof. **Zuraidah**, and Prof. **Jamaliah** from UT Mara Malaysia.

Doing PhD is not a walk in the park, even more so doing it abroad, with differing cultures and languages, and most importantly, weather! I was grateful to be surrounded by supportive friends who helped me cope with the "non-technical" challenges. Many thanks to the Lunch Club members: Kang **Hariadi/Aji/Jejey** with your many aliases and your "leading by example" in this club! Mbak **Fira,** with your witty observation and remarks, Mbak **Emmy**, Mas **Budi** (Pak Lurah), with your composed smile, Mas **Aldy**, Mas **Ifan,** Mas **Antra**, Mas **Aga**, Mbak **Dita**, and Mbak **Reni**; longing for our future insightful chitchats! I extend my heartfelt appreciation to all my friends, Mas **Alam** and Bang **Ando**, for welcoming me, even in the height of COVID-19, and to Mas **Maundri** for allowing me to stay while finding permanent housing. To all KMD fellows, among others: Mas **Widana**, Mas **Tono**, Mbak **Hamida**, Mas **Rifki**, Mbak **Fira**, Mas **Dhoni**, Mas **Fakhri**, Mas **Satria Permana,** Mas **Habbie**, Mas **Syakal**, Uda **Hanif**, Mbak **Bella**, Mbak **Sasa**, and Mas **Satria Galih**, and the subsequent teams and supporters, Mas **Raihan**, Mas **Teddy**, Mas **Fafa**, Mbak **Eka**, Mbak **Nana**, dan Mbak **Nadhira**, thank you and may The Almighty repay all your good deeds! To Kelurahan fellows: Mas **Irvan**, Mbak **Aprisia**, Mbak **Nafi**, Mas **Fahmi**, Mbak **Adibah**, Mas **Budi**, and Mas **Wildan**, thank you for supporting our endeavour and shared mission! To Kang **Mamin**, Pak **Deden**, Mas **Pandu**, Mas **Tofan**, Mas **Habib**, Bli **Wayan**, and Bang **Goban**, thank you for all the warmth and help. To all Indonesian students, including Mas **Arya** (Pak Pres), Mas **Yafie**, and Mas **Ranggo**, best wishes to all of us! To my old friends like **Uli**, Om **(Abd) Rahman**, Bunda **Vita**, and **Badru**, thank you for our occasional jokes that provided a refreshing break; and to new friends (to name a few): **Mark** (my bro!), **Rusgard** (hope I spell your name correctly), **Tareq** (best wishes for your business abroad!), and **Dave** (my favorite tempeh 'dealer'!) thank you for our engaging and funny conversations.

I was also fortunate to meet similar minds, although accidentally, with which I can share my unorthodox thoughts. Hence, I dedicate my special thanks to the "support group", *BNLB yg penting lulus* (and by extension *Halan-Halan NL*), Mas **Dhoni**, Mas **Rifki**, Mbak **Nuri** (and by extension Mas **Rifko**, and **UP**), for our laughs and discussions, from VAT increase to *garam krosok,* from poker to beverbende, and other seemingly absurd topics which enriched and expanded our minds beyond our research topics. Hopefully, we will meet again, continue our discussions in more encouraging circumstances, and bear more tangible values from our ideas!

This research reflected my professional journey, which always intersects between (internal) audit and technology. I thank the people in this professional community who have helped me shape my research and, through this research, contribute to society. My professional and personal mentors, Pak **Dodo** and your mentees, among others, Mas **Vini**, Mas **Agung, Iim,** Mas **Tri**, Mas **Yudhy**, Mas **Yogi**, **Ipong, Echa, Dwiky, Andri, Ade, Reza** (Pabos), **Miftah**, **Ananta,** Mas **Faiz**; and also, Mbak **Amy**, **Sendi, Angga Jun, Nugie,** Kang **Arief,** and **Lilik,** thank you for all our convos as the building blocks to my professional experiences and my research. The meta-structure team, **Syannie, Iim** (*si paling ordal!*)**,** and **Hadie** for our side project. In a broader community, Pak **Erwin**, Mas **Rizza**, Mas **Ricki**, Mas **Eka**, Mas **Fauzi**, and Mas **Muddin**, thank you for your insights and feedback. Thanks to Bu **Sum**, Pak **Awan**, Pak **Patrick**, Pak **Roberth**, Pak **Jim**, and Pak **Ghufron** for your advisory, insights, and support. To MOFIG personnel who are always there to help and answer my questions (and to remind my duties), among others: Mbak **Sandra**, **Putri, Alfiani, Desyntha, Silmina,** Mbak **Yayuk**, **Emir**, (now I must call 'Bu') **Devi**, **Dovi**, Mbak **Gladys**; I am sorry for bothering you every once in a while.

Apart from its scientific nature and my professional background, doing PhD was a personal journey, responding to the hopes and dreams of my closest ones. Therefore, I dedicated this piece of work to my late families: Bapak, Umi, Nenek, Nenek Ndut, Engkong, Kakek, Umi, Papa Daeng, Mama Daeng, Mama Siah, and Wa' Dadang. On the one hand, I am glad to finally fulfil all their hopes, dreams, and unconditional support, love, and kindness. On the other hand, it is unfortunate that I can't present this achievement much earlier so they can witness this aspiration being accomplished. I must say that I am very sorry for not being the best child, grandchild, or nephew; I hope this can be a slight redemption for all my shortcomings and past ineptitude. To **Mama**, you once said, "*gak kebayang, anak supir bemo yang kecilnya lumpuh sekarang S3 di luar negeri*" I hope you are delighted with this piece and that it fulfils a long dream from Engkong, Nenek, and Bapak. I know this would not repay any of you and Engkong, Nenek, and Bapak's sacrifices, and for that, I am forever grateful! **Iqbal**, **Maya**, I am sorry for not being the best big brother to you. Yet, you two turn out to be better children to our parents than I am. Thank you for being good kids and allowing me to embark on this journey. **Reza**, **Icha**, and **Alvi** thank you for all your helping hands; I hope this inspires you for your future and a much more fruitful journey! For my in-laws, **Ibu,** Bapak, Mas **Luqman**, Mbak **Opi**, **Tuti**, Mas **Ribut**, and **Yuli**, thank you for your endearing support and kind understanding.

And of course, my lovely family, **Ai**, kakak **Dinda**, dedek **Kinan**. I love you all. No words can describe how much I thank you for your support, for being here, for embracing and weathering this journey together. Ai, my love, *nanti kita cerita tentang hari ini*, about how you become a multi-talented professional: a teacher, school committee member, cashier, and chef, creating all incredible meals with strange names like *klepon cake* (while I become the "quality control" and your biggest fans!); and becoming the glue for all communities you are part of. Kakak, *nanti kita cerita tentang hari ini*, about how you became a respected Paskibra member abroad, fulfilling your mother's dream, something she could not achieve. About you participated as one of the delegates in The Hague International Model United Nations

(THIMUN) and delivered an opening speech for the Economic and Social Council (ECOSOC), far beyond your father's and mother's achievements. Dedek, *nanti kita cerita tentang hari ini*, about you not being an NPC but actively contributing to the school community. About you won third place in the international writing competition by Youth Leaders of Indonesian Embassy Schools (YLIES)! Again, this is far beyond your mother's and father's achievements at your age. I know I was never the best figure for you all. Please forgive me for that and for all the things you all must endure to support me. I hope we can look back on these experiences, journeys, and adventures with smiles and that this will enrich our minds, hearts, and souls for our future tales together! May this journey be fruitful for our *dunya* and *akhirat,* and may Allah be pleased with us! *Aamiin.*

Schiedam, 1 June 2025/5 Dzulhijjah 1446

M. Gilang R.

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Part I: Prologue

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Chapter 1 – Introduction

> *"Technology is disrupting the audit process by increasing automation to drive efficiencies. … the only option for the audit profession is to embrace the developments in digital technology … ultimately it is always humans who are the driving force behind developments in technology."*[1]
>
> ~ Khurram Siddiqui, Partner, MENA Digital Leader, EY

We live in the digital era, with worldwide digital data growing exponentially each year in size, value, and influence. Its global size is estimated to be around 79 Zettabytes (ZB) in 2021 (Djuraskovic, 2023). This amount nearly doubled from the initial estimation at around 40 ZB (IBM in Jibril et al., 2017, p. 36). The quantity of digital data further translates into significant economic and monetary value. In 2022, the global big data industry and the overall value are estimated at US$114,9 billion and US$274 billion, respectively (Djuraskovic, 2023; Gupta, 2020).

The above numbers suggest the growing opportunities and challenges for many fields, including the *internal audit function* (IAF). In line with this notion, 56% of IAF leaders (i.e., the Chief Audit Executive/CAE) believe that technology influences IAF's value to the organization (PwC, 2018). Nevertheless, in contrast to the insight from CAEs, most IAFs continue to employ traditional approaches in performing their tasks (EY, 2020). This insight lays the opportunity for further examination of the phenomenon.

This research investigates *audit analytics* (AA) as the use of digital data and technology by IAF to improve the IAF's effectiveness and efficiency in performing its role to improve the organization's governance, risk management, and internal control. For that purpose, the first two sections of this chapter (Sections 1.1. and 1.2.) lay the background and the context of the study, i.e., the IAF and the implication of digital technology for IAF, followed by the practical and scientific values of this research (as shown in Section 1.3.). The following part of this chapter (Section 1.4.) shows the research objective and breaks it down into research questions. Finally, the research outline of this dissertation is presented at the end of this chapter (Section 1.5).

1.1. The Internal Audit Function

The *internal audit function* (IAF) is essential for many organizations as a provider of accountability in organizations and bridging the gap between stakeholders and management through its assurance and advisory services (Erasmus & Coetzee, 2018; Mihret, 2014). Although not universally required, IAF is imperative in many sectors and particularly mandatory for listed companies (DPNC, 2022; Tuovila, 2022). In its origin, audits were concerned with the establishment of the accuracy of transaction

[1] https://www.icaew.com/-/media/corporate/files/middle-east-hub/understanding-the-impact-of-technology-in-audit-and-finance.ashx (pp.7-8), last accessed 20-02-2025, 21:52 CET.

records and fraud prevention, which is reflected in the requirement for financial audits. In this regard, IAF operates as an extension for an external audit to provide a more detailed verification of an organization's (financial) transactions (Swinkels, 2012). This origin reflects the *initial* role of IAF to provide reasonable assurance of internal control practices for financial reporting quality (Adams, 1994; Erasmus & Coetzee, 2018; Mihret, 2014; Vadasi et al., 2019). In the early part of the modern era, the IAF's role then gradually shifted throughout history, slowly expanding from focusing on financial reporting to including operational and internal control effectiveness (Swinkels, 2012).

In performing its role, the IAF collects, evaluates, and analyzes data as (internal) audit evidence, and provides conclusions and/or recommendations for the (internal audit) client(s) (in the past known as "auditee"). Furthermore, the complex interactions and the socio-technical elements of IAF's interactions with stakeholders are also reflected in the internal audit tasks, both for assurance and advisory services. The tasks involve collecting, evaluating, and analyzing data as (internal) audit evidence, and providing conclusions and/or recommendations for the (internal) audit client(s) (in the past, known as "auditee").

The internal audit tasks can be viewed from various stages, from the planning until the communication of the results (reporting), including following up on the client's responses to the (internal) audit recommendations. The main stages are visualized in Figure 1 below, with brief explanations afterward.

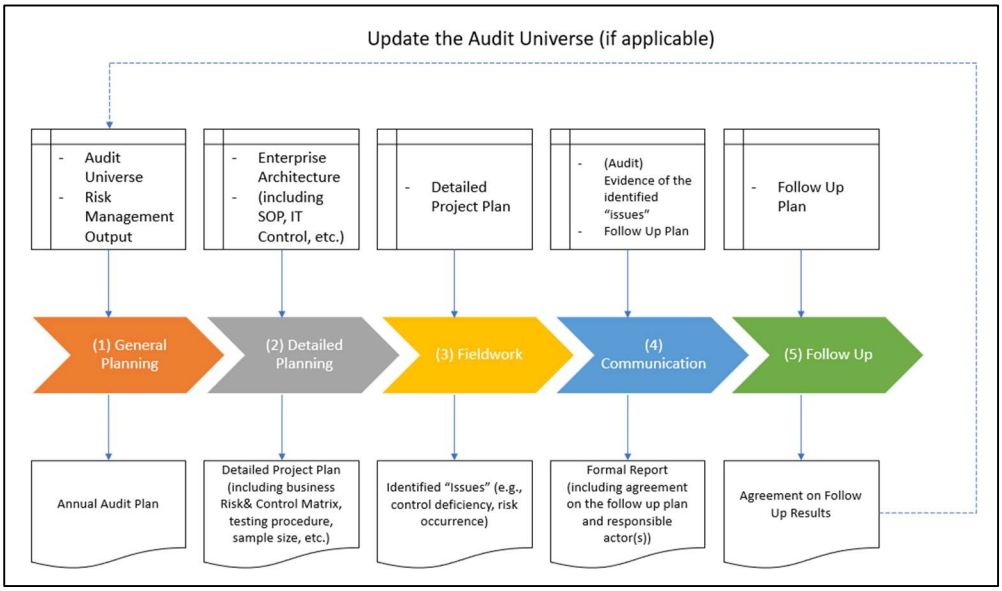

Figure 1. Simplified Visualization of the (Internal Audit) Stages in the Traditional Approach

1. General Planning

There are two types of planning. The first one is general planning (or annual planning), which aims to determine or select the scope and objectives of (internal) audit projects from the whole (internal) audit universe (Anderson et al., 2017; Messier Jr., 2010). Audit universe is the whole scope (can be in terms of business units, processes, applications, or a combination of those) that can be the object for internal audit projects. In a risk-based internal audit paradigm, this stage uses risk management results to select the area as the object for the (internal audit) project for the upcoming period (Coetzee & Lubbe, 2014; Gray et al., 2019). This planning results in an annual internal audit plan, consisting of a list of business areas (or units) as the objects for internal audit projects in the given year. In an organization with mature risk-management practices, IAF must consider the results of risk-management activities performed by the business areas/units to determine the annual plan. IAF must also share its plan with the internal compliance unit (if any), which underscores the complexities of the social aspects of IAF's tasks, i.e., its relationships and interactions with stakeholders.

2. Detailed planning

Another type of planning is the detailed (or project) planning. This planning is pertinent to determine the technical steps in collecting, evaluating, and analyzing evidence to develop conclusions and recommendations. It must take into account the technical aspects like the nature of the (business) process and its technological architecture. It affects the planning stage through, for instance, IT general control or data confidentiality (and/or privacy, if applicable) requirements in the areas/units. Hence, the audit team must obtain a comprehensive understanding of the characteristics of the (internal) audit objects, including evaluating the operational risks and the control designs in the area(s) (Anderson et al., 2017; Coetzee & Lubbe, 2014). This detailed planning phase results in the key operational risks (relevant for the audited areas) and control testing (known as risk-control matrix/RCM), a detailed audit procedure (Anderson et al. 2017, pp. 13-31 to 13-35), and a sample size (if applicable), which demonstrates the complexities of technical aspects of IAF's tasks, i.e., its considerations of technical elements of the (internal) audit objects.

3. Fieldwork

The fieldwork stage is when auditors perform the "main" activities in an (internal) audit project, i.e., data collection and analysis, based on the results of the previous stage. In short, the data collection and analysis evaluate the effectiveness of key controls of the business processes and the occurrence of the identified risks.

In a digitalized and data-driven organization, the fieldwork stage is heavily affected by the technology architecture of the organization, i.e., how the data will be collected and analyzed. It will also influence the required skills for the auditors to perform this task (and by extension, to carry out the internal audit project). Digitalization will also affect the interaction between the audit team and the business unit as the "data owner". These notions exhibit the socio-technical characteristics of internal audit tasks in a digitalized and data-driven environment.

The internal audit team will develop the conclusions based on the results of this stage. The internal audit team will also develop recommendations to address the control deficiencies and/or mitigate the risk of occurrence (as identified from the fieldwork result), which will be presented and discussed with the (internal) audit client in the communication stage.

The audit team generally manages this stage fully as one of the core activities. Nevertheless, the team may ask for assistance from an expert (either internal or external to the IAF) if necessary (Anderson et al., 2017; IIA, 2017).

4. Communication

The (internal) audit team must communicate the results of the internal audit project in a timely manner. This stage includes presenting the (internal audit) recommendations and reaching an agreement with the client on the follow-up plan to address the recommendations.

A formal report will be provided after the project. It may consist of individual reports for each unit, such as the (internal) audit sample, and the general/combined report to convey the IAF's conclusion on the (internal audit) area. If needed, the team can provide an interim report, especially for issues requiring urgent client response. Moreover, besides formal reports, the audit team (or IAF) may also provide a dynamic report that provides greater visibility into high-risk activities. Digital technology provides an alternative platform for this stage, such as in the form of an interactive dashboard (Stippich & Preber, 2016).The communication stage acknowledges the social and technical aspects of the IAF's interactions with its clients and the technical contexts in which the IAF operates.

5. Follow Up

The essence of the internal audit services is to improve the organization's governance, risk management, and internal control effectiveness. Hence, the (internal) audit project does not end with the delivery of the report. Instead, subsequent to the report, the (internal audit) client must perform the agreed-upon action plans as follow-ups on the recommendations to address the issues identified in the (internal audit) project. Depending on the complexity of the issue and the recommendation, follow-ups may take some time after the (internal audit) project concludes. Nevertheless, both parties, the internal audit team and the client, are obliged to keep track of each recommendation and its follow-up.

Furthermore, IAF's role became more comprehensive over time, driven by the increasing complexities of risks and challenges faced by organizations. IAF expanded its roles from focusing on financial reporting accuracy towards becoming a crucial part of corporate governance to provide services on improving governance, risk management, and internal control, including fraud prevention and detection in the organization (Bonazzi & Islam, 2007; Chambers & Odar, 2015; Erasmus & Coetzee, 2018; Haynes & Li, 2016; Sarens & Abdolmohammadi, 2011; Stewart & Subramaniam, 2010). As a part of corporate governance, IAF primarily provides

independent and objective assurance and advisory services for the governing body. In doing so, IAF acts as a trusted advisor for business units as internal audit clients to help them improve their governance, risk management, and internal control processes. Moreover, IAF also indirectly serves external stakeholders, such as the government as a regulator or external auditor. Figure 2 below visualizes the contemporary functions of IAF in the organization. The IAF acts as the third line of defense after management, whereas external auditors serve as the assurance provider for external stakeholders like government agencies, as regulators.

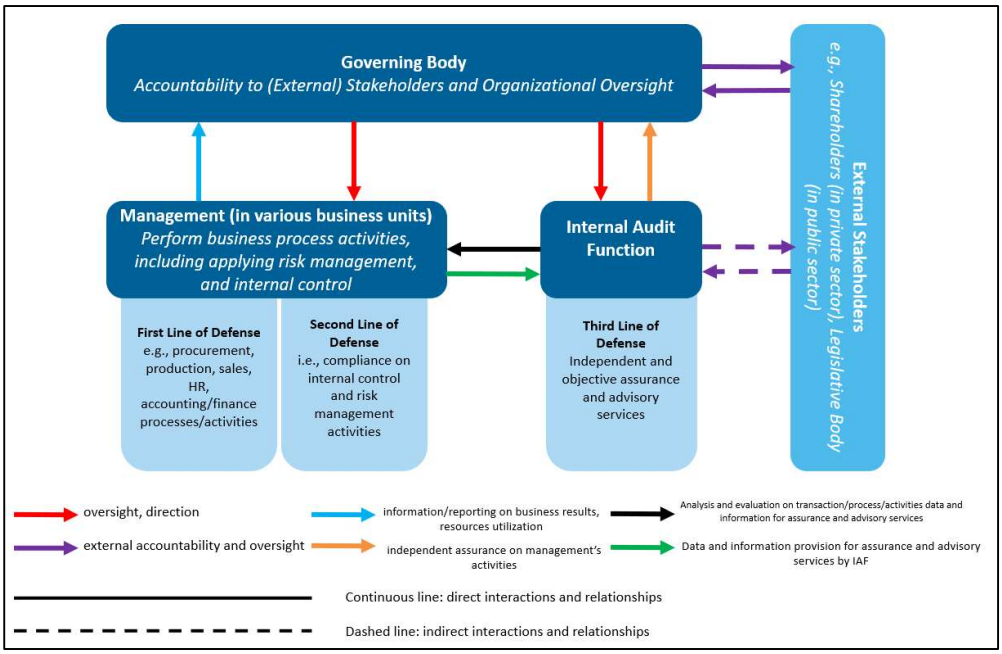

Figure 2. The Role of IAF (adapted from the IIA, 2020)

Figure 2 illustrates the roles and relationships between IAF and its stakeholders, highlighting their interrelations and the socio-technical challenges encountered by IAF. From a societal aspect, IAF faces organizational challenges due to the relations with various stakeholders. The complexity not only arises from the number of actors and factors involved, but also from the diverse nature of their interactions and expectations. This diversity contributes to a generally poor perception of the IAF's value for the organization (Nuijten et al., 2015). Furthermore, technological advancement aggravates the complexity of IAF's interaction with its stakeholders. Information and communication technology (ICT) advancement facilitates the organization to become 'digitalized' in performing its business processes. Digitalization results in the emergence of big data, including its volume, velocity, veracity, and variety, known as *the 4 V's* (Bhimani & Willcocks, 2014; Cardoni et al., 2020; Gallhofer & Haslam, 2006; Knudsen, 2020; Stippich & Preber, 2016; Tang et al., 2017). The vast amount of data results in the possibility of using AA.

Digitalization introduces additional complexities for IAF. Data in various formats and from diverse sources can be used by auditors but it also complicates auditors' work (Austin et al., 2018; Cardoni et al., 2020; Gambetta et al., 2016). Multiple business processes with different applications and databases introduce compatibility and interoperability issues, including for audit tasks. The flow of data and interrelation from one business process and application to another further extends risk and control pertinent to audit activities. Moreover, the connected process and data also raise the concern for the *contextual integrity* of the data, i.e., the use of data in other contexts (e.g., business areas) with different norms and appropriateness (Burns & Igou, 2019; Winter & Davidson, 2019). These issues, such as various formats or contextual integrity of (digital) data, reflect challenges from the 4 V's of digital data faced by IAF. Furthermore, (information and communication) technology and digital data can result in the rocketing of numbers and interrelations of transactions and processes, and even the development of new products and services (as internal audit objects) (Cha et al., 2015; Liu & Yuan, 2015; R. Sharma et al., 2014), which further exacerbates the complexities for IAF. Digitalization also connects business processes through multiple applications with different platforms, databases, and infrastructures. These phenomena imply more responsibility for IAF as reflected in the increased internal audit areas of responsibility (e.g., digital transactions or products), thus requiring increased coverage, depth, and speed of IAF's services.

The social and technical complexities and challenges force the IAF to respond and transform by better utilizing digital technology. The subsequent subsection briefly describes Audit Analytics (AA) as a transformation initiative to sustain IAF's value and relevance for the organization.

1.2. Audit Analytics for Internal Audit Function

Digitalization not only poses challenges but also provides opportunities for IAF, which allows various technology-based audits (Bumgarner & Vasarhelyi, 2018; Chou et al., 2007; Craja et al., 2020; Eulerich & Kalinichenko, 2018; Gonzalez et al., 2012; Lovata, 1990; No et al., 2019; Stippich & Preber, 2016). This research views the various technology-based audits for internal audit purposes under the umbrella terminology of audit analytics (AA). AA is "the process of identifying, gathering, validating, analyzing, and interpreting various forms of data within an organization to further the purpose and mission of internal auditing" (Lambrechts et al., 2011, p. 3 in Dai et al., 2019, p. 17). This study slightly modifies this definition to focus on the use of digital data and information technology for internal audit purposes. Therefore, this research defines AA as, "*The process of identifying, gathering, validating, analyzing, and interpreting digital data using information technology to further the purpose and mission of internal auditing*" (Ramadhan et al., 2023a). This definition is adopted from Lambrecht et al.'s early concept, with a slight modification to focus on the use of digital data and information technology for internal audit purposes.

The traditional audit approach, which views technology as a black-box (see further in Chapter 2), may not be suitable for coping with the various challenges in the digital era encountered by IAF. Manual examination of physical documents limits IAF's ability to analyze a large amount of data (Dai et al., 2019; de Freitas et al.,

2020; Shuhidan et al., 2020). Furthermore, in a fully digitalized organization, physical documents may not be available and replaced by digital data, which renders the traditional audit approach irrelevant. Hence, these notions suggest that the traditional approach becomes less effective and efficient in addressing the current and more complex risk environment and meeting the stakeholders' expectations (Chaqiqi & Nugroho, 2021; Soedarsono et al., 2019; Vasarhelyi & Halper, 2018). In response, AA answers to these limitations of the traditional approach by internalizing digital technologies into internal audit activities.

AA enables IAF to improve its effectiveness and efficiency (Bumgarner & Vasarhelyi, 2018; Li et al., 2018). The most distinct characteristic is its ability to provide proactive and ongoing assurance. In proactive assurance, IAF assists an organization in anticipating future risks and opportunities, such as through predictive analytics (Huibers, 2013; Stippich & Preber, 2016). Ongoing assurance can be achieved through the use of *Continuous Auditing* (CA). A CA approach allows IAF to deliver its report (issues and recommendations) in a real-time or near real-time manner so that the audit client can respond more timely (and mitigate the risks immediately), in contrast with the time lag in the traditional approach. AA also enables IAF to expand its service coverage (such as in operational and fraud areas) with the same resources, test larger samples, or complete population data (Ames et al., 2015; Barr-Pulliam et al., 2022). This benefit of AA significantly improves IAF's effectiveness in detecting issues from more comprehensive data compared to the use of a limited sample in the traditional approach. Furthermore, AA allows auditors to perform audits remotely (Teeter et al., 2010), saving traveling time and being able to conduct their work when meeting or traveling is not allowed, like during the pandemic. Table 1 summarizes the distinction between the traditional and AA approaches.

Table 1. Comparison of the Traditional Audit with Audit Analytics

Aspect	Traditional Audit	Audit Analytics
Period	Periodic	Ongoing (real-time/near real-time)
Coverage	Limited sample	Larger sample or even the whole population data
Focus	Past (historic)	Present (insight) and future (foresight)

The above characteristics of AA influence and alter all facets of internal audit activities. From the process perspective, AA may result in a dynamic and iterative process, such as for CA, since the findings are 'instantly' communicated to the client, which blurs the distinction between the fieldwork and reporting stage, instead of being sequential as in the traditional approach (see Figure 3). It may also alter the nature of the relationship and interaction between the IAF (the audit team) and the (internal audit) client, like in the predictive analytics project, which obscures the distinction between assurance and advisory services by the IAF. Therefore, AA not only reiterates but also amplifies the socio-technical complexities for IAF at the internal audit project level.

AA can be used for both internal and external audits. Nevertheless, this research focuses on AA in the internal audit setting for the following reasons. First,

compared to external audits, which mainly engage in financial audits, an IAF covers more areas of services (Li et al., 2018). IAF is not only focused on the financial aspect but also on other aspects such as operational or risk management (Li et al., 2018) (see also Figure 1). Secondly, external audits are bound by stricter regulations with legal implications (Austin et al., 2018; Eilifsen et al., 2020; Krieger et al., 2021). The absence of clear standards leaves external audit firms uncertain about whether AA can serve as acceptable evidence in regulated or mandated audit task like financial audits, potentially limiting its use in external audit practices. (Austin et al. 2018; Appelbaum, Kogan, and Vasarhelyi 2018). IAF's services are primarily risk-driven rather than regulatory-driven. The IAF has options regarding how it will perform its missions and can select the most appropriate auditing approach, e.g., whether to use AA and what type and why.

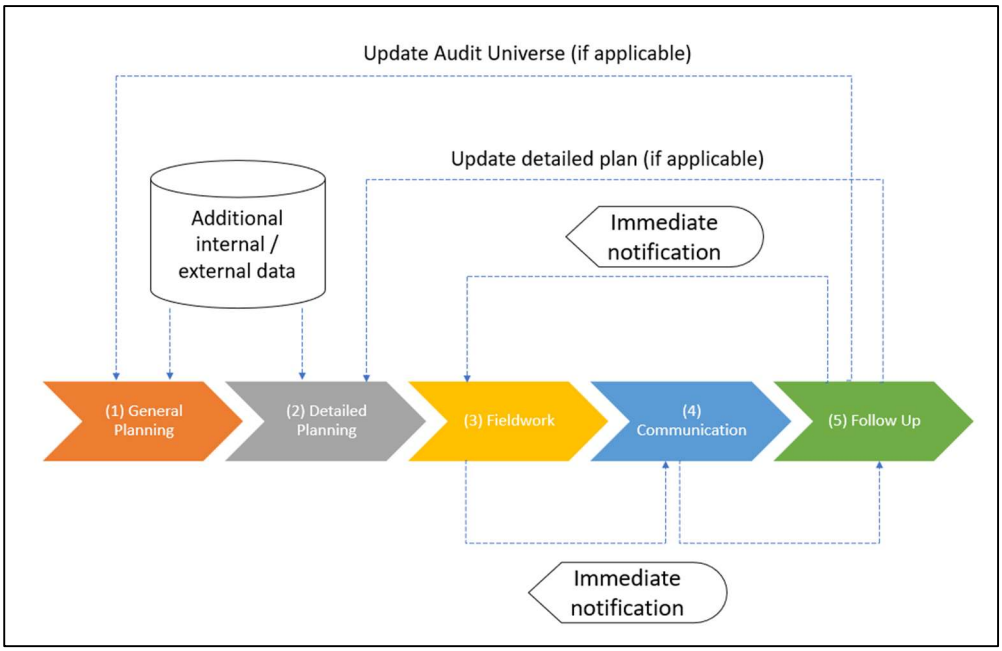

Figure 3. Simplified Visualization of AA Implications on (Internal) Audit Stages

1.3. The Need for Audit Analytics Implementation Framework

While the benefit of AA is widely recognized, the use of this practice is surprisingly low (Cardoni et al., 2020; Eulerich & Kalinichenko, 2018; Gambetta et al., 2016; Gonzalez et al., 2012; Krieger et al., 2021; Li et al., 2018; Wang & Cuthbertson, 2015; Woodroof & Searcy, 2001). AA implementation reshapes all facets of audit activities, including the required auditor's skill, the data collection and analysis, and how to deliver the (assurance/audit) results (Vasarhelyi et al., 2012). AA also influences the relationships and interactions between IAF and its stakeholders and requires adjustment on the current practices, actors, and structures (Joshi & Marthandan, 2020).

Moreover, AA implementation in practice also adds other issues, both for the organization and individual. From organizational perspective, utilizing the client's data may render internal auditors (or the IAF) responsible for the client's data security (Koskivaara, 2006). From individual perspective, this approach may also require additional effort, such as to learn new techniques (Betti & Sarens, 2021), which overlap with the need for completing the task (internal audit project). Therefore, these socio-technical complexities may persuade the organization (or the IAF) to opt for the traditional approach instead of trying to implement AA and therefore let go of its possible benefits.

Furthermore, the extant literature hints at various challenges related to AA implementation. While the internal factors like skill requirement are one of the concerning challenges (Austin et al., 2018; Chaqiqi & Nugroho, 2021; de Freitas et al., 2020; Haynes & Li, 2016), other challenges represent external factors that are not necessarily within the authority of the IAF (or the CAE, in this matter) to solve, like dynamics in audit process (Eilifsen et al., 2020; Soedarsono et al., 2019; Vasarhelyi & Halper, 2018). Further, as a transformational change, AA implementation may face resistance and call for a mindset adjustment at the organizational level to accept AA requirements and implications (Byrnes et al., 2018; Chaqiqi & Nugroho, 2021; Searcy et al., 2003; Vasarhelyi & Halper, 2018).

AA permeates to all facets of IAF activities and influences IAF's process, structures, and even roles and relationships. In this regard, the traditional audit approach, i.e., data and information collection and analysis through manual techniques and sources, may not be suitable for coping with the various challenges in the digital era encountered by IAF. Manual examination of physical documents limits IAF's ability to analyze a large amount of data (Dai et al., 2019; de Freitas et al., 2020; Shuhidan et al., 2020). Furthermore, in a fully digitalized organization, physical documents may not be available and replaced by digital data, which renders the traditional audit approach irrelevant. Hence, these notions suggest that the traditional approach becomes less effective and efficient in addressing the current and more complex risk environment and meeting the stakeholders' expectations (Chaqiqi & Nugroho, 2021; Soedarsono et al., 2019; Vasarhelyi & Halper, 2018).

Therefore, the limited use of AA in internal audits also restrains the realization of its benefits. For instance, CA (as a type of AA) enables real-time or near real-time (internal) audit output delivery using non-traditional reporting mechanisms, such as through alerts or notifications for the client (e.g., Codesso et al., 2020; de Freitas et al., 2020). This practice allows the internal audit clients (i.e., business units) to follow up on the issue immediately. Another example is the use of advanced and continuous analytics to filter findings so that any issues (or findings from internal audit results) can be handled more effectively and efficiently (No et al., 2019; Yoon et al., 2021). This practice further allows the IAF and the organization to identify and mitigate critical risks more effectively and efficiently, such as through immediate alerts for potential fraudulent transactions or filtering records that indicate possible misstatements in the financial report. These examples highlight the practical benefits of AA. Therefore, the limited use of the AA approach by IAF, particularly for already

digitally mature organizations, can lead to suboptimal value out of their IAF and missed opportunities for the organization as a whole.

The above attributes indicate that AA transcends beyond digitization and digitalization, i.e., converting analog into a digital version (be it information or process) using digital technology (adapted from Knudsen, 2020, and Tangi et al., 2021). Instead, AA can be viewed as IAF's transformation to adapt to the digitalized environment (Joshi & Marthandan, 2020). Tangi et al. (2021, p.1) define transformation as "a complete redesign of the existing processes, procedures, structures, and services". They further argue that transformation often requires a radical change of the *status quo*. Similarly, Hinings et al. (2018, p.53) outline key notions of transformation as "novel actors (and actor constellations), structures, practices, values, and beliefs that change, threaten, replace, or complement existing rules of the game within organizations, ecosystems, industries, or fields". Moreover, Knudsen (2020) underscores that transformation entails "major organizational changes".

Building on the existing concept, AA characterizes transformation as it implicates modifying the existing process, relationships among actors, and even cultures of the organization. However, such transformation is not without problems. It ranges from the individual and organizational resistance to change, the need to incorporate the local (or organizational) context instead of applying a generic approach, to its impact on the multilayered organizational processes and structures (Porras & Silvers, 1991). Particularly for AA implementation, multiple actors beyond IAF (or audit team) are involved with possible changing roles and relationships, resulting in complex and interrelated problems and requiring a holistic approach to deal with. AA can be further viewed as a digital transformation, by embedding the digital technologies into the modified process and which influences the interactions among actors (Nahrkhalaji et al., 2018). As a digital transformation, AA implementation leverages advanced technologies to navigate a complex risk and digitalized environment. Such transformation necessitates not only technical competence but also organizational readiness to embrace the cultural and structural shifts they entail (Heavin & Power, 2018; Oludapo et al., 2024; Tangi et al., 2021).

The notion of AA implementation as a digital transformation emphasizes the need for an organization-level instead of a project-level perspective. In this regard, while the use of AA in internal audit activities is a project in itself, AA implementation by the IAF is an organizational endeavor, considering that the complex AA implementation challenges and that it affects not only the IAF but also the IAF's stakeholders (e.g., the client, the board). From a project-level perspective, discourse on AA focuses on the audit team, i.e., how the audit team (auditors) plan and execute the project (e.g., see Codesso et al., 2020 or de Freitas et al., 2020). While it may involve stakeholders, such as the client, for data access, the emphasis remains on the audit team's project development. In contrast, from an organizational-level perspective, AA acknowledges the cross-functional implications that closely involve actors beyond the ones directly related to the project; for instance, the need for a comprehensive skill development plan involves the HR division and the board.

This notion further reinstates AA as a digital transformation, therefore, highlights the need for a prescriptive framework to guide the effort. A framework is a structured approach with concepts and components to understanding, analyzing, or solving a particular problem, which in the context of this research is AA implementation and the associated challenges. The prescriptive framework should consist of high-level and normative principle (or principles) to deal complex problems (Bharosa & Janssen, 2015; Gong & Janssen, 2013), which characterizes AA implementation as a digital transformation. Borrowing from information system literature, a principle is a directive and normative guideline to address ill-structured problems, which in the context of this study is AA implementation (more details in Chapter 2.3). Furthermore, the principles in the framework also serves as a strategy that address the socio-technical aspects of AA implementation as well as the complexities and dynamics of the IAF and its environment in which AA is implemented (Costan & Popa, 2017; Heavin & Power, 2018; Jedynak et al., 2021; Nuijten et al., 2015).

Furthermore, while there are existing frameworks in this field, such as the maturity model of CA and AA, they are either descriptive (e.g., Vasarhelyi et al. 2012) with limited value in fostering implementation or focus on AA as an individual technology project (e.g., No et al., 2019; Yoon et al., 2021) and, thus, do not address organization-wide problems and limited in assisting AA implementation effort. Moreover, while some organization-level frameworks are available, they are not directly connected to the challenges (e.g., Stippich & Preber (2016) and is conceptual or does not address organizational-level challenges of AA implementation in practice, e.g., Alles et al. (2008, 2009), Álvarez-Foronda et al. (2023).

1.4. Research Objectives and Questions

Based on the abovementioned considerations, this research aims to answer for the call to address the challenges of onboarding new technologies into audit practices (Tiron-Tudor & Deliu, 2022). In doing so, this research develops a 'prescriptive framework' to address the practical problem and advance the scientific discourses of AA. The above objective is translated into the following research question:

"*How does a framework help the internal audit function to implement audit analytics to transform its internal audit practices?*"

The main question is broken down into sub questions as follows:

1) *What are the challenges of AA implementation by IAF?*

   The first research question (RQ1) intends to identify the challenges that hinder AA implementation and prevent IAF from realizing AA's promised benefits. For this purpose, this research will explore the extant discourses in the field from the literature.

2) *What are the relationships among the challenges to be addressed in AA implementation by IAF?*

Based on the identified challenges, the second research question (RQ2) aspires to determine the challenges prioritization by developing the hierarchical model of challenges of AA implementation. This research will obtain insight and experience from internal auditors who are experienced in AA use in their internal audit tasks.

3) *What are the principles for addressing the challenges of AA implementation by IAF?*

   The following research question (RQ3) is to unravel the principles from a real-world experience of AA implementation, incorporating its dynamics, including success stories and lessons learned from failed attempts. The principles serve as high-level guidance adaptable to different contexts to overcome AA implementation challenges.

4) *How do the proposed principles address the challenges to fostering the AA implementation by IAF?*

   The final research question (RQ4) aims to examine how the proposed framework contributes to addressing the challenges encountered in AA implementation by IAF. For this purpose, this study will use empirical and conceptual insights through informed arguments with experienced AA practitioners from diverse industries and evaluate the framework using the conceptual quality model.

From a scientific perspective, the proposed framework as the answer to this research question complements the field's existing frameworks by providing principles for AA implementation and theorizing the connection between the principles and the intertwined challenges of AA implementation. From a practical point of view, the developed framework provides a practical reference to guide AA implementation and tackle the challenges that can be applied differently in different circumstances.

1.5. Dissertation Outline

This research performs several steps to achieve its objective and answer the research questions. Figure 4 below visualizes the research steps and the related research question and dissertation chapter. A brief explanation of each chapter is provided afterwards.

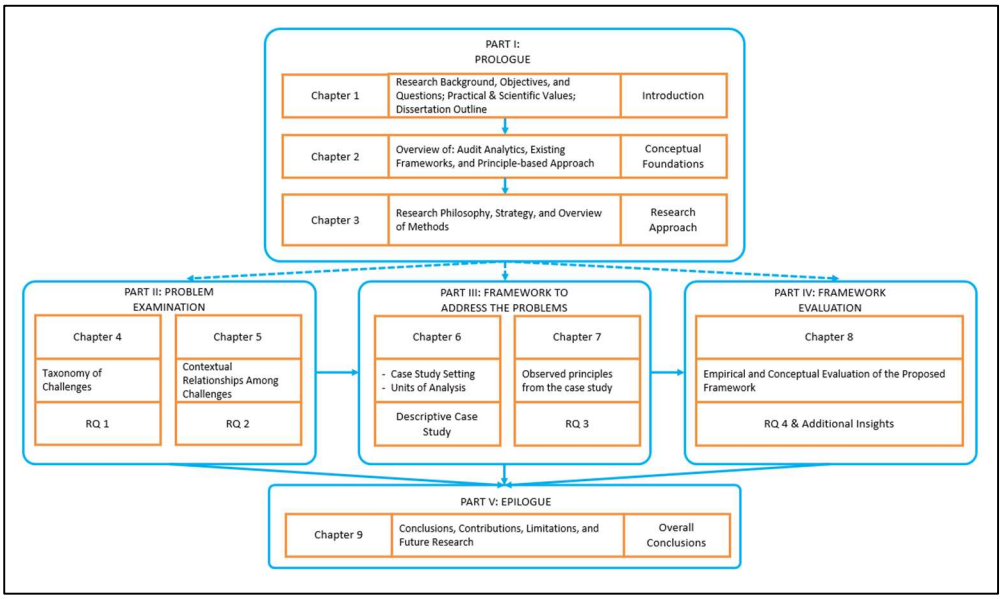

Figure 4. Dissertation Outline

The first three chapters of this dissertation present the foundation and construction of this dissertation. **Chapter 1** presents the context and study setting as the research background. Further, the practical and scientific problems are laid out to motivate the research. The first chapter also includes the outline and publications pertinent to the dissertation. **Chapter 2** explores the existing literature to inform the state-of-the-art AA research as the conceptual foundation for this research. This second chapter includes the development of AA, existing AA implementation frameworks, and a principle-based approach to AA implementation. The literature provides the theoretical positioning of this research. **Chapter 3** elaborates on the research philosophy and strategy employed for each research phase.

Building on the previous three chapters, the next two chapters examine the challenges of AA implementation. **Chapter 4** answers the first question (RQ1) by systematically reviewing the literature and identifying the challenges of AA implementation. The review results in a taxonomy of the challenges of AA implementation. Based on the taxonomy of the challenges, **Chapter 5** answers the second research question (RQ2) that seeks the interrelationship among challenges of AA implementation using *Matrice d'Impacts Croisés Multiplication Appliqués à un Classement* (cross-impact matrix-multiplication applied to classification or MICMAC) - Interpretative Structural Modelling (ISM) (or MICMAC-ISM for short) to develop a hierarchical model of challenges of AA implementation.

Subsequently, **Chapters 6 and 7** provide the case study results, including the description of the case study settings (the organization), the units of analysis (AA projects), and the observed principles from the case (RQ3). These chapters also present the relationship between the principles and the challenges of the proposed

framework, which will be evaluated in the next part of this study. The final phase of this research is the evaluation of the framework. The identified principles and their relationships with the challenges are evaluated in **Chapter 8**, which informs the quality indicators of the framework, such as its relevance, comprehensiveness, and practical value to assist IAF in addressing AA implementation challenges and answer the last research question (RQ4). It also provides insights from the respondents to assist in translating the framework into practices beyond the examples in the case study.

Finally, **Chapter 9** is the last part of this dissertation that concludes the research results. First, this last chapter starts by outlining the research objective and questions, with the comprehensive conclusion presented afterwards. Subsequently, this chapter outlines the reflections of the research's results on the relevant theoretical lenses. In this chapter, the lessons learned from the empirical studies (i.e., MICMAC-ISM analysis, Case Study, and Informed Arguments by Practitioners) are reflected on the Agency theory as the classical view of IAF and the Socio-technical Systems (STS) and Complex Adaptive Systems (CAS) theories as the alternative lens in viewing IAF and AA phenomena. Furthermore, this chapter reasserts this research's scientific and practical contributions, including its contribution to theory, methods, and discourse in the field, along with the future implications of digitalization for IAF. This chapter also provides the limitations of this dissertation. Finally, building from these insights, future research recommendations are provided to wrap up this dissertation.

Chapter 2 – Conceptual Foundations

The first chapter lays the context and study setting as the background for this research, which informs the practical and scientific problems motivating this dissertation. From a practical perspective, AA implementation remains limited despite its promised benefits, which implies practical problems to be addressed. Moreover, the practical problems may be rooted in a limited prescriptive framework to guide the implementation; hence, the need to expand the existing scientific knowledge in this field.

Therefore, this chapter reviews the extant discussions in the field as a basis for which we build this research. This chapter starts by discussing types of AA (Section 2.1.), from the simplest type to the most advanced one, which indicates the characteristics and possible significance for further investigation in this research. Subsequently, this chapter lays out the existing frameworks related to AA implementation (Section 2.2.), followed by the elaboration of the principle-based approach (Section 2.3.). The latter section of this chapter (Section 2.4.) briefly discusses the theoretical lenses used in the existing literature and the implications for this research. These discussions hint at the approach of this research discussed in the next chapter of this dissertation.

2.1. Evolution of Audit Analytics

Auditors treated information systems and technology as a 'black box' at the early stage of the computerized (or digitalized) business process (Byrnes et al., 2018). This notion, also known as 'audit around the computer', rendered auditors to limit their interaction with the said technology when performing audit tasks. Consequently, auditors focused on non-computerized data in evaluating and analyzing audit evidence to develop audit conclusions (i.e., documents for input and the report as the output). This research refers to this approach as the traditional (internal) audit approach, in which auditors 'ignored' the control mechanisms (including their failure, if any) inside the computerized process. Instead, auditors rely on core auditing skills, such as risk analysis and (audit) testing techniques and focusing on non-computerized aspects and controls of the process.

Nevertheless, the digitalization of the business process forced auditors to perform 'audit through the computer' (Byrnes et al., 2018; Krieger et al., 2021). This notion, facilitated by the development of generalized audit software (or GAS, such as IDEA, ACL, and other software), flourished the computer-assisted audit techniques and tools (CAAT) as the initial use of digital data and IT for audit purposes (Gambetta et al., 2016; Krieger et al., 2021). CAAT "helps auditors to perform data extraction, querying, manipulation, and analytical tasks" (Gambetta et al., 2016) to develop audit conclusions. This approach facilitates risk analysis and control testing through the software. Therefore, auditors are required to 'translate' the audit procedures into the software's syntax. CAAT substitutes manual techniques in delivering those tasks by evaluating and analyzing internal control mechanisms in the 'computer' rather than merely testing the inputs and outputs of transactions.

Another form of digital data and IT for audit purposes is the embedded audit module (EAM). EAM allows auditors to monitor business transactions continuously and triggers an 'alarm' when anomalies (deviation from the criteria) occur by embedding audit testing from CAAT into the business system. The embedding of audit testing into the business system may be performed by the internal system developer (or software engineer) in the organization or external consultant specialized in developing EAM. Due to this characteristic, EAM is considered the predecessor of continuous audit (CA) (Debreceny et al., 2003).

CA is perhaps the most well-known and widely researched AA type. Practically, CA is similar to EAM 'with no strings attached'. Rather than embedding the testing procedure in the business system, CA extracts business data and independently tests the data in a specific environment for audit purposes (Vasarhelyi & Halper, 2018). As the most widely researched type, there are variations of this form, such as the use of a three-layer approach to predict the 'normal' business behaviour (and identify anomalies) or the use of machine learning to filter out insignificant errors in MADS model (No et al., 2019; Yoon et al., 2021). This approach requires auditors to thoroughly understand risks and controls in a digitalized business process and develop testing procedures based on it. CA also requires a deep understanding of the digital data to develop the testing procedures. However, most GAS provide user-friendly interfaces for auditors to translate the data, risk, and control understandings and testing procedures to develop CA.

In addition, the rise of big data analytics enables auditors to perform more advanced techniques for audit tasks. Therefore, in addition to the core auditing skills like risk analysis and control testing, this approach also needs advanced analytics skills, like model development and evaluation. Moreover, this approach implies the need for basic programming skills to deploy and utilize the model as an (internal) audit project. For instance, the Institute of Internal Auditor Research Foundation (IIARF) states the use of predictive and prescriptive analytics (Stippich & Preber, 2016). These types of analytics use modelling to predict and prescribe future action by IAF's client (Gepp et al., 2018). However, unlike other types of AA, this type also relies on external data that is not necessarily available in the organization (Stippich & Preber, 2016). Moreover, these types are relatively new and require more research, especially empirical study, to propose an appropriate design.

Table 2 summarizes the development of AA from the simplest version, i.e., the utilization of basic computerized tools to evaluate initial evidence in digital format, to the most advanced form through the use of machine learning for predictive analytics. These types of data analytics influence internal audit tasks in multiple aspects. AA entails different data requirements, from ad-hoc and batch data processing to near real-time or real-time data access (Codesso et al., 2020; Krieger et al., 2021). Consequently, AA requires a variety of processing environments, from a stand-alone computer to the embedded in the business analytics information system. Notably, AA implicates the adjustment of auditors' skills, and the skills requirement advances in line with the AA's sophistication level.

Table 2. Summary of the Development of Audit Analytics

AA Type	Analysis Environment	Digital Data Requirement	Relevant Skills
Audit Around the Computer (non-AA)	N/A (manual)	N/A (physical documents)	Risk analysis and control testing skills.
CAAT	Desktop/stand-alone computer	Ad-hoc (per engagement)	Risk analysis and control testing skills, basic data preparation, data analysis using spreadsheet.
EAM	Integrated with business system	Real-time/periodic, depending on the architecture	Risk analysis and control testing skills, programming skills (can be performed by external consultant).
CA	Analytical environment for audit purposes (e.g., OLAP for audit team)	Real-time/near-real time	Risk analysis and control testing skills, data analysis using GAS.
Advanced analytics (e.g., machine learning for predictive analytics)	Analytical environment for audit purposes	Batch	Risk analysis and control testing skills, advanced analytics skills, advanced data preparation skills, basic programming skills.

2.2. Existing Audit Analytics Frameworks

The previous section elaborates on the various types of AA, each with its own characteristics and requirements. With regard to those various AA types, the extant literature also offers studies on frameworks for AA use in audit activities. A framework is a structured approach with concepts and components to understanding, analyzing, or solving a particular problem, which in the context of this research is AA implementation and the associated challenges.At the organizational level, there have been studies about a stage model for assessing the (AA) implementation level or the conceptual analysis of the (AA) implementation process. At the project level, numerous studies provide detailed accounts of how to develop AA projects for various types and purposes. This section will elaborate on the extant guideline or framework in AA studies and, building from that, identify the fruitful studies that will expand and advance AA-related research.

One of the earliest frameworks is the CA maturity model (Vasarhelyi et al., 2012). The CA Maturity Model framework builds on Roger's work on the diffusion of innovation and the extensive elaboration on the existing CA literature. The framework provides an overview of the CA implementation stage and breaks down the stages into elements. This framework is valuable for assessing the level of CA implementation in an organization and covers organization-wide elements in viewing AA implementation. Nevertheless, this framework is not specifically intended to guide the implementation. Additionally, as explicitly mentioned in its title, this framework focused on CA, and its applicability to other types of AA may require further investigation.

Further, the IIA Research Foundation (IIARF) developed a maturity model for a broader range of AA[2] (Stippich & Preber, 2016). This framework contains the maturity model for evaluating the AA implementation and cascades the maturity level into organization-wide elements. However, the central part of the framework is the process model that guides the implementation. While this framework is a powerful tool, it serves more as a practical reference and requires more theoretical grounding. Additionally, the presented framework refers to success stories from scattered cases instead of comprehensive use of the framework. This type of framework is similar to the literature-synthesized framework by (Álvarez-Foronda et al., 2023) and conceptual analysis by (Alles et al., 2008, 2009). However, these frameworks require more coherent grounding and miss the conceptual 'guidance' in dealing with the challenges.

The literature in the field is also rich with practical and detailed guidelines at the project level. For instance, (No et al., 2019) propose the Multidimensional Audit Data Selection (MADS) framework to select outliers among vast numbers of anomalies resulting in AA analysis (e.g., the use of CA to test control compliance). Another example is the three layers of tests to identify and categorize the significant findings resulting from CA, thus improving the effectiveness and efficiency of the system (Yoon et al., 2021). These frameworks guide the development of AA projects in fascinating detail. Moreover, the use of design science research in developing these frameworks results in robust and theoretically sound guidelines.

However, these latter frameworks serve at the project level and work specifically for each type. Unfortunately, many challenges inhibiting AA implementation are related to the organizational-wide level. For instance, the frameworks (i.e., MADS or Three-layer) suggest techniques (e.g., machine learning model) to filter or categorize anomalies for further investigation. However, auditors' skills in this matter still need improvement, and this (project) type may entail a particular data access arrangement and, therefore, requires the involvement of another unit (e.g., HR Division, IT Division) to address (de Freitas et al., 2020; Haynes & Li, 2016). There are other possible organizational-level issues of AA implementation, such as the organization's mindset adjustment to accept AA requirements (Chaqiqi & Nugroho, 2021; Vasarhelyi & Halper, 2018), dynamics in the audit process, involving protocol and interaction between the auditor, client, and other stakeholders (Tang et al., 2017), or risk for IAF's independence or the potential for counter-analytics (Austin et al., 2018), which necessitate an organization-wide perspective, such as through support and communication strategy from outside the audit team to overcome.

Table 3. Overview of Studies of Guideline or Framework for AA Implementation

#	Name	Author(s)	Description	Level
1	CA Maturity Model	(Vasarhelyi et al., 2012)	Consists of four levels of maturity, and eight elements of assessment at each level.	Organization

[2] Note: It uses the term Data Analytics for Internal Audits

2	DA Framework for IA	(Álvarez-Foronda et al., 2023; Stippich & Preber, 2016)	Process model for implementing audit analytics in the organization; it includes assessment of the current stage of the IAF using maturity model.	Organization
3	Principles for Audit Automation	(Alles et al. 2008; 2009)	A set of principles for automating audit tasks, incorporating triggers and challenges, audit procedure, technological aspect, and change management for continuous audit implementation based on conceptual analysis.	Organization
4	MADS	(No et al., 2019)	AA framework to filter large number of outliers, enabling auditors to focus on high risk 'findings'.	Project
5	Three-layer CA System	(Yoon et al., 2021)	CA Framework to categorize the 'findings' based on three indicators, namely: unusual transactions, exceptions, and anomalies; allowing different actions (by auditors) for each type.	Project

The existing discourses of AA offer fruitful opportunities for further investigation, both from academic and practical perspectives. From the academic perspective, a prescriptive, end-to-end, empirically based framework is needed to fill the void in the extant literature. This type of research addresses the limitations of the existing descriptive, fragmented, and conceptual organizational-level frameworks. It also addresses the limitations of project-level frameworks in addressing organizational-level issues. Moreover, considering the limited discourse of this type of framework in the existing literature, an exploratory research on this subject will open up a multitude of academic avenues, not only to fill the gap but also to further advance the field. From a practical perspective, this type of framework provides guidelines that target organizational-level issues and assist IAF (and the organization) in realizing the benefits of AA.

2.3. Principle-based Framework for Audit Analytics Implementation

The contemporary literature hints that AA implementation faces complex and intertwined challenges (Ramadhan et al., 2023b), hindering IAF from realizing its benefits. This complex problem, which characterizes AA implementation and cannot be formulated in explicit and quantitative terms, requires a principle-based approach to overcome (Simon, 1997, in Bharosa & Janssen, 2015). The principle-based approach is also sought after in broader fields like technology, environmental policy, or digital government (Gunningham & Sinclair, 1999; Malik, 2013; Matheus et al., 2021).

TOGAF (2018, section 20.1) defines principles as "general rules and guidelines, intended to be enduring and seldom amended, that inform and support the way in which an organization sets about fulfilling its mission". Meanwhile, Richardson et al. (1990, p. 388) define principles as "beliefs upon which the enterprise is created, and the bases of its decisions" and Bharosa et al. (2011, p.1)

suggest it as a means "to guide stakeholders in proactively dealing with some of the transformation issues" (in Matheus et al. 2021, p. 4). Another definition of principles is "normative, reusable and directive guidelines, formulated towards taking action by the information system architects" (Bharosa & Janssen, 2015, p. 472). Building on those definitions, this research defines the principles as "*normative, reusable, and directive statements that are understandable and enduring to guide AA implementation*". (adapted from Bharosa & Janssen, 2015; Gong & Janssen, 2013; Matheus et al., 2021; TOGAF, 2018)

A principle consists of the statement describing the principle, the rationale as a justification for the principle, and the implication that shows how it will influence AA implementation. For practical purpose, the principle should also include the code and short name for each principle. Furthermore, within the context of this research, the principles should also address and overcome the challenges associated with the implementation of AA. Practical example of the principle may also present to improve clarity. These elements serve the principles' purpose of addressing AA implementation challenges by providing an easy-to-understand directive statement that supports decision-making in dealing with AA implementation as a digital transformation effort. This notion aligns with Gregor et al.'s (2020) anatomy of principles, which also includes the decomposition of high-level principles into 'smaller' elements.

Table 4. Elements for Describing a Principle (adapted from TOGAF, 2018)

Element	Description
Statement	A complete unambiguous description which contains the essence of the principle. It serves to communicate the principle across organization.
Rationale	Justification for adhering with the principle, including its relationship with other principles (if any). For practical purpose, it should use business terminology.
Implication	The implication for the organization in applying the principle in terms of resources and other requirements, including possibility of changes in activities/tasks.
Challenges Addressed	A list and explanation of challenges influenced by applying the principle.
Example(s)	A set of activities, documents, or other business practice as the practical translation(s) of the principle.

A principle-based framework provides high-level guidance that is adaptable to different contexts to overcome AA implementation challenges. Moreover, principles are particularly relevant to guide an organization in dealing with problems in transformation efforts (Matheus et al., 2021). Furthermore, the principle-based approach fosters for AA implementation by connecting the principles to the challenges. Therefore, developing this type of framework from empirical evidence will complement the existing frameworks and foster AA implementation.

In the context of this research, the principle-based framework works as a 'theory' for AA implementation as a transformation effort by IAF. This type of 'theory' serves as a 'rule of thumb' that explains, predicts, or prescribes a particular action (i.e., AA implementation by IAF) in a certain context. This type of 'theory',

however, implies there are other possible suitable actions. Zwart and de Vries (2016, p.229) classify this type of 'theory' as a *means-end knowledge*, i.e., "… prescribes how to act (and what to avoid) in order to achieve some pre-specified goal in a specific context …".

Furthermore, this notion implies the appropriate methods to develop and evaluate 'theory' as a *means-end knowledge* rather than *descriptive knowledge*. Descriptive *knowledge* tends to provide an explanation that generally holds true, implying that any deviation will reject the proposed 'theory'. In contrast, *means-end knowledge* focuses on the reliability or effectiveness of the 'theory' to achieve the pre-specified goals in the relevant setting, thus, unsuitable for falsification (Zwart & de Vries, 2016). In addition, the context-dependent characteristic of *means-end knowledge* suggests that it is empirical and should be developed from a real-world setting to become reliable (idem).

2.4. Theoretical Lenses

Theory serves various purposes, from explaining, analyzing, assisting to understanding, predicting, and designing interventions to address a phenomenon (Gregor, 2006). In this regard, this research focuses on IAF and its use of AA to deliver and improve its value to the organization. Therefore, this section elaborates on theories relevant to the phenomena of the IAF as an entity and AA as one of the practices of IAF in delivering its values to the stakeholders (as elaborated on in Chapter 1). For that purpose, this section will briefly elaborate on Agency, Socio-technical System (STS), and Complex Adaptive System (CAS) theories, which underpin the analysis and discussion in this research and serve as the foundation for the developed framework and its scientific and practical implications.

The Agency theory is chosen as the most common theoretical lens in viewing IAF (which includes its activities, such as AA). In the classic view of the Agency theory, IAF serves as an intermediary between the principal and the agent (Adams, 1994). From the perspective of Agency theory, AA implementation can be analyzed as an effort to fulfill IAF's role in bridging the gap between the principal and the agent.

Whereas STS and CAS are selected as the alternative perspectives in viewing the phenomena, i.e., IAF (and by extension, AA implementation), from the System view's perspective. From STS and CAS perspectives, the IAF can be considered as a part of a system within the organization it belongs to, as suggested by Costan & Popa (2017) or Nuijten *et al.* (2015). In this view, this research reflects on the STS to define the social and technical aspects of AA implementation by IAF and CAS which characterizes AA implementation by IAF as a complex evolving socio-technical system.

2.4.1. Agency Theory

Agency theory originated from the agency problem, i.e., when cooperating actors have their own autonomy and operates for different goals and interests (Eisenhardt, 1989a). While the Agency theory is rooted in the organizational theory, it applies to

a wide range of research, such as information systems, economics, finance, or accounting (Eisenhardt, 1989a). The Agency theory is accused of being too narrow and, by focusing on the organization's outcome from interactions among actors, potentially dehumanizing and "dangerous" (Hirsch & Friedman, 1986; and Perrow, 1986 in Eisenhardt, 1989a). However, the proponents of this theory argue that the Agency theory offers empirical propositions and universal scenarios that it can explain (Jensen, 1983; Ross, 1973 in Eisenhardt, 1989a), which apply to the internal audit (or general audit) field.

Literature analysis suggests that the Agency theory is the most used theoretical lens in analyzing and explaining the IAF as a phenomenon, either as a single theory or combined with other theories (Hazaea et al., 2023). While this theory applies to a wide range of settings, such as in the relationship between elected officials and citizens, in the context of this study, this theoretical lens focuses on the interrelation among actors within an organization to explain the role of IAF.

In one of the earliest contemporary discourses of internal audit, Adams (1994) used the agency theory to underscore the role of IAF in bridging the gap between the principal as the 'resource owner' and the agent as the 'resource user'. The principal refers to the organization's resource owner. In contrast, an agent refers to the manager who utilizes the resources to maximize the benefit for the principal. In a private setting, this representation refers to the role of IAF as an intermediary between the board (as the principal) and the management (as the agent). However, this relationship also applies to other settings, such as government institutions. In a government institution, the principal might be the head of the agency (e.g., the Minister) that holds the mandate and its accompanying resources (such as the budget), and the agent is the public institution manager who executes the mandate and utilizes the resources on behalf of the principal.

The Agency theory posits that IAF serves as one of the control mechanisms in the organization's governance (Sarens & Abdolmohammadi, 2011). From the agency theory's perspective, IAF primarily addresses the problem of *information asymmetry* to ensure that the agent conforms to the principal's stakes in utilizing the resources. This focus underlies the emphasis of the Agency theory in viewing IAF phenomena from an economic stance (Adams, 1994; Mihret, 2014). From this perspective, the IAF roles and relationships are primarily a monitoring mechanism for the principal (to ensure that the agent serves the principal's best interests) and an accountability tool for the agent (Adams, 1994). From a broader perspective, the IAF's role is also to assure that all governance, risk management, and internal control processes are functioning properly and, by extension, advise the organization (e.g., management and board) in these matters (Mihret, 2014).

A critique of this theory highlights potential internal inconsistencies in explaining the IAF (Mihret, 2014). In this perspective, IAF acts as a control mechanism employed by the principal to monitor the agent's behaviour whilst being remunerated by management as the agent. However, proponents of this theory argue that IAF as a control instrument also serves as a sign of transparency and accountability from the management (Adams, 1994). Hence, this view alludes to the

"benefit" of IAF from the agent's perspective. Agency theory also hints at the IAF's role alongside other layers of control, such as an audit committee, as a part of the overall governance mechanisms. (Sarens & Abdolmohammadi, 2011).

Agency theory explains the IAF and its activities, including AA implementation, as a mechanism for addressing the potential contradicting interests between actors in the organization (Sarens & Abdolmohammadi, 2011). Hence, the Agency theory implies that IAF focuses on meeting the principal's (as the main stakeholders) need to enhance the organization's outcome (Hazaea et al., 2023), be it profit in a corporation or public value for a public sector institution. Nevertheless, this theory does not particularly address technology-related issues like AA implementation. Instead, the agency theory serves as a lens through which IAF's roles and relationships with its stakeholders within an organization can be viewed, as well as how AA implementation affects (and is affected by) these roles and relationships. Hence, from the perspective of agency theory, AA is viewed as an approach used by the internal audit function (IAF) to provide better services to the principal, such as through more timely reports or analysis of larger samples. These improved services through AA help IAF to ensure that the business unit, as the agent(s), aligns with the principal's interests. Additionally, AA improves IAF's value to the agent(s) in enhancing their control, risk management, and governance processes through faster and more comprehensive audit recommendations and advisory services.

However, recent studies point out the intricacies of the IAF's roles and its relationships with its multiple stakeholders, which complicates the role of the IAF. Mihret (2014) underscores the divergence between assurance and advisory roles, which may lead to conflicting interests and the deficiency of the agency theory in understanding this notion. Furthermore, agency theory falls short to account for complex relationships among management, IAF, and the audit committee – and confusion about it – which may divert the IAF's focus from serving the organization's best interests (Lenz & Hahn, 2015). AA implementation exhibits these complexities. For instance, an AA project can be both assurance and advisory services, obscuring the barrier between the (IAF's) two roles, and business unit/management acts both audit client (or auditee) and data (and process) owner. Lenz and Hahn (2015) further argue that IAF should operate within a broader governance framework, allowing for collaboration with audit committees, boards, management, and even external stakeholders like regulators to achieve the organization's objectives. In response, this research transcends these perspectives by viewing IAF as a part of intertwined elements with other elements of a system, which will be further elaborated in the following subsection.

2.4.2. Socio-technical System (STS) and Complex Adaptive System (CAS) Theories

The fundamental tenet of system theory posits that a system is a combination of its elements, and its features do not emanate from each element's sole feature. This characteristic is famously (and 'mystically') stated as "*the whole is more than the sum of its parts*" (von Bertalanffy, 1968, p.55). The original concept of a system applies to wide range of notions, from an organism to society (idem). This study, however,

focuses on an organization and its parts as the object of interest. In this regard, this study concerns IAF as a subsystem within an organization as the system. Therefore, this view offers an alternative perspective in analyzing IAF and AA implementation phenomena.

In the context of this study, an organization is considered a system (Bostrom & Heinen, 1977). An organization fits the concept of a formal system that consists of mutually interdependent parts and planfully structures its resources or processes (von Bertalanffy, 1968, p.9). Further, an organization reflects systems' elements in its wholeness and growth (by processing inputs into outputs and receiving feedback throughout the process) (von Bertalanffy, 1968, p.47). In a modern context, these elements are represented in the efficacious process or sophisticated structure of an organization (Ravichandran & Rai, 2000).

Furthermore, Bostrom and Heinen's (1977) work addresses the distinction between information systems (IS) and the social elements of an organization as a system. This distinction (and particularly negligence of the social aspects) results in failures in many IS initiatives. Therefore, they argue that both elements should be incorporated into any IS-related initiative. Building from this notion, the Socio-technical System (STS) theory acknowledges the interdependence of the system's elements and specifically recognizes the interaction between a system's social and technical elements (Leonardi, 2012; Sony & Naik, 2020). This view contributes to understanding AA implementation as an IS-related initiative influences and influenced by the social aspects within the context of an organization as a system.

From the earlier STS perspective, the technical elements of an organization consist of technology and tasks, which are segregated from the social aspects (S. H. Appelbaum, 1997, p.461; Bostrom & Heinen, 1977, p.25). This stark demarcation is understandable considering that these works were the early inception of the concept, not only in recognizing but also in incorporating social aspects into IS-related initiatives, both from scientific and practical perspectives. Nevertheless, contemporary discourses of STS acknowledge the entanglement of technical elements with its social aspects' counterparts. For instance, Leonardi (2012, p.25) suggests that tools, technologies, and processes that constitute the technical elements are intricately linked to social agencies such as actors' goals. Furthermore, Sony and Naik (2020, p.5) integrate all elements into dimensions of infrastructure, technology, process/procedure, goals, people, and culture. These dimensions reflect the facets that influence (and are influenced by) AA implementation by IAF.

STS highlights the importance of integrating IS initiatives' social and technical elements. The initial STS (hypothetical) "application" prescribes to incorporate both technical (e.g., workflow, data processing, technology) and social (e.g., communication, job roles) aspects in IS initiatives (Bostrom & Heinen, 1977). Further, Sony and Naik (2020) exemplify how the technical aspects (technology, processes) allow and require shared responsibilities among involved actors as the subsystems to achieve the goal of digitalization as an IS initiative. STS also suggests that strategic thinking is a starting point and should precede the process design and, eventually, technology arrangements (Govers & van Amelsvoort, 2023, p.34).

Furthermore, Govers and van Amelsvoort highlight the impact of digitalization on the organization and its environment, which entails a comprehensive and systemic perspective.

Complex Adaptive System (CAS) theory further extends the System view from STS through its openness to external factors and allows the system to respond and adapt to it (Dooley, 1997). CAS acknowledges 'chaos' in the interactions among these elements of a system. In this view, people or units (as actors) interact based on a set of structures and rules, yet are influenced by their interpretation, which often leads to unpredictable emerging behaviors (Janssen et al., 2014). Further, CAS recognizes the informal interaction besides the formal structural interaction among actors (Ellis & Herbert, 2011). These collective behaviours in all actors eventually shape the overall system's dynamics. Consequently, CAS entertains the notion of a 'feedback loop' (or co-evolution) to enable new possibilities from the interactions (Eidelson, 1997, p.46; Janssen & Kuk, 2006, p.3). These notions extend the interaction between social and technical elements from the STS perspective.

This theory, as an extension of STS, is relevant since IAF deals with and as a part of an organization as a complex and dynamic system (Costan & Popa, 2017; Nuijten *et al.*, 2015). Furthermore, in implementing AA, the IAF must also consider the self-organization and the dynamics of feedback from other subsystems of the organization. For instance, Costan and Popa (2017, p.372) posit that the interaction between IAF and its stakeholders and the choice of technology resulted from the internal dynamics of the organization instead of being predetermined and static. Moreover, Nuijten *et al.* (2015, p.202) argue that the internal audit profession must adapt its approach to dealing with "interactive complexity" in an organization.

These views enrich the literature and counter the limitations of agency theory in understanding IAF's roles and relationships with other parts of the organization in general, as well as AA implementation in particular. In this regard, CAS explains the divergence assurance and advisory services of IAF, which exhibits the complex property of the internal audit (Costan & Popa, 2017). Furthermore, these views acknowledge the dynamic interaction between IAF and other parts and the intertwined social and technical elements in their process, resulting in the possibility of collaboration (Nuijten et al., 2015), such as for data sharing for business and audit analytics purposes.

These notions underscore the relevance of the system view, i.e., STS and CAS, in AA implementation by IAF. The system view encompasses the social aspects, such as the organization's structure, actors involved, or the interactions between IAF and its stakeholders, as well as the technical elements, like technology, infrastructure, (internal) audit processes, and data processing. This view acknowledges that AA implementation influences (and is influenced by) social aspects such as the interactions and communication between the IAF (i.e., the audit team) with other units. Further, the social aspect entangles with the technical aspect; for instance, how the communication between IAF and data owners is (or should be) translated into data exchange mechanisms and infrastructure. This view also recognizes the complexity of the interactions between IAF as a subsystem and other parts of the

organization as other subsystems. On the one hand, AA implementation (by IAF) reflects the co-evolution resulting from digitalization in an organization, to which the IAF responds through AA. On the other hand, in responding to digitalization through AA, the IAF must take into account the dynamic interaction and its emergent phenomena affecting the AA implementation.

Consequently, AA requires adjustment of each actor's roles, which affects their relationships, e.g., IAF and the auditee/audit client must embrace the possibility of obscured barriers of assurance and advisory in an AA project or the need for various data access modes for different AA types. This notion transcends the notion of digitalization and reflects digital transformation as a result of this co-evolution. Furthermore, all actors (at least the audit team and the auditee/audit client) must respond to this change, such as by developing a safeguard to protect the IAF's independence and objectivity in a 'hybrid' project or a safeguard to protect each actor's concerns regarding data access (in a different mode).

Nevertheless, there are possible caveats in peeking at AA implementation phenomena through these alternative theoretical lenses. For instance, STS underscores the intertwining between a phenomenon's social and technical aspects (S. H. Appelbaum, 1997; Bostrom & Heinen, 1977; Geels, 2004). While this notion is one of the basic tenets that leads to the development of the STS view, different element may have a slightly stronger influence in different phenomena (Van Veldhoven & Vanthienen, 2022). Therefore, there is a need for consideration that, for instance, the technical elements may have a slightly more significant influence in a technology-driven phenomenon like AA. Similarly, the acknowledgement of the dynamic nature of AA implementation from the CAS perspective may overlook the specific context of IAF with its regulatory and compliance-oriented features (Adams, 1994; Mihret 2014).

2.4.3. Synthesizing the Two Lenses

Both Agency theory and System view explain and help to understand IAF as a phenomenon and its relationship with its surroundings. However, the two perspectives differ in their angle of viewing IAF and AA as phenomena. From the Agency theory as the classical theory, IAF is viewed as a separate and discrete entity, to serve as a 'bridge' between two other entities (principal and agent). Meanwhile, the System views IAF as one of the subsystems that interact dynamically with other subsystems.

While the Agency theory explains the earliest reasoning or intention of establishing an IAF and its dealings with other parts of the organization, over time, it might be challenging to entirely rely on this view in understanding the IAF in general (e.g., its existence, quality) and AA implementation in particular (i.e., why and how). Therefore, by viewing IAF as an interconnected element with other parts of the organization, the System view complements the traditional perspective of the Agency theory. The System view acknowledges and captures the dynamic relationships between the IAF and its surroundings and views AA through the lens of these interactions between the IAF and its 'environment'.

In contrast, from the Agency theory perspective, AA implementation reflects one of the ways IAF fulfills its mission to intermediate the information asymmetry between the agent and the principal and that the implementation is influenced by this relationship, which reflects the traditional view of IAF from this theoretical lens. Extending from this perspective, the system view, both from STS and CAS, acknowledges AA implementation as a part of a system and, thus, requires a systemic view that will reciprocally exert influence on and is influenced by the system's elements such as business processes, technology and infrastructure, or relationship among actors. Therefore, while AA implementation can be viewed through IAF and the principal-agent relationship, it must also be acknowledged as part of a dynamic, interconnected system. The challenges and overall impact of AA can only be fully captured by considering the broader organizational context and the mutual feedback loops that shape how AA is implemented. In this way, these lenses complement the theoretical foundation in understanding the phenomena of AA implementation by IAF.

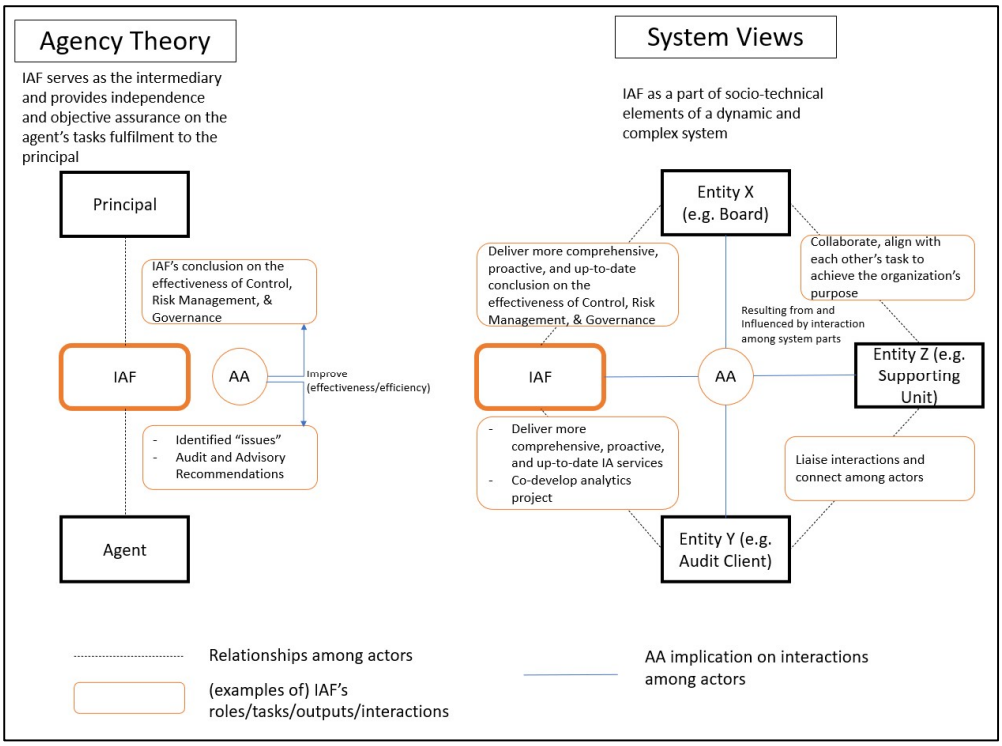

Figure 5. Visualized Synthesized Theoretical Lenses of AA Implementation by IAF

Furthermore, this research regards AA implementation as a transformational effort rather than an adoption issue. This notion considers that AA implementation requires adjustments in all facets of IAF's activities, from planning to the follow up, from technology-related matters to the interaction with stakeholders. Hence, unlike the adoption issue, the implementation issue does not start with the acquisition or complete with the mere use of technology. Instead, AA implementation implies

organizational transformation to change from one state (the use of the traditional approach) toward another state (the use of AA) with all its socio-technical complexities throughout the implementation effort. Moreover, while AA use is executed at the individual or project level, this research acknowledges the role of the IAF's environment at the organizational level.

Therefore, this research reflects its findings on these theories. In Chapter 4, the challenges of AA implementation captured from the extant literature (and confirmed with practitioners in the later chapter) indicate the need for a possible alternative view of IAF other than the principal-agency perspective. Moreover, the framework and principles for AA implementation by IAF emerged from the case study, as elaborated on in Chapters 6 and 7, further demonstrating the relevance of viewing IAF as a part of socio-technical and evolving systems in the form of an organization. Finally, the internal confirmation and external evaluation of the proposed framework (of AA implementation by IAF) in Chapters 8 and 9 assert the relevance of the STS and CAS theories in explaining IAF's role in general and how AA implementation affects the intertwined between social and technical aspects of the organization and the interdependency and co-evolution (or feedback loop) among actors within the organization as a system. These analyses enrich the IAF and AA implementation discourse and extend the theoretical lens with STS and CAS in addition to the classical view of Agency theory.

2.5. Conclusions

Chapter 2 presents the extant discourse in the field as the conceptual baseline for this research. This chapter outlines the development of AA as a practice; the existing AA-related frameworks, both at the organizational and project levels; and the theoretical lenses for reflecting the study results.

This research adopts the AA definition as the use of information technology to help IAF achieve its mission and purposes. The AA definition used in this research encompasses the simplest form of technology use, like CAAT (or audit through the computer), to the most advanced form, like using machine learning for internal audit projects. These varieties of forms imply the diverse facets of internal audit aspects and its implications, such as data access or skills requirements.

The extant literature suggests various frameworks for AA implementation, comprising descriptive and prescriptive types and organizational and project levels. However, the lack of AA implementation indicates the need for a guideline or framework to assist IAF in implementing AA and addressing the associated challenges, which is absent from the existing AA literature. Therefore, the AA research field will benefit from an organizational-level principle-based framework that connects with the challenges of the AA implementation effort.

As a response, this study aims to develop a principle-based framework from empirical research to assist IAF in addressing AA implementation challenges and realizing its benefits. Such a framework suits the nature of AA implementation and serves as means-end engineering research. Consequently, the framework as a means-

end knowledge should be developed from a real-world setting to result in an effective and efficient heuristic.

While the research is developed from a real-world case(s), the results will be reflected on the relevant theoretical lenses. For this purpose, this research will reflect its results on the Agency theory as the classical lens in viewing IAF and its activities as an intermediary to address the (possible) conflicting interests and information asymmetry between the principal and the agent. Moreover, this study will also reflect the findings on the system view (STS and CAS) as an alternative lens in understanding the phenomena (AA implementation by IAF) as a part of a complex system (an organization).

These reflections will offer a novel perspective on IAF beyond its relationships with the principal and agent which is needed for advancing understanding of AA implementation. This study will also extend the view of IAF with its multiple stakeholders. Instead, this research will provide empirical accounts of viewing IAF and AA implementation through the system view, i.e., to embrace AA implementation's social and technical elements and understand the co-evolution of IAF and its stakeholders as a complex system in AA implementation effort.

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Chapter 3 – Research Approach

The previous chapters provide the conceptual foundation for this study. Building from the research background and motivation laid out in Chapter 1, Chapter 2 elaborates on existing AA research and highlights the development and types of AA practices and the extant descriptive, conceptual, and project-level guidelines or framework for AA implementation. Furthermore, the previous chapter suggests that in contributing the additional knowledge to the AA field, it will be fruitful to reflect on the relevant theories on IAF and AA implementation as one of the activities in fulfilling the IAF's role.

Therefore, this research aims to develop a principle-based framework to foster AA implementation by IAF to complement the existing guidelines or frameworks in AA studies. For that purpose, this study first identified the challenges discussed in the existing literature on AA. Building from the identified challenges, this study investigated the relationship among critical challenges as a reference for the proposed framework. Furthermore, this research conducted a case study to observe real-world experiences and capture the principles of AA implementation efforts. The identified principles and the proposed framework were then evaluated by the internal audit practitioners from the same context as the case study.

This chapter presents how this research achieves its objective by elaborating on its philosophy, strategy, and overview of the methods. This chapter starts with a discussion of the philosophy behind this research (Section 3.1.). Furthermore, this chapter also discusses the research strategy as the implication of the philosophy (Sections 3.2. and 3.3.). This approach aligns with the framework suggested by (Creswell & Creswell, 2018, p. 4). The detailed methods employed in this research are presented in each content chapter (Chapters 4 to 8) of this dissertation.

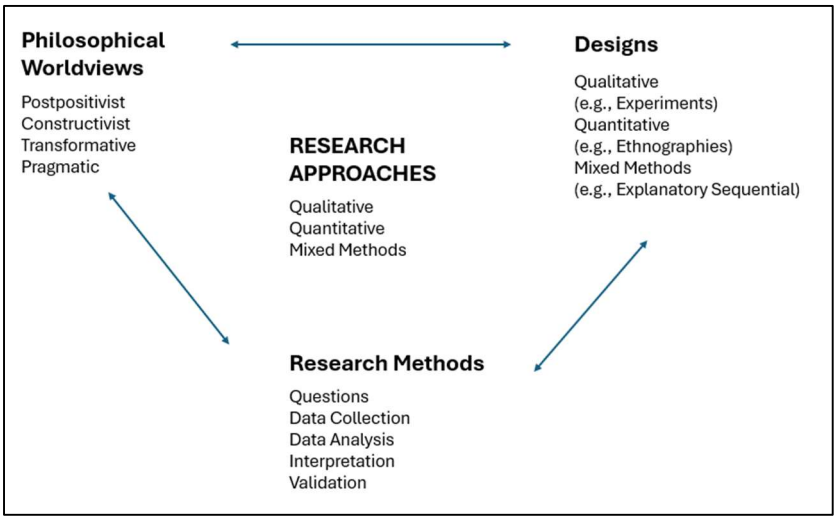

Figure 6. Framework for Research (from Creswell and Creswell 2018, p.5)

3.1. Research Philosophy

Creswell and Creswell (2018) use the term *worldview* in discussing research philosophy and define it as "a basic set of beliefs that guide action" (Guba 1990, 17 in Creswell and Creswell 2018, 6). Research philosophy acts as the basis for the research and determines its strategy, design, methods, and instruments (Creswell & Creswell, 2018; Twining et al., 2017). This section elaborates on different 'worldviews' derived from the knowledge's different ontological assumptions and how to obtain them (Creswell & Creswell, 2018; Saunders et al., 2016).

The first stream is positivism, which believes that the nature of reality is consistently examined and agreed upon, regardless of the observer's viewpoint or value (di Vanna, 2010; Newman et al., 1998; Ryan, 2018). Positivism is mainly used in nomothetic research to establish generalizations, or empiricist, which emphasizes empirical evidence in knowledge building. However, critics of this philosophy imply that absolute positivism of knowledge is unattainable while still holding the view on the objective nature of reality. This concern leads to the post-positivism view (Creswell & Creswell, 2018). Post-positivism still holds similar ontological and epistemological assumptions (with positivism) while acknowledging the limitation of absolute knowledge.

In contrast, constructionism or interpretivism sees that reality depends on the observer's interpretation, which entertains the possibility of multiple perspectives from a single phenomenon (Ryan, 2018; Twining et al., 2017). Interpretivism acknowledges the importance of context, which influences interpretation in developing knowledge (Creswell & Creswell, 2018). These views affect the ontological and epistemological premises on what is acceptable as legitimate knowledge and how to obtain it (Saunders et al., 2016). Interpretivism is primarily used in interpretivist or hermeneutics research, which integrates human interests in the study and emphasizes subjective interpretations of texts and other social phenomena.

In addition to the two most common streams, Creswell and Creswell (2018) introduce pragmatic philosophy. This philosophy emphasizes the importance of actions in addressing the research problem (Creswell & Cresswell, 2018). Pragmatism suggests that researchers can employ various methods, techniques, and procedures to achieve the research's purposes. Therefore, this philosophy does not attach to a specific method and may use a pluralistic approach to derive knowledge. This approach aligns with the notion of the false dichotomy of quantitative-qualitative methods (Newman et al., 1998), thus advocating mixed methods as necessary.

In summary, there are contrasting stances in research philosophy. From the ontological perspective, positivism strives for objective reality; interpretivism accepts the subjective interpretation of realities; and pragmatism focuses on addressing the research problem. These differences affect the overall approach and are employed by different types of researchers. The positivist focuses on objective measurements, the interpretivist acknowledges subjective perceptions and experiences, and the pragmatist approach does not commit to any system or mindset (Creswell & Creswell,

2018; Ryan, 2018). Table 5 below encapsulates the research philosophies and their emphasis.

Table 5. Summary of Research Philosophies (adapted from Cresswell and Cresswell, 2018)

Positivism/ Post-Positivism	Constructionism/ Interpretivism	Pragmatism
- Empirical observation and measurement - Theory verification	- Social construction - Theory generation	- Problem-centered - Pluralistic

This research aims to develop a framework that connects the principles and challenges to assist AA implementation by IAF. However, while this field has been heavily investigated, the extant literature lacks such research. The closest studies are unpublished works on principles and problems related explicitly to continous audit (CA) adoption (Alles et al., 2008, 2009), a subset of AA. Further, there is no structured overview or understanding of which challenges should be tackled first. Moreover, although there are principles for analytics implementation in other fields, its applicability in the context of IAF, with its unique roles in an organization, requires further examination.

Hence, this research relies on exploring the phenomena to derive the framework that connects challenges and principles for AA implementation. For this reason, this research employs pragmatism philosophy. This philosophy aligns with exploratory nature of this research to generate a "theory", i.e. to develop a prescriptive framework, which is absent from the current discourse in the field (see also Chapters 1.3. and 2.2.). This philosophy allows for a combination of methods that enables the researcher to apprehend the interplay between the conceptual and empirical realms as necessary (Pinto, 2010). Moreover, a combination of methods is inevitable for this research, which requires a variety of perspectives consisting of social, technical, and policy viewpoints (Ievenberg, 2018; Neilson et al., 2018; Newman et al., 1998; Salkind, 2018).

Building from this philosophy, this research utilizes the qualitative methods to uncover the knowledge from the data (Denzin & Lincoln, 2018; Salkind, 2018; Sarker et al., 2018; Twining et al., 2017) to obtain an in-depth understanding of the nature of AA implementation in internal audit practices, including the challenges and the corresponding principles revealed from the case, the actors' experience, and the contextual dynamics around the phenomena. This research also captured quantified data, i.e., using the MICMAC-ISM method, to capture the general consensus from the participants regarding the matters being studied. These methods will be elaborated on in the subsequent section and the detailed content chapters.

3.2. Research Strategy

The research objective and philosophy drove the strategies it employed. Research strategy is "a plan of how a researcher will go about answering her or his research question. It is the methodological link between your philosophy and subsequent choice of methods to collect and analyze data" (Saunders *et al.,* 2016, p.177). To achieve its objective, this study first synthesized the extant literature in the field as

the basis for further investigation. Building from the result of the literature review, this research employed a mixed-method approach by obtaining quantified and qualitative date to capture the respondents' experience and unearth the phenomenon of AA implementation, including its challenges and dynamics. The findings (the resulting framework) were then evaluated to validate the results. For this purpose, this section will briefly describe the overview of the MICMAC-ISM, case study, and informed argument methods employed in this research, with detailed processes presented in each content chapter (Chapters 4 to 8).

This research first explored the literature discussing the challenges in AA implementation. The choice to start with this step considers the numerous research studies on AA with various focuses, settings, and scopes (C. Brown et al., 2007; Eulerich & Kalinichenko, 2018; Joshi & Marthandan, 2020; Wang & Cuthbertson, 2015). Hence, the existing studies provide opportunities to synthesize the accumulative body of knowledge (Farshchian & Dahl, 2015; Snyder, 2019) and to extract definitions, themes, and especially factors (Card, 2010; Sirin, 2010), which is relevant to this research. This step identified challenges for AA implementation by IAF as a basis for further empirical research.

The next step was to evaluate the challenges of AA implementation. This step used *Matrice d'Impacts Croisés Multiplication Appliqués à un Classement* (cross-impact matrix-multiplication applied to classification or MICMAC) - Interpretative Structural Modelling (ISM) or MICMAC-ISM method to develop a hierarchical model and classification of the challenges based on their degree of power and relationships with other challenges (Janssen et al., 2019; Luthra et al., 2015). MICMAC-ISM has been successfully utilized in studies on the barriers to innovation or technology implementation (e.g., Dube & Gawande, 2016; Janssen et al., 2019; Katiyar et al., 2018), which characterizes AA implementation. This method utilizes real-world experience from practitioners to analyze complex and multifaceted phenomena using a systematic approach to acquire practitioners' views on the matter (Dube & Gawande, 2016; Sindhwani et al., 2018). Further, practitioners' opinions incorporate their experience and the dynamics in the field over time, improving the analysis result's reliability.

The next part was to identify principles that will assist IAF in addressing the challenges of AA implementation. The challenges and the corresponding principles emerged from one's experience (e.g., auditor). For instance, auditors experienced various challenges in the use of CA, like the need to utilize multiple platforms and analyze a vast amount of data (Bumgarner & Vasarhelyi, 2018; de Freitas et al., 2020; Dzuranin & Mălăescu, 2016). The observed challenges in AA implementation in real-world settings could confirm (or negate) the factors identified from the previous steps. Further, the observation from a real-world setting also aimed to identify principles as 'theory' generated from a phenomenon. This method 'extracted' the principles based on the experience of practitioners (e.g., as exemplified by Bharosa & Janssen, 2015). This method aligns with the approach for a means-end engineering project that yields reliable and efficient heuristics (Zwart & de Vries, 2016, p. 229).

The final facet of this research was to evaluate the proposed principles. This research was inspired by the Conceptual Modeling Quality Framework (CMQF) (Nelson et al., 2012). Although mainly intended as a quality framework for software modelling, CMQF incorporates an analysis of the quality of a framework based on its representation, development processes, and practical use to achieve its objective. For that purpose, this study conducted a confirmation of the developed framework with the case study informants through a focused group discussion (FGD) and interviewed external practitioners to obtain their opinions on the framework. By doing so, this research obtained an insight into the framework's quality of its presentation, process, and effectiveness in achieving its objective. This method represents an informed arguments approach to evaluate the artefacts as the result of a research project.

This research reflects the results of each step using the chosen theoretical lenses. First, the Agency theory serves as a classical perspective in viewing IAF, including the use of technology for performing its tasks. Reflecting on the Agency theory helps to understand how this theory's perspective on the phenomena of AA implementation as a part of IAF's efforts to fulfil its roles. For instance, some identified challenges emerge from the unidimensional relationship between the IAF, principal, and agent. However, the finding also suggests that viewing it as a multidimensional relationship between IAF as a subsystem and other subsystems helps to understand the phenomena better. Therefore, this study also reflects its findings from the perspective of the IAF as a subsystem based on Sociotechnical Systems (STS) and Complex Adaptive Systems (CAS) theories. These perspectives and theories enrich the discourse and expand the understanding of the AA implementation by IAF phenomena. For example, AA implementation requires the integrated view and involvement of the entire system rather than just the IAF as a subsystem, as reflected in one of the principles of AA implementation.

3.3. Data Collection Strategy

There are possible ethical considerations that need to be adequately addressed. The issues affected both the participants (of the study) and the researcher. Therefore, this study applies a data collection strategy on all facets of data collection, such as the case study for developing the framework or practitioners' evaluation of the proposed framework, to mitigate the risks.

The first issue is the confidentiality and privacy of the research participants. Several measures have been taken to address this issue. The researcher explained the purpose of the study and the data analysis method to the participants (DiCicco-Bloom & Crabtree, 2006; Saunders et al., 2016). Further, before continuing with the data collection, the researcher asked for consent (and filled in the consent form), including the agreement on confidentiality from the participants (Saunders et al., 2016). Another measure was to maintain the participants' privacy by using impersonal identity (e.g., transcript ID) (Saunders et al., 2016). The interview data will also be stored in a secure location, as reflected in the research Data Management Plan (DMP).

The second issue related to the participants is the potential harm from the research (data collection) process (Salkind 2018). Typically, an interview poses little to no physical harm to the participants (other than privacy issues, as discussed above). Nevertheless, the pandemic affected how the data collection was conducted. Therefore, the interviews (and other data collection processes, such as confirmation of the transcript) were performed in accordance with applicable health guidelines, such as through online interviews as requested. Nevertheless, the online interview did not affect the outcome of the interview. In addition, the data collection process should also consider the effort required by the study participants (Anderson, 1991 in DiCicco-Bloom and Crabtree, 2006). Hence, this research should share the benefits of addressing this issue (Salkind 2018), which in this context was in the form of sharing the research result with the participants (as individuals and organizations). Notably, the selected participants (for case study and evaluation) from Indonesian government institutions received an early communication of this research process and (interim) results.

Another ethical issue is related to the research process itself that may influence its results. Several measures have been taken to mitigate this risk.

1. The use of a guiding protocol during the process enables verification. This measure supported the research's reliability, validity, and unbiased process and result (Brereton et al., 2008; Yin, 2014).
2. The researcher used pilot testing before using the instruments. This measure mitigated interviewer bias by ensuring the relevance and integrity of the formulated questions (Kallio et al., 2016).
3. Confirming the summary/analysis result and the transcript (to the participants) further addressed the risk of researcher bias by clarifying (and correcting, if necessary) the interpretation and completeness of the researcher's understanding (DiCicco-Bloom & Crabtree, 2006; Saunders et al., 2016).
4. Intercoder assessment to maintain the internal validity and reliability of the analysis (Cresswell & Cresswell, 2018, p.315).

3.4. Summary

Chapter 3 presents the research approach for this dissertation. This chapter lays out pragmatism and mixed methods as the chosen philosophy and overall approach. Pragmatism philosophy aligns with this study's exploratory nature and its objective to develop a framework (as a 'new theory') from real-world instances. This philosophy allows the study to utilize various methods to achieve its objective.

Consequently, this study opts for qualitative and quantitative methods as necessary. The methods include MICMAC-ISM, Case Study, and Informed Arguments from practitioners, with literature exploration as the starting point. These methods obtain rich insights and in-depth understandings of the phenomena. The first two steps focus on a specific case/setting to ensure thorough comprehension of the

phenomena. Conversely, the latter method aims to address the possible limitation of the method by obtaining a broader perspective of the phenomena and the (interim) research results.

In each research phase, this study acknowledges the potential constraints. Hence, the data collection strategy incorporates measures like piloting, informed consent, or confirmation to/from the study participants (both at the organizational and individual levels, whichever is relevant). This research also offers participants alternatives for data collection methods (onsite or online), especially during COVID-19. These measures mitigate anticipated risks, such as confidentiality and privacy issues, the (possible) physical harm to the participants, and biases.

Visualized summary of this research's approach is presented in Figure 7 below.

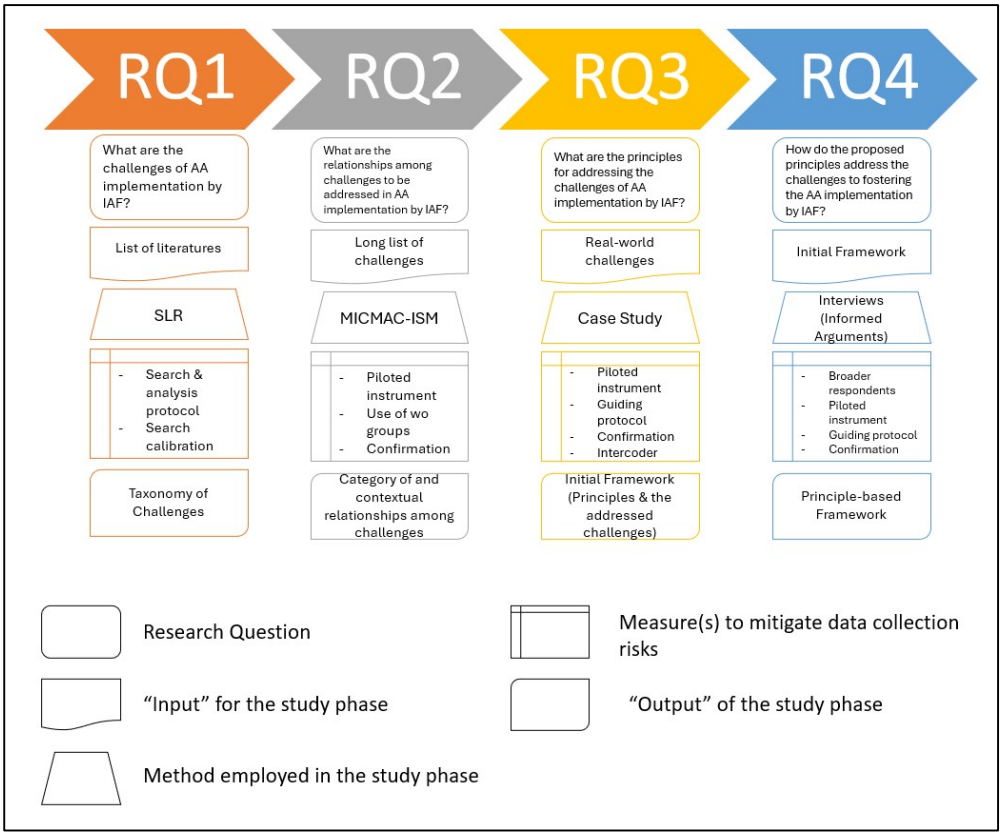

Figure 7. Visual Summary of the Research Approach

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Part II: Problem Examination

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Chapter 4 – Challenges of Audit Analytics Implementation

The previous three chapters elaborate on the foundation of this research, including the motivation for and the key concepts and the overview of the methods employed throughout the research. Building on that, this study first investigates challenges pertinent to AA implementation by IAF by harnessing the knowledge from the existing literature in this field. The literature review informs about the challenges encountered in AA implementation to answer the first research question: *What are the challenges of AA implementation by IAF?*

This chapter is mainly based on the paper titled "Driving and Inhibiting Factors of Audit Analytics Implementation by IAF" by Ramadhan, Janssen, and van der Voort (2023), which presents the systematic literature review employed in this study to answer the first research question. This chapter first lays out the literature review design and the resulting literature landscape and selection. Building on that selection of literature, this study identifies the 'long list' of challenges of AA implementation from the literature and presents them as a taxonomy of challenges. This result amalgamates the existing discourse of AA implementation and accumulates insights from the extant literature. The latter part of this chapter discusses the implications of the results, i.e., the identified challenges. These results serve as the basis for understanding why AA implementation is limited despite its promised benefits and how the challenges influence/hinder AA implementation, which will be elaborated on in the following chapters.

4.1. Exploring the Discourse through a Systematic Literature Review

4.1.1. Review Design

This research explored the extant literature related to AA implementation (in its various forms), especially with relevance to IAF. A systematic approach for this purpose generally consists of three main phases, i.e., planning, conducting and analyzing, and reporting (Kitchenham & Charters, 2007; Morioka & de Carvalho, 2016; Petticrew & Roberts, 2006; Snyder, 2019; Thomé et al., 2016; Wahono, 2015).

The planning phase is crucial as it defines and formulates the review protocol. This phase includes setting explicit criteria to select the appropriate literature and developing a methodology to analyze the selected literature. The next phase is literature identification and selection, extraction, and analysis to answer questions based on the predetermined review strategies (Kitchenham & Charters, 2007; Rouhani et al., 2015). This phase also involves identifying literature from the relevant databases, including the application of search string and metadata recording, and analysis based on the developed analysis strategy and evidence synthesis. The final facet is disseminating the result as a part of the dissertation or as an independent academic work (e.g., conference or journal paper).

4.1.2. Review Question

Research on AA has covered many important aspects, including drivers, issues, tools, and types of AA implementation (Eulerich & Kalinichenko, 2018; Joshi & Marthandan, 2020). This research, however, particularly focused on the inhibiting factors encountered when implementing AA, which was reflected in this research's first question (RQ1), i.e., *What are the challenges of AA implementation by IAF?*

4.1.3. Search Strategy

The search strategy aims to retrieve relevant studies to achieve its objectives (Thomé et al., 2016). It consists of a database as the source of papers extracted, search strings, and inclusion (and exclusion) criteria. Figure 8 visualizes this research's search strategy.

This study utilized the Google Scholar database to provide a wide range of research and study results on AA implementation. This approach assisted in ensuring the comprehensiveness of the search results. One might argue that Google Scholar deliverables vary in quality, which may affect the result. Nevertheless, (Tober, 2011) suggests that Google Scholar indexes the most important papers across disciplines. Furthermore, this research addressed the possible limitations through inclusion and exclusion criteria.

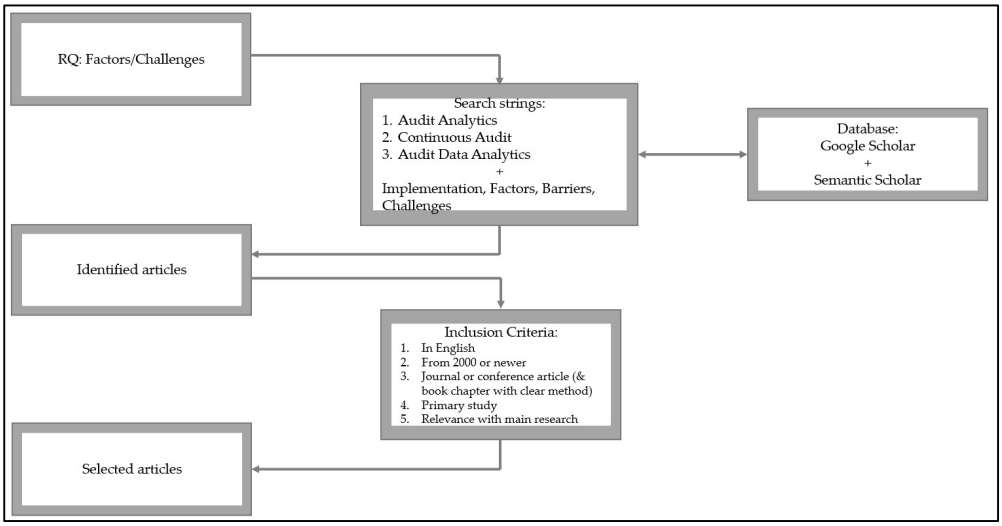

Figure 8. Literature Search Strategy

There are alternatives to initiating a literature search. One of those is through search strings (Jalali & Wohlin, 2012), which was employed in this study with the following keywords to extract studies from the Google Scholar database:

1) "Audit Analytics" is the umbrella term that encompasses all practices, including continuous audit, predictive analytics, and other technology and digital data in internal audit practices;

2) “Continuous Audit” is used as the initial term for the use of digital data for real-time or near real-time audit; and
3) “Audit Data Analytics” is used to emphasize the use of technology in audit practices (Barr- Pulliam et al., 2022; Krieger et al., 2021).

Each keyword was used on its own or combined with “implementation” to capture the study of ‘real-world’ AA practices (e.g., has been or is being implemented). Moreover, each keyword was combined with “factors”, “barriers”, or “challenges”; to align with the research questions. These keywords resulted in 15 search strings. This approach helps to improve search results’ relevance (vom Brocke et al., 2015). In addition, this research retrieves the articles from 2000 onwards to balance the coverage of the studies and their relevance with the current progress of AA. This choice considers that the AA field has been progressing significantly; hence, the driving and inhibiting factors from an older era (older than 2000) might have limited relevance to the future development of this field.

The initial list was assessed based on the following inclusion criteria:
1) Only papers written in English are considered;
2) Only including papers from journals and conferences. Book chapters were only included if they clearly stated their research method;
3) Focusing on primary studies to obtain factors reflecting real-world practice obtained from those studies; and
4) Analysis of relevance (as suggested by vom Brocke et al. (2015)) to ensure the paper retrieved examine AA practices.

The article included studies of AA in the internal audit field or general audit with relevance to internal audit activity.

In addition, this research calibrated the initial result through additional search using an alternative tool and method. In addition to Google Scholar, Semantic Scholar (using Research Rabbit) was used for additional literature searches. Furthermore, the string keywords search was complemented by snowballing from one of the key articles in the field (i.e., Li et al., 2018). This additional search ensured that all related works were considered.

Selecting literature is crucial as it addresses the need to balance coverage and depth of analysis from the selected papers (Morioka & de Carvalho, 2016). The strategy presented in this section aimed to ensure the selection of appropriate literature, as this will affect the next steps of the review and its result.

4.1.4. Analyze and Synthesize Strategies

This study collected the general information of the selected articles to provide an overview of the research landscape. Furthermore, the research performed a detailed analysis to answer the first research question based on data and information extracted (from the selected studies). In this step, the challenges of AA implementation were elaborated on from the literature, including common themes, similarities, and

differences from each article. This approach resulted in a taxonomy of challenges identified from various literature in AA-related research.

This study extracted information based on the explicit narration as well as implicit insight provided in the articles. This research obtained relevant notions from the articles to identify the challenges, i.e., the inhibiting factors of AA implementation. Challenges are commonly preceded or followed by explaining the hurdles to using AA in internal audit tasks. Further, the results of the first step were grouped to develop a 'factor'. For instance, narrations that mention investment or funding requirements to develop and utilize analytics were grouped as investment/funding factors and texts that discuss knowledge and skills requirements for utilizing AA in internal audit tasks were grouped as AA-related skills factors.

The identified factors then coalesced into five categories, i.e., internal factors, regulation, technology (infrastructure and data), and audit practice. The categories were adapted from categories in the previous literature reviews (C. Brown et al., 2007; Eulerich & Kalinichenko, 2018), with slight modifications. Internal factors refer to factors related to the organization's operation or within the scope of authority of the organization (to which IAF belongs). In comparison, regulation refers to factors that are forced by authoritative entities. While the initial description focused on the legal aspect, this study extended the description of regulation to include less formal types, such as standards or guidelines pertinent to audit activities. Moreover, technology was split into two categories for more detailed analysis, i.e., infrastructure that deals with (IT) hardware and software and data that represent digital data for AA purposes. Another category is audit practice, which refers to factors related to audit activities, which in the previous reviews comprised external and other factors. The analysis results list is presented in tabular format, as shown in the table below.

Table 6. Tabular form for the List of Challenges (adapted from Matheus et al., 2021)

No	Item	Description
1.	ID	Unique ID of Challenge
2.	Category	Category of Challenge
3.	Challenge	Name of the Challenge
4.	Description	Description of the Challenge
5.	Count	Number of the selected literature mention/elaborate the inhibiting factor
6.	References	Identity of the literature mentions/elaborates the factor

4.1.5. Selection Analysis and Process

The initial search was performed from 26 to 28 June 2021. The initial search resulted in 118 articles, with some appearing more than once during the search process—further examination resulted in 98 uniquely identified articles. Moreover, the initial search was calibrated with an additional search using an AI-based tool and snowballing method (on 18 October and 1 December 2022).

Thirty of the initial result articles were excluded for failing to meet the inclusion criteria (i.e., not published in academic research, like in the form of

commentary or course material). Subsequently, twenty-seven articles were excluded for not being a primary study. Furthermore, twelve articles were left out for their lack of relevance to this paper's objective, e.g., study on medical technology, accounting education, or programming language, resulting in twenty-nine articles. Thirteen relevant articles were added based on additional searches using a different database (Semantic Scholar) and technique (snowballing). Finally, forty-two articles were included in the final analysis. The analysis, findings, and discussions in the subsequent sections of this paper refer to the forty-two articles. Figure 9 visualizes the article filtering processes.

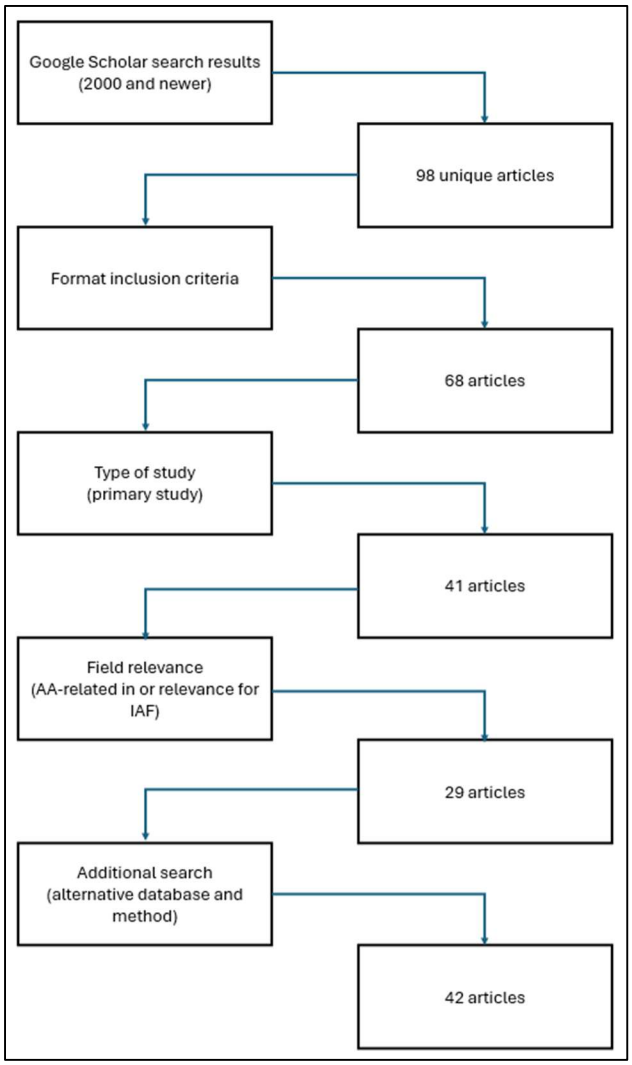

Figure 9. Literature Search Process

The initial search results (98 articles) indicated a notifiable increase in AA-related articles since the mid-2010s, in contrast to the search results from Eulerich & Kalinichenko's (2018) work, which showed relatively consistent results from 2001 to

2014. This difference might come from different search strings employed between this research and their study. Since their study focused on CA, they used terms related to CA such as 'continuous auditing', 'continuous monitoring', or 'continuous assurance', which are more popular terms, including in the guidelines for internal auditors (Ames et al., 2015; Coderre, 2005; Lambrechts et al., 2011). Conversely, this study used the terms 'audit analytics' and 'audit data analytics' (besides 'continuous audit') to obtain broader insights into audit practices. The term 'analytics' has increased in popularity in internal audit literature since 2016 when the IIA published its working paper on data analytics (Stippich & Preber, 2016). Although less popular (especially in the early 2000s), this terminology is relevant for our search string, considering the prevalence of digital data and information technology enables more advanced techniques like predictive and prescriptive analytics as a part of AA. Moreover, this result also suggests that this research extends the discussion in the field by expanding the scope of analysis to cover not only CA but other types of analytics for audit purposes.

4.2. Taxonomy of Challenges of Audit Analytics Implementation

The selected articles show that IAF encounters multiple and intertwined challenges in AA implementation that need to be anticipated. Moreover, AA implementation affects IAF's parts and stakeholders differently, requiring internal and external collaboration by the IAF. In short, the literature informs 23 challenges commonly encountered in AA implementation studies, which will be presented and elaborated on in the remainder of this chapter.

4.2.1. Selected Articles

The articles gathered for the analysis cover twenty-one years of research, from 2001 to 2022. This choice balances the coverage of the studies and their relevance with the latest progress of AA (at the start of this dissertation project) as the basis for the next step of this research. Most selected articles are from journal papers, whereas less than 15% originate from conference proceedings and book chapters. Moreover, the articles analyzed employ various research methods such as case studies, experiments, design science research, and simulation, although some methods are implicitly stated. These various methods support the strength of gathered insights for analysis in this paper. Table 7 displays the categorization of articles based on the publication type. This selection shows the variety of article sources. While it is mainly sourced from journal papers, the selection includes book chapters and conference papers to incorporate wider discourse on the topic.

Table 7. Distribution of Articles based on the Type of Publication

Type of Publication	Count	Lit IDs	Examples
Book chapter	2	2, 18	- *Continuous Auditing: Theory and Application*, Emerald Publishing Limited. 2018.

			- Rutgers Studies in Accounting Analytics: Audit Analytics in the Financial Industry. Emerald Publishing Limited. 2019.
Conference	4	3, 17, 19, 41	- 36th Annual Hawaii International Conference on System Sciences, 2003. - Proceedings of the 11th European Conference on e-Government. 2011.
Journal article	36	1, 4-16, 20-40, 42	- International Journal of Accounting Information Systems. - Journal of Information Systems. - Journal of Emerging Technologies in Accounting.

One of the indicators of the quality of a study is the 'cite count', which shows how often an article is cited in other studies. Nonetheless, it is also important to note that the number (of cite-count) will typically increase over time. Hence, older articles are expected to have a higher cite count than newer ones. Articles published in 2016 and newer were cited 20.8 times on average, with the exception of the paper "Understanding usage and value of audit analytics for internal auditors: An organizational approach" by Li et al. (2018), which cited 126 times. In contrast, older articles (published in 2015 or older) were cited 110.5 times on average, with most of those cited at least 29 times (15 out of 18). Older articles have had a longer time period to be cited and likely receive a higher number of citations. According to the 'cite count', the selected articles are adequate to be included.

This study also mapped the selected articles to see the relationships among them. It shows the connections among articles and that the discourses are centred among several pivotal articles, like "Understanding usage and value of audit analytics for internal auditors: An organizational approach" by Li et al. (2018), "Explaining the (non-) adoption of advanced data analytics in auditing: A process theory" by Krieger et al. (2021), or "Factors associated with the adoption of data analytics by internal audit function" by Islam and Stafford (2022). The map also shows the connection between these essential journal papers and influential book chapters or conference papers, like "The Continuous Audit of Online Systems", a book chapter in "Audit Analytics and Continuous Audit: Theory and Application" by Vasarhelyi et al. (2018). The connection among these selections informs the cohesiveness of the study incorporated in the analysis.

In addition, some more 'independent' journal and conference papers or book chapters were also included, like "Audit Analytics: A Field Study of credit card after-sale Service Problem Detection at a major bank", a book chapter in "Rutgers Studies in Accounting Analytics: Audit Analytics in the Financial Industry" by Dai et al. (2019), or "Understanding the internal audit function in a digitalized business environment" by Betti and Sarens (2021). These sources expand the insight and discussion on AA implementation, which reinstates the sufficiency of the selected paper for further analysis in this study.

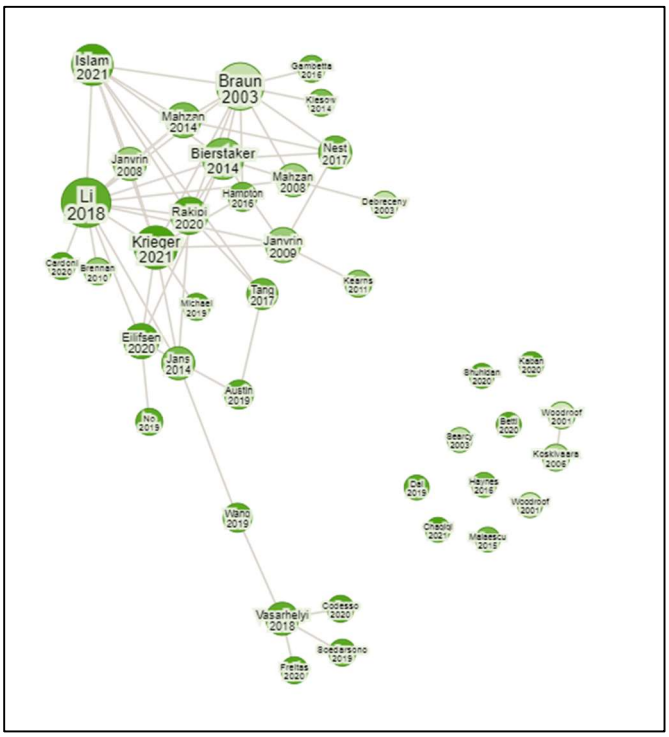

Figure 10. Mapping of the Selected Articles

4.2.2. Identified Challenges

The analysis of the selected articles identified 23 challenges and classified them into five categories, as listed in Table 8. Four challenges have the most occurrences. The auditor's competence issue (ID 4) is found to be the most frequent and mentioned in 25 articles, followed by high investment requirement (ID 1) and dynamics in the audit process (ID 3), with the appearance in 18 studies, respectively. Another challenging issue is the data access issue (ID 12). While the internal factor (i.e., limitation in auditor competence) is the most concerning challenge, the subsequent three challenges represent external factors that are not necessarily within the authority of IAF (or the Chief Audit Executive (CAE)[3], in this matter) to solve. Therefore, this implies the importance of stakeholders' support.

Conversely, some challenges get less attention, like independence impairment (ID 19), counter analytics (ID 20), or the need for aid (specifically consulting services from external consultants) to assist IAFs in developing AA (ID 22). However, these challenges' lack of appearance does not imply they are less

[3] CAE might come in various terms. Nevertheless, in this regard, CAE refers to the head of IAF.

critical or require less attention. This notion, at most, indicates that these are less observed in AA discussions.

Table 8. Identified Challenges from the Selected Literature

ID	Category	Challenge	Description	Count	References (Lit ID)[4]
1	Internal	Investment/ Funding Requirement	AA implementation in assurance activities requires financial commitment (including cost-benefit consideration), such as for tools/infrastructure, training, including outsourcing AA for an engagement.	18	1, 5, 7, 8, 9, 10, 13, 16, 18, 19, 20, 22, 24, 25, 30, 33, 34, 38
2	Regulation	Inadequate (Internal) Audit Standard/ Guideline	Lack of (Internal) audit standard and its derivation, including guidelines or procedures, which inform how (internal) audit perform/conduct the use of AA in internal audit tasks, including the impairment in independence and objectivity and how to mitigate it.	(5[5]) 3	1[6], 5[7], 25[8], 29, 42
3	Audit Practice	Dynamics in Audit Process	Problems due to unclear interaction mechanism and dynamics in interaction between the auditor, client, and other stakeholders in an assurance engagement (or other activities related to it), including the use of AA in internal audit tasks.	18	1, 5, 7, 8, 10, 11, 13, 17, 18, 19, 20, 24, 25, 29, 30, 32, 35, 36
4	Internal	Limited Auditor's AA-related Skills	The limitation of (Internal) auditor's ability to perform the necessary task (e.g., obtain business understanding in IT-based environment, scripting, statistical knowledge) to use AA in internal audit tasks.	25	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 22, 24, 26, 29, 33, 34, 36, 39, 40, 41, 42
5	Internal	Inadequate number of auditors (for AA implementation)	Inadequate numbers of IAF's personnel with skill and knowledge to perform AA-related tasks in an engagement.	4	8, 17, 29, 32
6	Audit Practice	Limited AA Use-Case	Limited audit analytics use cases appropriate for an engagement by IAF. Audit analytics use-case includes the engagement objectives, analysis techniques, and data requirements for internal audit Tasks.	5	5, 9, 16, 25, 32
7	Internal	Different Stakeholder's Interest	Problems due to varieties among the related parties' (such as the board, management or audit client, or IT	4	1, 8, 17, 36

[4] refer to Literature ID in the Appendix
[5] the articles refer to circumstances pertinent to external auditors with relevance for IAF
[6] idem footnote #4
[7] idem footnote #4
[8] idem footnote #4

ID	Category	Challenge	Description	Count	References (Lit ID)[4]
			division) perception, preferences, support, and interest (which within their respective authorities) on the use of AA by IAF.		
8	Audit Practice	Potential Bias	Risk of bias in the AA results resulting in skepticism from the auditors, clients, or other IAF's stakeholders (e.g., model bias due to limited training data for predictive analytics, or conclusion derived from incomplete data).	2	3, 5
9	Internal	Cultural barriers	Limited organizations' and IAF's awareness of the importance and benefit of AA and commitment to do the necessary process to implement AA.	7	1, 17, 18, 21, 29, 35, 41
10	Technology – Infrastructure	Infrastructure Capacity Issues	Limited ability of an organization's IT infrastructure and system to enable AA in assurance engagements, such as to facilitate: data exchange and sharing process, or analysis and computational task to a large amount of data.	6	11, 12, 21, 22, 29, 31
11	Technology - Data	Missing Data (or Uncaptured Data)	Unavailability of data in the digital form required for AA within an organization's data ecosystem (including database or data warehouse).	3	1, 10, 18
12	Technology – Data	Data Access Issues	Unavailability of digital data for the auditor to collect, evaluate, and analyze in the context of AA (including authorization, approval, and provision).	14	1, 3, 5, 7, 10, 11, 13, 17, 18, 19, 20, 24, 28, 29
13	Technology – Data	Data Security Concerns	Concern regarding data confidentiality[9], i.e., ensuring data is accessible only to those with proper authorization; this concern might affect data exchange among business/data owners and including IAF.	3	13, 15, 30
14	Technology – Data	Data Inaccuracy	Data does not represent the object (such as an event, transaction, or item details) in an error-free (or within the acceptable level of error) manner.	7	1, 2, 5, 7, 24, 28, 39
15	Technology – Data	Data Incompleteness	Data is not completely representing the object (such as an event, transaction, or item details) or that some objects are unrepresented in the data.	2	24, 28
16	Technology – Data	Varieties of Data Format	Different types of data format and platforms with its own specific characteristics which will affect how to process (collect/extract, evaluate, cleanse, and analyse) the data,	6	1, 4, 17, 22, 29, 41

[9] In most references, data security often refers to confidentiality, integrity, and availability (known as CIA triad). Nevertheless, in the context of this research, security particularly refers to confidentiality as integrity and availability are discussed as separate issues. Moreover, confidentiality includes privacy issue.

ID	Category	Challenge	Description	Count	References (Lit ID)[4]
			including in this regard for AA implementation.		
17	Technology – Data	Huge Data Volume	The huge size of data which will affect how to store, exchange/transmit, and process the data, including in this regard for AA implementation.	2	2, 5
18	Technology – Infrastructure	Unavailability or Limited AA Tools	Unavailability or limitation of software (IT application, including the required software) capable of performing AA-related tasks, including data extraction, cleansing, evaluation, and analysis.	3	15, 17, 26
19	Regulation	Risk of Independence Impairment	Possibility of AA-related tasks in assurance or consulting engagement affecting IAF's (or individual auditor's) independence and objectivity.	2	1, 32
20	Audit Practice	Counter Analytics	Possibility of limitation in analytics result (especially for fraud detection) if the perpetrator understand how analytics work.	1	1
21	Internal	Organization and Business Complexity	Problems due to complex organizational structure and business process (including IT system complexity and variations) influencing the effort required to implement AA in an engagement.	6	10, 13, 17, 21, 30, 38
22	Internal	Limited Aid in Development Process	Development of innovation requires practical aids, such as in the form of the implementation framework, an example from a success story, or consulting services. Although not mandatory, these aids assist in innovation diffusion, such as in AA implementation by IAF.	3	9, 39, 42
23	Audit Practice	Audit Team Dynamics	Challenge due to the dynamics in the interaction among auditors within audit team in an audit practice (or other related activities, including the use of AA), such as task assignment or sharing, or internal communication.	2	13, 28

4.3. Insights from the Findings

The section consists of further elaboration on the results of the literature review related to the answer to the research questions.

4.3.1. Different Perspectives Among Different Actors

The literature review shows the possible competing interests among different IAF stakeholders. A possible example is that while the board expects accurate and timely audit results which can be delivered using the AA approach, the business process owner's primary concern might be to exercise their authority on data security (Haynes & Li, 2016; Koskivaara, 2006) or the system's performance to serve the business process (Debreceny et al., 2003; Kearns et al., 2011). In addition, there might be

different perspectives on the significance of the issues between different levels of actors. For instance, executives might consider strategic opportunities or challenges essential for AA implementation. Conversely, employees on the operational level might be more concerned about data accuracy or infrastructure capability.

Furthermore, findings from the literature suggest that three out of the four most identified challenges are related to external actors (from the perspective of IAF or the audit team), like dynamics in the audit process or data access issues. The significance of externally sourced challenges indicates the need for IAF to respond carefully and anticipate its environment concerning AA implementation. Therefore, the implementation of AA will not only address IAF's needs but also acknowledge the stakeholders' concerns.

The notion that IAF may serve multiple stakeholders *confronts the traditional view of an IAF from the Agency theory*, which views the IAF as the intermediary to resolve conflicting interests between principals and agents. Therefore, an alternative perspective may be needed to view this relationship in which the IAF is not pivoted only to serve the principal but to cater for its multitude of related actors. This alternative perspective reveals the possible different perceptions of *the benefits* of the traditional approach compared to AA. From the agency theory perspective, the primary reason why IAF is to bridge the conflicting interests between the board as the principal and the business process owner as the agent. However, the examples mentioned above suggest that IAF should consider other actors' concerns, which implies the need for a novel outlook in viewing IAF's roles and relationships in the organization. Therefore, an alternative perspective, such as viewing IAF as a part of an organization as a system (or complex system), may yield a better understanding of the IAF and AA implementation phenomena and complement the traditional view of the Agency theory.

4.3.2. Emerging Challenges

This research's literature review uncovered emerging challenges, like the possibility of IAF's independence impairment, unclear use-case, and counter analytics. Although derived from selected articles focusing on AA implementation studies, these insights align with the general discourse on IAF's roles and relationships with other parts of the organization (Nuitjen et al., 2015). Furthermore, these challenges only emerge in a few articles, and some even in only one (article). It might be because those challenges arose just recently due to the recent advancement of AA in audit practices. Therefore, they are fruitful for further studies. For instance, the emergence of predictive and prescriptive analytics (Austin et al., 2018; Stippich & Preber, 2016) enables IAF to provide foresight, i.e., predict the future rather than merely evaluate the past, to direct management's decision. These techniques might obscure the barrier between assurance and consulting services, possibly impairing (internal) auditors' independence (Austin et al., 2018; Betti & Sarens, 2021). These techniques also generate challenges for IAF to develop relevant AA use-cases specifically relevant for audit purposes (Codesso et al., 2020; Islam & Stafford, 2022; Krieger et al., 2021; Malaescu & Sutton, 2015) instead of emulating business units' analytics. Another

intriguing issue is the possibility of counter-analytics (Austin et al., 2018), which requires IAF to mitigate this risk in advance in developing its AA capabilities.

Another less-mentioned challenge in the literature is the issues related to the regulatory matters in the IAF context appear only in one article. Although there are publications from IIA regarding this matter (Ames et al., 2015; Coderre, 2005; Lambrechts et al., 2011), its use is more as a suggestion rather than a binding standard. These findings imply that regulatory requirements in the IAF environment might be less rigid than in the external audit setting, especially in financial audits (Li et al., 2018). For instance, the lack of clear standards renders external audit firms uncertain whether AA provides acceptable evidence for financial audits (Austin et al., 2018; Eilifsen et al., 2020; Krieger et al., 2021), while this issue might not necessarily apply to IAF's context. This rather loose regulatory context offers the opportunity for the IAF to explore the possibility of AA for the IAF. For instance, academics and practitioners in this field may explore the use of advanced AI techniques for predictive analytics for audit purposes. Such approaches should consider organizational and regulatory factors and newly emerged challenges like implications on IAF's independence or the possibility of counter-analytics.

Those challenges' lack of appearance does not imply that they are less critical or require less attention. While AA implementation is closely associated with technological advancement, the recent literature indicates that the newly emerged issues are also related to other categories of factors (regulation and audit practices). This notion implies that the aspects of regulation and audit practice need to catch up with the rapid advancement of technology. Practitioners and academics may have to anticipate that these aspects will have to adapt quickly as technological aspects keep progressing rapidly.

4.4. Conclusions

The literature review results showed that internal auditing encounters various challenges, as shown in the identified 23 challenges of AA implementation. The analysis suggested that the IAF is confronted with many diverse stakeholders and various functions for which it can be used. The analysis also suggested that AA implementation affects IAF's stakeholders and parts differently, as exemplified by the differing concerns between the governing body and audit client or between IAF's executive and operational layers. Hence, the implementation of AA should involve various parts of IAF and incorporate different considerations from different stakeholders. In this regard, an internal stakeholder approach alone is insufficient, and external stakeholders should be involved. Furthermore, the identified challenges outline the complexity of AA implementation involving and affecting various actors and technology, which indicates the nature of AA implementation phenomena as a digital transformation for IAF and the organization.

There are challenges that are frequently found in the literature, like skills and infrastructures, while other issues, such as the importance of the chief audit executive's active support, the possibility of independence impairment, and counter analytics, are overlooked by past studies. This insight informs the promising avenues

to investigate these challenges and their implications for future AA implementation. Furthermore, this notion suggests that a broader range of factors should be considered to implement AA in IAF effectively. From a conceptual perspective, analysis of the identified challenges highlights the importance of an alternative perspective in understanding the IAF's roles and activities (including AA implementation), which warrants an alternative theoretical lens for viewing IAF. From a practical standpoint, academics and practitioners need to keep up with technological advancements to sustain IAF's relevance and improve its value for the stakeholders.

This chapter sheds light on the diverse challenges encountered in AA implementation. Building on this insight, this research will examine the relationships among key challenges of AA implementation, which will be presented in the next chapter. Understanding these relationships helps to comprehend how these challenges influence each other and AA implementation efforts. Furthermore, this understanding serves to determine which challenge (or challenges) need to be prioritized as a reference for developing the principle-based framework of AA implementation.

Chapter 5 – Contextual Relationship Among Challenges

As presented in the previous chapter, this study first identifies challenges hindering AA implementation from the extant literature. The first phase informs the challenges commonly faced in AA implementation efforts and provides the answer to the first research question. The previous chapter lays out the literature landscape and the selection. This phase results in the 'long list' of challenges of AA implementation from the literature and presents them as a taxonomy of challenges.

The identified challenges indicate that they do not influence AA implementation in isolation. Hence, insight into the relationships among challenges is fruitful in understanding how those challenges influence AA implementation. Therefore, the results from the literature, as presented in the previous chapter, are calibrated based on practitioners' opinions and case study observations to provide a 'shorter list' of challenges. Further, this chapter elaborates on the intertwined challenges and answers the second research question: *What are the relationships among the challenges to be addressed in AA implementation by IAF?*

This chapter refers to the paper titled "Transforming the Internal Audit Function (IAF): An Integrated MICMAC-ISM Approach for Unravelling the Relationship Among Challenges" by Ramadhan, Janssen, and van der Voort (2024) and answers the second question by theorizing the interrelationships among challenges of AA implementation. The theory development refers to the MICMAC-ISM method. First, the MICMAC analysis informs each challenge's driving power and dependence. Secondly, the ISM depicts the hierarchical model representing the interrelationships among challenges. The latter part of this chapter explores the insights from the resulting analysis and model.

The MICMAC-ISM analyses show that technical challenges directly influence AA implementation initiatives. However, these technical challenges are affected by organizational and data-related challenges. Moreover, social aspects, such as cultural barriers, are foundational challenges affecting other AA implementation challenges. These results serve as a reference for identifying AA implementation principles and developing the framework in the following chapters.

5.1. Overview of MICMAC-ISM Method

5.1.1. MICMAC-ISM Design

The literature review identifies many challenges related to the use of AA by IAF. Nonetheless, each challenge faced by IAF in AA implementation does not take effect in isolation. Instead, it is most likely that each of those challenges is somewhat related to one or more other challenges, which influences IAF's attempt to implement AA even further. Therefore, this next step of the research identifies the relationship among challenges of AA implementation gathered from the literature and to develop a

hierarchical model of challenges as a reference for action in overcoming those challenges.

Several possible methods can be applied to examine the relationships among identified challenges. For instance, the Decision-Making Trial and Evaluation Laboratory (DEMATEL) is suitable for analyzing a complex problem and concentrates on a cause-effect analysis (Rajput & Singh, 2019). However, the main benefit of this method differs from the aim of this part of the research, which focuses more on the interrelation among factors. Another option is Principal Component Analysis (PCA), which is also beneficial for analyzing multifaceted issues. Nonetheless, it is regarded unfit for this research as this method creates new (virtual) variables (Rajput & Singh, 2019) rather than utilizing factors identified from the literature. Other options are multi-criteria decision-making (MCDM) methods, such as the *analytical hierarchy process* (AHP) or the *best-worst method* (BWM). However, these methods are more suitable for solving problems rather than categorizing and prioritizing the problem itself (for instance, as exemplified by (Goyal et al., 2015; van de Kaa et al., 2018). For this research, the answer to the challenges of AA adoption is expected to result from the case study (the subsequent phase of the research).

Therefore, this study adopted the MICMAC-ISM method to acquire practitioners' (of AA implementation) views to evaluate each challenge's driving and dependence power. This approach is arguably more robust and comprehensive than other multi-criteria decision-making approach like analytic network process (ANP) and analytical hierarchy process (AHP) (Janssen et al., 2019; S. K. Sharma et al., 2021). This step resulted in a hierarchical model reflecting the relationship among those challenges, which will help IAF better implement AA by determining the priority of challenges to be addressed.

Before collecting data on the actual respondents, this study's instruments were piloted to eight (pilot) participants with characteristics similar to those of the respondents. In three iterative rounds, the pilots were performed through a simulated questionnaire (offline and online) and verbal and written interviews. The instruments[10] (for actual data collection) were then updated based on the feedback from the piloting. The table below presents the demographics of the (pilot) participants.

Table 9. Demographics of Pilot Participants for MICMAC-ISM

Category	Group	#
Participants' Location	The Netherlands	2
	Indonesia	6
Instruments' Language	English	1

[10] Refer to Appendix for the MICMAC-ISM instruments.

	Indonesian	7
Occupation	Internal Audit Manager (or equivalent)	3
	Auditor (Team Leader or Team Member)	3
	Academics (Researcher or PhD candidate)	2
Qualification	Experienced in internal audit field	6
	Experienced in IT or IT-related audit	2

5.1.2. Data Collection and Analysis Strategy

The respondents for this part of the research were practitioners from IAF with experience using AA in their assurance engagements. For this research, the respondents are practitioners from IAF in an Indonesian government institution, i.e., the Ministry of Finance-Inspectorate General (the MOFIG). The setting and respondents were chosen since it has the revelatory characteristic of an emergent phenomenon being studied. First, IAFs in Indonesian public sector institutions were instructed by the Indonesian President (Mr. Jokowi) during the National IAFs Coordination Meeting in 2015[11] one of which to leverage IT in their activities (including to implement AA in their internal audit tasks). Secondly, the MOFIG has used AA in its various assurance engagements so far (Chaqiqi & Nugroho, 2021). Figure 11 visualizes the MICMAC-ISM data collection and analysis steps, and brief explanations are presented afterwards.

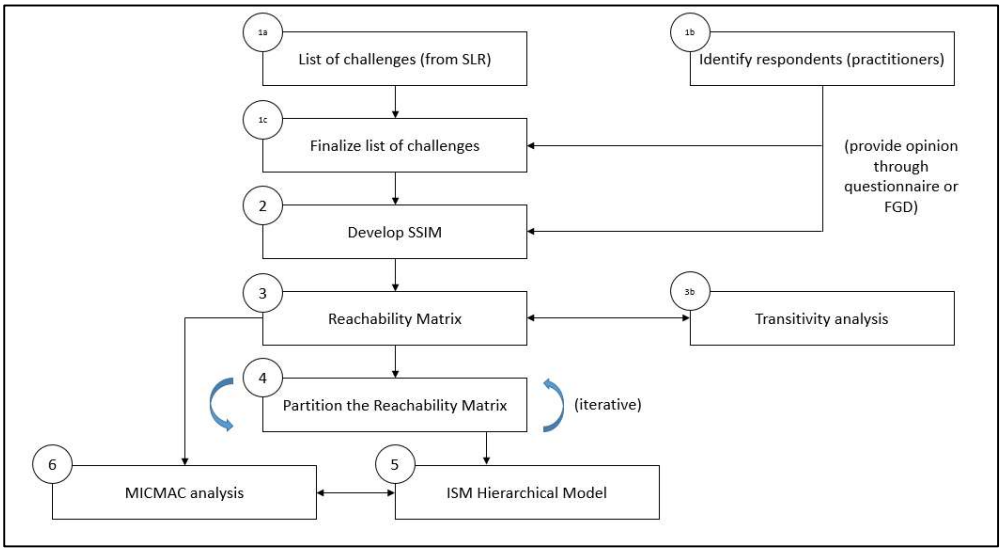

Figure 11. MICMAC-ISM Steps

1) First Part: Finalizing the List of Challenges

[11] https://kabar24.bisnis.com/read/20150513/15/432935/jokowi-buka-rakornas-pengawasan-intern-pemerintah-2015 (Mr Jokowi Inaugurates National IAFs Coordination Meeting, Bisnis.com, accessed 20/05/2021, 11:34 AM CEST).

The first step was to finalize the challenges based on the practitioners' opinions (Steps 1a to 1c). The respondent(s) are practitioners with more than five years of experience, which included:

a) Auditors from IAF using AA in their assurance engagement, and
b) Employees of IAF who are involved in the development of AA in their institution.

This research asked respondents' views on the identified factors, i.e., their significance and additional factor(s), if any, using a questionnaire listing the factors (and a follow-up structured interview).

Eleven practitioners participated in finalizing the list of challenges. All respondents have more than six years of experience in the internal audit field, are involved in three or more AA projects, and hold various relevant professional credentials in the technology-related audit fields, like certified Indonesian government auditor (JFA) or Certified Information System Auditor (CISA). The table below presents the demographics of respondents who participated in finalizing the list of challenges for MICMAC-ISM analysis through questionnaires and follow-up interviews.

Table 10. Demographic data of Respondents to Finalize the List of Challenges

Category	Group	Number of Respondents
Organization Unit	Audit Unit	7
	Innovation Unit	4
Level of Occupation	Audit Manager	3
	Audit Team Leader	4
	Auditor/Staff	4
Internal Audit Experience	> 15 years	2
	11 – 15 years	5
	6 – 10 years	4
AA-related project	> 4 projects	8
	3-4 projects	3
Professional Certification[12]	JFA (Indonesian Government Auditor Certification)	11
	CIA (Certified Internal Auditor)	2
	CISA (Certified Information System Auditor)	3
	CGEIT (Certified in the Governance of Enterprise IT)	1
	CISM (Certified Information Security Manager)	1
	CRMP (Certified Risk Management Professional)	1
	Others (e.g., OCA, CFE, CEH)	4

[12] All respondents were certified government auditors (JFA) holders, and some hold one or more additional professional certifications. JFA certification issued by BPKP, an agency responsible for overseeing Indonesian government internal auditors.

The respondents provided their views on the list of challenges using questionnaires and follow-up interviews (hereafter mentioned with prefix 'M' in the later presentation of this part). The questionnaire and interview used a 5-point Likert scale (from 1-very insignificant, 3-neutral, to 5-very significant) and a narrative description to capture the respondents' opinions on the significance of each challenge. Further, follow-up interviews were performed with some respondents to capture the importance of the challenges (or lack thereof). The follow-up interviews provided additional insight. For instance, respondent M7 suggested that "… data (access) is the main ingredient for AA; otherwise, there will be no AA"[13]. Furthermore, respondents M1 and M8 stated that the organization's culture is a

"… common habit from people as a part of a particular community (including an organization)".

This habit translates into mindset that reflects organization's (members) characteristics. According to respondents M2 and M8, some characteristics like "reluctant to change", "expect instant result", and "fear of missing out", which are common in technology-based innovation in an organization, can significantly hinder AA implementation in IAF. Some respondents also suggested additional challenges. However, those challenges are already included, with different emphasis/terminology. For instance, "dependency on key personnel (with skills in AA)" (respondent M2) represents the limited auditor's AA-related skills and "no standardized quality assessment for AA project" (respondent M9), which resembles the inadequacy of internal audit standards.

2) Second Part: Determining the Relationship and Prioritizing the Challenges

The next step was to test the contextual relationship among the final list of challenges, using the focused group discussion (FGD) to determine the relationship between a pair of challenges based on consensus among participants (Steps 2 to 6). However, there are various parts of the organization that may be involved in AA implementation (Krieger et al., 2021). AA implementation may involve the audit team (as the leading actor) and another unit, such as the innovation unit, which supports the audit team in developing AA projects (Krieger et al., 2021). Furthermore, AA implementation challenges affect IAF as an organization, and the perceived effect might differ for different actors involved. For instance, the audit team (as the operating core, in Mintzberg's (1979) classification of the organization's sub-unit) might focus on operational or technical challenges. In contrast, the unit supporting the AA project and the AA implementation program in general (or 'innovation unit' in Krieger et al.'s terms as the technostructure in Mintzberg's classification of the organization's sub-unit) might prioritize organizational challenges.

[13] The actual explanations/responses from the respondents (presented throughout this dissertation) were in Indonesian.

Therefore, the FGD was performed on the audit team and innovation unit to calibrate the views among the involved units in the AA implementation. The organization units' profile as the respondents for SSIM is presented in the Table 11 below.

Table 11. Organization Units for SSIM Analysis

Organization Unit	Description
Audit Unit	The audit team is experienced in using AA in assurance engagement, from *simple* CAAT to developing a web-based application for CA (with testing automation). The team consists of 1 audit manager, 1 audit team leader, and 3 audit team members (with one skilled as a programmer and two skilled as a data engineer and database administrator).
Innovation Unit	The innovation unit is mandated as the coordinating unit for AA implementation in the IAF in the MOFIG (as the research object). Cumulatively, the unit has experience in assisting many AA projects development (by audit teams), including developing the required supporting infrastructure (e.g., training plan, in collaboration with HR division; AA guidance for auditor). There were three personnel of the innovation unit participated in the FGD, consisting of 1 team leader and 2 team members; 2 of them also acted as data scientists.

5.2. MICMAC-ISM Results

FGD with two groups of practitioners resulted in the contextual relationship among selected critical challenges. Both audit and innovation units agree that social and technical challenges are critical to enabling transformation. Those units differ in the detailed assessment of other challenges like data security issues and the limited audit standard. However, the general hierarchical models and categorization of challenges between both groups are similar. This analysis will be presented and elaborated on in the remainder of this chapter. In addition, the MICMAC-ISM analysis as presented in this chapter was calibrated using an online platform (www.micmac-ism.com)[14] developed by R. Darmawan, R.R. Pratama, and T.R.I. Radarma.

5.2.1. Calibrated Challenges

For MICMAC-ISM analysis, this study first calibrated challenges identified in the literature by incorporating perspectives from practitioners. The practitioners' opinions obtained through the survey refined the list of challenges, which were identified as critically relevant to the implementation of AA. This subsection provides a detailed explanation of the compiled list of calibrated challenges, which has been derived from the perspectives of practitioners.

The calibrated challenges from MICMAC-ISM analysis will be further corroborated through the case study. It strengthens the MICMAC-ISM analysis, albeit with varying emphases. For instance, practitioners for MICMAC-ISM analysis pointed out the inadequacy of internal audit standards, which the case study indicated

[14] Last accessed 25-07-2024, 12:29 CEST.

this concern as a risk that could influence independence. While this issue is relatively newly emerged, as indicated by its limited discussion in the extant literature, the practitioners of MICMAC-ISM analysis emphasize its growing importance for the current and future discourse of analytics for IAF (or the audit field in general). This notion is further corroborated by the case study. In contrast, the practitioners for MICMAC-ISM and the case study respondents affirm that the risk of counter-analytics mentioned in the literature, while emergent, currently poses minor threats. It is because the analytics for the audit field is still developing, hence providing limited reference points for potential perpetrators to counter analytics AA projects effectively. Similarly, while practitioners mainly focused on data difficulties in the technology domain, the case study offered a more nuanced perspective, highlighting specific infrastructure-related concerns. The corroboration of challenges from the case study is presented in this subsection, while the detailed case study results are presented in the subsequent chapters of this dissertation (Chapters 6 and 7).

1) Data Access Issues

'Theoretically', internal auditors have the authority to access all data and information pertinent to their tasks. However, that is not always the case in reality. Discussion in this field found data access as one of the challenges in AA implementation (de Freitas et al., 2020; Krieger et al., 2021; No et al., 2019; Rakipi et al., 2021; Vasarhelyi & Halper, 2018).

The practitioners affirmed this issue, with 9 out of 11 of them believing data access issues are a "very significant" challenge. M7, one of the surveyed audit managers, expressed his/her concern,

"a lot of issues related to data. This significantly affects AA implementation since data is the main ingredients (for AA), otherwise there will be no audit analytics."

The case study further asserted this notion, especially for CA projects. For instance, R2 informed the limitation to further improve the project due to the limitation for data access from certain business applications,

"[…] we still could not get access from the newer financial system to improve our project […]".

Similarly, this issue gave the audit team a hard time starting another AA project, as exemplified by R14,

"[…] from the stakeholder side, we really feel related to their eagerness to provide data, which at first hinders (the project). So, these clients sometimes have problems and are a bit reluctant to provide their data to the MOFIG for audit analytics activities [AA projects]."

2) Data Security Concerns

Data security issues are multifaceted and influence both sides (in the AA context), i.e., the auditors as the "data users" and audit clients as the data owners. From the auditors' side, there is a concern regarding the integrity of the data related to the AA project, both the one used/analyzed for AA projects and the one as AA projects' results (Alles et al. 2008; 2009). From the clients' perspective, security issues mainly concern the ownership aspect, i.e., it is only accessible to

those who are authorized, and the performance aspect, i.e., data access (for AA purposes), will not interrupt their business systems (Haynes & Li, 2016; Koskivaara, 2006).

The surveyed practitioners affirmed this concern, with 8 out of 11 respondents remarking that this issue is significant or very significant. Meanwhile, participants from both sides of the case study agreed on the importance of this issue. For instance, R11 shared his/her experience with clients who were overly concerned about data security and hampered his AA project, to which R5, a respondent from the client side, expressed,

"[...] it's about data confidentiality, because there are some data elements that are considered confidential, hence we can't share them [...]"

3) Missing Data (or Uncaptured Digital Data)

There were quite polarized views on this challenge. On the one hand, 9 out of 11 practitioners categorized this challenge as "significant" or "very significant". On the other hand, there are other practitioners who consider this to be not an issue at all. Nevertheless, it is agreed that digital data is critical for AA, and thus, its absence will significantly impair the AA implementation effort. M2, an audit manager as one of the practitioners surveyed, stated that,

"[digital] data is the main resource for AA."

While M8, an audit team leader, estimated that there are some data in the organization that has not been digitalized,

"I estimate around 75% of the audit data is digitalized [in my organization]. [So,] some physical documents may still exist [so auditors have to analyze it 'manually']"

However, the case study respondents did not specifically mention this challenge. Presumably, this issue is inherently related to another challenge, i.e., data access issues, which will be elaborated on later in this section.

4) Cultural Barriers

Joshi and Marthandan (2020) argue that AA implementation is transformational. This notion is reflected, for instance, by the significant intrusion in the IAF's and organization's business process and IT, and changes in determining audit priority and conducting audit process (Brennan & Teeter, 2010; Mahzan & Lymer, 2008; Vasarhelyi & Halper, 2018). This transformational effort implies adjusting every facet of internal audit activities, which requires some (organization's) mindset adjustment. These changes push for the resistance from the influenced actors, for instance due to the bureaucratic culture or fear of losing control over process or position, which reflect the cultural barriers (Tangi et al., 2021).

The surveyed practitioners strongly agreed with this notion, with 8 out of 11 respondents stating that this is a "very significant" challenge for AA implementation. Similarly, the case study affirms that cultural barrier is one of the challenges encountered. R16, a participant from the innovation unit, spoke about the general circumstances in the IAF,

"[...] I think [auditors are] too comfortable with the traditional approach, regardless of its effectiveness [...]",

Which another participant (R2, although he/she spoke in a general sense) affirmed,

"[…] this approach requires tenacity, perseverance, and a strong will [from the personnel]; hence, I think the organization needs to provide strong stimulus [for personnel to embrace this new approach]".

5) Different Stakeholders' Interests

AA implementation requires involvement from various stakeholders, like the client, IT unit, and the organization's governing body as the IAF's primary stakeholders. Each actor brings its concerns which may be incompatible with one another. The extant literature highlights this issue, like the contrasting concern from the client and the organization's governing body (Ramadhan et al., 2023a).

The surveyed practitioners considered this challenge as "significant" or "very significant", and only 1 out of 11 chose neutral for this challenge. Nevertheless, while the extant literature mainly concerns conflicting interests among external stakeholders (from the IAF's perspective), the case study even showed that this issue may also emerge internally, as suggested by one of the participants,

"[…] each Inspectorate focuses on its own goal and does not really concern to improve AA use in our tasks […]", "[…] The dissimilarity of the agenda for each Inspectorate, their commitments to the development of data analytics vary […]".

Although different concerns were also observed among external stakeholders, as another participant from case #1 exemplified,

"[…] there is a conflicting interest, between our client, which is responsible for financial reporting who focuses on accurate results, and the system manager who concerns for a secure system […]".

6) Limited Auditors' AA-related Skills

Basic internal audit skills and knowledge, like comprehension of risks, control, and business implications, are still relevant for AA use in internal audit tasks (Betti & Sarens, 2021, p. 206; Joshi & Marthandan, 2020, p. 30). However, its form may change. For instance, internal auditors need to understand risks and controls and how to test those risks and controls in the digitalized environment (idem). Internal auditors must also be savvy in translating the testing procedures for the digitalized environment (idem), using pseudo or basic programming skills like SQL or Python, depending on the environment.

Polled practitioners shared their experience with this issue, with 9 out of 11 believing the limited AA skills in auditors as a "significant" or "very significant" issue. Aligned with the literature, M2 highlighted two aspects of this issue, i.e., the limitations of auditors' understanding of risks and controls in digitalized environments and the technical skills to translate the traditional internal audit approach into the AA approach. Furthermore, M8 shared his/her view on this matter,

"There were efforts to address this challenge through various trainings. However, participation in the trainings often only to meet the KPI.

There is also issue regarding uneven (AA-related skills) among different audit units."

The case study indicated that the skills and knowledge gap are one of the barriers to AA implementation. Participants from one of the selected projects specifically mentioned that the technical skills needed to support the project were one of the challenges. For instance, R2 pointed out,

"[…] our skills are limited to ACL[15]; although we can make use a slightly more advanced technique like SQL […]",

and R3 corroborated that,

"[…] we were limited in technical skills since only limited numbers of personnel have the ability to code, so we were lagged behind in coding [developing the project]".

However, general participants (refer to the case study participants, see Table 23 (the last row), p. 103) also indicated that this issue appears in many other AA projects, as a participant from the innovation unit (R17) informed that one of their roles is to assist the audit team in developing AA projects,

"[…] we also act as a partner for audit teams to assist them when they encountered problems in their project, like errors in scripting or to optimize the tools they use […]"

The case study even brought more insight into this issue, which was not discussed in the extant literature. It is suggested that there are layers of skills for implementing AA in internal audit tasks. While the literature primarily focused on the technical skills of internal auditors (Chaqiqi & Nugroho, 2021, pp. 3, 9; de Freitas et al., 2020, p. 158), the case study showed that appropriate AA-related managerial skills are also crucial for the success of an AA project. In this context, the audit manager is expected to direct and guide the audit team on what risks to focus on and how to investigate those risks in the digitalized business environment,

"[…] in some cases, the projects' quality is lacking due to the lack of involvement and direction from audit manager […]",

as suggested by R17, to which R7 as an audit manager admitted it,

"[…] In my opinion, at the audit manager level are still fumbling. So, we need to increase awareness regarding our function as a bridge between business processes and IT because at the middle level is still rarely IT aware […]".

to which R14 stressed the issue based on his/her experience,

"[…] if the direction from the (audit) manager could be clearer, in which areas of AA projects are needed, the strategic value will be higher, and maybe it will be better for the future AA projects […]".

7) Dynamic in Audit Process

AA alters the internal audit process and adds complexities both within the internal audit team (e.g., additional tasks as 'data engineer' to prepare the data

[15] Audit Command Language, an audit software

with its various formats and issues for testing) and between the audit team and the client (e.g., communication protocol for continuous audit project) (Codesso et al., 2020; Haynes & Li, 2016; Islam & Stafford, 2022). The case study encountered this challenge, as R6, a participant from the executive level, underlined this matter,

"[…] This change in the audit approach has extraordinary magnitude because it changes mindsets, changes the way we work […]"

The surveyed participants also corroborated this problem, with the average score for this challenge being 4 or "significant". For instance, M1 highlighted this issue,

"The relationships between auditors and the clients are highly dynamics, and sometimes in a negative tone. […] There were initiatives to mitigate this issue, although the results are mixed."

8) Organization and Business Complexities

The client's business process as the object for the internal audit task is often complex, with interrelation among sub-processes, documents, and actors responsible for each sub-process and document. The digitalized business process exacerbates these complexities, requiring auditors to understand not only the business flow but also the information system architecture behind it (de Freitas et al., 2020; Janvrin et al., 2008; Kiesow et al., 2014). It consists of databases with numerous tables and fields, each with different parameters and settings.

Surveyed practitioners acknowledged the importance of this notion. M2, an internal auditor surveyed about the identified challenges, shared his/her view,

"Complex business process increases the barriers for AA implementation and exacerbates the limitation of auditors AA-related skills. […] I consider this as a significant concern since the business and risk understanding are crucial for AA implementation. The lack of this understanding will significantly hinder AA development (and implementation)."

The case study further exemplified this notion in the form of a complex data structure influencing how auditors develop the test script. R14 mentioned this challenge for one of his/her projects,

"[…] the client's data is quite complex, the structure is also quite complex, because they divide the data into three periods, each with different validity status […]".

Moreover, the case study amplified this issue with the changing regulation or business process that requires auditors to update the project; as R2 said,

"[…] [one of the] problems for our project are that we have to keep up with the changing regulation […]".

9) Limited AA Use Case

AA provides a new avenue for internal auditors to bring value to the organization. However, this change creates a challenge for auditors to determine 'the right questions to ask' in developing a valuable use case for the AA project (Islam and Stafford 2022). In particular, auditors face difficulty identifying a use case for an advanced AA project (Eilifsen et al., 2020; Krieger et al., 2021).

Furthermore, the possible overlapping between the internal audit's AA project and the client's business analytics makes it more challenging to develop a use case for an internal audit task specifically suitable for an AA project, exacerbating this challenge.

Several practitioners strongly expressed their concerns in this matter. For instance, M8, an internal audit team leader stated that,

"Many auditors are clueless on how to optimize digital data to improve their (assurance/advisory) engagements. They prefer traditional approach with less challenge […]"

to which M1, a manager from an internal audit R&D unit, affirmed and added some nuances,

"There was no guidance of examples on how to effectively implement AA, so AA only repeats what has been done manually. Hence, AA will be considered ineffective when other problem like counter-analytics occurred. […] In addition, there is a strong view on the need to maintain 'watchdog' role of IAF. Hence, advanced AA (e.g., predictive analytics) is less favorable. [I think] it is important to clear this up."

The case study ascertained this issue which hinders advanced analytics projects. R17 from the innovation unit shared his/her experience in this matter,

"[…] we already using computer-assisted audit techniques (CAAT), but for predictive analytics, the use case is still not very firm […] [we tried] to predict the error patterns that will be caught from the CA [which has already been executed] so that we can predict the risk of errors that might occur from [future] transactions. Nevertheless, until now, we are not confident about the use case because the CA is not very effective […]".

This problem might be one of the reasons why advanced analytics projects are far less in the case study setting compared to CA projects. However, the literature also suggests that some more common types of AA, like CA, may encounter similar difficulties in different aspects, like developing a cost-effective CA project (Eilifsen et al., 2020; Malaescu & Sutton, 2015).

10) Risk of Independence Impairment (related to Inadequate Standard)

Recent literature identifies a new challenge in the use of AA, namely the possibility of independence impairment (Austin et al., 2018; Islam & Stafford, 2022). This issue arises due to the obscure barrier between the IAF and management (the clients) and between assurance and advisory services.

This challenge is entangled with the limitations of the current standard to guide auditors. With unclear guidelines, auditors are exposed to this conundrum. M1, one of the practitioners surveyed to finalize the challenge list, critically highlighted this issue,

"Auditors work based on standards and guidance; hence, I think this aspect is important. Auditors tend to wait for guidance for a new approach/tools, so the lack of it may delay the implementation and thus its benefit."

The case study substatiates this concern. This issue emerged in the case study mainly because of the possibility of collaboration with the clients for AA projects. As R5 and R15, participants from the client side, pointed out,

"[…] Anyway, in the future, we can join development together instead. […] Well, such an opportunity should be opened […]",

and

"[…] As far as I know, the adage is that the auditor generally does not know better than the client, right? So, like it or not, collaboration with the technical unit [the client] is very necessary […]".

While auditors are eager for this option, they are cautious about its implication, as this approach may influence auditors' independence. R16 and R17, participants from the innovation unit highlighted this concern,

"[…] I think it is [collaboration] quite realistic and workable. However, I am unsure if it is accepted as an appropriate approach to auditing. I think there are risks in such an approach. For instance, does it meet the auditor's professional scepticism? […]",

"[…] if the term is collaborative, it is hard to accept, it is strange if the auditor and audit client collaborate, so there is a nuance of fraud […]".

5.2.2. Contextual Relationships Among Challenges

Building from the calibrated challenges based on practitioners' opinions, the next step in this research phase is to understand the relationships among selected challenges. Further, the relationship will be determined based on FGD with two groups of practitioners (refer to Figure 11 and its subsequent explanation in Section 5.1.2. for more details). The determined relationships will define the challenges' category and position in the developed hierarchical models, which will be elaborated on in detail in this section and the following subsections of this chapter.

The next step in MICMAC-ISM is to develop a Structural Self-Interaction Matrix (SSIM). It maps the relationship between a pair of challenges based on the consensus among participants in each group. Hence, there will be two SSIM matrices representing the Audit and Innovation units (refer to Table 11, p. 62). With each relationship between pairs of challenges is denoted as follows:

1) V, if the challenge on the left side of the table (L) affects the challenge on the top side of the table (T);
2) A, if challenge L is affected by challenge T;
3) X, if both challenges (L and T) affect each other; and
4) O, if both challenges (L and T) do not affect each other.

The resulting SSIMs are presented in the tables below.

Table 12. SSIM Analysis of AA Implementation Based on the View of the Audit Unit

Challenges of AA Implementation	Contextual Relationship									
	10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1 – Data Access Issues	A	X	O	A	X	O	A	A	A	
2 – Data Security Concerns	O	O	O	V	O	V	A	O		
3 – Missing Data (or Uncaptured Digital Data)	V	V	O	V	O	O	A			
4 – Cultural barrier	V	V	V	O	V	V				

5 – Different Stakeholders' Interests	O	O	O	V	O	
6 – Limited Auditors' AA-related Skills	A	V	X	V		
7 – Dynamic in Audit Process	A	A	A			
8 – Organization and Business Complexities	O	O				
9 – Limited AA Use-Case	A					
10 – Inadequate (Internal) Audit Standard/Risk of Independence Impairment						

Table 13. SSIM Analysis of AA Implementation Based on the View of the Innovation Unit

Challenges of AA Implementation	Contextual Relationship									
	10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1 – Data Access Issues	A	V	O	A	X	A	O	O	A	
2 – Data Security Concerns	O	O	O	V	O	V	A	V		
3 – Missing Data (or Uncaptured Digital Data)	O	V	O	V	O	O	A			
4 – Cultural barrier	V	V	V	V	V	X				
5 – Different Stakeholders' Interests	O	X	O	V	V					
6 – Limited Auditors' AA-related Skills	A	V	A	V						
7 – Dynamic in Audit Process	A	V	A							
8 – Organization and Business Complexities	O	O								
9 – Limited AA Use-Case	A									
10 – Inadequate (Internal) Audit Standard/Risk of Independence Impairment										

The next step was to transform SSIM into a reachability matrix, i.e., a matrix showing relationships among challenges using binary notation (1 and 0, with 1 means challenge L influences challenge T). The reachability matrix will be presented as follows:

1) 'V' results in 1 for factor L, and 0 for factor T;
2) 'A', results in 0 for factor L, and 1 for factor T;
3) 'X' results in 1 for both factors L and T; and
4) 'O' results in 0 for both factor L and T.

The Initial Reachability Matrix (IRM) from the audit unit and innovation unit are presented in the tables below.

Table 14. IRM of AA Implementation (Audit Unit)

Challenge	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	0	1	0	0	1	0	0	0	0	1
2	0	0	0	1	0	1	0	0	1	1
3	1	1	0	1	0	0	0	1	0	1
4	1	1	1	0	1	1	1	1	1	1
5	0	0	0	1	0	1	0	0	0	0
6	0	1	1	1	1	0	0	0	0	1
7	0	0	0	1	0	0	0	0	0	1
8	0	0	1	1	1	0	0	0	0	0
9	0	1	0	1	0	0	0	0	0	1
10	1	1	0	1	1	0	0	0	0	1

Table 15. IRM of AA Implementation (Innovation Unit)

Challenge	10	9	8	7	6	5	4	3	2	1
1	0	1	0	0	1	0	0	0	0	1
2	0	0	0	1	0	1	0	1	1	1
3	0	1	0	1	0	0	0	1	0	0
4	1	1	1	1	1	1	1	1	1	0
5	0	1	0	1	1	1	1	0	0	1
6	0	1	0	1	1	0	0	0	0	1
7	0	1	0	1	0	0	0	0	0	1
8	0	0	1	1	1	0	0	0	0	0
9	0	1	0	0	0	1	0	0	0	0
10	1	1	0	1	1	0	0	0	0	1

Further elaboration used transitivity analysis to develop the final reachability matrix (FRM). Transitivity analysis adds notation 1 for a pair of (directly) unrelated challenges that are related through another challenge. For example, if factor 'a' affects factor 'b', and factor 'b' affects factor 'c', then factor 'a' must affect factor 'c' even though the initial analysis defines the relation between factor a and c as (for instance) 'O'. The transitivity analysis is visualized in the figure below.

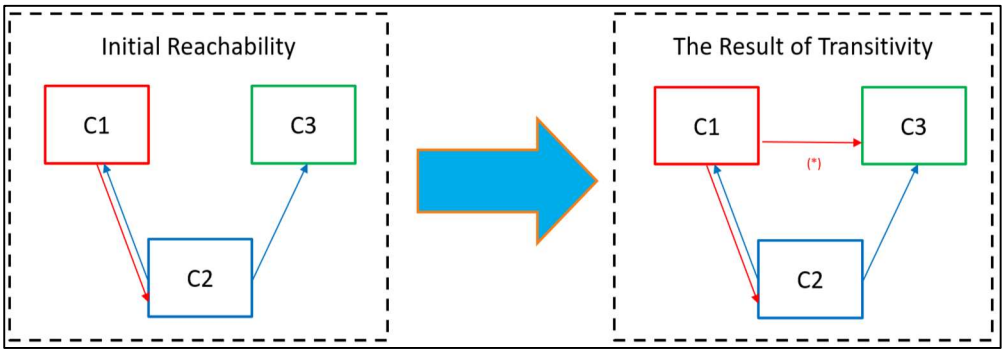

Figure 12. Visualization of Transitivity Analysis

The resulting Final Reachability Matrix (FRM) for the two units are presented below.

Table 16. FRM of AA Implementation (Audit Unit)

Challenge	10	9	8	7	6	5	4	3	2	1	Driving Power
1	0	1	1*	1*	1	0	0	0	0	1	5
2	0	1*	0	1	1*	1	0	0	1	1	6
3	1	1	0	1	1*	0	0	1	0	1	6
4	1	1	1	1*	1	1	1	1	1	1	10
5	0	0	0	1	0	1	0	0	0	1*	3
6	0	1	1	1	1	0	0	0	0	1	5
7	0	1*	0	1	1*	0	0	0	0	1	4
8	0	1*	1	1	1	0	0	0	0	1*	5
9	0	1	0	1	1*	0	0	0	0	1	4
10	1	1	1*	1	1	0	0	0	0	1	6
Dependence	3	9	5	10	9	3	1	2	2	10	

*) adding transitivity

Table 17. FRM of AA Implementation (Innovation Unit)

Challenge	10	9	8	7	6	5	4	3	2	1	Driving Power
1	0	1	0	1*	1	1*	0	0	0	1	5
2	0	1*	0	1	1*	1	1*	1	1	1	8
3	0	1	0	1	0	1*	0	1	0	1*	5
4	1	1	1	1	1	1	1	1	1	1*	10
5	1*	1	1*	1	1	1	1	1*	1*	1	10
6	0	1	0	1	1	1*	0	0	0	1	5
7	0	1	0	1	1*	1*	0	0	0	1	5
8	0	1*	1	1	1	0	0	0	0	1*	5
9	0	1	0	1*	1*	1	1*	0	0	1*	6
10	1	1	0	1	1	1*	0	0	0	1	6
Dependence	3	10	3	10	9	9	4	4	3	10	

*) adding transitivity

FRM informs each challenge's dependence and driving power, accounting for the indirect influence represented through the transitivity analysis. The sum at the bottom of the table shows each challenge's dependence, i.e., how many challenges influence the said challenge; the higher the number, the more the said challenge is influenced (by other challenges). Conversely, the sum in the right column presents each challenge's driving power, i.e., how many challenges are influenced by the said challenge; the higher the number, the stronger its influence on other challenges. These results will be reflected in the MICMAC and ISM diagrams, which will be further elaborated in the following subsections.

5.2.3. Driving Power and Dependence of Challenges

The MICMAC analysis uses the FRM to identify each factor's driving power and dependency in a diagram consisting of four quadrants. The MICMAC analysis then determines the position of each challenge as follows:

1) Autonomous: scored low in both driving power and dependence;
2) Independent: has a high driving power;
3) Linkage: relatively high in both driving power and dependence; or
4) Dependent: scored high in dependence and low in driving power, indicating that other challenges mostly influence the (said) challenges.

The resulting MICMAC diagram from the audit and innovation units is depicted below.

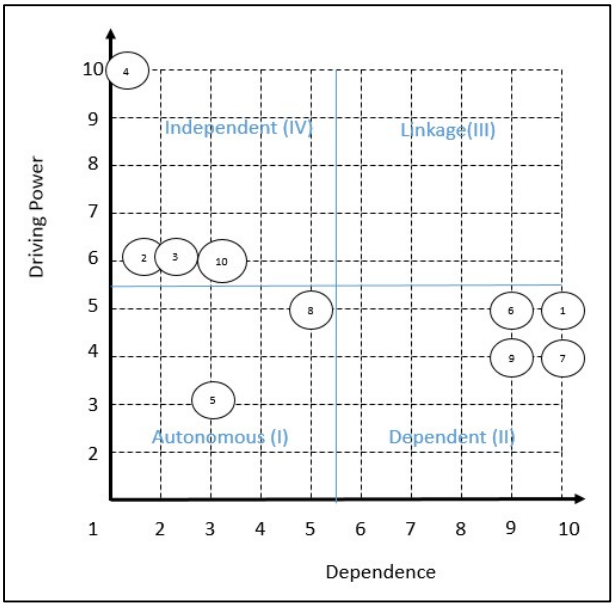

Figure 13. MICMAC Analysis for AA Implementation Challenges Based on the View of the Audit Unit

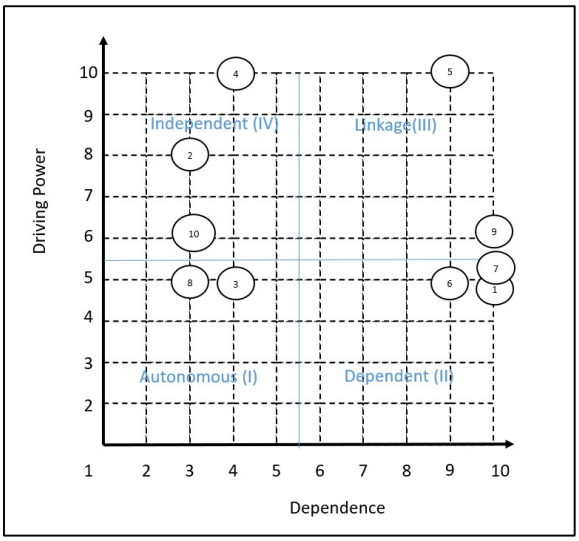

Figure 14. MICMAC Analysis for AA Implementation Challenges Based on the View of the Innovation Unit

Analysis of consensus from both units found similarities in categories of several challenges. Both teams agreed that the cultural barrier (C4) and data security concerns (C2) are independent challenges with strong driving powers, thus influential to other challenges. This notion suggests that addressing these challenges may benefit in solving problems derived from other challenges and eventually help the AA

implementation. In contrast, inaccessible data (C1), limited AA-related skills (C6), dynamics in the audit process (C7), and limited use-case (C9) have a high dependence on other challenges, which implies that other challenges influence them. This notion indicates that these challenges are influenced by the other challenges to be solved to reduce or eliminate their effect on AA implementation. Therefore, practitioners can focus on addressing the earlier challenges (cultural barriers and data security concerns), which will indirectly address these latter challenges with high dependence.

Nevertheless, there are seemingly different views on other challenges. Analysis of consensus from the audit unit showed that missing data (C3) is a relatively influential challenge, while different stakeholders' interests (C5) is an autonomous challenge. For instance, the audit unit considered that uncaptured data (C3) indirectly influences the lack of AA-related skills (C6) through data access issues (C1). They argued that the lack of digital data limits data access for AA purposes. One participant from the audit unit stated that,

> *"[…] if an auditor asks for, let's say, data about the address, how can the data owner provide it if the business application does not require/capture that data? […]".*

Further, the lack of data access (C1) limits the opportunity for auditors to improve their skills (C6). In comparison, the innovation unit saw that C3 has a slightly weaker driving power, while C5 is a linkage challenge with strong driving power and dependence.

5.2.4. Hierarchical Model of Challenges

The final step was to define the levels of the challenges based on the reachability and antecedent set of each challenge. The reachability set (R(Ci)) consists of the (analyzed) challenge and other challenges influenced by the said challenge. Meanwhile, the antecedent set (A(Ci)) consists of (the analyzed) challenges and other challenges that affect the said challenge. The challenges in which the reachability set equals the intersection set are put at the first level and removed from the list. The process performs iteratively for the remainder of the challenges until all the challenges' levels are defined.

The partitions of challenges based on the Audit Unit consensus require five iterations, as presented below.

Table 18. Partitions of Challenges (Audit Unit)

1) 1st iteration

Challenge	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,6,7,8,9	1,2,3,4,5,6,7,8,9,10	1,6,7,8,9	1
2	1,2,5,6,7,9	2,4	2	
3	1,3,6,7,9,10	3,4	3	
4	1,2,3,4,5,6,7,8,9,10	4	4	
5	1,5,7	2,4,5	5	
6	1,6,7,8,9	1,2,3,4,6,7,8,9,10	1,6,7,8,9	1
7	1,6,7,9	1,2,3,4,5,6,7,8,9,10	1,6,7,9	1
8	1,6,7,8,9	1,4,6,8,10	1,6,8	
9	1,6,7,9	1,2,3,4,6,7,8,9,10	1,6,7,9	1

Challenge	Reachability Set	Antecedent Set	Intersection Set	Level
10	1,6,7,8,9,10	3,4,10	10	

2) 2nd iteration

Challenge	Reachability Set	Antecedent Set	Intersection Set	Level
2	2,5	2,4	2	
3	3,10	3,4	3	
4	2,3,4,5,8,10	4	4	
5	5	2,4,5	5	2
8	8	4,8,10	8	2
10	8,10	3,4,10	10	

3) 3rd iteration

Challenge	Reachability Set	Antecedent Set	Intersection Set	Level
2	2	2,4	2	3
3	3,10	3,4	3	
4	2,3,4,10	4	4	
10	10	3,4,10	10	3

4) 4th iteration

Challenge	Reachability Set	Antecedent Set	Intersection Set	Level
3	3	3,4	3	4
4	3,4	4	4	

5) 5th iteration

Challenge	Reachability Set	Antecedent Set	Intersection Set	Level
4	4	4	4	5

The ISM analysis result based on the opinion of the Audit Unit is presented in the figure below.

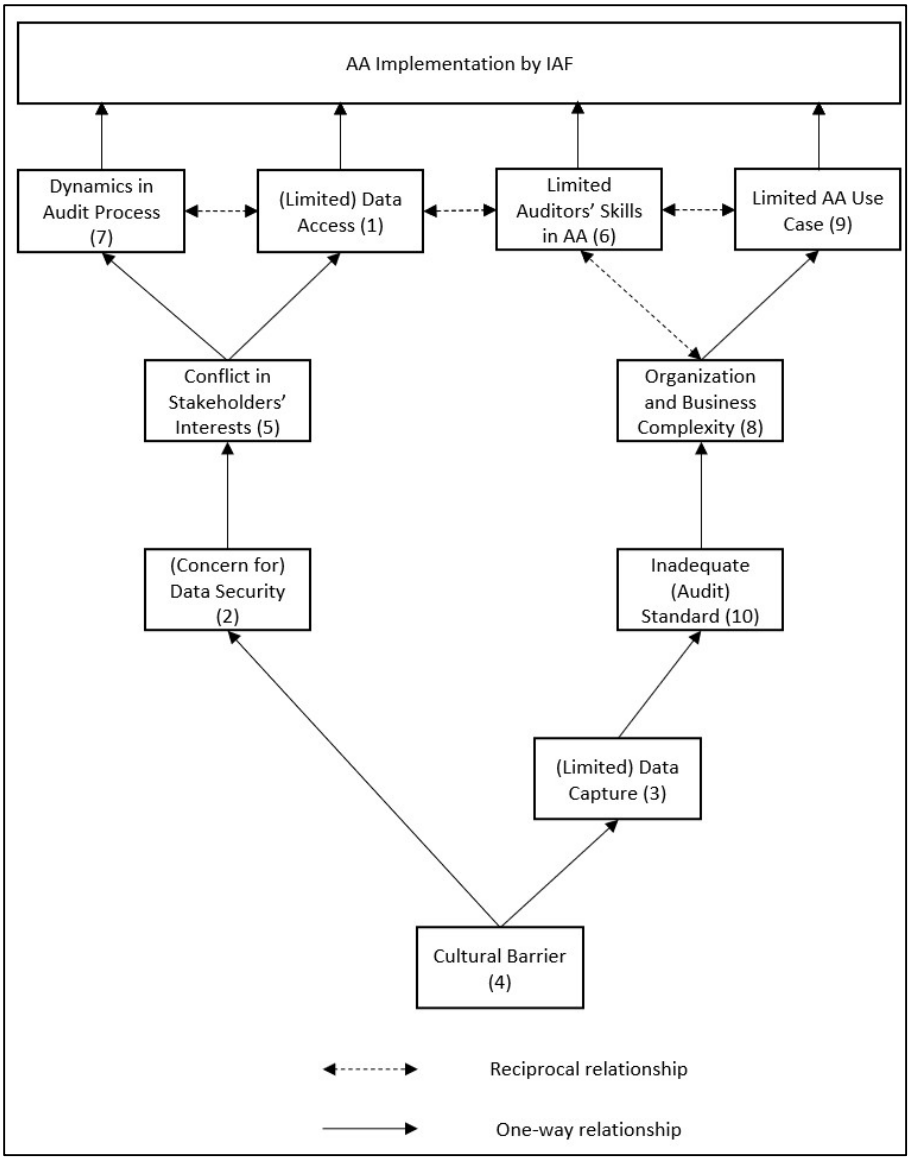

Figure 15. ISM Analysis based on the View of the Audit Unit

In comparison, the challenges partitions based on the view of the Innovation Unit was completed in three iterations, as presented below.

Table 19. Partitions of Challenges (Innovation Unit)

1) 1st iteration

Challenge	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,5,6,7,9	1,2,3,4,5,6,7,8,9,10	1,5,6,7,9	1
2	1,2,3,4,5,6,7,9	2,4,5	2,4,5	
3	1,3,5,7,9	2,3,4,5	3,5	

Challenge	Reachability Set	Antecedent Set	Intersection Set	Level
4	1,2,3,4,5,6,7,8,9,10	2,4,5,9	2,4,5,9	
5	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,6,7,9,10	1,2,3,4,5,6,7,9,10	
6	1,5,6,7,9	1,2,4,5,6,7,8,9,10	1,5,6,7,9	1
7	1,5,6,7,9	1,2,3,4,5,6,7,8,10	1,5,6,7,9	1
8	1,6,7,8,9	4,5,8	8	
9	1,4,5,6,7,9	1,2,3,4,5,6,7,8,9,10	1,4,5,6,7,9	1
10	1,5, 6,7,9,10	4,5,10	10	

2) 2nd iteration

Challenge	Reachability Set	Antecedent Set	Intersection Set	Level
2	2,3,4,5	2,4,5	2,4,5	
3	3,5	2,3,4,5	3,5	2
4	2,3,4,5,8,10	2,4,5	2,4,5	
5	2,3,4,5,8,10	2,3,4,5,10	2,3,4,5,10	
8	8	4,5,8	8	2
10	5,10	4,5,10	5,10	2

3) 3rd iteration

Challenge	Reachability Set	Antecedent Set	Intersection Set	Level
2	2,4,5	2,4,5	2,4,5	3
4	2,4,5	2,4,5	2,4,5	3
5	2,4,5	2,4,5	2,4,5	3

Which resulted in the hierarchical model of challenges as depicted below.

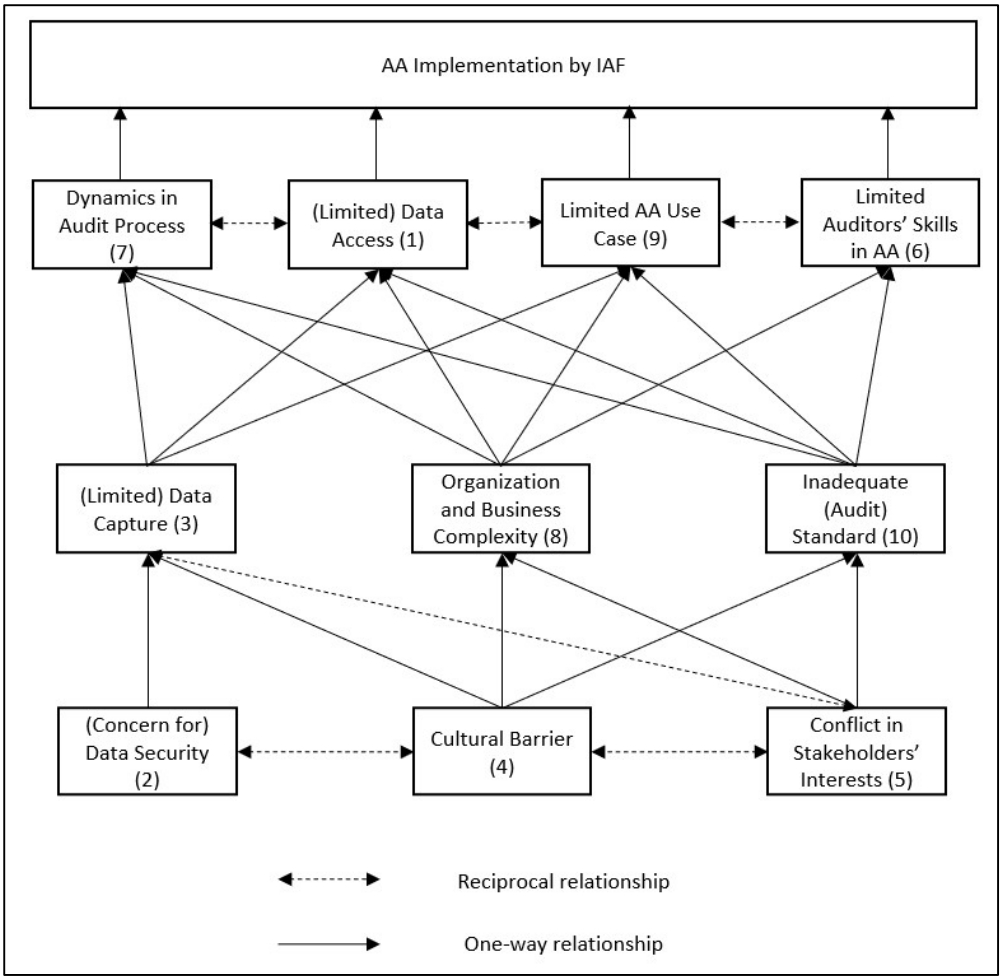

Figure 16. ISM Analysis Based on the View of the Innovation Unit

The developed models visualized the interrelations among challenges based on the experience of the FGD participants. The independent challenges with strong driving powers tend to be the foundational challenge (at the bottom). Aligned with the MICMAC analysis, these independent challenges show strong driving power and, thus, influence other higher-level challenges. Conversely, top-level challenges are dependent and tend to be affected by other challenges. Hence, the organization can review the impact of their effort in addressing foundational challenges (with higher driving power) to these dependent challenges.

Both units seemed to agree on the importance of the cultural barrier (C4) as the foundational level challenge and that the Data Access Issues (C1), Limited Auditors' AA-related audit skills (C6), Dynamics in the Audit Process (C7), and Limited AA Use-case (C9) have the most direct impact on AA implementation. Nevertheless, there are some discrepancies in the level of challenges between those units. The audit unit is more concerned with the Missing Data (C3) as one of the

foundational challenges and slightly less concerned with the differences of interests among stakeholders (C5), while the innovation unit views otherwise. These views, both agreement and disagreement, inspire how to embark on the AA implementation endeavor.

5.3. Models Interpretations

Although presented individually, challenges intertwine and might simultaneously affect AA implementation. This notion suggests that IAF faces multiple factors and needs to anticipate many pressures. Therefore, the AA field will benefit from research examining these intertwined challenges, which expect to answer the most critical factors that require IAF's attention. The MICMAC-ISM analysis shows the complex interactions among the challenges and how they affect AA implementation. Moreover, understanding the interrelationships among challenges will serve as a reference for the prescriptive framework for AA implementation by IAF.

Cultural Barrier Issues as the Possible Root Challenge

The transformational nature of AA implementation complicates the challenges to be addressed. It urges IAF to adjust its personnel (mindset), process, and resources simultaneously. Hence, each challenge may not be addressed in isolation as they are intertwined. In this regard, MICMAC-ISM's resulting models help to identify the key challenges and conceptualize the layers and interrelationships among those challenges.

Both the audit and innovation units were concerned with cultural barrier (C4) as one of the critical challenges. MICMAC analysis suggested that this challenge has a strong driving power and influences all other challenges. Furthermore, ISM models indicated that at the foundational level, this challenge affects the concern for data security (C2) and missing data (C3). In this regard, cultural barriers render the organization focused on confidentiality while undermining the value of data sharing and interconnection, which a participant from the innovation unit mentioned that,

> *"[…] 'traditional' organization tends to overvalue the secrecy of their data […]".*

Similarly, cultural barriers (C4) may limit the initiative to digitalize (the organization's) business processes, which results in limited digital data capture (C3). Therefore, this notion implies that addressing the mindset issue is one of the critical tasks in initiating AA implementation by IAF.

This finding aligns with concerns in the literature (Austin et al., 2018; Brennan & Teeter, 2010; Chaqiqi & Nugroho, 2021; Vasarhelyi & Halper, 2018). Interestingly, the extant literature focused on this issue from the auditors' side. This research, however, suggests that it extends beyond the scope of auditors (or IAF as an entity) and reaches its stakeholders. Therefore, addressing cultural barrier should not only be directed towards the auditors (e.g., to overcome the auditors' resistance) but also toward the IAF's stakeholders, such as the internal audit clients or data owners.

Data and Organizational Related Challenges

Furthermore, although presented on different levels, the subsequent layers of challenges focused on data-related issues, which influence organizational and regulation-related issues. The audit and innovation units agreed with the significance of the concern for data security (C2) and uncaptured data (C3) and those challenges' influence on other challenges. For example, one of the FGD participants stated that,

> *"[…] if the client is overly concerned with their data confidentiality, this (concern) will be reflected in their interests towards AA implementation by IAF […]".*

This statement shows how concerns for data security (C2) influence stakeholders' interests (C5). This notion reaffirms the previous discussion about including external stakeholders of IAF (e.g., the client) in the AA implementation effort. Furthermore, another participant from the audit team stated that,

> *"[…] the absence of digital data implies the lack of need for additional standard (regarding data for audit purposes, as it has been accommodated in the current standard), and vice versa […]".*

This statement suggests the influence of uncaptured data (C3) on the need for additional internal audit standard (C10) for more digitalized audit activities.

The ISM models also show that the audit and innovation units differ in viewing organizational and regulation-related issues. For instance, the innovation unit focused more on data security (C2). In comparison, the audit unit's concern on data security (C2) was on the same level as their concern on audit standard (C10), as the standard will directly influence how they perform their job. Moreover, the audit unit viewed stakeholders' interests (C5) as more practical and directly influenced by technical challenges. In contrast, the innovation unit saw it as a more foundational challenge, which indirectly influenced many other challenges. These different views may result from the experience of the innovation unit in assisting many projects with different characteristics (e.g., different teams, different clients), while the audit unit is more focused on how to perform the audit tasks.

Technical Challenges with Direct Implications on AA Implementation

The higher-level challenges consist of technical challenges that directly influence the use of AA in internal audit activities, such as limited data access (C1), limited AA-related skills (C6), dynamics of the audit process (C7), and eventually, limited AA use-case (C9). Both audit and innovation units viewed these challenges as having high dependencies. Hence, those challenges are influenced by many other challenges, although they also influence each other (as reflected by dashed and bi-directional arrows representing reciprocal relationships in Figures 11 and 12). For instance, one participant suggested that,

> *"[…] dynamics during audit assignment affect communication between auditors and the client, which may eventually lead to the challenge of data access […]",*

to which another participant replied,

> *"[…] while I agree with that statement, I can also see that the difficulty in accessing data may lead to more 'dynamics' during the audit assignment […]".*

Interestingly, although the initial consensus did not result in reciprocity, transitivity analysis reinstated this notion.

5.4. Conclusions

This chapter presented the analyses of the challenges around AA implementation. Building on the existing discourses of AA implementation challenges from the literature, this study performed MICMAC-ISM analysis to understand how the challenges simultaneously influence AA implementation.

This study invited two groups of practitioners as the respondent for the MICMAC-ISM analysis. Although slightly different in detail, the developed models from the two groups show fundamental similarities. Additionally, different perspectives from audit and innovation units enrich the MICMAC-ISM analysis in this study. The audit unit based their opinion on their own work in developing and implementing AA for their tasks, and the innovation unit viewed the relationships among challenges based on their involvement in assisting various AA projects with different characteristics (e.g., different audit teams, different clients). The similarity between the two groups strengthens the findings, while discrepancies indicate different contextual factors between those groups, such as their roles and responsibilities in AA implementation.

This research analyzed the relationship between the ten challenges of AA implementation. In this way, different layers of challenges to AA implementation were identified, from the foundation level with the strongest driving power to the top level that directly impacts AA use, as presented in Section 5.2.4. earlier. The analysis shows that both groups agreed that cultural barrier is the 'foundational' challenge that influences many other challenges; hence, it is critical to address. This finding aligns with the notion of AA implementation as a transformational change. The next layer is data-related and organizational issues, which are influenced by mindset issues but indirectly influence technical challenges, although both groups have slightly different concerns in this layer. Further, both groups also agree that the final layer is technical challenges with a more direct impact on AA implementation, such as data access (C1), AA-related skills (C6), or limited AA use cases (C9). Aligned with the existing discourses, this study strengthens the notion that these challenges directly hinder AA implementation. However, these latter challenges are prone to be influenced by other challenges. This notion warrants focusing on other challenges to overcome the technical challenges directly hindering AA implementation.

The resulting models, i.e., categorization, interrelation, and hierarchy of challenges, should not be interpreted as an exact representation of the phenomena. Instead, it conceptualizes the relationship and hierarchy among challenges of AA implementation based on real-world experiences. The calibration of the analysis of two groups with different characteristics strengthens the resulting conceptualizations. Therefore, the resulting model helps practitioners and academics better understand the contextual factors around AA implementation, as exemplified by similarities and differences between the two groups of respondents.

These results advance the discourse of AA implementation phenomena by offering novel insights and a structured overview of challenges around AA implementation efforts. These insights serve as a reference for developing a strategy to address the issues and assist IAF in realizing AA's benefits. The model suggests that IAF needs to address the fundamental challenges through a systemic and integrated approach involving actors across the organization. The ISM analysis also implies the need to acknowledge the adjusted interrelationships among actors and clarify the roles of the involved actors. The model also suggests a technology-related principle to address technical issues directly affecting AA implementation and satisfy all actors' concerns, like data access and security.

Moreover, the developed strategies need to acknowledge the socio-technical complexities of IAF and its relationship with other actors (units) in AA implementation, as represented by the hierarchical models of challenges. Therefore, aligned with the findings from the previous chapter, and as indicated in the conceptual foundation part of this dissertation, this finding supports system views, through STS and CAS, as the other potential lenses in viewing IAF and its activities (including AA implementation). This view enriches the discussion regarding IAF's role from the classical view of the Agency theory and AA implementation as one of IAF's activities to fulfill its roles. The proposed framework will be further discussed in the next part of this dissertation, while the theoretical reflection will be elaborated on in the last part of this dissertation.

Part III: Framework to Address the Problems

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Chapter 6 – Descriptive Case Study

The previous chapter analyzed the intertwined characteristics and interrelation of the challenges of AA implementation. Chapter 5 also shows how some challenges pose a high driving power and may lead to other challenges. Following up on the insights from the literature that were calibrated from the experience of practitioners elaborated in the previous chapters, the next step in this research is to observe an in-depth, real-world experience of AA implementation and how it addresses the encountered challenges.

This research used a case study method to observe and obtain insights from an actual AA implementation effort. Therefore, this chapter elaborates on the case study setting (the institution experiencing AA implementation) and the units of analysis (AA projects with diverse characteristics). For that purpose, this chapter first lays out the institution as the case study setting to give an overview of the case. The next sections present a detailed AA project as the case study's units of analysis, with the final section concluding this chapter. This description serves as an empirical reference for AA implementation based on the actors' experience (from the case study). Moreover, the case study and the units of analysis presented in this chapter outline the empirical references for the findings (the identified principles and the proposed framework) presented in the subsequent chapter. This chapter is a part of the article titled "Principle-based Framework for Audit Analytics Implementation" by Ramadhan, Janssen, and van der Voort, which is ready for submission.

6.1. Case Study Setting

The case study setting is the Inspectorate General (MOFIG), i.e., the internal audit function for the Ministry of Finance of the Republic of Indonesia (MOF). The units under the MOF (commonly known as Directorate General (DG for short), some with other terminologies) are the business units of the MOF, performing the MOF's core business like fiscal policy, tax policy and administration, customs and excise policy and administration, or state budget and financial reporting. Some bodies equivalent to DGs also provide internal services to the MOF, like training and human resources development, policy coordination (among DGs), or the MOF's internal general affairs.

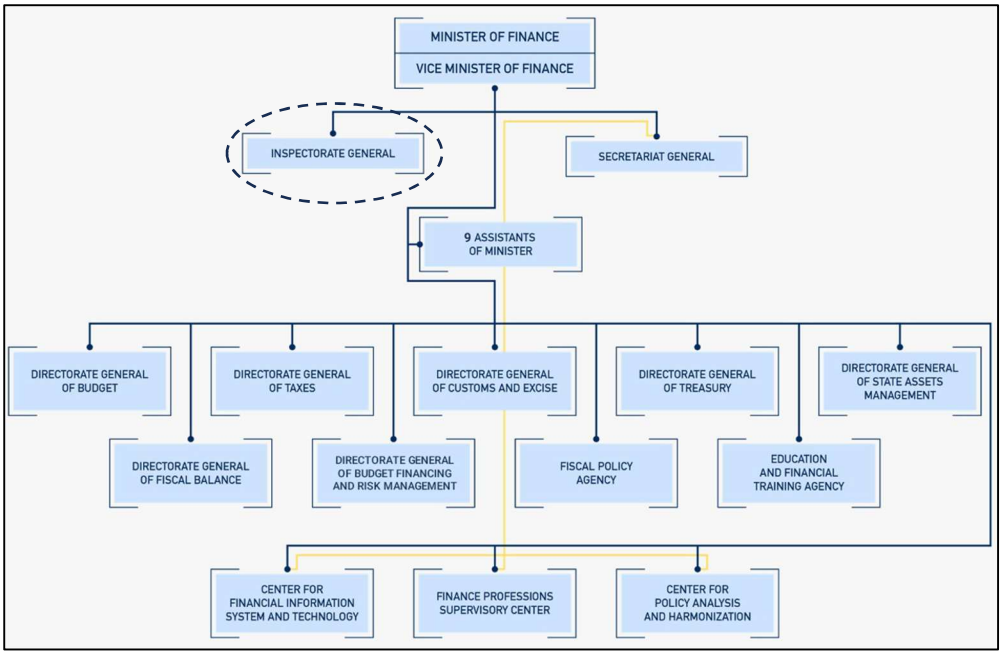

Figure 17. Organization Chart of the MOF[16]

The MOFIG is one of the internal service units in the MOF. The core tasks of the MOFIG as the internal audit function are to perform assurance and consulting services for units under the MOF. The MOFIG was chosen due to its revelatory characteristic, which supports this study's objective. The MOFIG has experienced AA implementation, attempting to perform AA projects in its various internal audit activities with some successful and less successful experiences (Chaqiqi & Nugroho, 2021). Figure 18 visualizes the organizational structure of the MOFIG as the case study setting.

[16] Source: https://www.kemenkeu.go.id/en/profile/struktur-organisasi, last accessed 29/07/2025, 03:18 AM CEST

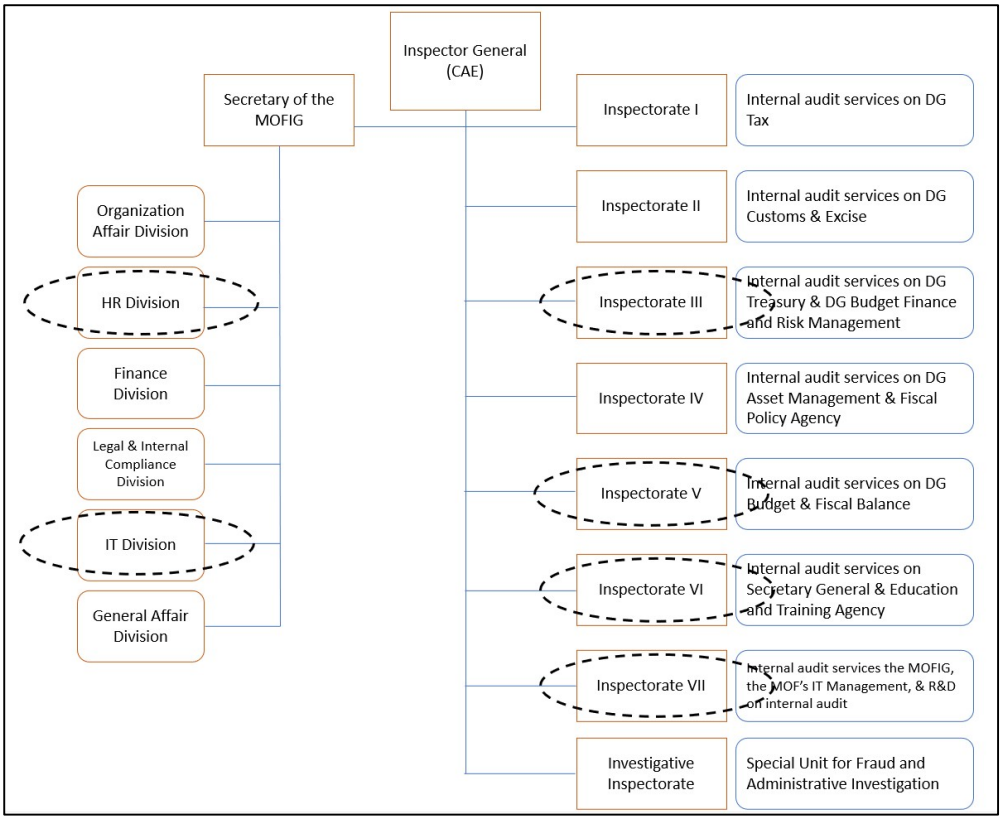

Figure 18. Organization Chart of the MOFIG[17]

There are many actors involved in AA implementation in the MOFIG. The audit teams under Inspectorates are responsible for carrying out the AA project. In obtaining (digital) data as the main 'ingredient' for an AA project, they have to obtain approval from the DGs as the data owners (refer to Figure 17). The innovation/coordinating unit from the R&D Inspectorate often mediates the communication between the audit team and data owner and assists the (AA) project development (refer to Figure 18). Once approved, the IT division assists the audit teams in executing the data access. Moreover, the R&D Inspectorate and the audit teams coordinate with HR to develop a skill development plan. Furthermore, the R&D Inspectorate also plays a key role in orchestrating the overall implementation program, such as proposing a long-term implementation strategy, assisting and evaluating the progress of the overall program and each project, and mediating communications among actors at different organizational levels.

The MOFIG initiated the use of AA in 2009 through the use of a GAS to perform analysis and testing for audit purposes and simpler tools such as Microsoft

[17] Adapted and translated from: https://itjen.kemenkeu.go.id/#/newsfeed/Struktur+Organisasi+Inspektorat+Jenderal, last accessed 17/07/2024, 09:48 AM CEST

Excel. Since 2014, the MOFIG enacted the Inspector General[18] Decree to guide the use of CAAT and continuous audit (CA) for the MOFIG's activities. In 2019, the MOFIG enacted an Inspector General Decree about the roadmap for AA implementation in internal audit activities in the MOFIG. The roadmap consisted of milestones and targets, such as a training plan or guidelines for AA projects. Furthermore, in 2021, the MOFIG enacted other Decrees to support AA implementation, i.e., guidelines for AA use in audit/advisory projects and data governance review guidelines.

Between 2009 and 2018, the MOFIG developed numerous stand-alone AA projects for its internal audit tasks, with some successful and less successful experiences. Since 2019, the MOFIG has embarked on a more coordinated effort of AA implementation. Along with other milestones and targets, each Inspectorate was mandated to have an AA project for its respective (internal) audit task. These projects are the main deliverables of the implementation initiative and represent the most tangible artefact of the MOFIG's AA implementation effort. Hence, this study observes and examines each project as the unit of analysis for the case study.

This study selected four projects as the units of analysis with diverse characteristics and involved multiple actors. The selected projects range from the mandatory task (i.e., review of the financial report) to the pilot project (i.e., predictive analytics), from the simplest task (i.e., continuous audit on administrative control) to the advanced ones (i.e., the use of machine learning models for foresight analysis), from using internal infrastructure to using the client's environment. The selected projects also varied in the involved actors and infrastructure requirements. Hence, this selection strengthens the case study's generalizability (within the research context and setting) (Yin, 2014). This choice also allows for affirming or negating the observations from different characteristics of the projects, further strengthening this study's approach for theory development (Eisenhardt, 1989b).

Each project will be presented in detail in the subsequent sections of this chapter.

6.2. Web-based CA Project

The MOF's financial report must be reviewed by the MOFIG (as the IAF of the MOF) before being published and audited externally by the supreme audit institution (known as BPK-RI). The review must be performed at least twice yearly (for interim (mid-year) and final financial reports). The financial review assignments have been using CAAT since the mid-2000s as one of the initial attempts of AA by the MOFIG. Since 2014, the MOFIG has attempted to automate the review process by using the scheduling feature of ACL Server so the scripts will be executed periodically. In 2018, they started to develop a web-based application for financial review tasks, namely eReviu-LK. This web-based application enables continuous (daily) review of financial transactions. Hence, using this approach, errors can be detected and

[18] The head of the MOFIG or the Chief Audit Executive (CAE).

corrected earlier instead of waiting until the end of the semester (when the review report is delivered).

Financial transaction data from the MOF's financial information system (namely eRekon) is reconciled daily (at midnight) to the eReviu-LK database through the MOF's data warehouse (namely SLDK). The analysis (review tests) is performed in the eReviu-LK database, separated from the financial system. A web page is developed as an interface for auditors to perform the analysis (financial review activities).

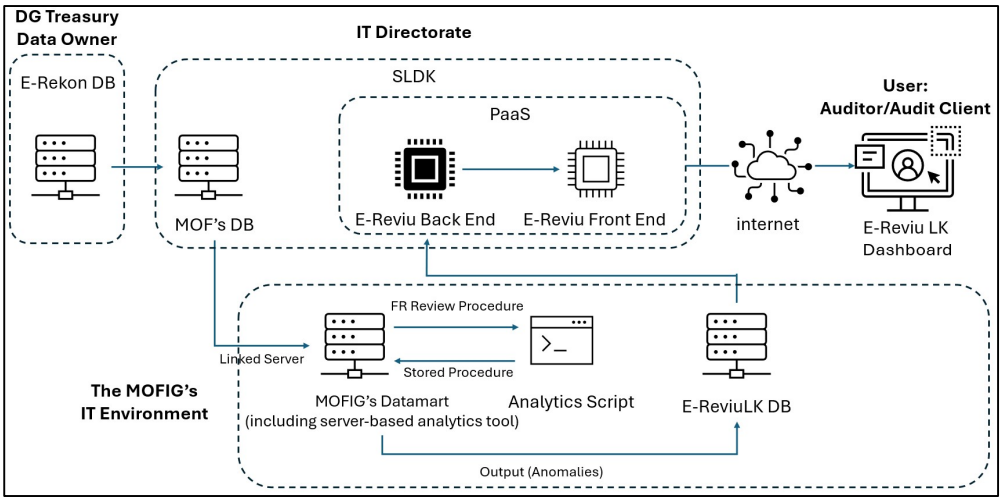

Figure 19. eReviu-LK Architecture

eReviu-LK is an advanced type of analytics that encapsulates the review steps in a web-based interface and requires more technical expertise for its development than auditors can provide. Hence, the review team collaborated with the AA implementation coordinating (or innovation) unit to translate the automated review testing into a web-based application.

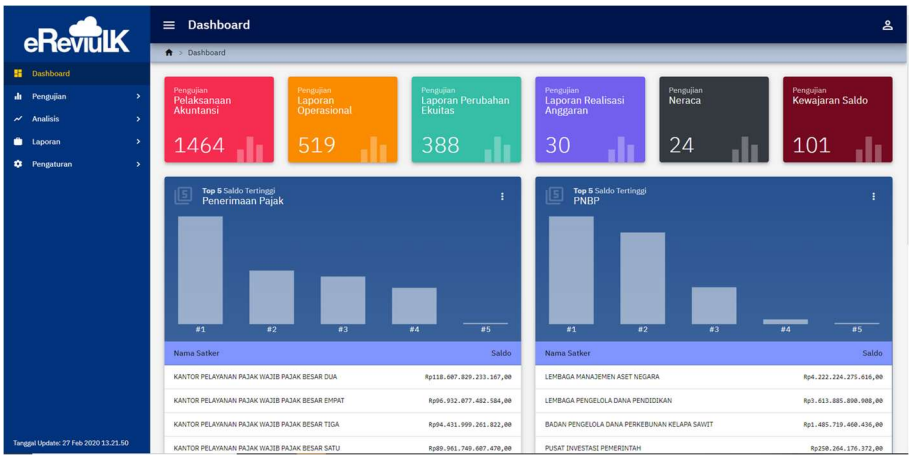

Figure 20. Preview of eReviu-LK Interface

Nevertheless, coordination among units is easier to be said than done. As an interviewee from the review team (R1) pointed out,

> "*The development of this application involved two inspectorates, Inspectorate VII and VI, […] but from Inspectorate VII, there are definitely other tasks and priorities apart from developing eReviu-LK,*"

which aligned with the experience of the interviewee from the innovation unit involved in the project (R3),

> "*So if, for example, we are having a get-together [informal discussion for the project], usually they [the review team personnel from Inspectorate VI] were unable to join, and the reason is that they have other work.*"

Hence, as R1 suggested, a solid internal collaboration (within IAF) is essential, especially for an advanced type of analytics like this project,

> "*So maybe that's it; we really need to sit down together, talk about what the risks are, and then what developments need to be added to the eReviu-LK.*"

Furthermore, the change of key personnel exacerbated the challenge for this project,

> "*[Anonymized] is continuing his/her studies [so he/she has to leave the project], then there are also those who transferred or moved outside the MOFIG, so it seems that [personnel from] Inspectorate VI who understand the financial report are limited.*"

However, R16 is optimistic as long as the organization is flexible enough to allow some of the possible strategies in addressing the limited key personnel for a project, either to find a suitable replacement or to allow the use of an external consultant to speed up the development.

> "*In my opinion, the cornerstone, the building block, is already there; all we have to do is find people who are fit and suitable to do this. If not, we use a consultant*."

Another critical challenge in this project is the need for daily data synchronization. This challenge has been addressed through intensive communication among the review team, IT unit, and business process and data owner, facilitated by the innovation unit. However, this challenge persists for future project development, such as obtaining more than financial data to allow a more detailed review. For this purpose, the data owner is hesitant since this upgrade will require a larger volume of data to be transferred/exchanged for the AA project, which incurs potential system performance disruption. As an alternative, the client (R5) offered a joint development,

> "*Actually, [our] team is ready to make [audit] menu for the MOFIG.*"

While this option may be entertained for future development, there are risks to be mitigated from this option; as R17 pointed out,

> "*I think it's quite realistic and workable. But is it acceptable as an appropriate approach to auditing? I think there are risks in such an*

approach. First, does it meet the auditor's professional scepticism? I am sure we need to test the module provided by the client. Alternatively, it is possible that the MOFIG will determine the approach, risk determination and testing logic, but it still needs additional stages, i.e. we have to evaluate the modules provided, for example, to ensure the suitability of the data source, or the criteria used to prepare the module. So, in my opinion, sometimes such an approach is more complicated than if we [the MOFIG] develop it by ourselves."

This problem signifies the need for a reference for auditors on how to develop AA projects. In addition, the data owner's concern is also valid. Hence, there should be data security management fit with the organization's (the MOF's) architecture to mitigate risks of availability (system performance), as further suggested by R17,

"*From a policy perspective, it is clear that data access is regulated as a part of data governance policy at the MOF (through the SLDK).*"

6.3. Generic CA Project (Using GAS)

These projects were developed by the Inspectorate, which is responsible for performing assurance and consulting activities on the fiscal relations between central and local government and non-tax government revenue administration. The Inspectorate (through the audit team) developed these projects to meet the targeted Key Performance Indicator (KPI) as a part of the roadmap for AA implementation. The projects focus on testing (some) administrative controls' compliance in the audited areas as the object for these projects (i.e., national government to local government or TKDD (in Indonesian) and non-tax government revenue or PNBP (in Indonesian)). This approach resembles continuous control monitoring (CCM) as a subset of CA (Bumgarner & Vasarhelyi, 2018; Haynes & Li, 2016; Malaescu & Sutton, 2015). These projects are expected to detect and report administrative errors monthly. For this purpose, the projects that require data access periodically align with the projects' period.

These AA projects utilize server-based GAS to perform the test and analysis. The tool (the GAS) is owned and managed internally by the MOFIG. The internal audit team develops the initial testing procedure in their internal machine before deploying it in the MOFIG's infrastructure with the help of MOFIG's IT Division. This approach is the generic mechanism for developing AA projects in the MOFIG, as depicted in the figure below.

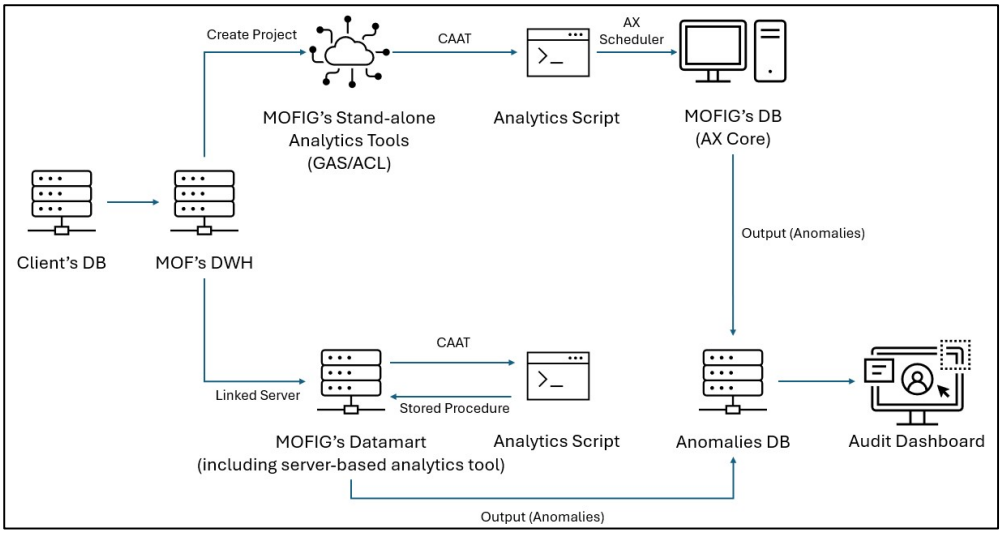

Figure 21. Generic AA Development in the MOFIG

However, the business areas as the project focus are chosen considering their importance, which reflects the focus of the audit team on business risks, as R8 stated about TKDD,

> "*We chose this project [areas] since, at that time, our client only focused on the transfer of the fund to the local governments and did not follow up with the output, let alone the outcome, assuming that it is under the full authority of the local governments. Our leader [Inspector] is concerned about the value realization of the transferred fund; hence, we set up this project to see, at least, the compliance on the reporting for the transferred fund."*

These projects, however, encountered several issues throughout their development and utilization. In the earlier phase, the audit team faced a lack of data accuracy, i.e., the data was severely lagged, limiting the quality of analysis results. This issue was gradually addressed through intensive communication between the audit team and the client.

Another critical problem is the lack of guidance from the middle manager of the audit team; as R9 pointed out,

> "*No direction and involvement [from the audit manager]. … I'm asking for advice or guidance on a flowchart [representing the business and data flow to be tested], for example, is this flow correct or not. That's not answered, […] This means that everything depends on us [auditor at the technical level]*."

To which R6 and R7 confirmed,

> "*We are currently still in transition. […] so it's still a conventional approach [in audit assignment]*."

"*So the managers' function as a bridge between business processes and IT may still need to increase their awareness; it still needs to be pushed around, that's from the middle level.*"

Although the MOFIG has enacted an AA guideline as a technical reference or a standardized method for auditors in developing AA projects, it is a generic reference; hence, detailed guidance concerning business domains, which is the role of audit managers, is necessary. The MOFIG has realized this problem and conducted several measures, like communication strategies to induce the awareness of related parties, including audit managers, and analytics training tailored for audit managers.

6.4. Specialized CA Project (Using Client's Environment)[19]

One of the tasks of the MOF is to allocate and pay the subsidy for national healthcare insurance to the National Healthcare Insurance Agency. The MOFIG, as the IAF of the MOF, is assigned to verify the amount of subsidy to be paid. This task was performed every quarter as the period for subsidy payment.

Due to the concern over data security (e.g., privacy over individual health record data), the National Healthcare Insurance Agency does not allow the transfer of any data outside its environment. Hence, the MOFIG performs the analysis in their environment instead of in the MOF's data warehouse, as with other AA projects. Figure 22 visualizes the architecture specific to this project.

The mechanism implies data access as one of the main challenges for this project. In this project, the client prepares audit data in a designated environment outside the production in their database. This approach is intended to mitigate security risks like system disruption or change in actual data (intentional or unintentional). Consequently, the audit team have to wait for access permission and for the client to prepare the data in the audit environment.

"[…] the data streaming process every quarter takes a long time. So, when we ask for data, the data is ready in the environment in about three weeks to one month,"

[19] This project has now been handed over to another Ministry as the responsible agency for national healthcare management. However, the MOFIG was still responsible for the review at the time of data collection (March – May 2022).

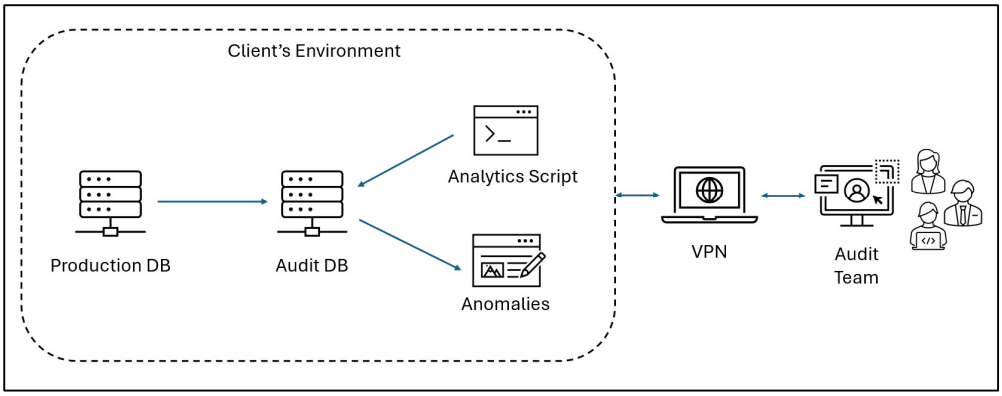

Figure 22. CA Architecture for Healthcare Subsidy Payment Review

The audit team included this waiting time in their assignment planning to tackle this problem, as R14 stated,

> *"[…] when we plan the review activities in PKPT [annual audit plan], there will be a long spare time to wait for [data owner] to prepare the data in the testing environment. That's the normal time.*"

Good communication also plays a vital role in convincing the data owner,

> "*These clients sometimes have problems, and they are a bit reluctant to provide their data to the MOFIG for the purpose of audit analytics activities. Fortunately, it can be solved as long as we can clearly define and explain our requests in detail and the purpose of our assignment.*"

Another interviewee suggested that possible action that could have been done to resolve concerns from the data owner, i.e., data management for audit purposes as R10 said,

> "*We can say that we have to know that the person who is going to access the data has to sign something like an affidavit (non-disclosure agreement) […] whereby those people who do access the data are then bound both morally and legally that they will not use it for any other purpose other than audit assignment.*"

This approach, however, may require some flexibility to overcome administrative barriers between two institutions.

Another challenge for this project is the complexity of the audit areas (the subsidy payment) and the corresponding (digital) data.

> "*In addition, another challenge is also in terms of the process of understanding the data. So because the data structure is also quite complex, because [they] divide the data into three periods, the past period has passed, then the present period is still valid, and the future period is still not valid, so it's a bit of a challenge (for us, the audit team) to understand the data.*"

R14 suggested that communication with the data owner is critical in tackling this challenge,

"*In terms of data complexity, there really is no other way other than to continue to communicate intensively with the data owners.*"

He/She also suggested that a risk-based approach helps to develop the analysis or test for the project and continuously update the project throughout its lifecycle,

"*We talked about the business process, then we studied the regulations, and we identified anything that might go wrong in the process of distributing and paying the subsidy. Well, after that, after we compiled the RCM,*[20]"

"[for the next review period], we usually evaluate from the risks that have been identified, whether there are new risks that need to be added, or there are risks that might need to be cut, or for instance not tested (individually) but combined with testing on other risks."

6.5. Predictive Analytics Project

Predictive analytics is an advanced and newly emerged audit practice (Stippich & Preber, 2016). In 2019, the MOFIG launched the AA implementation strategy, one of which is to perform pilot projects for advanced analytics. This project is one of the pilot projects directed by the AA implementation strategy of the MOFIG.

The team chose this business area to follow up on the previous year's audit result and to provide more value to the client. In addition to the audit findings and recommendations regarding the matter, the audit team attempted to provide a prediction on why such findings occurred, which will help the client to prevent the problem rather than address it after the fact.

"We conducted a performance audit on the foreign loans. There, we got several audit findings, such as there were several loans which, when they were approved to be procured, and signed agreements with the lenders, then after several years, those (loans) were cancelled due to technical problems. […] We tried to solve the problems or issues found in 2018, i.e., the issues in the performance audit we found, by trying to make predictive analysis."

The audit team developed a modelling analysis to predict (government) loan(s) that may encounter issues and require an extension, which will incur additional costs for the government. This project uses an ensemble model, combining logistic regression, random forest, and KNN Classifier, to determine the probability that a loan will require extension based on several determinants like infrastructure project type, the amount of loan, or lender characteristics.

The audit team developed the model in the local environment instead of the data warehouse. They trained the model using historical data from the previous assignments. This mechanism informed that not all types of analytics require a continuous data stream. However, training the predictive model requires relatively

[20] Risk and Control Matrix, as a basis to develop audit work-programs/procedures, to which some of the work-programs/procedures that involved digital data are translated into analytics scripts.

high computational performance. At the time of the project, the team performed the analysis on their devices. However, the MOFIG now has the infrastructure to perform such analysis as a part of the MOF's enterprise architecture, which will help advance AA projects in the future.

> *"The organization also improved the infrastructure, from what was previously ACL in some auditors' devices with a limited number of accounts, then moved to SQL in the data mart so that all auditors have access. This broadens the utilization of AA. And what also helps is that we are tied to one AA development task force as one of the drivers of communication and increasing the culture of collaboration."*

As pointed out above R17, the improved infrastructure is one of the results of the AA task force as part of the AA implementation strategy in the MOFIG. This approach facilitates internal collaboration so that the IT division can better understand the needs of the auditors through intensive communication in the task force.

This project has been handed over to the client, which further improves the model and uses it in their decision-making process. The client was enthusiastic about the project and has already used and improved the project and expects more collaboration for this and future projects, as R15 informed,

> *"We were thankful for the insight. From there (the report), we tried to rerun the model. And indeed, because then we have a good understanding about the business process, it becomes a very good foundation for us to analyze further."*
>
> *"I hope the MOFIG can monitor the project after delivered [the project] to the technical [our] unit, [to clarify] what has been improved, and so on. We can complement each other, from the MOFIG's side, from the risk management side, from the controlling side, as well as knowledge from our side, from the technical unit that understands the day-to-day business processes."*

The handover implicitly reflects the characteristics of internal audit advisory/consulting activities. This matter should be included in the methods for AA project development to guide the auditors and the client. As R16 suggested,

> *"Maybe if the term is collaborative, it's hard to accept; it's strange if the auditor and audit client collaborate, so there's a nuance of fraud. However, using consultative terms [which are also part of the duties of the internal audit unit] might be more acceptable."*

For instance, one of the implications is that from an internal audit standard perspective, the team that developed the project should refrain from involving in the future audit of this business area to avoid risks to objectivity and independence (the IIA, 2017).

6.6. Conclusions

The MOFIG has been evolving and has experienced dynamics in AA implementation in various forms and projects spanned over ten years. The program was derived from the need to keep up with digitalization occurring in the MOF and its units (DGs) and, further, to improve the MOFIG's values for its stakeholders. Initially, the MOFIG

developed numerous stand-alone AA projects for its internal audit tasks, with some successful and less successful experience. These projects represent the most tangible artefact of the MOFIG's AA implementation effort. These projects throughout the AA implementation effort suggest the evolution of roles and relationships among involved actors. In response, the MOFIG also conducted various initiatives, like a roadmap or data analytics competition, to support the implementation effort. This program, including AA projects and all initiatives surrounding the projects, reflects the context of this case study.

The selected projects as units of analysis represent various elements of AA. It includes a *simple* CA using generalized audit software, a more advanced CA with a tailor-made web-based interface, and a predictive analytics project. Therefore, it entails different technical elements such as data requirements, from batch data transfer to continuous data exchange. Further, the projects involve diverse social aspects like stakeholders, including internal and external clients and an innovation unit, and how to communicate with them. The selected projects also incorporate an advisory/consulting engagement, in addition to assurance engagements, which will enrich the discourse. These combinations enhance the insight gathered from this case study analysis. The table below summarizes the units of analysis for this case study.

Table 20. Overview of AA Projects as the Units of Analysis

#	AA Type[21]	Project Type	Service Type	Analysis Environment	Data Requirement	Dominant Challenges
1	Web-based CA	Mandatory	Assurance	Common/ Shared	Continuous	Advanced IT Skills; Data Access
2	CA using GAS	KPI-driven	Assurance	Internal	Periodic	Data Access; Limited Audit Manager's Direction
3	CA using GAS	Client's request	Assurance	Client's	Periodic	Security Concerns; Timely Data Access; Business Complexity
4	Predictive	Piloting	Advisory	Internal	Batch	Unclear Use-Case

The MOFIG as the case study setting and the AA projects as the units of analysis provide real-world dynamics and experiences of AA implementation, both at the organizational and project levels. The case study and the projects hint at the interaction between the MOFIG (i.e., the IAF) as a part of a system with other actors (or units) within the system. This notion resembles IAF as part of a complex socio-technical system (Nuijten et al., 2015), which implies the need for an alternative lens in viewing IAF besides the classical view of the Agency theory.

Finally, building from these real-world cases, this research unearths the common notions to develop principles to address AA implementation challenges and

[21] Refer to categorization by Stippich and Prebber (2016) with modification.

assist IAF in realizing AA's benefits. Detailed analysis of the cases will be elaborated on in the next chapter.

Chapter 7 – Framework Development

The previous chapter exhibits an in-depth experience of AA implementation. The AA projects encountered challenges, and analyzed how the team and organization responded to those challenges. The case study setting and projects show the relationship among actors and further indicate the complex and interrelated challenges in AA implementation. The case study also reemphasizes some challenges identified from the previous parts of this research.

This chapter aims to identify implementation principles to help IAF overcome those challenges based on the lessons learned from the case study and answers the third research question: *What are the principles for addressing the challenges of AA implementation by IAF?* This chapter further coalesces the challenges and the identified principles into a coherent principle-based framework for AA implementation. For that purpose, the first section of this chapter presents the detailed method for this part of the research. An overview of the proposed framework is presented afterwards. In the subsequent sections, this chapter elaborates on the identified principles of AA implementation and the challenges they overcome. The final section of this chapter summarizes and concludes the analysis. This chapter is a part of the article titled "Principle-based Framework for Audit Analytics Implementation" by Ramadhan, Janssen, and van der Voort, which is ready for submission to the relevant journal.

The resulting framework will be evaluated in the next chapter of this dissertation. Moreover, the proposed framework also hints at how to understand IAF roles and its activities like AA through Agency theory and System view (STS and CAS), which will be discussed and elaborated on at the end of this dissertation.

7.1. Case Study for Framework Development

7.1.1. Case Study Design

Following up on the identified challenges and understanding of relationships among challenges, the next step is to develop a framework consisting of principles to address those complex intertwined challenges. This research used an inductive approach to derive principles from particular instances, as the extant literature has limited discussion on principles for AA implementation. Hence, this research uses the case study approach by examining the in-depth and thick description of real-world phenomena to develop a 'theory' from data (M. Brown & Hale, 2014; Eisenhardt, 1989b; Putney, 2010; Sarker et al., 2018; Schwandt & Gates, 2018). The case study is employed to unravel the AA implementation framework, which consists of the principles and the associated challenges based on in-depth, real-world experiences. This method aligns with this research as a means-end engineering project to develop reliable and efficient heuristics (the framework) (Zwart & de Vries, 2016).

Yin (2014) suggests various options for employing case studies for research. First, it can be a single case or multiple cases. A single case study examines an instance with coherent elements (of the case) being studied. This choice is suitable

for theory development that requires analysis of either typical instance, i.e., the phenomena that occurred in many other cases in general, or unique, i.e., the phenomena as a focus of study occurred in the selected case, be it critical, revelatory, or unusual case. Conversely, multiple cases allow for arrays of instances covering different forms of every element of the case. Yin (2014) analogizes this option to multiple experiments, i.e., to obtain multiple pieces of evidence of a single analysis. Multiple case design is suitable for explanatory analysis, such as predicting phenomena. Furthermore, Yin (2014) argues that each type (single or multiple) can use a holistic or embedded design. These selections concern the boundary of analysis for a case study, be it an organization, program, or project. A holistic design assumes the unit of analysis within the case study setting as a single entity. In contrast, an embedded design recognizes various units of analysis in the case study setting. Finally, there are different considerations for case selection. Therefore, the (case) selection can aim either for variations of specific features or general features. In addition, the selection can also aim for a revelatory feature. Figure 23 visualizes the case study design options, and Table 21 summarizes the case selection considerations.

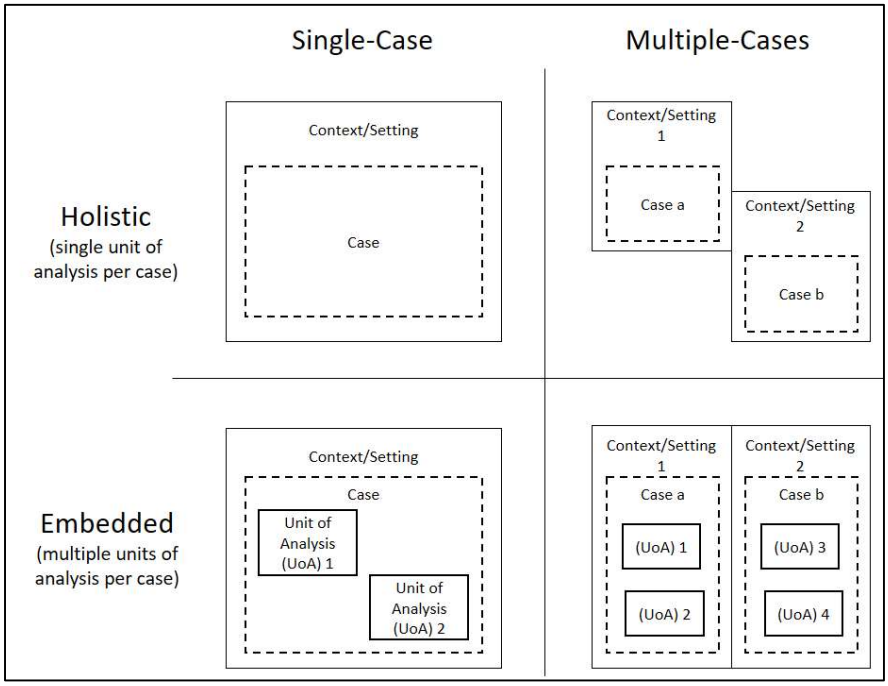

Figure 23. Case Study Types (adapted from Yin 2014)

Table 21. Considerations for Case Study Selection (adapted from Praditya et al., 2016; Yin, 2014)

No	Selection Type	Consideration
1.	Variation	To obtain information about the significance of various criteria for case process and outcome.
2.	Paradigmatic	To highlight more general characteristics of the problem in question.
3.	Revelatory	To observe and analyze an emergent phenomenon.

This research chose an embedded case study design, i.e., a single case with multiple units of analysis. This way, various AA implementation scenarios within the same context can be observed to identify general principles for AA in the implementation effort in the case study setting. This study examined an IAF experiencing the AA implementation process for its (internal audit) tasks as the case study setting (or context, in Yin's (2014) term). Further, this research selected AA projects as the units of analysis in the case study setting. Each project holds its specific characteristics (e.g., the type of AA used, the phase in which AA is used, or engagement with different clients with different characteristics). This research also collected and analyzed documents from the case to better comprehend the matter. The chosen case and setting have a revelatory characteristic of an emergent phenomenon being studied, which supports theory building for this research (Yin, 2014) and aligns with this research's philosophy. Meanwhile, the variety of projects allows for evaluating whether findings are consistent across projects as the unit of analysis or apply to a specific circumstance within the implementation setting. These selections improve the external validity or transferability of the findings within the study context.

The case study data was primarily collected through semi-structured interviews with the case study respondents. Before performing fieldwork data collection, the interview questions were piloted with respondents with characteristics similar to those of respondents, i.e., experienced in audit, government institution, or IT-related environment (see Table 22). This study performed two rounds of piloting from November to December 2021. The interview questions were adjusted based on pilot test feedback. Moreover, this study obtained relevant documents to corroborate the interviews.

Table 22. Demographics of Pilot Participants for Case Study Interview

Category	Group	#
Participants' Location	The Netherlands	4
	Indonesia	3
Instruments' Language	English	4
	Indonesian	3
Occupation	Internal Audit Manager (or equivalent)	1
	Auditor (Team Leader or Team Member)	2
	Academics (Researcher or PhD candidate)	4
Qualification	Experienced in internal audit field	3
	Experienced in IT or IT-related audit	2
	Academic expert in IT and/or organization dynamics	2

The interview questions aimed to extract the participants' experience in developing, using, or involving in an AA project, covering the following topics:

- Reasons for using AA in the internal audit task;
- Challenges encountered;
- How they or the organization respond to the challenges; and

- The situations in the organization help to overcome or exacerbate the challenges (if any).

The topics of the questions were derived from the discourses in the contemporary AA literature. The first two topics were suggested by literature reviews on AA in general or CA in particular (Ramadhan, et al. 2023a; Eulerich & Kalinichenko 2018), which focused on the triggers and hindrances of AA (or CA) implementation. This focus on the triggers and hindrances aligned with Stippich & Preber (2016) approach in the presentation of their framework. Further, as reflected in the last two topics, Ramadhan et al.'s (2023a) work hints at the need to respond to those triggers and hindrances. This notion is also hinted at in the organization-level frameworks like CA Maturity Level and DA Framework, which suggest the need for particular CA or AA implementation actions. For instance, (Vasarhelyi et al., 2012, p. 273) suggest a strategy to achieve a certain maturity level. Similarly, the process model proposed by Stippich & Preber (2016) exemplifies systematic steps to respond to the initial assessment results.

Due to the nature of the case study design, which focuses on a specific context, there are caveats to a case study that limit its generalizability (Salkind, 2018; Schwandt & Gates, 2018). Hence, as indicated above, several measures were employed to ensure a case study's external validity, reliability, and construct validity. First, the use of multiple units of analysis, which includes a wide cross-section (different roles) of participants, helps to generalize the result within the context of the study to ensure external validity of a case study (Brereton et al., 2008; Putney, 2010; Saunders et al., 2016; Yin, 2014). Moreover, the rigorous application of the method and the use of case study protocol sustain the external validity and reliability (Brereton et al., 2008; M. Brown & Hale, 2014; Saunders et al., 2016; Yin, 2014). Finally, the use of multiple data sources (interviews from different actors from different roles, analysis from documents/archives), the use of a pilot test for the case study instrument, counter-evidence or negative case, and clarification to the respondents affirm the construct validity of a case study (Brereton et al., 2008; Saunders et al., 2016).

7.1.2. Case Study Data Collection and Analysis Processes

Interviews for the case study were performed using the guiding questions. However, the guiding semi-structured interview questions may be modified, added, or omitted depending on interview dynamics[22] (DiCicco-Bloom & Crabtree, 2006; Saunders et al., 2016). Those questions were adjusted to maintain relevance depending on the participants' roles. For instance, instead of asking the clients about the motivations or challenges they encountered in AA, we asked them about their concerns related to AA projects. The summaries of the interview transcripts were sent to the participants, who were asked for their 'negative confirmation', i.e., they did not have to respond unless they wanted to correct the summary's content.

[22] Refer to Appendix for the guiding interview questions.

The interviews were performed in 2022 and 2023. In total, eighteen personnel were interviewed, some representing more than one role; for example, some auditors were involved in two selected AA projects. In terms of numbers, these respondents are sufficient to capture the theme(s) of the topic (Wutich et al., 2024). In terms of selection, the interviews targeted different actors to capture the complexities of the varieties of actors as a part of their role but also from the diversity and non-linearity of actors in public sector settings. The main actors in the AA project are the audit team, which usually consists of an audit manager and one or more auditors as a team leader or team member. The IAF's executive may be involved in an internal audit project, especially in the strategic/high-level planning phase. Moreover, various supporting units, like information technology or the research and development division (Krieger et al., 2021) and external actors, like the audit clients, may also have a voice in an AA project. Table 23 presents the list of interviewees (mentioned with prefix 'R' in this dissertation).

Table 23. Demographics of Interview Participants

Category	Group	#
Organization Unit	Audit Unit	13
	Other (R&D, HR, Client)	5
Level of Occupation (Audit Unit/Other Unit)	Executive (Inspector)	2
	Audit Manager/Manager/Division Head	4
	Audit Team Leader/Head of Sub-Division	7
	Auditor/Staff	5
Internal Audit Experience	> 15 years	6
	11 – 15 years	7
	6 – 10 years	2
	N/A (non-auditor)	3
Gender	Male	14
	Female	4
Project	eReviu-LK	6[a]
	CA local budget transfer and non-tax revenue	4
	CA healthcare insurance subsidy	4[b]
	Predictive analytics of debt for infrastructure (pilot)	5[b]
	General	3[a]

Notes:
a) Some personnel work in R&D unit and were assigned to an AA project.
b) Some personnel were involved in multiple projects.

This research used initial coding in the first cycle to explore all possible theoretical directions based on the data (Saldaña, 2016). Further, the second coding cycle used pattern coding to condense the resulting initial coding into smaller analytics units and develop a major theme from the data (idem). These coding techniques support thematic analysis as the method used in this research. This method suits this research as it extracts themes that emerge from the data and is particularly suitable for case study analysis (Putney, 2010). These techniques and methods are expected to assist this research in unraveling the key notions to develop a framework for AA implementation by IAF. The first round of analysis resulted in 146 initial codes, grouped into 14 pattern codes and then condensed into themes (see Figure 24

and Table 24 below). Based on this analysis and themes observed from the case, this research developed the framework (principles and the challenges addressed).

To enhance the reliability of the analysis, this study conducted an intercoder analysis. The codes developed by the first were compared to codes developed by the second coder on the excerpt of the interview transcripts. The comparison was then evaluated by the first and second coder and third independent evaluator. The first coder was the PhD candidate; the second was another PhD candidate working in the same research group with a different research topic; and the third independent evaluator was a senior researcher with experience and expertise in qualitative data analysis. The comparison and the evaluation showed strong consensus.

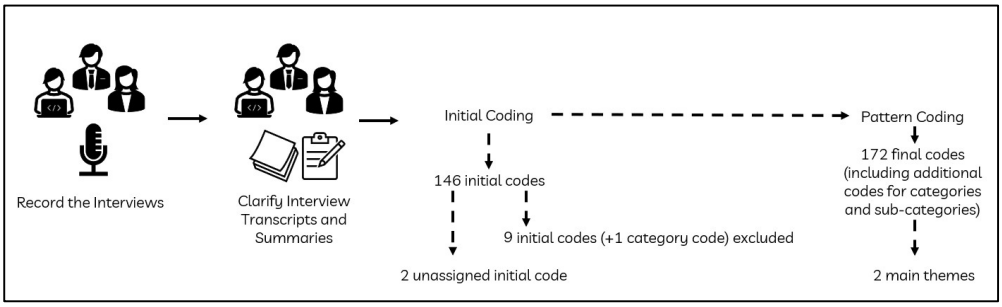

Figure 24. Overview of the Data Collection and Analysis Process

Table 24. Illustrative Examples of the Analysis

Quote Example	R-ID	Applied Coding Schema
Kita didukung inisiatif strategis juga kan. Jadi inisiatif strategis itu juga yang maksa kita untuk implement ini kan, dalam artian menjaga untuk implement. (this (AA implementation) even included as one of the strategic initiatives [to secure long-term funding] to ensure long-term continuity of this plan.)	R4	• Initial code: AA implementation as a part of the IAF strategic plan • First-pattern code (Sub-category): AA Implementation Roadmap • Second-pattern code (Category): Viewing AA as a Comprehensive Enterprise Effort (renamed to "Integrated System View") • Theme: Principle
Nah ini kan kita transisi, mas. Jadi kita pengendali teknis kita umurnya juga sudah ya di atas 50-an gitu ya. Jadi mungkin sebagian masih menggunakan manajemen gaya konvensional, jadi masih pengaturan konvensional. (We are currently still in transition. […] so some older audit managers are still clinging to a conventional approach [in audit assignment])	R6	• Initial code: AA implementation requires mindset transition • Pattern code (Category): Cultural barrier • Theme: Challenge

Quote Example	R-ID	Applied Coding Schema
Banyaknya hambatan terkait data yg ditemukan dalam pengawasan atau AA, dan ini sangat berpengaruh terhadap keberhasilan AA. (We encountered many data-related problems, which I think significantly hindered our implementation of AA)	R11	• Initial code: Data-related issues significantly hamper AA • Pattern code (Category): Data Access Issues • Theme: Challenge

7.2. Towards a Framework: Encapsulating Principles of Audit Analytics Implementation

This research extracts the principles from the case study (the internal audit function and the projects described in the Descriptive Case Study chapter) through which they use AA in their internal audit tasks. It helps to overcome the challenges around AA implementation. This research defines a principle as "*normative, reusable, and directive statement that is understandable and enduring to guide AA implementation*" (adapted from Bharosa & Janssen, 2015; Gong & Janssen, 2013; Matheus et al., 2021; TOGAF, 2018).

This definition aligns with TOGAF's (2018) prescription about principles, which consists of the statement describing the principle, the rationale as a justification for the principle, and the implication that shows how it will influence AA implementation. For practical purposes, it should also include the code and short name for each principle. Furthermore, within the context of this research, the principles should also address and overcome the challenges associated with the implementation of AA. A practical example of the principle may also be presented to improve clarity. These elements serve the principles' purpose of addressing AA implementation challenges by providing an easy-to-understand directive statement that supports decision-making in dealing with AA implementation as a digital transformation effort.

As discussed in the earlier chapter (Chapters 4 and 5), the extant literature suggests AA implementation is a digital transformation effort that encompasses all aspects of the IAF, including the required skills of auditors, data collection and analysis methods, and delivery of results. This transformation involves fundamental changes in current practices, structures, and values. The IAF, therefore, must acknowledge the complexity of AA and its implications for processes, structures, and relationships with other actors.

The identified principles reflect the digital transformation of AA implementation. First and foremost, the IAF must view AA implementation as a whole-organization approach instead of a series of siloed projects by the IAF. This approach enables integrated efforts on all elements (e.g., skills, processes, and interrelationships). Second, there must be mechanisms to clarify each party's roles. Third, AA entails collaboration among various actors, and the IAF can utilize a dedicated team to connect all involved parties and foster collaboration. Finally, AA

requires a dedicated, reliable, and secure platform to satisfy all actors' concerns regarding the implications of AA implementation.

The case study demonstrates that the first principle is pivotal as it leads to the second principle and suggests combining the second principle with the other two principles. Viewing AA implementation through an organization-wide perspective, instead of merely adopting technology by IAF, enables the necessary allocation of responsibility and accountability for each actor in the organization, instead of focusing solely on the audit team. Furthermore, this principle highlights AA implementation's interconnected nature, which entails collaboration among those actors. Hence, the first principle underscores, on the one hand, the need to clarify each actor's roles in AA implementation, which reflects the 'hard' measure, and, on the other hand, the collaborative spirit as the 'soft' measure. The entanglement of the second and third principles are then encapsulated in the fourth principle, i.e., the technological platform that not only supports AA but also acknowledges and satisfies all actors' concerns.

This observation provides a compelling reflection of the departure of IAF from its 'conservative' role as a mere intermediary between the principal and agent according to the Agency theory, toward the view of IAF as an integral part of dynamic and complex socio-technical systems (i.e., the organization it belongs to). The overview of the identified principles is presented in the table and figure below, and an elaboration on each principle is provided in the subsequent sub-sections of this chapter.

Table 25. Overview of the Identified Principles

ID	Short Name	Brief Description/Principle's Name
P1	Integrated System view	Audit Analytics (AA) is a whole-of-organization effort instead of ad hoc and technical projects.
P2	Clarity of Roles	Clarity of roles and responsibilities of each actor involved in AA implementation.
P3	Collaboration	Collaboration among actors involved in AA implementation. The IAF can make use of a dedicated team/unit to foster the collaboration.
P4	Dedicated Platform	Dedicated platform, including infrastructures and tools (both software and hardware), that facilitates data exchange for AA purposes.

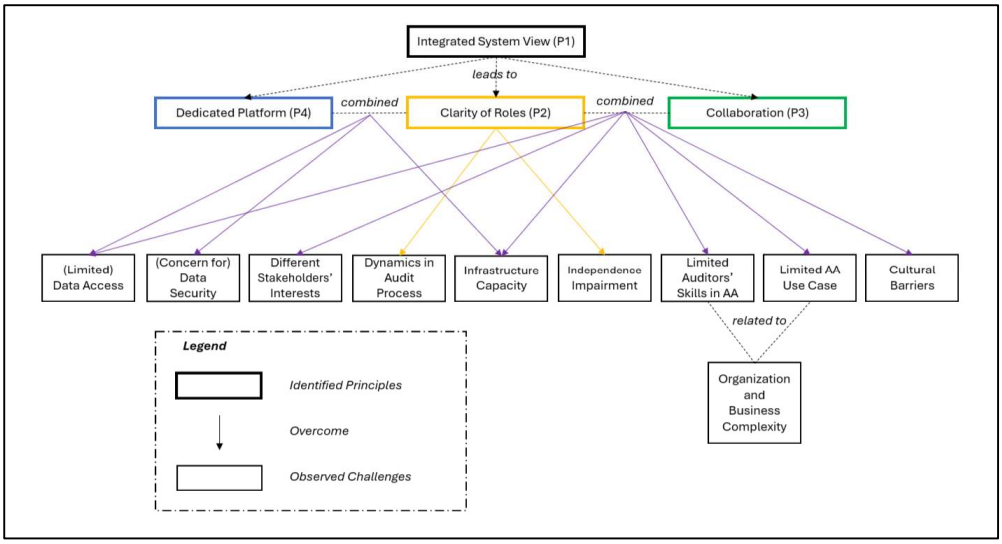

Figure 25. The Principle-based Framework for AA Implementation by IAF

7.2.1. Integrated System View

> *Identified principle #1: "Audit Analytics (AA) is a whole-of-organization effort instead of ad hoc and technical projects."*

The extant literature depicts AA as technical projects (e.g., (Codesso et al., 2020; de Freitas et al., 2020) and technology adoption issues (e.g., Krieger et al., 2021; Li et al., 2018). In this perspective, although the literature acknowledges the inherent difficulties, most implicitly perceive AA as an operational or project perspective or focus on the emergence of technology and its use. For instance, some practical research mainly focuses on developing AA as a project (e.g., Codesso et al., 2020; de Freitas et al., 2020; Gambetta et al., 2016; No et al., 2019; or Yoon et al., 2021). Further, while some more conceptual research (e.g., Austin, 2018; Krieger et al., 2021; Li et al., 2018) acknowledges the interplay among actors of AA implementation, its view still characterizes AA as a technology adoption issue. For example, Li et al. (2018) focus on individual propensity to use AA tools, while Austin et al. (2018) and Krieger et al. (2021) explore the development process of AA use in audit activities.

This approach risks the inconsistency of the utilization of analytics and unsolved issues in the interrelationships among the elements of AA implementation. Different AA projects may encounter different issues and get different support; for instance, one project may have the necessary AA skills in the team but is limited in infrastructure support from the IT Division, while another project is equipped with relevant tools and supported by the IT Division but does not get timely approval from data owners (as illustrated in Figure 26). Moreover, the view of AA as individual technical projects focuses mainly on the technology and may overlook the socio-technical complexities around its use for AA and the potential of AA as a catalyst for digital transformation.

Conversely, the case study analysis suggests AA implementation requires adjustments in all facets of IAF's activities and, thus, should be treated as an organizational transformation effort with all its socio-technical complexities. Furthermore, the case study shows that AA does not start with the acquisition or conclusion of the mere use of technology in an internal audit task. Instead, it requires a systematic and planned approach. This principle aligns with the notion of AA implementation as a digital transformation for IAF, as suggested by Joshi Marthandan (2020). This approach can (and should) be translated into actionable targets and milestones for every actor. Practically, this principle may be translated into the implementation plan, either on its own or as a part of the IAF's (or the organization's) strategic plan.

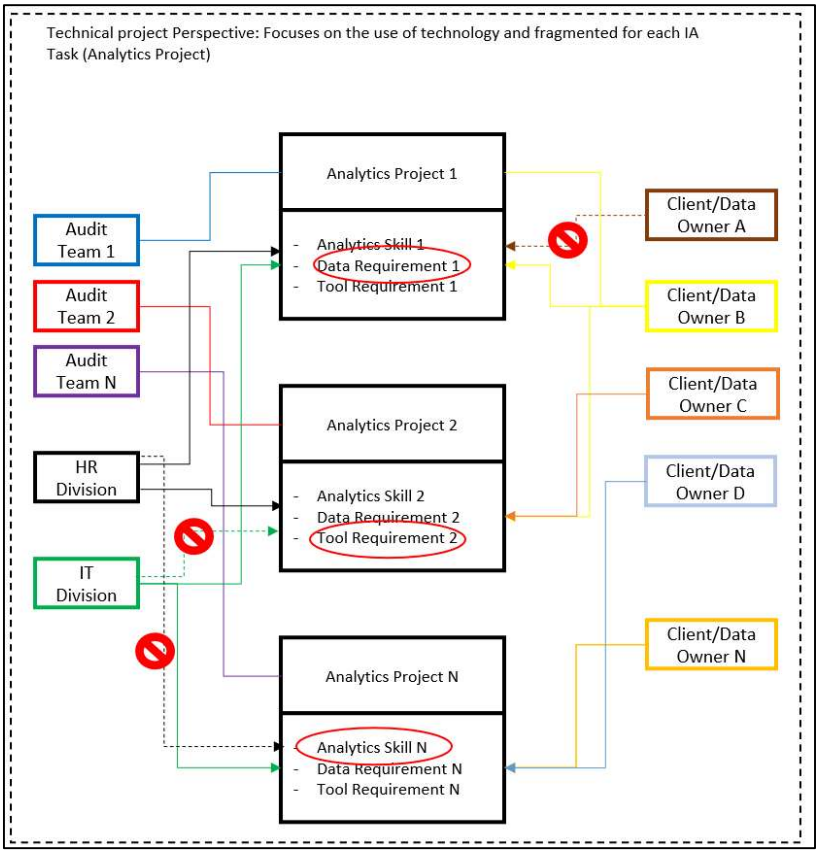

Figure 26. Illustration of Project and Operational Perspectives of AA Implementation by IAF

The case study exemplifies this principle as a strategy document. It cascades the strategy into actionable targets and milestones for each unit(s) to achieve those targets within a specific timeframe (five years). Further, it serves to guide and enable AA implementation effort, as R17 stressed,

"[…] we have AA implementation roadmap for 2019-2023, […] our leader [CAE] uses it to push each Inspectorate to use AA in their tasks […]".

This practice aligns with the broader analytics field, which acknowledges this concern and suggests a roadmap to guide such strategic endeavours (Malik, 2013, p. 6). Although implicitly, AA-related literature also admits the need for a long-term plan for AA implementation (Alles et al., 2009, pp. 20–23; Stippich & Preber, 2016, p. 67).

In addition, the case study informs that this practice is preceded by an initial assessment (document #1). This notion is acknowledged in the broader field of analytics (Malik, 2013, p. 7). In the AA-related field, Stippich & Preber (2016, p. 37) also suggest maturity assessment as an initial step for AA implementation, although this notion is not found in earlier AA literature. The MOFIG developed the assessment tool by synthesizing various references on the maturity assessment model in various topics. Building on the developed tool, the assessment is conducted internally, by observing the existing practices, procedures, and confirming with samples of relevant actors in the organization (e.g., auditors, HR personnel, IT personnel). The initial assessment result shows the MOFIG's current condition compared to its expected 'level'. For instance, the MOFIG (in 2018, when it initiated the assessment) rated its personnel element at level 2 from the ideal/expectation in level 5. The initial assessment is visualized in Figure 27 below.

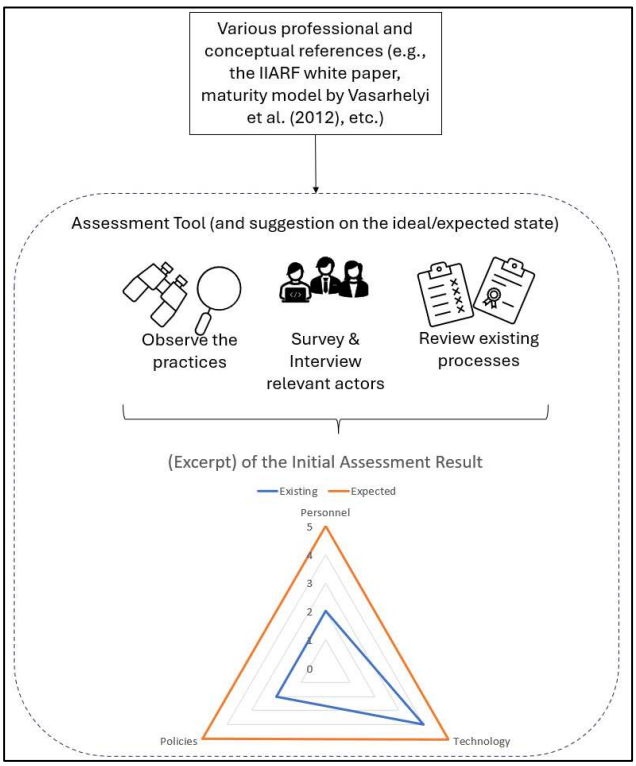

Figure 27. Visualized Initial Assessment Process and Result

The assessment result was the basis for developing the MOFIG's strategy document (document #2, i.e., the "AA Implementation Roadmap 2019-2023"). The strategy document consists of various elements such as auditors' skills requirements or data access as 'inputs' and the number of AA projects as 'deliverables'. Hence, the case demonstrates different approaches to address the challenges IAF and the organization face, which can be institutionalized in the AA implementation strategy. Table 26 partially exhibits the strategy document, which shows the whole-of-organization and long-term perspectives by involving various actors in the implementation initiatives for a multi-year plan.

Table 26. Excerpt from the Strategy Document

Element	Action	Milestone	Units Involved	Notes
Personnel (Auditors' AA-related Skills)	Skill development plan (training plan)	Skill requirement (2019)	HR Division, R&D Division, internal audit team representative(s), training agency	Define the required skillset, including tool-based skills for AA use in their internal audit tasks
		Training curricula (2019)	HR Division, R&D Division, training agency	Translate the defined skillset into sets of curricula for different levels of auditors
	AA Training for auditors	15 auditors with skills in intermediate audit analytics (data science) (2020)	HR Division, training agency, assigned auditors	
		11 audit managers with intermediate understanding of business analytics (2020)	HR Division, training agency, assigned auditor managers	
…	…	…	…	
IT Infrastructure	AA Tools (software)	IT Infrastructure study (software) (2019)	IT Division, R&D Division, internal audit team representative(s)	Determine the tool(s) software to be encouraged in AA
	Common/Shared Physical Infrastructure	IT Infrastructure study (data exchange and analysis platform) (2019)	IT Division, R&D Division, internal audit team representative(s), data owner/client representative(s)	Determine the platform for data exchange and analysis for AA purposes (and general purposes)
		Shared data exchange platform (2021)	IT Division, Data Steward(s), R&D Division, internal audit team representative(s),	

Element	Action	Milestone	Units Involved	Notes
			data owner/client representative(s)	
…	…	…	…	…
AA Project(s)	Pilot project	1 pilot project for each audit division (6 in total) (2019)	Internal audit team(s), R&D Division, IT Division	Initial pilot project, embed with the training
		Join analytics project among audit divisions (2020)	Internal audit teams, R&D Division	Join project between two or more audit teams with overlapping internal audit objectives
		Join analytics project with the client	Internal audit teams, data owner(s)/client(s)	Join project between internal audit team and the client
…	…	…	…	…
Evaluation	Periodic evaluation	Evaluation on the first phase (initiation) (2020)	R&D as the coordinating unit, with the support of all involved units	Determine the progress of the implementation and craft the action for the next phase of the roadmap
…	…	…	…	…

This practice highlights the socio-technical interaction of IAF with other parts of the organization. Further, as the plan goes on, the feedback on AA implementation (as reflected in the "evaluation", see the last row in Table 26) may alter the course of action for the next step of AA implementation. This principle works at the organizational level, encapsulating cross-functional matters across the organization. In practice, this principle can be embedded in the whole organization's implementation program, as demonstrated in the case study.

The case exhibits real-world experience in viewing the IAF through the socio-technical system and complex adaptive system perspectives by showing the dynamic interaction between IAF and other parts of the organization, influencing and being influenced by social and technical aspects of AA implementation. The case shows how the MOFIG responds to digitalization in the MOF by gradually using analytics in its internal audit projects. However, as an ad hoc and project-centric approach fails or is limited in addressing the cross-functional and intertwined socio-technical challenges of AA implementation, IAF moves toward an integrated system perspective in approaching AA as a phenomenon and views AA as a digital transformation for the MOFIG and the MOF. This move, therefore, demonstrates the co-evolution of the MOFIG and its stakeholders in responding to digitalization through AA. Hence, this observation departs from the common notion of viewing IAF as an intermediary between principal and agent, as suggested in the Agency theory.

The practical translation of this principle helps to overcome many technical challenges of AA implementation. For instance, skills development includes competence mapping and comprehensive training programs for auditors. Moreover, the training for auditors should be accompanied by hands-on practice, preferably

directly after the training, to help auditors internalize their newly acquired skills. The approach goes beyond the 'traditional' training plan suggested in the literature (e.g., Li et al., 2018; Tang et al., 2017).

R7, a participant from the middle manager on the auditor's side, praised this exercise,

> *"[…] almost all auditors, up to team leader level, have been trained in CAAT and data analytics, at least the basics […]",*

To which auditor at the staff level, R4, acknowledged the practice,

> *"[…] our organization provides meaningful supports, in terms of fundings, also training, which was a lot; this (AA implementation) even included as one of the strategic initiatives [to secure long-term funding] to ensure long-term continuity of this plan."*

However, he/she further continued that mere training is insufficient for skills development,

> *"[…] in my opinion, training, on itself, is not effective; it might be effective for knowledge acquisition, in a sense that, for example, knowing some SQL basic functions (syntax); but to be able to use that knowledge requires direct practice in a project […]".*

In light of this, the case study recognizes this need and incorporates piloting as part of the plan.

Furthermore, the strategy document (as partially presented in Table 26) informs how this practice addresses other technical challenges like infrastructure requirements. Nevertheless, the case study also informs that the strategy document is intended to address technical challenges derived from internal/organizational problems like dynamics in the audit process and data access issues through the development of AA practical guidelines (document #4) and actions for addressing data access as some of the targets. The practical guidelines clarify the role of auditors at all levels and implicitly imply the role of actors outside the audit team in AA projects. This aspect is further elaborated on in principle #2.

There are, however, caveats to this principle and its practical translation. The attempt to incorporate all actors into the (AA implementation) initiative may incur significant 'costs' in terms of finances and time to obtain 'buy-ins' from those actors. Hence, the case study suggests that the implementation plan embeds a change management and communication plan (to address the first concern). The case further exemplifies the unorthodox change management and communication plan, such as by using talk show and data analytics competition involving all units (not only for auditors). This approach helps capture all actors' interests regarding data analytics and partially addresses, directly or indirectly, fundamental challenges like cultural barrier and different stakeholders' interests. R17, a participant from the coordination unit, stated that,

> *"[…] the talk show helped to build awareness on the importance of data utilization for our tasks; and for the competition, thankfully that it got a very enthusiastic response from the organization, […] so, we kind of*

achieve the effect of those activities to build awareness on analytics […]".

Another concern against this principle's practical example is the relevance of the implementation plan (as the practical example of this principle) in a volatile environment (Worley & Mohrman, 2014), especially in a rapidly changing field like AA. In response, the case implies that this practice is dynamic instead of static. Hence, the MOFIG employs periodic evaluation as a continuous improvement mechanism. This practice addresses the concern of the relevance of strategy for a volatile environment like AA. Practically, periodic evaluation informs about the current state of AA implementation, for instance, if the milestones are achieved or the challenges are addressed.

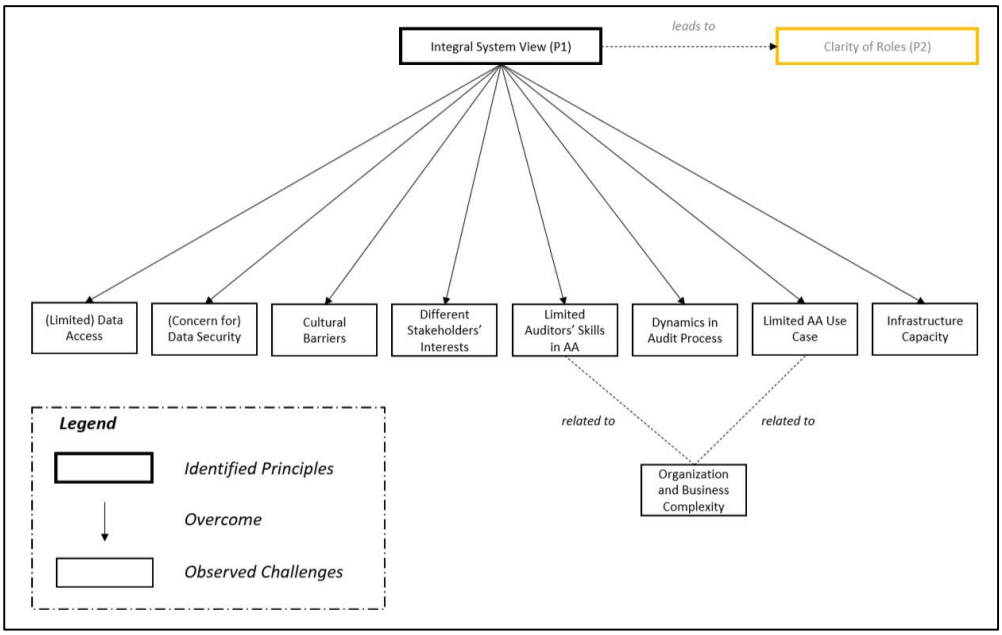

Figure 28. Visualized Summary of the "Integrated System View" Principle

7.2.2. Clarity of Roles

Identified principle #2: "Clarity of roles and responsibilities of each actor involved in AA implementation."

AA changes how the IAF conducts the internal audit process, including the interaction between the IAF (or audit team) with the client and other related parties (Joshi & Marthandan, 2020; Vasarhelyi et al., 2012). The audit teams under Inspectorates are the primary actor in AA implementation since they are the ones who performed the AA project to fulfill their internal audit task. The literature suggests that the audit team are supported by management to provide resources like training or tools for the implementation and a technical supporting unit (or innovation unit) to develop the AA project (Krieger et al., 2021). The case affirmed this notion with more details. First, the case exhibited that the role of the innovation unit (or coordinating unit) is

more pivotal than mere technical support in project development. In this case, this unit orchestrated the implementation program, from devising and proposing long-term strategies to mediating the communication among involved actors (see also Section 7.2.3.). Secondly, the case study outlined the diverse actors as the managerial support, like the IT Division for infrastructure support and the HR Division for skills development. Third, the case study also informed the critical role played by the internal audit clients as their approval for data access is crucial for AA projects, which may require various types of access (see further in Section 7.2.4.). This case study highlights the evolution of each actor's roles and the socio-technical elements involved in AA implementation. R6, a participant from the executive level, underlined this notion,

> *"[…] This change in the audit approach has extraordinary magnitude because it changes mindsets, changes the way we work […]*".

Further, each actor brings its concerns, which may be incompatible with one another. One of the participants from case #1 exemplified this issue,

> *"[…] there is a conflicting interest, between our client, which is responsible for financial reporting who focuses on accurate results, and the system manager who concerns for a secure system […]".*

Even more interestingly, the participant also suggested that this occurred internally (e.g., among audit teams),

> *"[…] each Inspectorate focuses on its own goal and does not really concern to improve AA use in our tasks […]", "[…] The dissimilarity of the agenda for each Inspectorate, their commitments to the development of data analytics vary […]".*

The case study indicates that this issue influences AA implementation, and the (audit) team must balance the concerns of different parties like data owners, clients, and the IT unit. The client as data and system owner may focus on the system performance, its business process reliability, and the confidentiality of their data. For example, R5, a participant from the client side, stressed his/her concern regarding the requirement for the AA project,

> *"[…] we only allow in the weekend for accessing data directly from the production system […] we must maintain the [system's] performance indeed […]".*

From a broader perspective, the organization's target (e.g., key performance indicator) may also influence each organization unit's response in supporting the AA implementation effort.

From the IAF's perspective, AA implementation involves internal and external actors. Therefore, this approach needs clarity on each actor's role to prevent confusion. In that regard, this principle allows IAF to accommodate all involved actors and clarify each authority and responsibility. From the case study, this research deduces some critical roles regarding AA implementation. Tables 27 and 28 partially summarize the crucial AA-related roles, both from at the organization perspective and from project perspective.

Other roles are presented in the case study outside the specific AA-related documents. For instance, some roles to determine data standardization or exchange platforms exist as a general data governance regulation applicable to the entire organization, not specifically for AA purposes (related to principle #4). Another governance aspect, like the ethical committee, also exists as a part of the broader governance aspect of internal audit activities. However, this practice can be viewed as an added value and a limitation. As an added value, this practice transcends beyond AA implementation and reaches the whole organization (aligns with principle #1). As a limitation, there might be specific requirements that are being overlooked. However, evaluation of the exemplified practice from the case is beyond the scope of this case study analysis.

Table 27. Organization-wide Implementation Program Roles (partial)

Role[23]	Brief Description	Example(s) from the Case Study[24]
Coordinate AA implementation program (new role)	It includes tasks like: 1. Develop and propose AA implementation initiative, 2. Bridge communication among actors, including periodic communication among audit teams to share best practice, and 3. Monitor the progress of AA implementation initiative.	- One team from R&D is dedicated to performing this role (and the associated tasks). - Task #1 requires approval from the governing body (of the IAF or the organization).
Develop required skills (existing role with additional emphasis)	It consists of various duties such as: 1. Define required skills for each actor, 2. Develop training plan, and 3. Facilitate training for actors.	- *One team from R&D perform these tasks in coordination with HR Division and involved actors/units (e.g., representative(s) from audit team and audit client).*
Provide and maintain shared infrastructure (existing role with additional emphasis)	This role includes tasks like: 1. Provide the necessary infrastructure (software/hardware) for data exchange for AA and general purposes, and 2. Maintain the infrastructure.	- *IT Division is responsible for this task in coordination with the coordinating unit and other involved actors.*

Table 28. AA Project Roles (partial)

Role[25]	Brief Description[26]	Example(s) from the Case Study[26]

[23] It is acknowledged that using role names instead of role duties will be more familiar. However, observation of the case shows some instances which some role duties are shared among more than one actor (more than one role name), e.g., for advisory AA project the project management role is shared between the audit manager and business unit manager, hence, we use role duties here, and mention the role name(s) (as necessary) in the example (right-most column).
[24] Text in italic implies existing roles with adjustment or additional emphasis.
[25] Idem #23
[26] Idem #24

Manage AA project	Some key tasks for this role like: 1. Liaise with external parties of the project (e.g., the client, IT division), 2. Delegate the leading role to the project team leader (lead auditor), 3. Deliver the project's output (report), 4. Monitor and assess the client's follow up on project results (e.g., follow up on audit recommendation)	- For an assurance AA project, audit manager is accountable for these tasks, with the support of audit team leader and members. - For an advisory/consulting AA project, audit and business manager may share accountability of these tasks, with support from the audit team and staff from business units.
Execute AA project	Technical tasks in AA project, such as: *1. Develop (audit) test procedure and/or develop script,* *2. Perform (audit) test procedure,* 3. Delegate some testing tasks, 4. Evaluate the client analytics pertinent to the project (if any).	Audit team leader is accountable for these tasks, with the support of audit team members.
Data preparation	Technical data-related tasks in AA project like: *1. Acquire the data,* *2. Cleanse the data, and* 3. *Ensure secure data access.*	- *Audit team members (auditors) are responsible for these tasks, in coordination with IT Division, the client's DBA, and data steward.* - *Audit manager and business unit manager are accountable for the formal authorization for these tasks.*
Manage and provide data	Some critical tasks include: *1. Perform data quality management, and* 2. *Authorize data access.*	*The client (manager from business unit) as data owner is responsible for these tasks, with the help of IT division and data steward.*

The case study also exemplifies the designated actor(s) for those roles, either explicitly or implicitly. The designations are explicitly put in the AA implementation roadmap (document #2) and AA practical guidelines (document #4) and implicitly in the IAF's detailed job descriptions. This clear designation reduces possible tension and confusion in interactions among actors. Hence, it helps, at least normatively, to address problems in the social aspect like the dynamics of the audit process and conflicting stakeholders' interests. R2 stressed the importance of clarifying each actor's role,

> *"[…] one of the tenets of governance is the clarity of roles and mandates, so it is known who is doing what, right? […]",*

to which he/she further exemplified,

> *"[…] this becomes a problem if it is unclear, for example, [in terms of AA] how to coordinate the responsibilities among IT units in each DG [Directorate General] […] hence, good governance results in effective*

coordination and collaboration […] and I don't think this is a technical issue […]".

This principle is, in the case study, enacted at the organizational level. However, its practice applies at the project level. This principle demonstrates how AA implementation integrates into all stages of the internal audit process, from the general planning to the follow-up, and how the responsibilities and roles are shared among IAF and other parts of the organization (refer to Figure 3 in Section 1.1.). For instance, new external data (e.g., new high-profile cases involving specific personnel from specific business units, such as DG Treasury in the example of the case study) or the result of predictive analytics may influence the risk level in the targeted business area and, consequently, affect the general planning stage. Another instance is the blurred stages between fieldwork and reporting in CA, which can be performed almost instantly, and the implication of the follow-up on the audit procedure development for the detailed planning stage. This principle underscores the importance of clarifying roles for each actor resulting from AA, as exemplified above.

The case study further suggests that this notion influences technical challenges of AA implementation, like data access and infrastructure-related issues. In terms of infrastructure for AA purposes, R16 from the coordinating unit firmly explained his/her confidence,

"[…] It has been fully solved, we can always request anything related to AA [to the IT unit] […] although we know auditors' preferences are diverse, they [the IT unit] can help us with the solution or workaround […]".

While in terms of data, R4 explained his/her experience in project #1,

"[…] data access is relatively easy, we know where to ask […] although it is true that we must adhere to certain bureaucratic processes, at the end of the day, we get what we need […]".

Furthermore, recent literature identifies a new challenge in the use of AA, namely the possibility of independence impairment (Austin et al., 2018; Islam & Stafford, 2022). This issue arises due to the obscure barrier between the IAF and management (the clients) and between assurance and advisory services. The case study substantiates this concern. This issue emerged in the case study mainly because of the possibility of collaboration with the clients for AA projects. As participants from the client side (for cases #1 and #4) pointed out,

"[…] Anyway, in the future, we can join development together instead. […] Well, such an opportunity should be opened […]".

While auditors are eager for this option, they are cautious about its implications, as they are aware that this approach may influence auditors' independence. Participants from the coordinating unit highlighted this concern. For instance, R17 stated,

"[…] I think it is [collaboration] quite realistic and workable. However, I am unsure if it is accepted as an appropriate approach to auditing. I think there are risks in such an approach. For instance, does it meet the auditor's professional scepticism? […]",

while R16 raised similar concerns,

> *"[…] if the term is collaborative, it is hard to accept, it is strange if the auditor and audit client collaborate, so there is a nuance of fraud […]".*

Nevertheless, effective AA projects may entail collaboration between (internal) auditors and the client. Consequently, instead of an exercise of authority, AA implementation strives through a collaborative approach among involved parties. Moreover, the collaborative approach helps to acknowledge each actor's concern to be incorporated into this principle, which relates to the subsequent principle (principle #3, see more on 7.2.3.). To this end, there should be a balanced approach to maintain (auditors') independence while aiming for a useful AA project. The case study extends the discourse in the AA field by further highlighting the often-overlooked issue of independence impairment, which is relatively limited and discussed in the extant literature (see Section 4.3.2. and 5.2.1.). The case study further adds nuance to the issue by outlining the potential trade-off between maintaining independence for auditors and aiming for effective analytics projects for both IAF and business units.

In light of this, the practical guidelines from the case study exhibit some procedures for dealing with this challenge. By categorizing the relationships between auditors' continuous audit (CA) and the clients' continuous monitoring (CM). The existing guideline in the case study specifically mentions CA and CM as it focuses on those types of analytics. However, we can extrapolate the measures on how to deal with AA projects that are related to business analytics (client's analytics project) (see Table 29). The guideline hints insight into, at least partially, addressing the problem of independence impairment. However, the example from this case study has limitations. First, it only regulates CA as a subset of AA. Secondly, the current guidelines do not provide suggestions on how to deal with joint development in AA projects. Instead, it applies to separately developed analytics projects.

Table 29. Relationship Between the Business Analytics and Audit Analytics

Relationship Type	Business Analytics	Audit Analytics	Safeguard
Initiation	Fully adopt the internal auditors' AA project	The basis for the client's business analytics	Not mentioned
Improvement	Already existed, with additional testing from the internal auditors' AA project	Add testing of risks and control (and/or operational business objective) to the client's business analytics	Not mentioned
Validation	Already existed	Already existed	The results of AA project to validate the client's business analytics results
Monitoring	Already existed	Already existed	The internal audit (team) monitors the follow up on the client's business analytics insight (e.g., if additional control is necessary, monitor if the additional control has been implemented)

Furthermore, this principle needs to consider the possible inherent diametral position among involved actors as implied in the classical principle-agent view. Although most IAFs have now transformed from their classical roles (Bonazzi and Islam, 2007; Haynes and Li, 2016; Mihret, 2014), it is critical to acknowledge this caveat in applying this principle. Hence, this principle should concern principle #1. As mentioned earlier, the case study exemplifies this by performing various communication strategies using different mediums, like through formal and informal communication and even data analytics competitions, to introduce and build awareness about the benefit of AA for all actors, not only auditors but also the clients or data owners. These activities help uncover the mutual benefit of AA and the accompanying activities for the involved actors, its prerequisite, and each actor's contribution to realizing the value. This informal communication results in fluid understanding and relationships among actors, which in turn will bolster support from the involved parties.

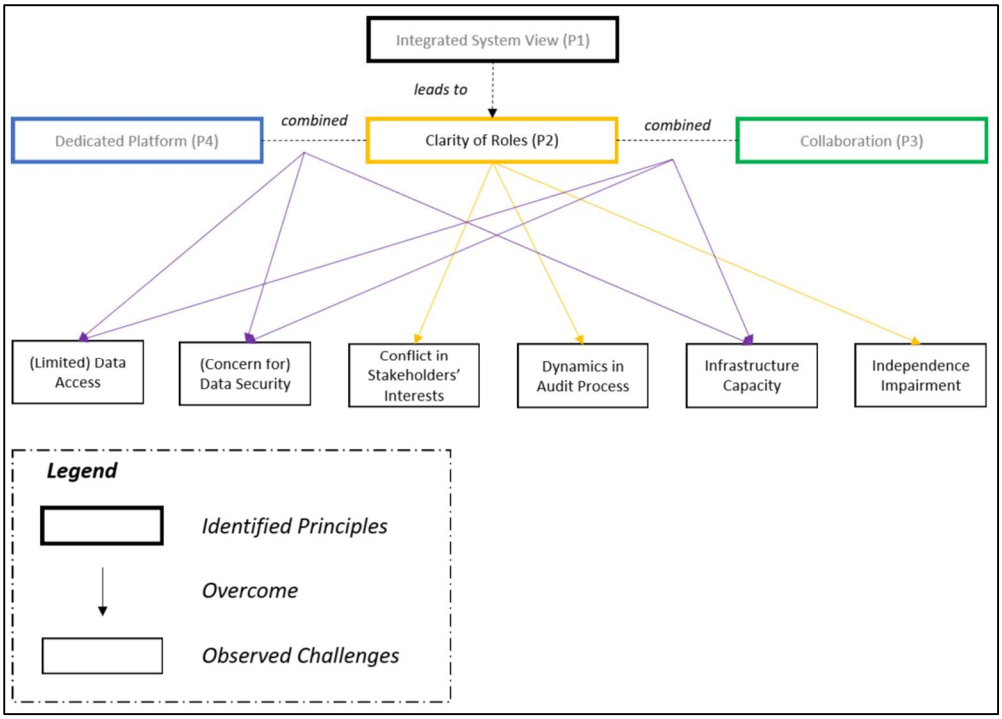

Figure 29. Visualized Summary of the "Clarity of Roles" Principle

7.2.3. Collaboration

> *Identified principle #3: "Collaboration among actors involved in AA implementation. The IAF can make use of a dedicated team/unit to foster the collaboration."*

AA project requires a non-classical approach to develop, which needs expertise from outside the audit team (Krieger et al., 2021). Further, as a digital transformation initiative, AA implementation necessitates various changes in the social and technical aspects of internal audit organization and activities. On the one hand, it aligns with the view of IAF as a part of a complex system as indicated in Section 2.4.2. On the other hand, these notions exacerbate the complex interrelations among actors for internal audit tasks. For instance, AA may require the audit team to use different tools or translate their project into a solution, in addition to the traditional approach's dynamic interaction with the client as exemplified by a participant from the auditor's side in case #1,

> *"[…] we coordinated with the innovation/coordinating unit [a team from R&D division] in developing this project […] since they are more advanced in utilizing SQL tool to develop query-based application [for financial review]".*

This research elicits the principle from the case study. In this regard, the internal audit team, as the focal point of the AA project, relies on many other units. While their authority for internal audit tasks remains, the practical application of that authority may need to be adjusted with a more collaborative nature. This practice helps to address technical issues like limited AA skills and infrastructure capacity. For instance, R2 shared his/her team's experience in collaborating with other units for case #1,

> *"[…] we had storage issues for our web-based application […], so we asked the IT unit to find a workaround to address that [issue]".*

From the client's perspective, collaboration stimulates the improvement of the AA project's value, which overcomes the limitation of the AA use case as another technical problem. R15, a participant from the client side, shared his/her view on this matter,

> *"[…] As far as I know, the adage is that the auditor generally does not know better than the client, right? So, like it or not, collaboration with the technical unit is essential, although there must be an introduction, as they did. But then, you [auditors] should indulge the curiosity of the technical unit [the client] if the project can be used, replicated, and refined. It is like when you build a model, it is not the end. I hope the MOFIG can monitor the project after [it is] handed over to the client, what has been improved, and so on. We can complement each other, from the MOFIG's side, from the risk management side, from the controlling side, as well as knowledge from our side, from the client that understands the day-to-day business processes […]".*

Related to the above notion, a collaborative spirit also assists in addressing non-technical issues like cultural barrier and different stakeholders' interests. In this regard, good communication and collaboration build trust with the clients. R7 shared his/her experience in dealing with these issues,

> *"[…] Communication is related to trust too. Maybe what I experienced with our client several times, we were well received; hence, more of our*

recommendations are easier to be accepted, and [we also] get [the required] data. This is not just data for analytics projects but for other tasks as well […]".

The general analytics discourse of analytics embraces collaboration (Mishra et al., 2019, pp. 1739–1740; Rösler et al., 2021, pp. 13–14) since analytics often comes as a separate domain from the business. AA-related literature also acknowledges this notion, i.e., AA implementation necessitates support and involvement from various parts of the organization (Krieger et al. 2021; Li et al. 2018). Particularly for AA, collaboration is even more crucial since actors outside the internal audit team mainly own digital data as the primary element of the project owner.

Furthermore, the case study exemplifies the existence of a dedicated unit to foster collaboration for AA implementation. This unit's role expands from the 'innovation unit' role, as suggested in the literature, which mainly supports the ideation and development of an AA project (Krieger et al., 2021). The case study shows the unit's more pivotal role, which includes coordinating the initiative and bridging the communication among different divisions (horizontally) and the technical and strategic levels of the organization (vertically). The unit also brings analytics expertise and combines it with the auditing perspective of the audit team in an AA project to assist the AA project (similar to Krieger et al.'s notion). R17 explained his/her team's coordinating role regarding AA implementation,

"[…] Our task is to prepare a strategy so that the MOFIG can implement analytics in audit activities. This strategy is turned into policies, for example, guidelines for CA, and other matters like training designs, for example for TABK (CAAT); personnel in my team also even teach in some of the training. We also act as the coordinators of KPI and evaluation of the target (achievements). We also act as a collaboration partner for the analytics team in each Inspectorate; for example, when they have problems, they will contact our team; we usually hold a meeting/meeting session for the team (who contact us). […] On several occasions, we have tried to be a bridge [communication], like between the audit team and the IT team […] We also play a role in communicating (results) from the analytics team of each audit unit to the CAE […] ".

The case study shows that the designated unit aims to help the IAF overcome various challenges, at least indirectly, from technical aspects like data access, auditors' AA skills, and infrastructure issues to non-technical aspects like cultural barrier or conflicting interests among stakeholders. Therefore, extending from (Krieger et al., 2021) notion of an 'innovation unit', the case study hints insight into a more pivotal role of the unit as one of the practical applications of this principle for AA implementation by IAF.

The 'coordinating unit' instrumental role highlights the MOFIG's view of AA as a transformative effort. In contrast, the limited role of the 'innovation unit' in the extant literature portrays the standard view of AA as a project. Nevertheless, not all

organizations have the extravagance to develop a new unit to carry out this role. Hence, its practical application may vary from one setting to another. For instance, the IAF may task this role to the research and development unit, with additional authority (for overseeing the audit team in AA projects). Further, the IAF must be aware of the risk of overlapping roles, especially for a decentralized role of this unit (Krieger et al., 2021).

The case study shows the principle's application at both organizational and project levels. The pivotal role of the coordinating/innovation unit in developing the AA implementation strategy and bridging, both vertically and horizontally, all actors exhibit the organizational level practice of this principle. Meanwhile, the role of the coordinating/innovation unit in supporting the audit team in developing AA projects demonstrates the collaborative action at the detailed planning stage (see Figures 2 and 3 in Section 1.1.) or the expected close communication from the client regarding their predictive analytics project (see comment from R15) shows the collaborative action at the iterative process from follow-up to detailed planning of the project.

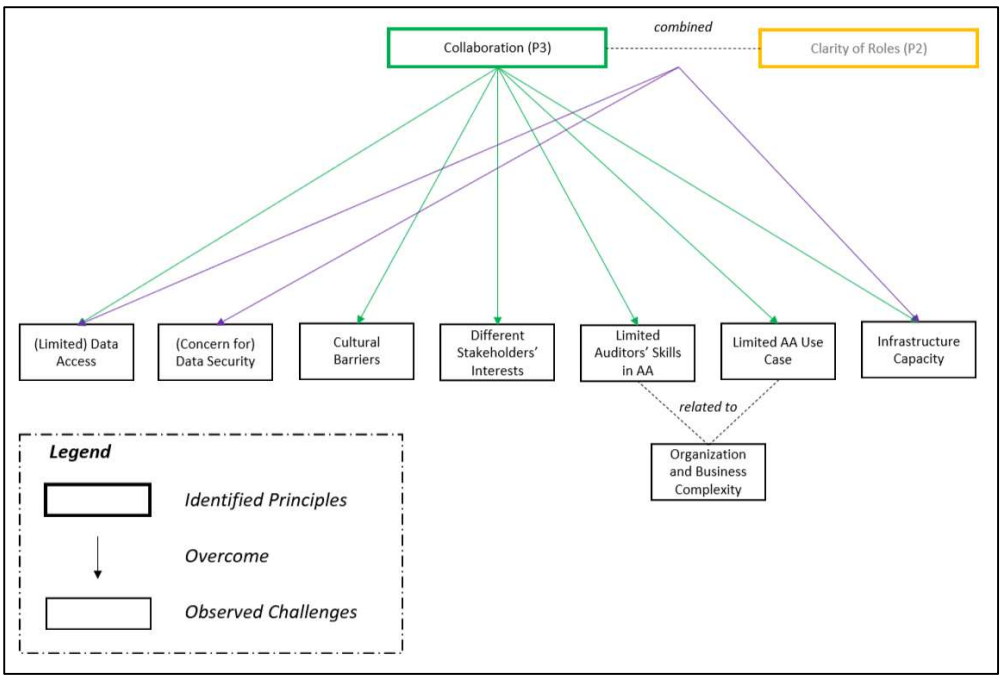

Figure 30. Visualized Summary of the "Collaboration" Principle

7.2.4. Dedicated Platform

> *Identified principle #4: "Dedicated platform, including infrastructures and tools (both software and hardware), that facilitates data exchange for AA purposes."*

Digitalization is one of the main antecedents for AA (Gambetta et al., 2016; Krieger et al, 2021; Rakipi et al., 2021). Contrariwise, this notion suggests that AA relies

heavily on digital data availability. The case study asserts this notion. For instance, one of the participants from the case study underlined that,

> *"[…] data is the main ingredient for AA; otherwise, there will be no AA."*

Further, it entails broad characteristics incorporating digital data's quality, accuracy, security, and other qualitative attributes. Hence, ensuring these attributes is critical for AA implementation.

The nature of the traditional approach allows for ad hoc and diverse data exchange platforms. In this case, some data owners/clients may have to cater to the needs of more than one audit team/AA project with various exchange modes. Hence, there is a possibility for a variety of mechanisms and results. Figure 31 illustrates this diverse data exchange protocol. This approach may not be the best mode for AA, considering there are generally three types of data access requirements for AA, as exemplified in the AA projects in the descriptive case, each with its complexities.

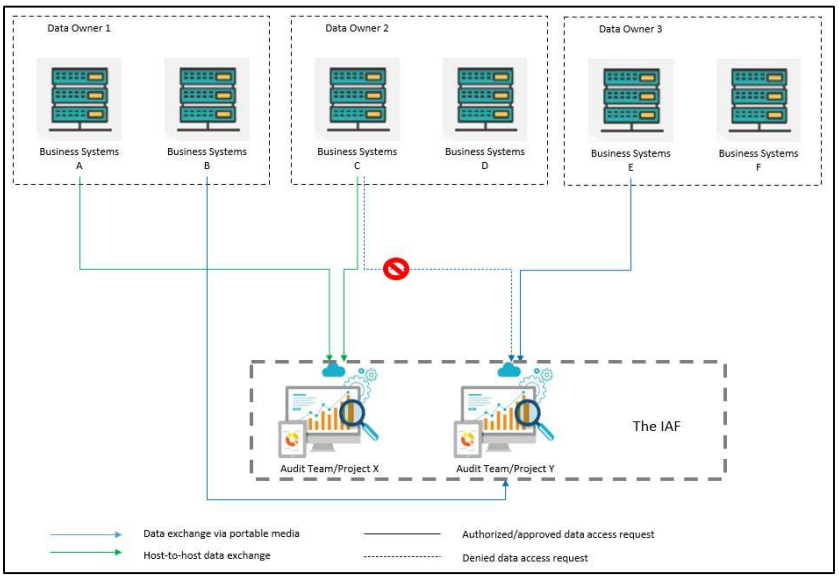

Figure 31. Illustration of Ad Hoc Data Exchange Protocol

The first type of data access is batch access. Interestingly, this type is suitable for the simplest and most traditional form of AA (i.e., computer-assisted audit techniques/CAAT) and the advanced ones (e.g., predictive analytics using machine learning). However, the two differ in terms of data volume and granularity. In this regard, CAAT necessitates access to a batch of data for the period being audited. Conversely, predictive analytics usually require a larger volume and winder characteristics (e.g., period) for optimum model development. R14 share his/her experience in using batch data for model development,

> *"[…] we requested the data through an 'offline' method, in a sense that it did not transfer through SLDK [the data warehouse], and we developed the model also in an 'offline' method [in local machine], and*

we tested the model iteratively. When we were satisfied with the [model's] accuracy, we deployed the model […]"

Some projects are cyclical; hence, the (batch) data will be requested periodically, as exemplified in Case #3. For this type, while the protocol (for data access) can be established on the first request, the technical provision must be performed for each period. This approach turns out to be cumbersome in some instances, as a participant from the auditor side remarked,

"[…] the data streaming process every quarter takes a long time. So, when we ask for data, the data is ready in the environment in about three weeks to one month […]."

Some of the reasons for that delay are data complexity and size. Another pressing reason in that particular case is that there was a data-related incident, which exacerbated the scrutiny of providing data access for outside parties, including auditors.

Another challenging type is continuous data access. This type is required for continuous auditing as one of the most popular forms of AA and presumably for other advanced analytics like process mining (PM) that expects live output (e.g., dashboard) based on dynamic input. The case study shows that the ideal scenario may not always be feasible as it conflicts with other considerations. R5, a participant from the client side, expressed his/her concerns considering the possible impact on the production system,

"[…] we only allow in the weekend for accessing data directly from the production system […] we must maintain the [system's] performance indeed […]

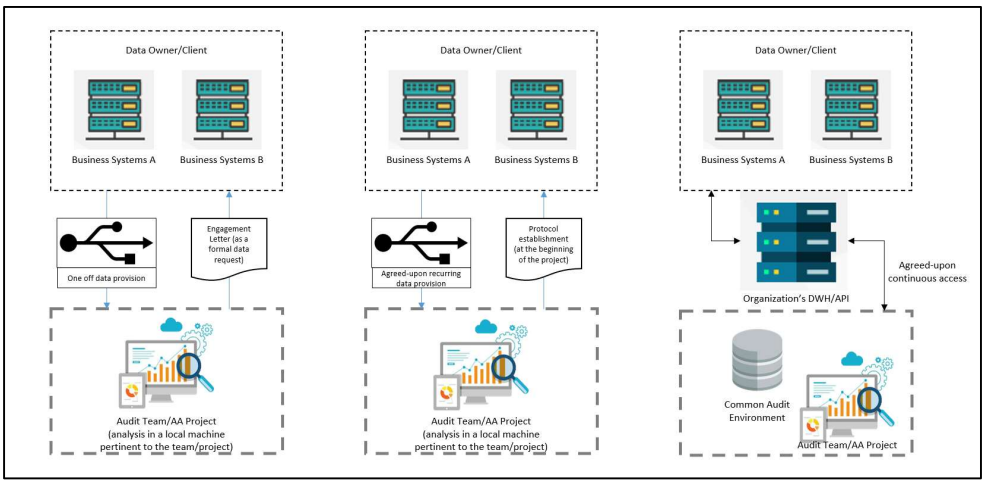

Figure 32. Three General Types of Data Access for AA Purposes

Therefore, the supporting infrastructure must satisfy the requirements of both auditors and owners. Regardless of the differences, the common themes are the need for data availability and security, with the addition of concern for performance.

Auditors are concerned with data availability in accordance with the project requirements, be it batch, periodic, or continuous. In contrast, data owners focus on the security of their data from two perspectives. First, from a technical aspect, data owners need to be convinced that the required access will not interfere with and have an undesired impact on their system's performance, as it will influence their business processes. Second, from a substantial aspect, they need to be sure that unauthorized parties will not access the content of their data, either in the development or in the utilization of an AA project. This practice will, in turn, help to overcome data-related issues, i.e., both data availability (access) for auditors and data security (confidentiality) for the client.

The case study suggests a dedicated platform to facilitate AA. This principle implies that the organization needs to determine the platform for AA purposes that satisfies the concerns of all actors. It can be centralized or decentralized, depending on the organization. However, without a clearly defined and agreed platform, it risks different ways for each project (as exemplified in Figure 31).

A practical translation for this principle is an agreed-upon system and data architecture as a part of enterprise architecture. It facilitates data exchange, both for general and AA purposes. Nevertheless, while the case study focuses on the infrastructure to address data access issues, thus emphasizing its reliability and security, it also incorporates various other relevant tools for AA and business analytics in general. The MOFIG uses ACL as the generalized audit software (or GAS) in its earlier development of AA. However, in recent years, it has used advanced data analysis tools, both embedded in the RDBMS (i.e., database query tool) and specialized tools for data analysis and visualization like Python, Tableau, and Power BI. Some of these tools are internally managed by the MOFIG, like the ACL or Python, while others are provided and managed by the IT Unit, such as the RDBMS, Tableau, and Power BI.

The MOFIG, with the help of the IT unit, utilizes the organization's centralized IT infrastructure (namely, SLDK) as the primary platform for data exchange among agencies, including AA projects. Besides the platform on which the analytics tool mentioned above resides, it also functions as the pivot for interconnection among systems in the MOF. This principle, moreover, relates to the previous principles of roles, i.e., ensures clear responsibilities among involved parties using the platform. Combining these notions strengthens the incentive to foster data exchange and sharing both for general and AA purposes. R16 and R17 from the coordinating unit emphasized this approach,

> *"[…] data access is regulated as a part of data governance policy at the MOF (through the SLDK); as long as the request is clear, usually, it can be resolved through SLDK […]",*

to which R5 from the client side shared agreement with this mechanism,

> *"[…] As far as we transfer or exchange the data through the internal path (intranet) like SLDK, it should be okay […]".*

The case study manifests the combination of these practices as "Data Governance Guidelines". There are, however, additional insights from the practice.

First, the guideline is not developed solely for AA (or IAF). Instead, it is enacted at the higher organization level (the MOFIG) and binds all actors (including data owners, data stewards, IT unit, and IAF) for the general data exchange/share process. Second, the guideline mandates that the IAF performs assurance activities to ensure that the guideline is followed by all units (including the IAF itself), to which this mandate is translated into "Data Governance Review Guideline". This practice connects principles #2 and #4 and emphasizes the notion that AA implementation is a digital transformation and reaches beyond the IAF. Figure 33 visualizes the shared platform, including the associated roles in this platform.

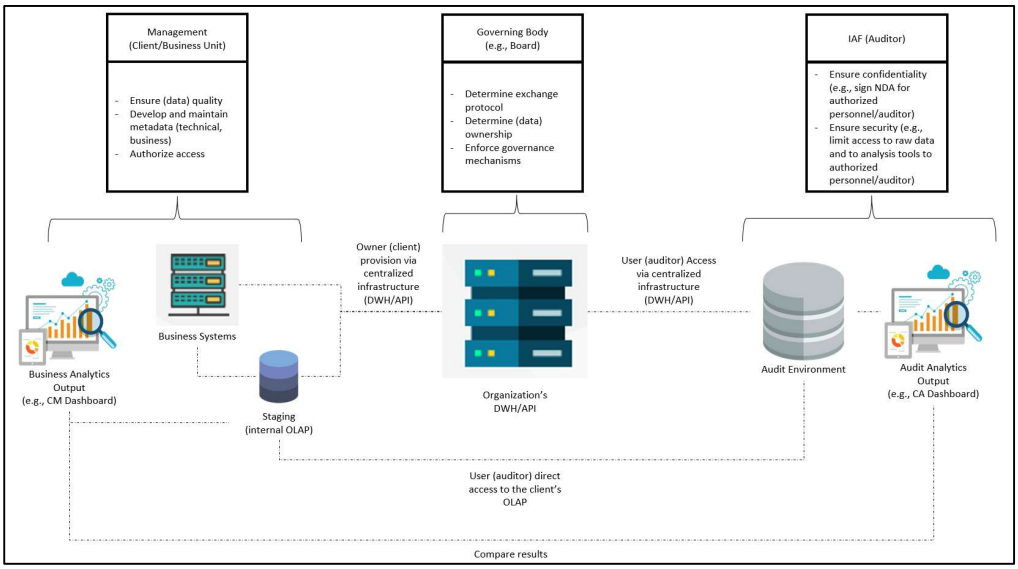

Figure 33. Visualization of Shared Platform and the Associated Roles

The participants indicated that applying this principle (and combining it with principle #2) directly targets overcoming infrastructure issues, in addition to data-related issues, as elaborated previously. First, it is crucial for analytics projects for the real-time or near real-time data access and output or reliable processing capability requirements, as R9 and R17 remarked,

> *"[…] We need bigger infrastructure with faster processing speed […]", "[…] currently, we still have some problems with our analytics infrastructure [namely, data-mart]; some scripts were error during the execution, and some processes consumed too much time, lagging the audit team; for example, R9 told me this issue [in his project]".*

Secondly, a proper infrastructure is critical for securing the AA project (e.g., to ensure the results are valid and free from unauthorized intervention from the IT operation unit). This notion also caters for the clients' or data owners' concerns regarding data security or confidentiality, as R5, one of the participants from the client side, stated,

> *"[…] from a security perspective, data exchange [for AA purposes] should be fine since we use internal network […]".*

Moreover, the practice from the case study also implies that this principle affects all stages of AA, from the general planning to follow-up and the subsequent iteration (if any). At the technical layer, the data analysis tool is vital for project development (i.e., the detailed planning stage, where the auditor translates the audit testing procedure into data analysis syntax). Subsequently, the execution of the developed syntax heavily relies on the reliability of the data processing tool (including its hardware capacity and considering other business processes that simultaneously run on the system). These technical layers significantly influence the project output. Furthermore, at the strategic layer, the visualization tool supports the necessary output development (e.g., a dashboard for the board of the organization that recaps the results of various AA projects), which, in turn, affects the general planning, such as the prioritized area based on the previous period's internal audit results.

The AA field literature highlights the importance of system architecture for AA (Alles et al. 2009). Further, the practical experience mentioned in the literature supports the necessity of dedicated infrastructure for AA purposes (Codesso et al., 2020). However, the IAF must be mindful of the integrity of its AA projects and results placed in shared IT infrastructure (Alles et al., 2009). The case study further exemplifies how to deal with this concern by incorporating the need to review the organization's data governance practices in addition to the safeguards in AA's practical guidelines (refer to Table 29).

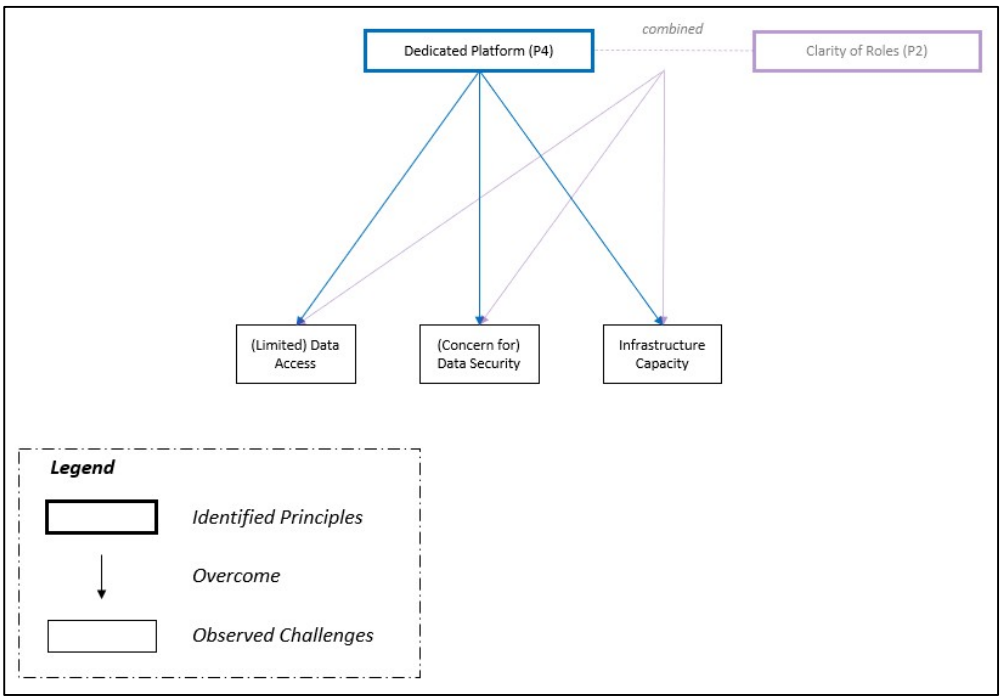

Figure 34. Visualized Summary of the "Dedicated Platform" Principle

7.3. Conclusions

The limited AA implementation indicates the need for a prescriptive 'theory' to foster AA implementation. Unfortunately, literature in this field lacks such research. There are only unpublished works on principles and problems related explicitly to CA adoption (Alles et al., 2008, 2009).

Therefore, this research answers this call. For that purpose, this chapter extracts the relationships among the challenges and the principles from the in-depth investigation of the case study. The case study informs the challenges that occur in AA projects and AA implementation in general and how the participants (the audit team, the IAF, or the organization) respond to those challenges, which hints at the implementation principles in the case study. The summary of the principles is presented in Table 30.

Table 30. Summary of the Principles

ID	Name	Short Name	Description
P1	Audit Analytics (AA) is a whole-of-organization effort instead of ad hoc and series technical projects by IAF.	Integrated System View	**Statement**: AA implementation involves various parts of the organization; thus, should be treated accordingly. **Rationale:** It requires adjustment to all facets of internal audit activities (practices, actors and structures, and values) which implicates to all elements of the organization. **Implication**: AA needs action involving all elements of the organization. **Level of Application:** - Organization (AA implementation strategy) **Addressed challenges:** Organizational awareness (cultural barrier); data-related issues (security, access); infrastructure issues; organizational dynamics (conflicting interests, dynamic in audit process); AA-related skills; and AA Use-Case. **Example(s):** Implementation strategy incorporating all relevant actors and their roles and responsibilities, including long and short-term targets.
P2	Clarity of roles and responsibilities of each actor involved in AA implementation.	Clarity of Roles	**Statement**: A set of processes, responsibilities, and authorities to handle tasks related to AA use in internal audit activities. **Rationale:** AA changes how internal audit activities being carried out, introducing new task with new responsibilities. **Implication**: Clear definition of roles and responsibilities for all relevant actors involved in AA implementation and use in internal audit activities. **Level of Application:**

ID	Name	Short Name	Description
			- Organization (Internal Audit Practice Guideline, including role adjustment and safeguard) - Project (all stages, from general planning to the follow-up) **Addressed challenges:** Organizational dynamics (conflicting interests, dynamic in audit process); change in audit dynamics and values (independence impairment; inadequate standards). **Example(s):** AA practical guideline/protocol; data governance guidelines.
P3	Collaboration among actors involved in AA implementation. The IAF can make use of a dedicated team/unit to foster the collaboration.	Collaboration	**Statement:** Mutual interaction among parties with the focus to provide value for the organization and benefit each involved actor. It can use a designated role to coordinate the collaboration among actors or AA purposes. **Rationale:** AA involves various actors with different focuses and interests. **Implication**: Development of formal and informal interaction mechanisms for AA implementation purposes. **Level of Application:** - Organization (AA Implementation Strategy, Coordinating Unit's role) - Project (all stages, from general planning to the follow-up and the possible iterations) **Addressed challenges:** Organizational awareness (cultural barrier); data-related issues (access); infrastructure issues; organizational dynamics (conflicting interests); AA-related skills; and AA Use-Case. **Example(s):** Dedicated R&D team for coordinating role, devising formal and informal coordination mechanisms.
P4	Dedicated platform, including infrastructures and tools (both software and hardware), that facilitates data exchange for AA purposes.	Dedicated Platform	**Statement:** Organization infrastructure dedicated to facilitating data exchange and analysis for AA and general purposes. **Rationale:** AA requires various data access types, with possible overlap with business needs. **Implication**: Data exchange and analysis platform that satisfy the need of auditors, data owners, and supporting unit in terms of quality, availability, and security. **Level of Application:** - Organization (Shared/interconnected infrastructure) - Project (all stages, from general planning to the follow-up) **Addressed challenges:**

ID	Name	Short Name	Description
			Data-related issues (security, access); infrastructure issues. **Example(s):** Organization's infrastructure, incorporating: - Data warehouse facilitating data exchange for business/operational and audit activities, - Data analysis and visualization tools, can be embedded in the database or using specialized tools.

These principles and the practical translations were identified from the case study in a government agency. Hence, the presented practical translations of the principles from the case study may make it appear that the principles have been turned into bureaucratization. Nevertheless, these principles should be adapted to the specific context rather than directly replicating the case study, and the practical example from the case should not detract from the fundamental transformation idea of the principles and convert them into mere bureaucratic measures. Therefore, it is crucial to consider the normative nature of the principle as means-end knowledge that can be translated differently in different contexts. Furthermore, it is also important to acknowledge the possible contingencies or caveats of the principles (and the exemplifying practices) as shown in the case study analysis and results.

Finally, the resulting framework expands the extant literature and highlights AA implementation as a digital transformation endeavour which transcends the IAF and reaches the broader organization (to which IAF belongs). This notion acknowledges the interactions between IAF and its stakeholders in the organization as a complex system, which further expands the existing discourses in IAF and AA-related field. Additionally, the case study also offers nuances on the existing knowledge pertinent to AA, like the importance of AA managerial skills, in addition to AA-technical skills. Nevertheless, this result is based on the qualitative analysis of the collected data in the case study. Therefore, it needs to be tested to ensure the external validity of the result and assess its generalizability. Considering the context of the case study in which this result is derived, the evaluation of the proposed framework will be presented in the next chapter of this dissertation.

Part IV: Framework Evaluation

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Chapter 8 –Evaluation of the Framework

The preceding chapter proposes a framework for AA implementation that connects the principles and the challenges. Chapter 7 constructs from the framework's antecedents laid out throughout the preceding chapters of this dissertation, i.e., the challenges, their taxonomy and relationships, and the principles identified from the case study.

This chapter evaluates the proposed framework using informed arguments from internal and external actors. This analysis answers the last research question: *How do the proposed principles address the challenges to fostering the AA implementation by IAF?* The answer to this (research) question informs the quality of the proposed framework (i.e., the principles and the associated challenges), like its relevance, completeness, and practical value to assist AA implementation by IAF. This chapter is a part of the article titled "Principle-based Framework for Audit Analytics Implementation" by Ramadhan, Janssen, and van der Voort, which is ready for submission to the relevant journal, and "More Than Just a Project! Guidelines for Transforming Audit Analytics in Action" by Ramadhan, Janssen, and Wahana, which is currently uder review.

This chapter first describes the evaluation approach, including the design and data collection process, followed by the detailed evaluation results. The results are summarized in the next section and concluded in the final section of this chapter.

8.1. Evaluation Approach

8.1.1. Evaluation Design

The final facet of this research was to evaluate the developed principles. The evaluation aims to assess the framework's relevance in representing the real-world aspects (in this context, of AA implementation by IAF) accurately and comprehensively. Therefore, the evaluation should address whether the proposed framework sufficiently captures aspects (e.g., condition, action, issues) critical to the real-world phenomena being investigated, i.e., AA implementation by IAF. The extant literature provides numerous references for evaluating a model as a conceptual representation of real-world phenomena. In particular, two main focus areas are found in these discourses, i.e., the quality of the 'product' (i.e., the model/framework) and the robustness of the process in developing the model/framework (Nelson et al., 2012, p. 202). The two seminal tools from each camp are Lindland, Sindre, and Sølvberg (LSS) and Bunge–Wand–Weber representational model (or BWW) (Lindland et al., 1994; Wand & Weber, 1990; in Nelson et al. 2012, p. 202). The LSS is a framework that focuses on the output, whereas BWW focuses on the process of developing the output.

We follow Nelson et al. (2012) who synthesized and combined both frameworks to develop the Conceptual Model Quality Framework (CMQF), incorporating the strengths of LSS and BWW to establish a comprehensive approach to evaluate both the process and the output. The synthesized framework primarily

concerns reality (physical and social) and its abstraction (knowledge). This approach is relevant for this study as a tool to evaluate a conceptual model. In particular, this approach evaluates how this study comes up with the framework and how the framework reflects the real-world phenomena of AA implementation and addresses the issues related to AA implementation. CMQF consists of several relevant elements, from the physical domain as the real-world representation of the phenomena to the representation knowledge as the stakeholders' comprehension of the model and how it will be applied. The summary of the elements of CMQF is presented in the table 31 below, with the elaboration on each elements is presented afterwards. Subsequently, this research synthesized and combined some overlapping CMQF's elements to evaluate the proposed initial principle-based framework (see Figure 35).

Table 31. Synthesized Elements of CMQF for This Study's Framework Evaluation

Element	Description	Evaluation Focus
Physical Domain	Real-world phenomena of interest	Relevance, Completeness
Domain Knowledge	Stakeholders' understanding of the domain	Accuracy, Consistency, Practical Value
Physical Model	Ontological constructs representing the domain	Ontological Clarity, Appropriateness, Goal Alignment
Model Knowledge	Cognitive understanding of the model by stakeholders	Alignment, Depth of Understanding
Physical Language	Grammar and Vocabulary for expressing the model	Syntactic Correctness, Expressiveness
Language Knowledge	Stakeholders' understanding of the modelling language	Application Accuracy
Physical Representation	Formalized Models or Diagrams	Representation's Clarity, Practical Usability
Representation Knowledge	Stakeholders' interpretation of the representations	Pragmatic Clarity, Social Consensus

The synthesized attributes align with the importance of multiple quality dimensions of a model (or framework), i.e., the model's correctness, completeness, clarity in representing real-world phenomena, and empirical value (Evermann, 2005; Gemino & Wand, 2005; Moody & Shanks, 2003). Nevertheless, there are also caveats in using the established reference for evaluating a model as a representation of real-world phenomena. First, Moody & Shanks (2003) and Evermann (2005) are

concerned with the subjectivity and cognitive load in comprehending the phenomena and their presentation in the model, which is often heavily simplified, and its implication in the usability of the model. Second, the evaluation framework assumes the consistency of the phenomena and, thus, the static representation of the phenomena in the developed model. In light of this, Evermann (2005) and Gemino and Wands (2005) underscore the need for flexibility and the dynamic representation of the model. While this notion is at odds with thoroughness as required in the CMQF, it may enhance the model's usability.

Furthermore, particularly pertinent to this research, the concept (CMQF) mainly focuses on the quality of modelling software development. However, some of its elements address the practical value of the model being explored, like how the model addresses stakeholders' needs. Hence, in the context of this study, which primarily aims at the framework's appropriateness in representing an idealized AA implementation and its value in fostering AA implementation, the use of CMQF will benefit from some adjustments.

With these considerations, this study adapted the CMQF to evaluate the proposed framework or AA implementation and its elements, i.e., the principles and the associated challenges. The quality attributes in CMQF encompass both the 'process' in model development and the 'product', i.e., the developed model. These notions evaluate how well the model (i.e., the proposed framework of AA implementation) captures the real-world socio-technical complexities of the phenomena, or the 'input', and how well the model is well understood by its stakeholders or users, or the 'output'. Additionally, this study is concerned with how well the model achieves its objective, which is to foster AA implementation by IAF. Inspired by CMQF and aligned with the study objective, this research synthesized a structured paradigm to evaluate the proposed framework, as visualized in the figure below.

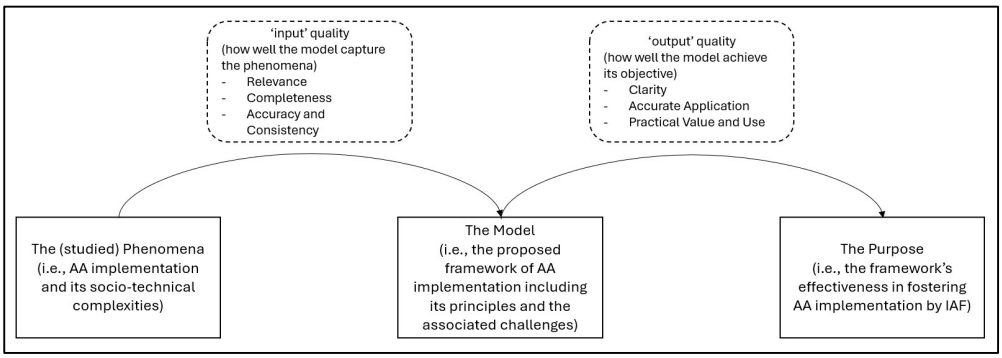

Figure 35. Synthesized Paradigm for Framework Evaluation

The evaluation was performed on two groups of respondents. First, group interviews were conducted with the respondents from the case study, i.e., some of those who were already interviewed for the previous phase of this study, including

representatives from the innovation/coordinating unit, internal audit teams, and IT units. This part aims to confirm the observations from the case study. Secondly, the evaluation was also performed through individual interviews with professionals from diverse organizations and industries in the broader internal audit community. This part aims to calibrate the findings and further capture the similar and different experiences of internal audit professionals in various organizations from the same setting with the case study (i.e., internal audit function in Indonesia).

The first part of the evaluation is the confirmation of the developed framework to the case study participants. This part aimed at obtaining feedback from the direct actors (in which the framework was developed) regarding their understanding of the framework and their views on the relevance, coherence, and practical value of the proposed principles (in fostering AA implementation and addressing the associated challenges). Therefore, in this part, practitioners from the MOFIG (as the case study setting) were invited as the respondents. The use of group interviews helps to minimize the risk of bias from the respondents (interviewees) since the interviews were performed directly with all respondents from various units at once. This approach allowed for 'triangulation' of the response from each actor from different units (with different focuses and interests). While they generally approved the initial framework, the internal confirmation also provided some additional insights to enrich the study result further (will be elaborated further in Sections 8.2. and 8.3.).

Nevertheless, the internal confirmation may still be prone to respondents' bias since the proposed framework is based on their experience. Therefore, this research calibrated the evaluation through interviews with external practitioners. This approach not only ensured the relevance and coherence of the principles but also assessed the applicability of the framework (the principles) as they were "tested" to external actors as the indirect stakeholders (who were not directly involved in the development of the framework). For this purpose, this study interviews practitioners from diverse industries with experience in AA implementation in their organizations.

This combination of represented a calibrated informed arguments approach to evaluate the artefacts as the result of a research project (Kogan et al., 2019). This method supports the 'accuracy' of analysis through confirmation with the case study participants (to which their inputs were used to develop the framework) and the 'effectiveness' of the framework through evaluation by external practitioners (who were not involved in the case study) based on their experience and expertise. This approach, albeit with a different evaluation paradigm, was exemplified in other studies in this field (e.g., No et al., 2019) or in the broader field (e.g., Klievink & Janssen, 2009). In addition to the approach mentioned in Chapter 3 regarding ethical issues, the evaluation might risk an additional issue in terms of respondents' bias by providing answers to please the interviewer or researcher. To mitigate this risk, this research employed several approaches, such as indirect questioning through the use of scenario-based questions and including disconfirmation, and probing through follow-up questions and asking for examples based on their experience (Bergen & Labonté, 2020). Moreover, combining internal and external actors' views further

mitigates the risk of bias from both the researcher and the participants in assessing the developed framework.

However, in addition to the risk of bias discussed earlier in this section, this study acknowledges the possible limitations of this approach in evaluating the developed framework. Internal confirmation and external evaluation assess the framework based on the respondents' experience instead of directly testing the framework. The experimental design might be considered the most robust approach to testing a model. However, its usage in this research context might be impractical. First, it is difficult to randomly assign the treatment (i.e., the principles) to various IAFs and compare the result with the control group (non-treated IAFs), as it interferes with their policies and procedures. Secondly, designing the experiment is challenging (at the beginning of the research) as the principles will be developed from the case study performed later in this research. Moreover, the complexities of AA implementation, the associated challenges, and the principles to address the challenges are too convoluted to be tested through an experiment, considering the limited time and resources. Thirdly, social theory is difficult to falsify (Wallis, 2008), in which the experiment is mainly aimed at doing so. Therefore, Wallis (2008) further suggests that falsification is less suitable for social theory. Finally, the nature of this research as a means-end knowledge is not always suitable for falsification, to which an experiment is typically aimed (see also Chapter 2, Section 2.3.). Therefore, for the context of this study, confirmations and evaluations with the internal and external practitioners are considered sufficient to examine the framework (the principles and their associated challenges) as a means-end knowledge.

8.1.2. Evaluation Process

Evaluation processes were conducted simultaneously with internal and external practitioners, depending on their availability. The first one was conducted through group interviews with practitioners from organizations (the IAF), in which the case study was performed (auditors and employees from the MOFIG). This part clarified the notions apprehended from the case study to develop the framework. The other part was interviews with external practitioners, i.e., internal auditors experienced in AA implementation from outside the organization where the case study setting in which framework was developed. This part affirmed or negated the notions presented in the proposed framework. Nevertheless, this step removed (or at least reduced) possible bias in this evaluation through an assessment of the framework by actors who were uninvolved in the development of the proposed framework.

The confirmation of the framework was performed by presenting the developed framework to the case study participants to obtain their views. The first step was a brief overview of the research processes, including the case study's relationship with other parts of the research. Subsequently, the researcher presented the framework, i.e., the framework overview, detailed principles, and their relationships with the challenges. Afterwards, the discussion was held, and the case study participants were invited to clarify, comment, ask, or criticize the proposed framework. In addition to clarifying the notions obtained from the case study to develop the framework, the group interviews aimed to elucidate the stakeholders'

understanding of the framework's concept and application and the principles' (or its practical translations') roles in fostering AA implementation.

The interviews with internal practitioners were performed as a group interview, based on the request of the participants, which was held in May 2024. Eleven participants joined the group interviews, including representatives of the audit team, innovation unit, and IT division (hereafter mentioned with the prefix 'F' in the later presentation of this dissertation). These participants represent actors (personnel and units) involved in AA implementation in the MOFIG and contribute to the case study phase of this research (which results in the proposed framework). This selection also included key personnel from the innovation (or coordinating) unit, which acts as the pivot for AA implementation in the MOFIG, representations from the audit team as the main actor in the AA project, and the IT division, which works closely with the innovation unit and audit team in developing AA projects. The initial framework for discussion was delivered to the liaison officer and disseminated to the participants before the event. After the event, the summary, including its conclusions, was provided for confirmation, and their response was optional, depending on whether they had an objection.

Meanwhile, the interviews with external actors (hereafter mentioned with the prefix 'E' in the later presentation of this part) were targeted to calibrate the group interview results in general and model knowledge and representation knowledge elements in particular. In addition, the interviews were also aimed at evaluating the framework's applicability to foster AA implementation and address its challenges. For these purposes, the interviews with the external practitioners consisted of three parts. The first part is scenario-based questions, in which the participants were asked their decision regarding AA use or implementation considering the stated circumstances. The scenarios included circumstances with which the principles are applied and not applied. The second part is open questions about the participants' opinions regarding the principles. The last part is open questions about the participants' views related to the connection between the principles and the challenges. The last part is optional, with consideration of the participants' answers for the previous parts.

Before being utilized to interview the external practitioners, the instruments (interview guiding scenarios and questions) were piloted to four (pilot) participants with knowledge and understanding of the matter. The pilots were performed in December 2023. The table below presents the demographics of the (pilot) participants.

Table 32. Demographics of Pilot Participants for Framework Evaluation

Category	Group	#
Participants' Location	The Netherlands	1
	Indonesia	3
Instruments' Language	Bilingual (Indonesian and English)	4
Occupation	Accounting/Auditing Lecturer	1
	Accounting/Auditing Master Student	1

	IT Audit Practitioner	1
	Academics (Researcher or PhD candidate)	1
Qualification	Knowledgeable in internal audit field	3
	Knowledgeable in IT or IT-related audit	2[27]

Interviews with external practitioners were performed using the final instruments[28], incorporating the feedback from the piloting. Nevertheless, similar to the interview for the case study part, the actual interview sessions may be modified depending on dynamics and the flow of the session, so long the objective to obtain their opinion on the framework is met (DiCicco-Bloom & Crabtree, 2006; Saunders et al., 2016). The summaries of the interview transcripts were sent to the participants, who were asked for their 'negative confirmation', i.e., they did not have to respond unless they wanted to or had some corrections to the presented summary.

The interviews spanned from December 2023 to May 2024. Eight practitioners from diverse backgrounds and industries participated in this part of the research. The demographic profile of external interviewees is presented in Table 33.

Table 33. Demographic Profile of External Practitioners

Category	Group	Number of Respondents
Sector	Government	3
	Non-government Public Sector	2
	Private Sector	3
Industry	Government agency	3
	Fintech	1
	Bank	3
	Logistic	1
Internal Audit Experience	> 15 years	1
	11-15 years	3
	1-10 years	3
	N/A (non-auditor)	1
AA-related project	> 4 projects	4
	1-3 projects	4
Gender	Male	7
	Female	1

8.2. Evaluation Results

This study confronts the developed framework (from the case study) with the synthesized quality attributes of a framework based on CMQF as elaborated on in the previous section of this chapter. This analysis was performed by comparing the frameworks' content (i.e., the principles and their relationships with the challenges)

[27] One participant was knowledgeable in both domains.
[28] Refer to Appendix for the instrument.

and process (in developing it) with the selected attributes like "Relevance" or "Completeness" from the 'input' side of the framework and "Clarity" or "Practical Usability" from the 'output' side of the framework (see Section 8.1.).

The proposed framework concerns AA implementation by IAF. In the context of this study, AA incorporates the use of IT to analyze and evaluate digital data to perform internal audit tasks and to further the mission of the IAF to provide value for its stakeholders. Meanwhile, IAF is a function within the organization that aims to provide independent and objective assurance and advisory services to improve the organization's governance, risk management, and internal control. This notion sets the context and scope of the evaluated framework as a basis to assess how well the proposed framework fosters AA implementation and addresses the associated socio-complexities and intertwined challenges.

8.2.1. Evaluation of the 'Input' Quality Attributes

The first part of the evaluation concerns how well the framework captures the phenomena, i.e., AA implementation and its socio-technical complexities and intertwined challenges.

1. **Relevance**

   Nelson et al. (2011, p. 209) argue that a model should emphasize aspects that matter to the problem(s) at hand for the users (of the model) and disregard other details with less relevance. Therefore, "Relevance" pertains to the ability of the model to encapsulate the essence of the real-world phenomena that suit stakeholders' concerns.

   The proposed framework aims to guide AA implementation. Nevertheless, the review of the literature suggests that it is encroached by complex and intertwined challenges inhibiting the implementation effort (Austin et al., 2018; Chaqiqi & Nugroho, 2021; de Freitas et al., 2020; Haynes & Li, 2016). Moreover, contemporary discourses on AA implementation indicate its transformative nature, i.e., AA implementation implicates the adjustment of all facets of internal audit activities and even transcends to the broader organization (instead of only affecting the IAF) (Joshi & Marthandan 2020; Ramadhan et al. 2023a).

   In response, the framework consists of principles to overcome the critical challenges inhibiting AA implementation efforts. For instance, the "Integrated System View" targets foundational challenges, i.e., the challenges with a strong driving power which influence other challenges, like cultural barrier and data security concerns (see also Chapter 4.4.). Other principles like "Collaboration" and "Dedicated Platform" address technical challenges that directly influence AA use in internal audit tasks, such as data access issues and limited auditors' AA-related skills (idem). The principles also cover issues to tackle the changes in roles and responsibilities affected by the use of AA in internal audit tasks, which implies the framework's acknowledgement of transformative characteristics of AA implementation. Therefore, these notions indicate the relevance of the proposed framework as it aims to address the challenges and incorporates all facets of

internal audit tasks, reflecting AA as a digital transformation for IAF and the organization.

The internal practitioners admitted the framework's relevance. For instance, one of the framework's premises is that AA implementation encounters many interconnected challenges, which the internal practitioners agree with. For instance, F6, one of the group interview participants from the IT unit, stated (although in the form of a clarifying question) that,

> *"[…] CA [continuous auditing, as a subset of AA] implementation faced a multitude of challenges; hence, one of our responses is to endorse and support the development of clients' CM […]".*

Another participant, F7, highlighted the criticality of mindset and its influence on many other challenges, which in turn hinder AA implementation, aligning with one of this study's findings as the basis for the framework. He/she stated,

> *"We realize that awareness from all parts of the organization is critical for this initiative. […] common culture of risk awareness from our clients and us [auditors] is essential to have a shared needs of CA-CM […]".*

Further, F9 affirmed the inherent entanglement between "Clarity of Roles" and "Collaboration" principles,

> *"We agree that AA implementation facets must be supported by clear regulation. For instance, we already have regulations regarding data access. However, we realize that data owners may perceive that the regulation only caters for our [auditors'] concerns. Hence, we should acknowledge their [data owners, business managers] perspectives and incorporate those perspectives into the regulatory framework so that they will feel included […]".*

The framework's notions (and its implications) were not only affirmed by internal practitioners (who were indirectly involved in the case study) but also asserted by external professionals. For example, E5, an external practitioner from the private sector in the banking industry assented that cultural barrier poses fundamental challenges as it influences many other challenges and hinders AA implementation,

> *"The main problem is about mindset [which inhibits this initiative]".*

Moreover, E2 and E3, external practitioners from government agencies acknowledged the insufficiency of relying on regulatory measures, and thus, requires collaboration, as acknowledged in the framework. He/she stated,

> *"We [internal audit] may have a formal authority, like in the form of an audit charter, but it may not always be sufficient to perform our tasks effectively; we ought to build good relationships and communication with our counterparts, including audit clients or data owners".*

The framework's development, which is built on the challenges around AA implementation, indicates its relevance. Moreover, these excerpts from the evaluation further confirm the relevance of the framework. It aligns with the

notions contained in the framework, from the initial premise, i.e., that AA implementation encounters multiple interconnected challenges, the criticality of mindset issues as one of the fundamental challenges, the entanglement among principles, to the background and consideration of the principles and the connection among those principles.

2. Completeness

A model should capture all aspects of the matter (Lindland et al. 1994 in Nelson et al. 2011, p.210). This attribute reflects the model's completeness, which, in the context of this study, is accomplished if the proposed framework comprehensively addresses the real-world phenomena associated with the matter being studied, i.e., AA implementation by IAF and its complex interconnected challenges.

The proposed framework was developed from the case study, which encounters several challenges and responds to those challenges, from which the principles are derived. The challenges mentioned (and addressed) in the case study align with the challenges identified from the literature and refined by practitioners' opinions (see Chapter 4.1.3.). These notions hint at the framework's quality of this attribute.

Nevertheless, the case study only encounters some of the challenges that considered consequential by practitioners instead of all of the initially identified challenges from the literature (refer to Chapter 4.1.2.). Consequently, this study focuses on the most significant challenges encountered in the case (which also aligns with the MICMAC-ISM analysis). While it can be argued that based on the case study's circumstance, those omitted challenges are less critical, future advancement of the field may require academics and practitioners to take those omitted challenges into account. For instance, while the case study respondents omit the risk of counter-analytics as they argue that it currently poses minor threats, the future development of AA and the advancement of AI may render the risks of counter-analytics more prevalent. Therefore, future studies should attempt to obtain a relevant principle (or principles) to address these omitted issues; either an enhancement to the current principles or a new principle is needed.

Similarly, the case study and MICMAC-ISM respondents consider the risks related to the compatibility or interoperability among various formats of data and technology as negligible. However, the evaluation respondents suggested that future compatibility should be an additional criterion for the fourth principle to keep up with possible technological advancements in the future. Analysis from group interviews exemplifies this notion. For instance, F11, a participant from the IT unit, highlighted the possibility of keeping up with future technological advancements and ensuring compatibility. He/she asserted that,

> *"We know that IT is progressing very rapidly; many new technologies are available and may disrupt our digitalization. I suggest we need to anticipate this issue".*

Initially, this study recognizes the possible problem caused by varying infrastructure and data format as suggested in the extant literature (Gambetta et al. 2016, Cardoni et al. 2020). However, this challenge was excluded based on the

MICMAC-ISM and case study analyses. F11's remark hinted at the possible future limitation of the framework in terms of completeness. Hence, he/she and F7, another participant from the audit team, further suggested additional details about the principle, such as the parameter or indicator for the "Dedicated Platform" principle, which includes compatibility, in addition to integrity and reliability.

Most interviewees (internal and external) admitted the framework's coverage in AA implementation. For instance, F2, a manager from internal practitioners, stated that,

> *"We appreciate that [the proposed framework as an academic work] has been presented in business language [and incorporated important elements of this AA implementation effort]".*

Moreover, E2, an external practitioner from a government institution, explicitly shared his/her view regarding the proposed framework,

> *"I think these are ideal principles, encompassing all important elements including people, process, and technology […] this framework is, in my opinion, highly useful for us, practitioners considering that we often have to deal with dynamics in our real-world challenges in many different ways, and with these principles in mind, help us to navigate throughout the quandary of AA implementation effort".*

However, some interviewees provided suggestions that may enrich the framework. For example, F5 and F6 suggested detailing the principles to include indicators which inform the principles' internalization,

> *"We wonder if there are indicators or parameters of these principles. So that we know how much we have applied those principles".*

Further, F4 asked about the identification or possibility of a sequence of principles' use, which, to some extent, aligns with the suggestion from E2, one of the external interviewees who suggested quick wins strategy as a part of the principle,

> *"Will this framework be equipped with some kind of success factors which support its application?"*,

and

> *"[…] as practitioners, we occupied with technical matters in the field, so I think it will be beneficial if [this framework is] incorporates strategies like quick-wins, like showcasing a project to highlight its value for our stakeholders; therefore, this framework is, in my opinion, highly useful for us, practitioners considering that we often have to deal with dynamics in our real-world challenges in many different ways ".*

F6 also invoked the connectivity with other frameworks based on his/her experience, which is familiar with maturity-level frameworks

"We are familiar with maturity level framework[29]; how does this framework connect with other frameworks that utilize maturity level?"

Confirmation with the case study participants and external professionals highlighted some positive aspects of the proposed framework, along with some possible improvements regarding its completeness. First, the framework developed based on the case study encompasses the most pressing challenges encountered, resulting in the most relevant framework for the case study context (as discussed earlier). Nevertheless, some omitted challenges may be relevant for other circumstances, like technology compatibility issues or risk of counter-analytics, which may implicate framework extension (e.g., additional principle or additional detail of the principle). Third, aligned with the previous notion, the internal and external interviewees suggested some finer details, like in the form of principles' indicators or process guidelines to support the framework's application.

3. Accuracy and Consistency

These attributes pertain to the framework's accuracy in capturing the complexities and nuances of the matter being explored and maintaining consistency in its representation (Nelson et al., 2011). Hence, this evaluation of the framework targets elaboration on both the accuracy and consistency of the framework (i.e., the principles and challenges) in capturing the essence of AA implementation by IAF.

The framework was developed based on the experience of the organization as the case study setting (through its personnel as the case study participants). Nevertheless, it also referred to the conceptual foundations built from the extant literature. For instance, the framework focuses on AA as the analysis of digital data using IT to improve the mission of IAF, as suggested by academic and professional literature (e.g., Lambrecht et al. 2011). It also acknowledges the challenges identified in the existing discourses in AA-related research, which were refined based on practitioners' experience. This approach partially demonstrates the framework's coverage of the problem's complexities and nuances, particularly in the challenges part (of the framework).

Further, consistency element requires that the principles maintain coherence and uniformity throughout the framework. The proposed framework maintains this aspect by using a standardized approach to describe and elaborate on the principles, including their connection with the challenges. In this regard, the use of TOGAF's elements (TOGAF, 2018), like statement, rationale, and implications, with the addition of challenges addressed and examples from the case study, support the consistency of the principles' presentation in this framework (see Chapter 2.3.).

[29] The case study object (the MOFIG) uses a maturity-level framework in many areas, like IT and data governance.

The case study participants embraced the framework, which was developed as 'lessons learned' from their experiences. F2, a manager from the internal (group) interviews, opened up his/her comment by stating that,

> *"We appreciate that [the proposed framework as an academic work] has been presented in business language [and incorporated important elements of this AA implementation effort]",*

which indicated the framework's relevance as well as accuracy.

Further, interviews with external professionals revealed that they encounter challenges incorporated into the framework. For instance, "Cultural barrier" issues both from the stakeholders' side, like clients' reluctance to assist with IAF's task and from the auditors' side, like auditors' hesitant to embrace new approaches, not only ensued in government institutions (in which the case study was performed) but also in other industries like fintech, logistics, and banking, as mentioned by E4, E6, and E7. E4, for example, stated that,

> *"auditors' traditional view in approaching internal audit tasks will limit the IAF's ability to perform CA"*,

and

> *"clients' understanding regarding auditors varies […] some still perceived that auditors' [only] disturbed their tasks, like when auditors' request data access for [audit] projects"*,

which is accurately represented in the framework as one of the critical challenges.

Interviewed participants also agreed that the principles have sufficiently encapsulated the practices they perform or consider performing and the circumstances in addressing those challenges. For instance, E7 and E8, internal auditor and risk management officer from banking institutions, highlighted their experience in the importance of collaboration in developing AA projects. E7 exemplified his/her experience,

> *"We developed AA projects not only for our [internal auditors'] tasks, but we also collaborated to develop features/menus for the clients, so that they feel significantly aided in their tasks as well […] our menus differ with menus provided for them, for instance, we focused on control effectiveness, while they [the clients] focused, for example, on the prognosis of their performance".*

These notions affirm the framework's accuracy in capturing the complexities and nuance of AA implementation. They further argued that this practice not only improves acceptance from the counterparts (e.g., clients, data owners) but also enriches the value of the project for the organization, which in turn further increases stakeholders' support for IAF in general and AA implementation in particular. This latter notion aligns with the framework's practical value, which will be discussed in the next section.

The framework was built on the existing discourses in the literature and refined based on real-world experiences. This approach supports the framework's ability to grasp AA implementation's nuances and complexities while maintaining its commonly known and simplified terminologies. Further, feedback from internal and external practitioners demonstrated the framework's accurate

representation of the phenomena and consistent presentation. These notions indicate the framework's accuracy and consistency both from the process aspect and product perspective (as suggested by Lindland et al. 1994 and Wand and Weber 1990 in Nelson et al. 2011, p.202).

8.2.2. Evaluation of the 'Output' Quality Attributes

The next part of the evaluation focuses on how likely the framework serves its purpose. Therefore, this part aims to ensure the proposed framework's clarity, suitability of representation and application, and eventually, the framework's alignment with its objective (i.e., to foster AA implementation by IAF).

1. **Clarity and Appropriateness**

   The framework's clarity is derived from its appropriateness in representing the socio-technical aspect of the problem in the model so that the model can be effectively communicated to the users. The proposed framework uses TOGAF's format to communicate the principles as the central element of the framework and associate them with the challenges it addresses. This standardized format enables precise articulation of the principles, enhancing their clarity and facilitating their application. Moreover, considering TOGAF is a well-known framework for representing architectural design in business and IT-related fields, its use facilitates a common understanding among users.

   The proposed framework comprises four principles targeting ten key challenges of AA implementation, which are associated with facets of AA implementation, such as AA type (e.g., CA or predictive analytics), internal audit task format (i.e., assurance or advisory), or data requirement (e.g., batch, continuous). Hence, this implies that the framework partially adheres to this quality attribute of clarity and appropriateness. However, while this representation (i.e., the principles and the related challenges) captures essential notions of AA implementation, the framework does not present its elements in association with each step of internal audit activities.

   Therefore, this study presented the proposed framework to the case study participants and external actors and obtained their views to evaluate the framework's clarity and appropriateness. This approach acknowledges the potential subjectivity in the framework development from its stakeholders and contributes to ensuring the "clarity" in a model as suggested by Moody and Shanks (2003, pp. 637-638).

   Internal and external practitioners who participated in the evaluation asserted the framework's general clarity. For example, F2, interview participants from the internal group, opened his/her remark with appreciation of the framework's presentation in the business language, which is easily understood. Furthermore, E6, an internal auditor from a logistic company as one of the external practitioners interviewed, admitted that,

"Based on my understanding of these principles, these all apply and reflect my experience and are relevant for embracing AA in our (internal audit) tasks".

Similarly, E3, an internal auditor from government institutions as another external practitioner, shared the same sentiment,

"*These principles are presented in a high-level language so that they can be applied to many different technical practices".*

Nevertheless, these interviews also bring additional insights to clarify some terminologies used in the framework. For instance, E2 and E3 underlined the use of "ad-hoc" and "technical projects" as the opposite of the notions encapsulated in principle and suggested an alternative,

"I think the first principle should focus on the comparison between holistic view against silos perspectives, instead of holistic view against technical projects".

Additionally, disentanglement from the steps of internal audit activities implies some notions are possibly absent from the principles. It might not necessarily be an additional principle but can also be another element of the principle. For instance, F2 asked about a possible principle or an element of the principle to ensure AA project continuity,

"I wonder if there is any part of this framework that addresses cases like some anomalies resulted from established AA projects are not followed up due to its absence from this year's audit plan",

to which F1 and F8 inspired possible activities as a project preparation and where they fit in the framework,

"Is there any principle or part of the principle to accommodate mapping of the digitalized audit universe? So that we [internal auditors] can determine areas to be focused for AA project",

which, subsequently, F1 acknowledged and expanded upon F8's statement.

"I agree with [F8] suggestion, and to add to that notion, we can add activities to determine the level in our enterprise architecture as the basis for potential [audit] areas for the AA project."

While these latter suggestions were insightful, for the context of this study, these additional insights might be too specific and attached to the milieu of the practitioners' organization. Therefore, the inclusion of these additions is fruitful for further examination in future research.

The practitioners who participated in the evaluation generally acknowledged the framework's clarity and appropriateness, which is derived from, among other things, the use of TOGAF's format. Additionally, presenting the principles as a means-end knowledge that uses high-level and normative statements (as suggested by Bharosa and Janssen, 2015; or Zwart and deVries, 2016) assists in encapsulating many possible practices. However, the practitioners also offered ideas to improve the framework, i.e., its clarity and usability. For instance, some practitioners suggested slight changes in terminology as a minor adjustment.

Moreover, other practitioners denoted more profound adjustments, such as detailed protocols to translate the principles into practices. This suggestion aligns with Gregor et al.'s (2020) notion of decomposing the principles to add clarity. The proposed framework, however, does not decompose the principles into more detail. Instead, it provides practical examples and connects directly to the challenges to clarify the principles.

2. Accurate Application

This attribute is influenced by clarity and appropriateness, as elaborated previously. However, while the previous notion pertains to the framework (i.e., how it is being represented), this subsequent attribute focuses on how it (the model) is actually captured by its stakeholders.

The framework was developed from the case study and synthesized the case study participants' experiences in AA implementation. The captured essence from the case study then coalesced using a standardized format like TOGAF, facilitating common understanding by the framework's stakeholders. This approach indicates the framework's fulfilment of this quality attribute from the process perspective. Nevertheless, its impact on the framework's quality as a 'product' must be affirmed through empirical validation, as suggested by Evermann (2005, p.150).

There are several concerns regarding the framework from 'product' perspective. In this regard, some internal practitioners suggested more practical references to guide the translation of these principles, which are presented as high-level, normative, and directive statements. As mentioned earlier, F4 and F5 suggested success factors and detailed indicators will be helpful for applying these principles into practice,

> *"Is there any part from this principle that maps digitalization initiatives to see which initiative (or initiatives) align with AA implementation and can support each other? […] Will this framework be equipped with some kind of success factors which support its application?"*

and

> *"We wonder if there are indicators or parameters of these principles. So that we know how much we have applied those principles".*

Further, F6 complemented with the possibility of the framework's connection with the maturity level which his/her organization is familiar with,

> *"We are familiar with maturity level framework; how does this framework connect with other frameworks that utilize maturity level?"*

These concerns open room for improvement for this framework as they directly influence the accuracy of the framework's application and eventually implicate the framework's value and usability in achieving its purpose.

Nevertheless, the resulting framework as a 'product' also has positive aspects. First, as has been repeatedly inferred in the elaboration of the previous

attributes, some internal practitioners indicated that the framework had been presented in 'understandable business language', which is helpful for internal audit professionals and other actors involved in AA implementation. The interviews with external participants further confirm this notion. For instance, as already mentioned previously, E3 stated that,

> "*These principles are presented in a high-level language so that they can be applied to many different technical practices".*

Interviews with external actors further strengthened this quality attribute of the framework. For example, E5 and E7 recognized the "Collaboration" principle's practice and its value for AA implementation from their experience. E5 shared his/her experience in utilizing hackathons, not only to address cultural barrier issues by bringing awareness to auditors and stakeholders regarding AA benefits but also to overcome auditors' limited AA-related skills issues,

> *"[…] we have provided numerous training events, workshops, seminars of data analytics for auditors with the standard approach to no avail; I think because data analytics is practical and technical, a mere in-class explanation, even with some hands-on exercise will not be effective […] so we need direct practice in a project and make a competition of it (to motivate the participants) […]".*

This hackathon approach allows for inter-department and even inter-directorate teams, flourishing collaboration among personnel from various institution units (including the internal audit). Additionally, E7 exhibited his/her join project as one of the strategies to overcome audit clients' reluctance to support internal audit in general and AA project development in particular,

> *"We developed AA projects not only for our [internal auditors'] tasks, but we also collaborated to develop features/menus for the clients, so that they feel significantly aided in their tasks as well […] our menus differ with menus provided for them, for instance, we focused on control effectiveness, while they [the clients] focused, for example, on the prognosis of their performance".*

This practice incorporates the safeguards for AA projects that are closely associated with clients' business analytics projects. Hence, this enriches the practical translation of the "Collaboration" and "Clarity of Roles" principles, in addition to the examples provided from the case study.

The framework facilitates accurate application for its users. From the 'process' perspective, this argument is shown by how it is developed, i.e., it coalesces real-world practitioners' experiences in AA implementation, incorporating the challenges they encounter and how to respond to them. This notion is further strengthened through the use of an established structure known to diverse actors, such as TOGAF's format. However, this quality feature's actual value should be affirmed or negated through empirical validation.

Therefore, this study affirmed this argument by clarifying the framework for internal and external actors. Generally, external practitioners (who were not involved in the development of the framework) were able to capture the essence

of the framework by reflecting on the presented principles and challenges with their experience, which indicates the framework's satisfactory fulfilment of this attribute. However, confirmation with the internal practitioners provided finer suggestions to enhance the framework's practical implications.

3. Practical Value and Usability

The effectiveness of this framework is eventually demonstrated by how the principles achieve their goals to help IAF overcome interrelated challenges of AA implementation. Hence, the assessment of this attribute is pertinent to the framework's value in fostering AA implementation.

The proposed framework consists of principles to overcome the challenges of AA implementation. First, this premise is supported by the extant literature, which suggests that critical challenges significantly hinder AA implementation by IAF despite its acknowledged values for IAF and its stakeholders. Furthermore, this value is hinted through the case study, which exhibits the connection between each principle and other principles and between each principle and the identified challenges.

For instance, the case study shows how the roadmap as the representation of the "Integrated System View" addresses many challenges as it contains various milestones for each facet of AA implementation, such as personnel skill development strategy to overcome skills issues or infrastructure acquisition plan to overcome data and infrastructure related problems. Some approaches included in the roadmap, like the communication plan, also address cultural barrier issues as the foundational challenges that strongly other direct and technical challenges (see Sections 4.3. and 4.4.). Another example is how to combine the "Clarity of Roles" and "Dedicated Platform" principles in the form of shared data exchange infrastructure with an embedded governance mechanism. This approach answers data security concerns and its implications on data access issues. The practical translation also answers concerns regarding data integrity issues, as highlighted by Alles et al. (2008, 2009). These examples indicate the alignment of the framework with its purpose. However, the assessment of the quality of this attribute of this framework inherently requires empirical examination.

Therefore, this study further validates the framework, i.e., the principles and the relationships between principles and challenges, by clarifying the developed framework with the case study participants and external actors. This approach aligns with the purpose of this study, which is to develop means-end knowledge that provides high-level directive statements while allowing for a variety of practical translations depending on the context (Zwart and de Vries 2016), as discussed in Chapter 3.5.

Interviews with external practitioners suggests that the proposed framework is valuable in guiding AA implementation efforts. For instance, E2 and E3, internal auditors from (different) government institutions, consider the framework to consist of 'ideal' principles that need to be kept in mind in AA implementation,

especially when facing challenges and quandaries of day-to-day dynamics of AA implementation. Particularly, E3 remarked,

> *"I think these principles are useful to foster AA implementation […] it is also good that the framework only contains four principles; otherwise, it will be too complex for users".*

Similarly, E4, an internal auditor from a fintech company, affirmed the framework's value,

> *"Based on my understanding of IIA's guidelines, these principles align and are beneficial for IAF in implementing AA [in their internal audit tasks]."*

Besides from general perspective, other external practitioners suggested alignment of the framework with their experience. For example, E5 shared his thought on addressing mindset and skills issues using hackathon,

> *"The main problem is about mindset [which inhibits this initiative], they always think AA is difficult, they object to delve into AA due to their non-IT-related academic background […]"*

and

> *"[…] we have provided numerous training events, workshops, seminars of data analytics for auditors with the standard approach to no avail; I think because data analytics is practical and technical, a mere in-class explanation, even with some hands-on exercise will not be effective […] so we need direct practice in a project and make a competition of it (to motivate the participants) […]"*

These statements substantiated the practical value and usability of the principle to cultivate AA implementation by IAF.

Nevertheless, as indicated in the previous evaluation of other quality attributes, confirmation with the internal actors revealed room for improvement in the framework. The respondents acknowledged the practical value and usability of the high-level and normative principles for various and different contexts. However, this flexibility goes hand in hand with its less directly actionable framework and may benefit from complementary elements. For instance, F4 and F5 pointed out that the framework will benefit from additional details in the form of success factors, indicators, or parameters to guide the practical translation of the principles. Meanwhile, F1, F2, and F8 suggested the need for a notion to accommodate the annual planning mechanism in their organization so that the AA projects can be utilized effectively. In contrast, F6 highlighted his/her familiarity with the maturity-level-based framework and asked about the possibility of connecting this framework with the maturity-level-based framework. Additionally, F7 and F11 highlighted future technological issues for consideration, either a need for an additional principle or an element of the principle, like the risk of technology incompatibility.

Granted, not all of these remarks are suitable for addition to the current proposed framework. Some suggestions, while appropriate, might not be applicable in other circumstances, like the suggestion to add a principle to

accommodate specific issues regarding the planning phase in the case study setting. Another proposition is relevant and valuable but may already exist in the literature, like a maturity level equivalent of the framework. Furthermore, other suggestions may be relevant and useful, but they existed in the current proposed framework, albeit in different terminology, like the principle related to AA skills improvement suggested by E1 and E2, which was exemplified in the external validation from E5.

Practical value and usability are the key attributes of this framework. Empirical validation from internal and external actors shown the framework's value in this matter. Generally, interviewees agreed that the framework and all its elements are suitable to assist IAF in implementing AA.

8.3. Practical Insights from the Evaluation

The evaluation targeted the framework's quality attributes, as elaborated on in the earlier part of this chapter. However, the insights from internal and external practitioners as the 'evaluators' also suggested additional actions and notions to exemplify the practical translations of the principles.

8.3.1. Contextualizing AA Implementation Within the Organization

The evaluation (of the framework) offered additional novel practices reflecting the "Integrated System View" perspective, which implies the whole-of-organization perspective, as opposed to the fragmented approach from a project-level perspective. This insight strengthens the notion of the first principle the fundamental tenet of AA implementation. These suggestions related to the planning of the AA project as a subset of the overall AA implementation programme.

Confirmation to the internal practitioners highlighted the need to determine the universe of internal audit areas as the basis for developing AA projects as a part of the AA implementation initiative. During the group interview, F1 asked that,

> *"Is there any principle or part of the principle to accommodate mapping of the digitalized audit universe? So that we [internal auditors] can determine areas to be focused for the AA projects",*

which, subsequently, F1 acknowledged and expanded upon F8's statement.

> *"I agree with [F8] suggestion, and to add to that notion, we can add activities to determine the level in our enterprise architecture as the basis for potential [audit] areas for the AA project."*

Further, interviews with external practitioners exemplified the practice as a part of the AA implementation initiative. E7 shared his/her experience,

> *"[…] in short, we have hundreds of business areas represented in hundreds of business applications […] we clustered those areas and applications into four main business process and systems as the basis for developing AA projects […]"*

The practice to determine the audit universe is actually embedded in the (annual) internal audit planning phase (Anderson et al., 2017). In the traditional approach, the annual planning phase pertains to determining the area (its scope and

focus) as the object of internal audit tasks based on enterprise risk analysis (Coetzee & Lubbe, 2014; Gray et al., 2019). However, in the context of this research, for the AA approach, this step might need additional factors and purpose. For instance, the level of systems maturity and data quality in those business systems or the interconnectedness of the application (and its data) with other business areas can be important criteria to target those systems (and business areas) for AA projects. In contrast, these additional considerations may be less relevant to the traditional approach. For instance, the level of digitalization and digital data quality does not affect the decision to perform the traditional approach for an internal audit project, as the data analysis will not depend on the availability of digital data. Similarly, the interconnectedness among systems (business applications) may have a limited impact on determining the internal audit project using the traditional approach as data is obtained ad hoc to each business area. Therefore, the additional considerations suggested by the evaluation participants complement the high-risk or mandatory areas to decide audit tasks in audit planning for the traditional approach.

This approach aligns with examples found in the AA literature. For instance, Codesso et al. (2020) decided to develop a CA project based on risk analysis, with additional considerations of a business process' digitization (or automation) level. These reasons lead them to focus on tax compliance, which is a high-risk and more automated process, instead of, for example, inventory management, which is still performed mostly through manual procedures. Similarly, de Freitas et al. (2020) developed a CA project for payroll, considering its risks and strategic importance for the organization (e.g., accounting for 70% of total expenditures). However, other crucial deliberations are that the payroll operations are already digitized, and the payroll data is interconnected with other critical functions, both internal and external.

Table 34. Comparison of Considerations for Determining Internal Audit Projects

Traditional[30]	AA
- Risk management results (composite of risk likelihood and impact), identified by management and corroborated internal auditors. - Shared assurance decision (with first and second lines, i.e., management and control compliance officer). - Regulatory requirement (e.g., financial statement for public institutions; IT security for some fields like banking and finance).	- All considerations in the traditional approach. - The level of digitalization of the areas (i.e., data for audit evidence available mostly in digital format, instead of physical or analog formats). - Data quality (i.e., digital data is available to be processed and analyzed using analytics techniques or machine readable). - Interconnectedness with other systems.

Related to the above practice on a broader scale, the evaluation participants, both internal and external, indicated the need to determine the 'universe' of digital transformation initiatives in the organization. The identified digitalization 'universe' serves to identify other initiatives that align and have the potential to bolster the AA implementation programme. This idea emerged from the curiosity and experience of

[30] Synthesized and adapted from Anderson et al. (2017), Coetzee and Lubbe (2014), Gray et al. (2019).

both internal and external practitioners. From internal actors, F4 is intrigued by this possibility,

> *"Is there any part from this principle that maps digitalization initiatives to see which initiative (or initiatives) align with AA implementation and can support each other?"*

In light of this, E7, one of the external participants, shared his/her experience,

> *"[…] we communicate with our counterparts and identify the existing digitalization; we consider those existing initiatives into our proposal to be included in the organization's strategic business plan."*

Although less formal and structured, the practice shared by the external practitioner aligned with the question proposed by the internal practitioner.

In a recent study, (Begkos et al., 2024) underline the interconnectedness of digital technologies in the widespread digital transformation initiatives. Using case studies in England's public health sectors, they find digital transformation as a process which is distinct yet interlinked with myriads of digitization, datafication, and digitalization activities. This study highlights the value of 'scanning' existing initiatives and harnessing them for the upcoming digital transformation effort. The study also indicates some considerations to determine the alignment of the existing initiatives with the new ones (see Table 35 below). This notion and practice are also acknowledged in the empirical studies of digital transformation in various fields, for instance, as exemplified in the winery and shipping industries (Bastard & Chaillet, 2023; Lambrou et al., 2019), which informs its value for AA implementation.

Table 35. Possible Considerations for Aligning AA with the Organization's Digital Initiatives

Consideration	Description
Integration	Focus on utilizing existing digital infrastructures for the new initiative.
Goal Alignment	Aim to identify existing initiatives with aligned or shared purposes.
Data Utilization	Leverage datafication from existing digital initiatives to support the new initiative.
Stakeholders' Engagement and Support	Assess the engagement and support for the existing initiative to be considered for collaboration (of initiatives).

8.3.2. Considerations of Technology Infrastructure for AA Implementation

The case study indicated the importance of an agreed-upon system and data infrastructure as a part of enterprise architecture. It facilitates data exchange (as well as analysis and project development in general), both for general and audit analytics purposes. However, while the case study exemplified this practice through a centralized architecture, this practice is not necessarily the norm. Other organizations perform, to some extent, a similar centralized approach. For example, E4, an internal auditor from a fintech company, shared his/her digital environment for AA,

> *"We don't access data for our analytics project from them [the clients]; instead, we access it directly from the central database, namely [obfuscated], since every database from our client's business systems is dumped into the [obfuscated]",*

to which E5, E7, and E8 from the banking industries shared similar practices, albeit with different technology. In contrast, other external practitioners encountered different and more decentralized or hybrid architecture. In this case, E6, an internal auditor from a logistics company, stated that,

> *"We have to identify what data we need [for our AA project] and with whom we should coordinate and request access […] for example, for finance, procurement, HR data we should request to those respective departments from their systems."*

These practices underline the essence and show the possible different translations of the principle. The centralized model might be suitable for an organization with an established infrastructure. Conversely, an organization with a bottom-up system development might not have 'that luxury' and has to connect many already existing systems. In this case, connecting each system (including for AA purposes) will be more efficient, as suggested in the literature (Bastard & Chaillet 2023; Begkos et al. 2024). Table 36 presents the possible considerations for the architectural model as a practical translation of the "Dedicated Platform" principle.

Table 36. Considerations for Technology Infrastructure for AA Implementation

Consideration	Centralized	Decentralized
Development characteristics	Top-down development	Bottom-up or federated
Infrastructure that caters the whole organization	Already exists	Under development
Analytics mode	Dedicated machine (server)	API, multiple analytics machine

Following up on the previous practice, the framework and its evaluation hinted at technical and non-technical criteria for the platform. From a technical perspective, regardless of its architecture (centralized, decentralized, hybrid), the key criteria for the platform are to satisfy the integrity and availability concerns of the auditors and the confidentiality and performance of the clients. Additionally, the internal clarifications underlined another criterion for the platform to keep up with the rapidly changing technologies and variety of infrastructure formats. F11 commented in the group interview session,

> *"I think this principle should accommodate the necessity of the infrastructure to keep up with future advancement of technology […] this notion also important to ensure compatibility with the upcoming technology and format".*

Moreover, from the organizational perspective, the platform must have clear roles to ensure unambiguous responsibilities among involved parties using the platform. This will avoid the responsibility gap or, conversely, overlapping responsibilities. For instance, the responsibility to maintain data quality (e.g., perform data cleansing activities) must be clearly assigned, and consequently, the relevant access to the platform must be provided for the responsible actor. These notions reflect the possible indicators of the principle as suggested in the internal clarifications.

8.3.3. Elements for Transformation

The internal practitioners suggested that the high-level, normative, and directive statements of the principles should be equipped with key parameters to inform the practitioners if they are going in the 'right direction' in applying the framework. Considering the framework is intended as a means-end knowledge which can be applied differently in different context, this suggestion aligns with the framework's purpose and strengthens its practical values.

The case study shows that AA is more than a mere use of technology in internal audit tasks. Instead, it influences all facets of internal audit activities and requires a systematic and planned approach. The case study exhibited this approach to actionable targets in the form of a roadmap. The evaluation with external practitioners strengthened this notion, for example, as shared by E7 in his/her experience of incorporating AA implementation into the organization's strategic business plan. Albeit not necessarily in the form of a formalized format, the key characteristics of this practice consist of a gradual plan in an explicit format incorporating specific milestones for each actor.

Related to the above notion, the framework also incorporated the explicit presentation of authorities and responsibilities regarding the AA project and AA implementation program (see Tables 27 and 28, Section 7.2.2.). In light of this, external practitioners attested to the importance of this notion, for instance, as stressed by E2, E4, and E6 (see previous section).

The significance of clear demarcation is not only about the roles of actors. Aligned with discourse in the extant literature and affirmed by practitioners in MICMAC-ISM analysis, the case study acknowledged the obscured barriers between assurance and advisory services of internal audit tasks in the AA approach. This notion implicates the risk of independence impairment of the internal audit (auditor or audit team) involved in such a hybrid assignment. Therefore, the case study exhibited procedures for dealing with this challenge by categorizing the relationships between auditors' continuous audit (CA) and the clients' continuous monitoring (CM). The specific practice that focuses on CA and CM can be considered one of the limitations of the practice in the case study. However, this practice can be extrapolated into broader relationships between audit analytics (AA) and business analytics (see Table 29).

Another insightful remark from internal clarifications is the need to observe the whole organization ecosystem as a basis for AA implementation (see 8.3.1.). This practice emphasizes the pivotal role of the "Integrated System View" principle. At the project level, this notion is translated into observing audit universe to determine the AA projects to be developed based on enterprise risk management results (and other complementary procedures like fulfilling mandatory assignments) and digitalization criteria as a part of the general planning phase (see Table 34). At the organizational level, this notion is translated into observing digitalization initiatives which align and support the AA implementation initiative (see Table 35).

The case study and the evaluation also underlined the communication element of the "Collaboration" principle. While this notion is already incorporated in the initial framework, the evaluation underscored the importance of communication from the CAE level. This idea expanded from the notion in the case study, which mainly focused on communication from the audit team level. This notion aligned with the requirements and considerations in the current internal audit standards.

Furthermore, the use of a dedicated unit to orchestrate AA implementation as a key component in the "Collaboration" principle also occurred in AA implementation experience in other organizations. In this regard, in E5's experience, the organization explicitly designated a unit to coordinate the AA implementation initiative, similar to the case study experience. Meanwhile, in E7's experience, the unit is organically conceived based on the evolution of the AA implementation.

Finally, the case study highlights the importance of an agreed-upon data architecture for AA purposes. While the case study utilizes a centralized architecture, insights from the evaluation suggested a decentralized model as a feasible alternative (e.g., as indicated by E3 and E6). The initial criteria from the case study include integrity and availability from the auditors' perspective, as well as confidentiality and performance from the clients' perspective. Internal clarifications highlight additional criteria, i.e., current and future infrastructure compatibility. Although not explicitly, the existing criteria (from the case study, such as confidentiality and reliability/perfornance) and the additional criteria (from the evaluation, like compatibility) imply the usability as the overarching criteria for the fourth principle.

The elements and principles from the proposed framework incorporate technology, organization, and environmental aspects. They align and strengthen the notion of AA implementation as a digital transformation initiative, encompasses all facets of IAF's activities, and transcends beyond the IAF. Table 37 summarizes the elements unraveled by the evaluation.

Table 37. Key Elements for Transformation

Key Element	Related Principle(s)
Explicit and gradual implementation plan exists	P1
Implementation plan includes specific milestones (targets and timeline)	P1
Implementation plan acknowledges (and involves) actors/units outside the audit team (IAF) with relevant role	P1, P3
Explicit authority and responsibility for each actor/unit regarding implementation program	P1, P2, P3
Explicit authority and responsibility for each actor/unit regarding analytics project	P2, P3, P4
Demarcation between audit analytics and business analytics project exists	P2
Explicit considerations of the organization's circumstances (e.g.., digitalization initiatives and level) for AA implementation program in general and AA projects in particular	P1, P2, P3
CAE (or equivalent) fluency in communicating the technical internal audit aspects and technological elements to the senior level of the organization	P3
Designated unit to oversee and orchestrate implementation program exists	P3

Key Element	Related Principle(s)
Infrastructure for performing analytics projects exists	P4
Infrastructure for performing analytics projects compatible with the existing and future organization's IT infrastructure	P3
Explicit authority and responsibility for each actor/unit regarding utilization of the designated infrastructure	P2, P4
Explicit consideration on data integrity and confidentiality	P4
Data processing (access, analysis) suits project and business requirements	P4

8.3.4. Transformation Guidelines

Another fruitful insight from the evaluation is the suggestion to append the framework with guidelines to further improve its practical value. The decade long AA implementation effort from the case study exhibits this part. Initially, the MOFIG attempted to embrace the digital technology through sporadic and ad hoc approaches, for instance, by intermittently use GAS for internal audit project. Over time, the MOFIG perform a more structured and deliberate approaches to incorporate technology, in this regard AA, into its internal audit activities.

In its latest attempt to implement AA, the MOFIG started with initial self-assessment to understand its current state before embarking on the AA implementation initiative. It started with identifying the MOFIG's existing state of input and output pertinent to AA implementation, like auditors' AA-related skills and data access for inputs or analytic method as output. The initial assessment became the basis for developing the strategy and guiding the overall effort. It captures This notion is acknowledged in the broader field of analytics (Malik, 2013). In AA-related field, (Stippich & Preber, 2016) also suggest maturity assessment as an initial step for AA implementation.

Building from the assessment result, the MOFIG developed a long-term plan for AA implementation. This plan became the anchor for the initiative. Other organizations also resort to this approach, although with different degrees of formalities. For instance, E7 and E8 in their respective organization incorporate digitalization (including the AA implementation programme) into the organization's strategic business plan. Conversely, E5 perform a more organic approach and gradually implements AA into the internal audit practices with a multitude of activities and plans. This approach aligned with the discourses in broader analytics and AA-related literature that suggest a roadmap to guide such strategic endeavours (Alles et al., 2009; Malik, 2013; Stippich & Preber, 2016). There are, however, caveats to this principle and its practical translation. In this regard, there are contesting ideas regarding the relevance of the implementation plan in a volatile environment (Worley & Mohrman, 2014), especially in a rapidly changing field like AA.

In response, the case study inspired the framework to incorporate this practice as dynamic instead of static. Hence, the MOFIG employs periodic evaluation as a continuous improvement mechanism. This practice addresses the concern of the

relevance of a long-term strategy for a volatile environment like AA. Practically, periodic evaluation informs about the current state of AA implementation, for instance, if the milestones are achieved or the challenges are addressed, and determines the remedies if deviations occur.

Additionally, as a long-term plan involving various actors with different concerns, the AA implementation programme embeds a change management and communication plan. The case further exemplifies the unorthodox change management and communication plan, such as by using talk show and data analytics competition involving all units (not only for auditors). External practitioners (e.g., E2, E3, E6) further suggested prototyping or pilot projects to demonstrate the value of AA for the stakeholders. These practices reflect key steps in the change management framework, as suggested by Kotter (1995). The summary of the guidelines is visualized in the Figure 36 below.

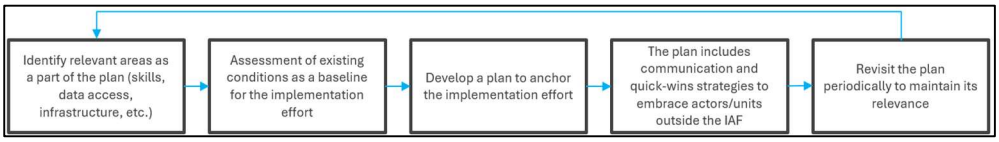

Figure 36. Visualized Transformation Guidelines

8.4. Evaluation Summary

Conceptual analysis and empirical validation of the framework indicate that the framework meets the quality attribute of a model and serves its purpose.

From the 'input' perspective, the framework thoroughly satisfies the attributes of relevance, by built on the literature and refined with the real-world experience in the case study, and consistency, by presenting the framework in a format commonly known and used by diverse actors. In contrast, the framework omitted some elements to focus on the most pressing issues according to practitioners; hence, opened some rooms to improve its completeness and accuracy.

From the 'output' perspective, the use of standardized 'format' enhances the framework's clarity, although there were some suggestions to adjust the framework's presentation, both minor to clarify some terminologies or major to possibly add a new element like practical guidelines to the framework. These views lead to the assessment of the framework's fulfilment of its ultimate purpose, i.e., to foster AA implementation by IAF. Some finer details were suggested to facilitate translation of the framework into multiple practices.

From the process perspective, the framework was developed from sound reference and empirically affirmed by the case study. Nevertheless, the focus on the challenges based on the specific context of the research may limit its completeness and accuracy. From the result perspective, the use of commonly known format does not only ensure the framework's clarity and consistency but also supports its practical value and usability. However, while the high-level presentation allows for flexibility

in various settings, it may limit the framework's direct application. The summary of the evaluation results, along with the implications, is presented in the table below.

Table 38. Summary of the Evaluation Results

Attribute	Analysis	Explanation	Implication/Follow Up
Input			
Relevance	Optimal	- Aligns with the discourse in the literature (i.e., to address challenges of AA implementation). - Focuses on the most pressing problems hindering AA implementation. - Affirmed by external actors' experiences.	No follow up needed.
Completeness	Marginal	- Focuses on several critical challenges encountered in the case study (and refined from the MICMAC-ISM analysis); it omits some emerging challenges like compatibility or counter-analytics. - Finer details are useful to guide the translation of the principles into practices.	- Indicators of the principles. - Process guidelines to complement the framework.
Accuracy and Consistency	Satisfactory	- Uses standardized format, commonly known and used by diverse actors. - Some terminologies may require adjustments (based on internal confirmation and external evaluation).	Slight adjustment in the principles' presentation.
Output			
Clarity and Appropriateness	Satisfactory	- Uses standardized format, commonly known and used by diverse actors. - Some terminologies may require adjustments (based on internal confirmation and external evaluation). - Possible additional principle to capture issues in audit planning mechanism in the organization (from internal confirmation).	- Slight adjustment in the principles' presentation. - Additional elements or examples for the principles (e.g., audit universe and digitalization initiative mapping).
Accurate Application	Marginal	- The use of standardized format known and used by diverse actors facilitates common understanding.	- Indicators of the principles. - Process guidelines to complement the framework.

Attribute	Analysis	Explanation	Implication/Follow Up
		- External practitioners affirmed the notions based on their experience. - Internal interviewees suggested finer details to guide the translation of the principles into practices.	
Practical Value and Usability	Marginal	- The framework aligns and serves its purposes. - Evaluation with external practitioners showed the framework's alignment with their experience and indicated its value and usability. - Internal interviewees suggested finer details to guide the translation of the principles into practices.	- Indicators of the principles. - Process guidelines to complement the framework.

Internal audit activities, including the use of AA in internal audit tasks, are bounded by (internal audit) standards and codes of ethics. However, the evaluation did not refer to the existing standards, guidelines, and ethics code. One of the considerations is that standards or guidelines for the audit field are generally technology-agnostic or neutral regarding the use of analytics (Krieger et al. 2021). Further, besides time constraints, another consideration for this approach was that while those standards, guidelines, and codes provide a general direction for AA implementation, they have limited value for evaluating the proposed framework (i.e., the principles and the associated challenges). Moreover, even when leaning toward supporting the use of technology in general and analytics in particular, the standards or guidelines often do not connect with the challenges on which the proposed framework focuses. For instance, the International Professional Practices Framework (IPPF) standard (hereafter, the standard) by the Institute of Internal Auditors (the IIA) in their 2017's standard mentions,

> *"In exercising due professional care internal auditors must consider the use of technology-based audit and other data analysis techniques."* (Standard 1220.A2)

Whereas the 2024 (the IIA, 2024) standard mentions,

> *"The internal audit function should use technology to improve its effectiveness and efficiency. Examples of such technology include tools that assist with data science and analytics."* (Standard 10.3).

In general, the interviewed internal and external practitioners did not comment on any potential issues between the proposed framework and the regulatory paradigm of internal auditing. In particular, one of the evaluation participants specifically affirmed the framework's alignment with the existing IIA references,

"Based on my understanding of IIA's guidelines, these principles align and are beneficial for IAF in implementing AA [in their internal audit tasks]."

The evaluation offered an adequate analysis of the framework's quality by employing an informed argument approach using an adaptation of a recognized paradigm. It incorporated how the framework captures real-world phenomena, how it (the framework) is represented to the stakeholders, and how it will likely fulfil its aims.

Furthermore, evaluation of the framework not only attests to the quality attribute of the framework but also provides additional insights. These insights further bridge the gap between high-level statements of the framework and its practical use in a wider context beyond what was exemplified in the case study setting. Therefore, it helps to improve and operationalize the framework, allowing diverse uses (of the framework) by retaining its flexibility. The practitioner-informed improvements ensure that the framework is both firm and adaptable.

8.5. Conclusions

Evaluation of the framework evidences its value and the notions indicated in the framework. Building on the conceptual quality framework for software modelling, the evaluation assesses the framework's relevance, completeness, and accuracy in capturing the AA implementation as the phenomenon being investigated and its socio-technical complexities. Furthermore, the evaluation also examines the clarity of the framework to be applied and, by extension, its practical worth in fostering AA implementation and its associated challenges.

The interview participants, both internal and external professionals, acknowledge the framework's quality and suggest further improvements to enrich the framework and enhance its effectiveness. The internal and external interviewers based their responses on their professional experiences and knowledge. Hence, they acknowledged the principles' benefits in addressing the challenges of AA implementation based on their own experience. Moreover, as professionals with a practical mindset, the respondents value the flexibility of the high-level principles, which can be applied in various settings and different contexts. However, they argue that more detailed guidance, like indicators or process guidelines, is beneficial as a complement to the proposed framework. Additionally, minor changes in the principles' presentation will improve its clarity and accurate representation of the concept incorporated in the framework (see Table 39 below, with adjustments based on the evaluation are presented in *italic*).

Table 39. Updated Summary of the Principles

ID	Name	Short Name	Description
P1	Audit Analytics (AA) is a whole-of-organization effort instead of *series of siloed*	Integrated System View	**Statement**: AA implementation involves various parts of the organization; thus, should be treated accordingly. **Rationale:**

ID	Name	Short Name	Description
	and ad hoc projects by IAF.		It requires adjustment to all facets of internal audit activities (practices, actors and structures, and values) which implicates to all elements of the organization. **Implication**: AA needs action involving all elements of the organization. **Level of Application:** - Organization (AA implementation strategy) **Addressed challenges:** Organizational awareness (cultural barrier); data-related issues (security, access); infrastructure issues; organizational dynamics (conflicting interests, dynamic in audit process); AA-related skills; and AA Use-Case. **Example(s):** - Implementation strategy incorporating all relevant actors and their roles and responsibilities, including long and short-term targets *(including quick-wins strategy) and with consideration of various digitalization initiatives in the organization* - *Hackathon involving multiple units of the organization as the organizer and participants.*
P2	Clarity of roles and responsibilities of each actor involved in AA implementation.	Clarity of Roles	**Statement**: A set of processes, responsibilities, and authorities to handle tasks related to AA use in internal audit activities. **Rationale:** AA changes how internal audit activities being carried out, introducing new task with new responsibilities. **Implication**: Clear definition of roles and responsibilities for all relevant actors involved in AA implementation and use in internal audit activities. **Level of Application:** - Organization (Internal Audit Practice Guideline, including role adjustment and safeguard) - Project (all stages, from general planning to the follow-up) **Addressed challenges:** Organizational dynamics (conflicting interests, dynamic in audit process); change in audit dynamics and values (independence impairment; inadequate standards). **Example(s):** - AA practical guideline/protocol. - *ARCI Matrix[31] related to AA implementation program or AA project.* - *Data governance guidelines.*

[31] A matrix that defines actor(s) (or unit(s)) who are Accountable, Responsible, Informed, or Consulted (hence, the acronym, ARCI) in a particular decision, process, or activity.

ID	Name	Short Name	Description
P3	Collaboration among actors involved in AA implementation. *If possible,* the IAF *may* make use of a dedicated team/unit to foster the collaboration.	Collaboration	**Statement:** Mutual interaction among parties with the focus to provide value for the organization and benefit each involved actor. It can use a designated role to coordinate the collaboration among actors or AA purposes. **Rationale:** AA involves various actors with different focuses and interests. **Implication**: The availability of formal and informal interaction mechanisms for AA implementation purposes. **Level of Application:** - Organization (AA Implementation Strategy, Coordinating Unit's role) - Project (all stages, from general planning to the follow-up and the possible iterations) **Addressed challenges:** Organizational awareness (cultural barrier); data-related issues (access); infrastructure issues; organizational dynamics (conflicting interests); AA-related skills; and AA Use-Case. **Example(s):** - *Communication plan for various level of the organization, involving intensive communication by the CAE (or equivalent).* - *Quick-wins strategy.* - Dedicated R&D team for coordinating role, devising formal and informal coordination mechanisms.
P4	Dedicated platform, including infrastructures and tools (both software and hardware), that facilitates data exchange for AA purposes.	Dedicated Platform	**Statement:** Organization infrastructure dedicated to facilitating data exchange and analysis for AA and general purposes. **Rationale:** AA requires various data access types, with possible overlap with business needs. **Implication**: *The provision of agreed-upon infrastructure for AA and general purposes that satisfies all actors' concerns.* **Level of Application:** - Organization (Shared/interconnected infrastructure) - Project (all stages, from general planning to the follow-up) **Addressed challenges:** Data-related issues (security, access); infrastructure issues. **Example(s):** Organization's infrastructure, incorporating: - Data warehouse facilitating data exchange for business/operational and audit activities,

ID	Name	Short Name	Description
			- Data analysis and visualization tools, can be embedded in the database or using specialized tools.; *It meets the quality criteria of integrity, availability, confidentiality, performance, and compatibility, which imply usability.*

In addition, the suggestions from internal and external practitioners in the evaluation enrich and improve the framework's quality attributes. The evaluation also aligns with and expands the internal audit practices as suggested in the accepted standard, such as examining the audit universe as a basis for AA implementation at the project level and leveraging existing digitalization initiatives for AA implementation at the program/organization level. From a broader perspective, the evaluation inspires an overarching notion to translate the framework into practices, particularly its practical value and usability through practical insights from their experience and generalized elements and guidelines.

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Part V: Epilogue

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Chapter 9 – Overall Conclusions

This research departs from a practical problem that is recognized in the academic realm. The fact that AA has many benefits for IAF (or audit practice in general; however, external audits are beyond the scope of this research and may yield different research results) yet is relatively limited in use is intriguing. The extant discourse provides abundant knowledge on *why* AA implementation is limited. However, this knowledge is scattered. Moreover, guidance on *how* to address the limited use of AA in internal audits is scarce. Existing frameworks for AA (or CA, a subset of AA) are either descriptive, i.e., focusing on assessment over implementation; prescriptive but disconnected from real-world challenges; or limited to project-level issues, failing to address organizational challenges.

This study aims to address the limited AA implementation phenomena through a coherent principle-based framework to foster AA implementation by IAF. For this purpose, this research is attached to pragmatism philosophy to use the appropriate methods to achieve its objective. For this purpose, this study first explores the literature as a basis for the substantive examination of AA implementation, which is the focus of this research. Further, this research uses a mixed-methods approach through MICMAC-ISM, case study, and informed argument methods. These methods aim to understand how the challenges influence AA implementation, identify the principles and the associated challenges of AA implementation, and, based on the principles, develop and evaluate the framework for AA implementation by IAF.

This study achieves its objective of developing a principle-based framework for AA implementation by IAF that complements the existing frameworks in the field. In doing so, this research asserts that Socio-Technical System (STS) and Complex Adaptive System (CAS) theories enrich the classical view of Agency theory in understanding IAF and its activities (including AA implementation). By reflecting this study's findings on those theories, this study finds that IAF is part of an organization as a complex system. Hence, AA implementation as one of IAF's activities needs to consider this relationship, in addition to its classical role as an intermediary between principal and agent. This study also offers scientific and practical contributions, such as advancing the existing methods through an alternative data collection approach for MICMAC-ISM.

This concluding chapter synthesizes the results of this research. The first section of this chapter (Section 9.1.) presents the answers to each research question and the answer to the main research question. Subsequently, theoretical reflections and scientific and practical contributions will be presented in more detail in the following sections (9.2. and 9.3). This chapter also presents the future of the digitalization of IAF and this study's limitations in the Sections 9.4. and 9.5. respectively. The final section (9.6.) offers future directions for the research in AA and the broader technology-based audit innovation.

9.1. Revisiting Research Objectives and Questions: Findings and Overall Conclusions

This first section revisits the results of each phase of this study to answer each research sub-question. To conclude, the main research question is answered at the end of this section.

9.1.1. RQ1: What are the challenges of AA implementation by IAF?

The initial curiosity of this research is to understand factors hampering AA implementation. Therefore, the first research (sub) question is motivated by the need to harness the accumulated knowledge of this matter from the extant studies of AA-related fields, which is filled with empirical evidence of AA implementation. This research extracts challenges encountered in implementing AA and develops a structured overview of the array of those challenges. This overview serves as the basis to answer the main research question and achieve the research objective.

Using a systematic literature review (SLR), this research identifies the initial long list of twenty-three challenges affecting AA implementation by IAF. The important takeaway from this finding is that IAF encounters internal and external factors hindering AA implementation. Even more, literature analysis suggests that while an internal factor (i.e., the limited auditors' AA-related skills) is the most mentioned challenge, the next three out of the top four challenges are external factors, namely dynamics in audit process (which at least involving the clients), funding necessity (which often requires stakeholders' approval), and data access issues. Some of the critical challenges encountered in AA implementation are beyond the authority of the IAF (or the CAE). Another intriguing insight from the literature is that some challenges, while acknowledged and mentioned in a few articles, have received less attention. These are emerging challenges from the ever-advancing analytics for internal audit activities.

This research refines the long list by capturing the 'wisdom' and experience of internal audit practitioners through two strategies. First, this study clarifies the long list with the practitioners, using questionnaires and follow-up interviews (with some participants) as the initial step of MICMAC-ISM analysis. This approach presents the initial findings and obtains the participants' views on the significance of each challenge. Second, the study captures the socio-technical complexities of AA implementation and extracts challenges from the real-world phenomenon from the case study. These strategies condense the long list into a short list of the eleven most critical challenges.

Table 40. Summary of the Identified and Selected Challenges

Identified Challenge	SLR	Refinement for MICMAC-ISM	Case Study
Investment/ Funding Requirement	√		
Inadequate (Internal) Audit Standard/Guideline	√	√	
Dynamics in Audit Process	√	√	√
Limited Auditor's AA-related Skills	√	√	√

Identified Challenge	SLR	Refinement for MICMAC-ISM	Case Study
Inadequate number of auditors (for AA implementation)	√		√[32]
Limited AA Use-Case	√	√	√
Different in Stakeholder's Interest	√	√	√
Potential Bias	√		
Cultural barrier (initially termed as Lack of Cultural Readiness)	√	√	√
Infrastructure Capacity Issues	√		√
Missing Data (or Uncaptured Data)	√	√	
Data Access Issues	√	√	√
Data Security Concerns	√	√	√
Data Inaccuracy	√		
Data Incompleteness	√		
Varieties of Data Format	√		√[33]
Huge Data Volume	√		
Unavailability or Limited AA Tools	√		
Risk of Independence Impairment	√		√
Counter Analytics	√		
Organization and Business Complexity	√	√	√
Limited Aid in Development Process	√		
Audit Team Dynamics	√		

The condensed challenges are the focus of the prescriptive framework as the main objective of this study. Some discussions from the findings in the literature are affirmed, while others are contradicted. For instance, the practitioners admitted that the counter-analytics currently pose limited risks and, hence, were omitted from further MICMAC-ISM and case study analysis. This notion aligns with the insight from the literature (see 4.3.2.). In contrast, through their decade-long experience, practitioners acknowledged the risk of independence impairment due to the nature of the AA project, which is further emphasized in the observed principle (#3), negating the initial insight from the literature that this is an emerging issue (and therefore, less discussed in the literature). While this approach is considered the most relevant for the context of this study, a deeper investigation into some of the omitted challenges may be fruitful for future research to affirm or expand this study's findings.

9.1.2. RQ2: What are the relationships among the challenges to be addressed in AA implementation by IAF?

The finding from the first step of this research reinstates the socio-technical complexities of AA implementation with its many challenges. While understanding the challenges is critical, AA implementation will benefit from a structured overview

[32] Included in Auditors' AA-related skills issues.
[33] Implicitly appears in the evaluation interview in the form of suggested improvement of the framework to include the compatibility criteria.

to determine the priority of challenges to be addressed. For this part, this study uses MICMAC-ISM analysis to decompose the many challenges and categorize the challenges based on their influence on the matter of interest, i.e., AA implementation.

This study uses the refined list of challenges based on practitioners' views on the matter. In addition, this study utilizes novel approaches in conducting the MICMAC-ISM analysis through an FGD and the use of two distinct groups. The analysis finds a general consensus between the two groups with a slight difference.

First, the audit team and the innovation/coordinating unit agree that cultural barriers poses the fundamental challenge of AA implementation. This challenge has strong driving power and influences many other challenges that ultimately hamper AA implementation. The two groups also concur that data security and (internal audit) standards have a strong driving power. However, the audit team focuses more on cultural barrier as the most influential challenge, while the innovation/coordinating unit acknowledges other challenges like data security and stakeholders' interests to have a relatively equal influence on AA implementation.

Second, although presented on different levels, the subsequent layers of challenges focused on data-related issues, which influence organizational and regulation-related issues. The two units have comparable views on the influence level of business complexity and inadequate standards. However, they are rather contrasting in viewing missing data (or limited data capture) and stakeholders' interests. The audit team is more prioritized with data capture issues, while conversely, the innovation/coordinating unit is more attentive to the stakeholders' interests issues.

Finally, the two teams unanimously assent to the direct influence of technical challenges like the limited auditor's AA-related skills or data access issues on AA implementation. Besides the slightly stronger perceived impact of the limited AA use case challenge by the innovation/coordinating unit, the two groups shared similar assertions regarding these problems.

The similarity between the two groups calibrates and strengthens the findings of this part of the research. At the same time, the slight differences show and affirm the socio-technical complexities of AA implementation challenges and how they affect the implementation effort and are perceived by the involved actors. The complete tabular and visual presentation of this analysis is presented in Chapter 5 (Section 5.2.).

9.1.3. RQ3: What are the principles for addressing the challenges of AA implementation by IAF?

This research's core tenet lies in the prescriptive framework for AA implementation. While, to some extent, prescriptive frameworks exist in the AA literature, they are disentangled from the challenges which significantly inhibit AA implementation (Eulerich & Kalinichenko, 2018; Joshi & Marthandan, 2020; Ramadhan et al., 2023b). Therefore, this study complements the literature by proposing a prescriptive framework that connects with the critical challenges of AA implementation.

For that purpose, this study opts to examine the real-world phenomena of AA implementation, with successful and less successful experiences. The case study encounters crucial challenges, as identified in the previous phase of this research. The dynamics in the case study show how the case study object responds to the challenges, with performing and underperforming responses. These lessons revealed the principles and the associated challenges they overcome to develop a prescriptive framework for AA implementation. Furthermore, by using a real-world experience, this approach also equips a principle's high-level, normative, and directive statement with practical examples as conducted in the case study setting. This asserts not only the scientific contribution but also the practical value of this research.

The first principle underlines the notion of AA implementation as a digital transformation (Joshi & Marthandan, 2020). However, it transcends the IAF since the principle addresses the whole organization instead of only the IAF as a part of the organization. It answers to the concern that AA adjusts all facets of internal audit activities and the involved actors. Consequently, AA invites all elements of the organization to contribute, which asserts the view of IAF as a part of the complex socio-technical system from STS and CAS. This principle addresses almost all critical issues, from the 'abstract' problem like cultural barrier to the most technical ones like infrastructure capacity. The exemplified practice is a roadmap incorporating targets and milestones for actors involved in the AA implementation programme.

With the close involvement of other actors in AA implementation, the roles and responsibilities and the relationships among those actors are worthy of a revisit. Therefore, the second principle is to clarify the roles among actors. This implies the possibility of refining or reinstating those actors' roles. Most organizational challenges, such as the possibility of conflicting interests among stakeholders or independence impairment, are targeted by this principle. While this clarification may vary from one entity to another, the case study object devises an internal audit practice guideline with a mention of the roles of some actors in AA implementation programme-related activities.

The third principle is the importance of collaboration. This notion is somewhat alien to many auditors, especially considering the classical view of Agency theory, which distant internal auditor from audit client as the agent. However, considering the involvement of many actors in AA implementation, as viewed through STS and CAS lenses, this practice might be inevitable. For internal auditors, this notion might feel to be conflicted with the basic tenet of internal auditing. Therefore, in the context of this framework, this principle is closely associated with the second principle to ensure it fits with the internal audit's core tenet. In a certain case, a formal definition of collaborative interaction may be necessary; in the case study, this practice is exemplified and moderated by a dedicated unit to orchestrate this collaboration. This principle contributes to addressing a wide range of issues, from the limited auditors' AA-related skills issues to data-related issues.

Finally, as a technology-based innovation, the last principle concerns the technological aspect. The dedicated platform principle asserts that AA implementation requires an agreed-upon platform for performing AA projects. This

platform, however, could (or should) serve general data exchange and analysis purposes besides AA projects. The key tenet of this principle is that the platform should satisfy all actors' concerns, like integrity and availability for auditors and confidentiality and performance for data owners or business units. This technological aspect of the framework addresses technology-related challenges, like data or infrastructure issues.

The last three principles apply at both organizational and project levels. They affect every stage of the internal audit process, shifting the approach from traditional methods to those used in AA. In contrast, the first principle, "Integrated System View", only applies at the organizational level. This notion is the most compelling reflection of the departure of IAF from focusing on unidimensional relationships with principals and agents and toward becoming a part of dynamic socio-technical and complex systems. The importance of the first principle is also demonstrated through its influence on the other three principles, as shown in the summary of the framework. The visualized summary of the framework is presented in the relevant chapter (see Chapter 7).

9.1.4. RQ4: How do the proposed principles address the challenges to fostering the AA implementation by IAF?

This research adopts the pragmatism philosophy, which allows different approach to understand the phenomenon being studied. In light of this, the emerging framework, i.e., the principles and the associated challenges, from the case study satisfies this worldview (in Cresswell & Creswell 2018 terms). However, the lessons learned from the case study may particularly be relevant for the case study setting. Therefore, this research extends its value by evaluating the results through informed arguments from professionals in the relevant context of the case study setting.

The evaluation adapts from a modelling quality assessment tool to capture the quality attributes of the proposed framework. It captures the 'input' side of the framework, like how relevant and complete the framework is in capturing the socio-technical complexities of the matter being investigated, i.e., AA implementation and its challenges. More importantly, it also gauges the framework's effectiveness in achieving its objective by assessing its clarity (for the stakeholders), practical value, and usability.

This evaluation is twofold. First, it confirms the findings with the case study participants to evaluate the framework's accuracy and completeness in capturing the experience as well as its practical value for fostering AA implementation. These notions are indicated by the case study participants' understanding (or approval) of the proposed framework. Second, it calibrates the internal evaluation results with professionals from outside the case study to compare the findings with their experiences. These approaches confirm to the framework's quality and improve its practical value in the form of slight adjustments to the principles and the practical insights from the practitioners. The complete tabular and visual presentations of these insights are presented in Chapters 8 of this dissertation.

9.1.5. Main RQ: How does a framework help the internal audit function to implement audit analytics to transform its internal audit practices?

This study achieves its objective in the sense that it delivers answers to the main research question. The proposed framework, which consists of principles and the associated challenges, helps the internal audit function (IAF) better implement audit analytics (AA) to transform its practices and gives the answer to the question of "How does a framework help the internal audit function to implement audit analytics to transform its internal audit practices?"

The framework suggests that IAF should view AA implementation as an integrated and comprehensive organizational endeavor instead of a mere technology adoption issue. AA implementation implies the need for a revisit the roles to respond to this collective endeavor. This notion also necessitates collaboration among actors, including IAF, to which the clarification of roles comes in handy as a safeguard against the problem that may arise from this collaborative approach. Finally, AA requires technology that addresses the concerns of involved actors to ensure data integrity, availability, confidentiality, as well as system performance and infrastructure compatibility. These principles address the pressing challenges of AA implementation, which have occurred in other empirical studies on AA implementation. It ranges from mindset/reluctance, organizational dynamics, and skills issues to data and technology issues. Therefore, by applying the proposed framework, i.e., the principles can assist the IAF to address the challenges of AA implementation and transform its practices.

From a theoretical standpoint, the proposed framework affirms the possible alternative view of IAF (and AA implementation as one of IAF's activities). The need to incorporate actors from an organization-wide perspective, along with its consequences to revisit their roles and to allow collaboration with safeguards, outlines IAF as a part of a dynamic and complex system as viewed through STS and CAS lenses. These views enrich the contemporary view of IAF as an intermediary actor that bridges the information asymmetry between principal and agent, as seen through the Agency theory. Hence, while AA implementation aims to fulfil this role (as the intermediary), in practice, IAF interacts, influences, and is influenced by other actors and processes within the organization as a system.

As an additional note, the research philosophy motivates the choice of this research's settings, i.e., to obtain a setting with revelatory characteristics and rich experiences in the phenomena being studied. Hence, this study deliberately chooses a setting with emerging phenomena and 'dynamic' stories, consisting of successful and less successful stories, and captures lessons learned from the study object. However, given its nature, this study's substantive theory should be viewed as a proposition or hypothesis to provoke further research in the broader context.

9.2. Reflections

9.2.1. Revisiting the Framework

The proposed framework acknowledges AA implementation as an organizational effort. This notion requires a clarification of new roles and responsibilities of involved actors such as the audit team, audit clients, supporting units, and coordinating units. Moreover, the whole-organizational approach also necessiates collaboration among involved actors. Finally, as a technology-based innovation, a dedicated platform that satisfies those actors' concerns is needed to support AA implementation effort. Considering AA is often viewed as a project and technology adoption issue, this study's findings may explain why AA implementation is lagging behind. Furthermore, the framework was synthesized based on the experience in the case study setting, i.e., how the MOFIG deals with the challenges in implementing AA and evaluated through internal confirmation and external evaluation. With that regard, the framework provides rich examples of genuine practices and the actual translation of the principles.

The framework consists of principles to overcome the challenges hindering AA implementation. This research complements the literature by encompassing characteristics scattered in the existing AA-related frameworks in the field. For instance, the CA Maturity Model by Vasarhelyi et al. (2012) provides an organization-wide view, yet it focuses on assessing the implementation level rather than guiding the implementation effort. Conversely, the DA for IA framework by Stippich & Preber (2016) or Álvarez-Foronda et al. (2023) offers a process model to guide AA implementation; however, it disentangles from the challenges surrounding the effort. Moreover, detailed practical guidelines like MADS (No et al., 2019) or Three-Layers CA System (Yoon et al., 2021) are powerful in guiding AA project development for such types. However, these frameworks do not address organizational or even industry level challenges. For instance, addressing skills issues requires the organization's knowledge development effort (Nonaka et al., 2000), as shown in the case study and the external practitioners' experience, which suggests that the effort requires involvement from other divisions (e.g., HR Division). Another example is the roles regarding data, which help overcome data access issues. Nevertheless, this notion is absent from the project-level framework. Hence, this study identified organizational-level and principle-based framework to complement the gaps in the extant frameworks in the field.

The *Integrated System View* principle supports AA implementation as a digital transformation, as Joshi and Marthandan (2020) suggested. Further, both the case study and external practitioners' experience reveal that the transformation transcends the IAF and applies to the entire organization, including business units, data owners, and other supporting units. This notion expands the scope of future AA studies beyond the IAF. The principle indicates that AA implementation necessitates a broader perspective outside the audit team, challenging the notion in the existing frameworks that focus on the audit team and the view of AA as a technical project or technology adoption issue (e.g., Codesso et al., 2020; de Freitas et al., 2020). This

extant view risks a fragmented and heterogeneous approach in dealing with challenges, leading to unresolved issues and inconsistencies. This view even calls the traditional view of IAF through Agency theory into question, which will be elaborated further in the next subsection.

The case exhibits its perspective of AA implementation as a transformation initiative through a roadmap for the implementation plan, which translates the *Integrated System View* principle into tangible and measurable artefacts. Albeit with a slightly different approach, external practitioners share a similar experience, i.e., incorporating AA implementation into the organization's strategic plan, which emphasizes this practice. These practices align with the AA-related and broader analytics literature, which suggests a roadmap to guide such transformative efforts (Alles et al., 2009; Malik, 2013; Stippich & Preber, 2016). The case study even suits the suggestion from Stippich and Preber (2016) and Malik (2013) to conduct an initial assessment as a basis for the roadmap. The case further exemplifies the execution of the roadmap reflecting the principles. They perform unorthodox approaches to address challenges they encounter, like a talk show, which entertains the organization (business units and auditors) with the potential benefit of data analytics and raises awareness of the value of data sharing, and data analytics competitions to address the limited auditors' AA-related skills issues. Moreover, in human resource-related activities, the case study conducts tailor-made data analytics training based on the competition results for both technical and managerial levels, with a mandatory practical project embedded with the training to help auditors incorporate their newly acquired skills in real-world tasks. Another external practitioner informs his/her experience in utilizing a similarly unorthodox approach through hands-on training embedded in a hackathon using a real-world task/project. These approaches go beyond the 'typical' training plan suggested in the literature (e.g., Li et al., 2018; Tang et al., 2017). Auditor at the staff level, R4, suggests that,

> *"[…] in my opinion, training, on itself, is not effective; it might be effective for knowledge acquisition, in a sense that, for example, knowing some SQL basic functions (syntax); but to be able to use that knowledge requires direct practice in a project […]",*

to which E5 shared a similar experience.

Further, the involvement of many roles in AA implementation warrants *Clear Relationship Among Roles*. This principle provides a valuable addition to the field since there is limited discussion of this issue in AA-related literature. Presumably, the roles and responsibilities of each actor surrounding internal audit activities have been considered (but normatively) settled. However, considering AA requires changes in the internal audit's and the organization's process and even mindset, as suggested in the current literature (Joshi & Marthandan, 2020; Ramadhan et al., 2023a) and further strengthened in this research, it warrants a re-clarification of roles and responsibilities associated with these changes. Furthermore, the broader field of analytics studies acknowledge this notion for a specific area, such as big data governance, and how it should be institutionalized in the organizational structure to clearly define the roles and the relationships among those roles (Malik, 2013; Tiron-Tudor & Deliu, 2022).

The case study acknowledges the complexities in dealing with multiple actors of the organization and translates it into practical guidelines. For instance, by categorizing the relationships between auditors' continuous audit (CA) and the clients' continuous monitoring (CM), the case demonstrates how to deal with clients' analytics projects that are related to (or based on) the IAF's AA projects and hints insight into, at least partially, addressing the problem of independence impairment. This notion contests earlier AA literature, which dissents the need for guideline or direction for implementing AA as "such guidelines now would be more of a constraint to the evolution of best practices than an aid to their implementation" (Alles et al., 2009, p. 11). Conversely, this notion aligns with the broader analytics field that recognizes the need for practical reference (Lery et al., 2016) and the more recent AA literature that admits the need for such reference, especially to assist auditors in dealing with emerging issues like the obscure auditors' role and the possibility of counter-analytics (Austin et al. 2018; Islam & Stafford 2022; Ramadhan et al., 2023a).

The evaluation suggests adding an informal approach to strengthen the formalized approach, as exemplified in the case study. For instance, external practitioners use a "quick-wins" strategy, such as by providing a mini-project, to exhibit the value of AA for the client or data owner. This approach assists in convincing the client and data owner to satisfy their role and responsibility and further amplifies the formal mechanisms to support AA implementation.

The case study elucidates the principle of *Collaboration* in the framework, i.e., AA implementation does not only involve other actors/units outside IAF but also admits that those actors/units are an integral part of the AA implementation effort. This notion then affirmed by the internal confirmation and external evaluation of the framework. The general analytics discourse of analytics embraces collaboration (Coyne et al., 2018; Mishra et al., 2019; Rösler et al., 2021) since it often comes as a separate domain from the business. Contemporary AA literature also acknowledges this notion, i.e., AA implementation necessitates support and involvement from various parts of the organization (Krieger et al., 2021; Li et al., 2018). Particularly for AA, collaboration is even more crucial since actors outside the internal audit team, like the clients as data owners, mainly own digital data as the primary element of the project; as acknowledged in the contemporary audit discourse (Löhlein & Huber, 2024). At the project level, this notion is somewhat 'alien' to the auditor as it connotates negatively,

> *"[…] if the term is collaborative, it is hard to accept, it is strange if the auditor and audit client collaborate, because this term is associated with fraud […]." (R16)*

Hence, this implies the need to frame the required collaboration for some AA projects as an advisory service instead of an assurance service, as exemplified in project #4. However, this practice requires safeguarding and, thus, entangles with the second principle (Clarity of Roles) for AA implementation.

One of the crucial tactics in enabling *the Collaboration* principle is through a designated unit to orchestrate AA implementation. This unit's role expands from the

'innovation unit' role, as suggested in the literature, which mainly supports the ideation and development of an AA project (Krieger et al., 2021). Conversely, the case shows this unit's more pivotal role, which includes coordinating the initiative and bridging the communication among different divisions (horizontally) and the technical and strategic levels of the organization (vertically), underscoring the view of AA as a transformative effort. This practice transcends the view of AA as a technology adoption project in the existing literature, which limits the focus of the 'innovation unit' to support AA project development. Nevertheless, the less pivotal role, as suggested in the literature, i.e., focus on assisting project development, is also useful in fostering AA implementation, as exemplified in the experience of some external evaluators (e.g., E5 and E7).

The fourth principle, the *Dedicated Platform*, aligns with the suggestion from the AA-related and broader analytics literature. The CA Maturity Model does not explicitly discuss infrastructure in its framework. Meanwhile, the DA for the IA Framework and CA Principles specifically mentions technology as one of its elements. This research, therefore, extends the notion and answers the concern in the literature by suggesting the need for a dedicated platform to enable AA implementation (e.g., (Franke & Hiebl, 2023; Laslett & Hardy, 2015); Codesso et al., 2020), which includes the quality requirement and its entanglement with the other principles. This principle aligns with AA-related literature (Alles et al., 2009; Stippich & Preber, 2016). In addition, through the case study and the framework evaluation, this research manifests this principle in the centralized and decentralized formats, each with its own considerations.

The case study demonstrates the *Dedicated Platform* combined with *Clarity of Roles* and *Collaboration* principles in the form of a centralized shared IT infrastructure. This platform serves more than just the IAF for AA purposes; it serves general purposes by other business units in the organization. Therefore, the supporting infrastructure must satisfy the auditors' and data owners' requirements. Auditors are concerned with data availability in accordance with the project requirements. In contrast, data owners focus on the security of their data from two perspectives. First, from a technical aspect, data owners need to be convinced that the required access will not interfere with and have an undesired impact on their system's performance, as it will influence their business processes. Second, from a substantial aspect, they need to be sure that unauthorized parties will not access the content of their data (Arif Perdana & Tan 2024), either in the development or in the utilization of an AA project. The shared infrastructure fulfils this requirement and helps overcome data-related issues, i.e., data availability (access) for auditors and data security (confidentiality) for the client.

Further, the practical experience mentioned in the literature supports the necessity of dedicated infrastructure for AA purposes (e.g., Laslett & Hardy 2015; Codesso et al., 2020). However, the IAF must be mindful of the integrity of its AA projects and results placed in shared IT infrastructure (Alles et al., 2009). The case study further demonstrates how to deal with this concern by embedding the governance aspect into the shared infrastructure and incorporating the need to review

the organization's data governance practices (i.e., "Data Governance Review Guideline") in addition to the safeguards in AA practical guidelines.

Finally, it is critical to note that the exemplified practices are not the only way to apply the principles. Aligns with the principle's definition and nature as a means-end knowledge (Bharosa & Janssen, 2015; Gregor, 2006; Zwart & de Vries, 2016), the principle can (and should) be adapted differently in different contexts. Hence, while this research (both from the case study and framework evaluation) exemplifies the practical translations of the principles, its application in different settings requires further reflection. This flexibility asserts the principle-based framework as a means-end engineering knowledge that provides a general prescriptive theory while allowing for diverse practices depending on the context and, therefore, strengthens the framework's practical value.

9.2.2. Theoretical Implications: Understanding IAF and AA Implementation through STS, CAS, and Agency Theories

This study focuses on AA implementation by IAF. While the main objective is to understand how to foster AA implementation and assist IAF in realizing its benefits, this research process and the resulting framework unveil alternative perspectives in viewing IAF as a part of the organization. On the one hand, the alternative perspective of STS and CAS complements and expands the traditional view of the Agency theory, which views IAF's main role as bridging the information asymmetry between different parties. On the other hand, inspired by AA implementation examined in this research, these alternative perspectives open up insights into how to improve IAF's value for the organization. This section discusses these implications by reflecting on theories regarding IAF's positioning in an organization.

Audit activities were originally focused on ensuring the accuracy of financial report and fraud prevention. Fast forward to the modern era, financial audits are required for many types of organizations, such as listed companies or government institutions. In this role, IAFs operated as an extension for an external audit to provide a more detailed verification of an organization's (financial) transactions (Swinkels, 2012). This role is reflected in the responsibility of IAF to review the (organization's) financial statement in particular and internal control in general before being audited by external audits in some circumstances. This origin reflects the *initial* role of IAF to provide reasonable assurance of internal control practices, and especially financial reporting quality (Adams, 1994; Erasmus & Coetzee, 2018; Mihret, 2014).

Agency theory can be used to explain the *original* purpose of IAF (and audit function in general) (Adams, 1994). In this view, IAF bridges the *tension* from the contradictory nature of self-interest between the principal and the agent in an organization (Mihret, 2014). In its original terms, principal refers to the owner of the organization's economic resources. In contrast, an agent refers to the manager who utilizes the resources to maximize the benefit for the principal. Agency theory is based on the concept of *information asymmetry* between the involved actors, i.e., the agent holds information regarding the organization's operation, which may or may not be in the principal's best interest. Therefore, there is a need for mechanisms to ensure

that the agent works for the principal's best interest (rather than an opportunistic behaviour that favours the agent) (Rakipi et al., 2021; Sarens & Abdolmohammadi, 2011). From the agency theory perspective, one of the primary purposes of the IAF is to provide assurance service as a mechanism through internal audit activities.

However, the IAF's role became more comprehensive over time. Nowadays, IAF's service is a crucial part of the corporate governance practice in an organization, along with other mechanisms such as external monitoring or executive compensation (Bonazzi & Islam, 2007; Haynes & Li, 2016; Sarens & Abdolmohammadi, 2011; Stewart & Subramaniam, 2010). IAF fulfils this role by providing independent and objective assurance and advisory services for the organization to which it belongs (the IIA, 2017, 2024). Further, technological advancement allows IAF to utilize digital data and information technology to improve its value for the organization, one of which is through the use of AA.

This research is inspired by the limited AA use despite its lauded benefits. In response, the proposed framework may illuminate insights into this phenomenon. One possible explanation is that challenges hinder IAF from utilizing AA and realizing its benefits, which this study focuses on. This concern might build from agency theory, in which IAF serves as the intermediary to resolve conflicting interests between principals and agents (Adams 1994; Rakipi et al. 2021), which is reflected in some challenges like data access issues emerge since there is a conflicting interest between business units as the data owners and an agent in agency theory and the IAF.

Nevertheless, alternative lenses exist to view the relationship between IAF and its stakeholders (Hazaea et al., 2023). For instance, instead of viewing the IAF as a one-dimensional entity in its relationship with the principal and agent, an IAF might face multiple collective action problems due to (competing) interests of various stakeholders under joint service delivery, which can be explained, for example, through *multiple-agency* perspective (Spiller, 1990; Spiller & Urbiztondo, 1994; Voorn et al., 2019). In this view, while it is true that IAF serves the highest rank in the organization, IAF also serves other parties in the organization as its clients through assurance and consulting services. In addition, IAF may indirectly serve external parties of the organization, e.g., regulators, through mandatory assurance. The influences from various actors from the inside and outside of the organization indicate the need to incorporate those actors' views in IAF's activities, including, in the context of this research, AA use.

The alternative lenses for viewing IAF other than from the perspective of the Agency theory as shown above highlight the reason for the seemingly opposite stances of IAF's stakeholders. For instance, while the board expects accurate and timely audit results which can be delivered using the AA approach, the business process manager's primary concern might be to exercise their authority on data security (Haynes & Li, 2016; Koskivaara, 2006) or the system's performance to serve the business process (Debreceny et al., 2003; Kearns et al., 2011). In addition, there might be different perspectives on the significance of the issues between different levels of actors. For instance, executives might consider strategic opportunities or challenges essential for AA implementation. Conversely, employees on the

operational level might be more concerned about data accuracy or infrastructure capability. This reciprocal feedback and its implication are particularly crucial for the success (or failure) of transformational initiative (like AA implementation) in an organization as a complex system (Janssen et al., 2015).

Therefore, this study reflects on the Systems views through the Socio-Technical System (STS) and Complex Adaptive System (CAS) theories to understand the phenomenon of AA implementation by IAF. The use of these theories is aimed at complementing the commonly used Agency theory in analyzing IAF. Nevertheless, from a theoretical standpoint, the Agency theory and Systems views have different conceptualizations of IAF and AA as phenomena. While the Agency theory views IAF as a separate entity in the relationship between principal and agent, the Systems view IAF as an integral part of the organization as a dynamic socio-technical and complex system. Hence, the variety of theoretical lenses in this study offers the possibility to enrich the analysis of this study.

The proposed and evaluated framework suggests that AA implementation by IAF is a complex endeavor involving interdependent components and the possible contextual translation of the principles, aligning with dynamic organizational change, which reflects the system view. The framework shows that AA implementation by IAF resembles the socio-technical system (STS), which consists of technical elements like technology and (audit) procedure and social aspects like people (e.g., auditors, audit client's personnel) and the related organizational units (e.g., audit team, audit client, IT unit). Further, the framework and its practical translations also signify the reciprocal feedback among actors involved in AA implementation, which may result in unpredictable results, as reflected in the principles' caveats (or contingencies). This dynamic can be explained through the complex adaptive system (Dooley, 1997; Eidelson, 1997). Therefore, this research and the resulting framework affirm the complexities of IAF's roles and relationships, as conceptually suggested by Nuijten et al. (2015) and Costan and Popa (2017). Furthermore, these alternative theoretical perspectives further explain the nature of AA implementation as a digital transformation with its socio-technical complexities, which may answer the limited use despite its many promised benefits. From the technological perspective, this view expands the AA studies, which often view AA as a technology adoption issue. From an organizational perspective, this perspective also adds complexity to viewing and valuing IAF for the organization (Costan & Popa, 2017; Nuijten et al., 2015).

Based on the observed experience of AA implementation in the case study and as affirmed by the evaluation, CAS theory offers an alternative view of the IAF as a part of interdependent components within a complex system (i.e., the organization) and extends the traditional views of internal audits as an intermediary between principal and agent (Agency Theory). First, the case study and the observed principles suggest that AA entails reciprocal relationships between IAF and other parts of the organization as a part of a system. Conversely, the agency theory 'positions' IAF acts as an 'external' actor from both principal and agent, which is at odds with the need to view AA implementation from an integrated system perspective (principle #1). Secondly, the expanded view of IAF and its stakeholders beyond its

intermediary role entails revisiting of each involved actor's role, which reflects the co-evolution of IAF and other parts of the organization. Hence, clarity of roles (principle #2) represents the CAS's view. Third, the system view (STS and CAS) resonates with the importance of clear roles to 'govern' the collaboration (principle #3) among involved actors in AA implementation. In contrast, the agency theory avoids collaboration as it is negatively connoted with IAF's independence and objectivity, which is at odds with AA as it entails a give-and-take between involved actors. The exemplified practical translation of these principles from the case study (e.g., safeguards, coordinating unit) acknowledges this nuance and addresses the possible problem with the independence and objectivity requirement of IAF. Fourth, as a technology-driven innovation, AA requires technological support, which is reflected in the dedicated platform (principle #4). This research further shows that this principle entangles the technology element (i.e., the platform consisting of the application and its related infrastructure and architecture) and the social element, like the concerns regarding performance[34] and confidentiality[35] from the business unit's side, and integrity[36] and reliability[37] from the auditor's side.

The examples and discussions above reveal the different perceptions of *the benefits* of the traditional approach, not only from the organization's perspective but also from the audit client's perspective. Using agency theory, some of these examples are the primary reason IAF is needed, i.e., to bridge the conflicting interests between the board as the principal and the business process owner as the agent. Conversely, in STS and CAS theories, these examples inform IAF to consider other stakeholders' concerns. IAF's actions often require cooperation and assistance from those other stakeholders (de Freitas et al., 2020; Haynes & Li, 2016) and, ultimately, aim to benefit those stakeholders as well as the organization as a whole. Therefore, by reflecting on these alternative lenses (STS and CAS), this research enriches the theoretical framework to understand the IAF roles and relationships in general (in addition to AA implementation in particular), besides the classical view of the Agency theory. Finally, from the case study and practitioners' experience gathered in this research, it can be inferred that AA implementation and the realization of its benefits go beyond the scope of the authority of IAF (i.e., CAE, the auditors, and the relevant divisions in IAF), further emphasizing the need to view IAF from system perspective. Therefore, these alternative lenses show that external stakeholders (from IAF's point of view) need to be taken into account for AA implementation. These accounts provide empirical experience that affirms the IAF phenomenon as a part of the organization as a dynamic socio-technical and complex system, and AA

[34] i.e., data access for AA purposes must not negatively affect the reliability of the data stream for operational business processes.
[35] i.e., data access provided for AA purposes will be used solely for the AA project and not used for other purposes or accessed by other parties, and that if access will be provided to other parties, it will be granted with the approval of the data owner.
[36] i.e., data provided for AA projects is free from unauthorized intervention or manipulation.
[37] i.e., data provided in accordance with the project's need.

implementation as a digital transformation for the organization beyond digitalization for IAF.

9.2.3. Practical Implications of the Framework: AA Implementation as a Technology-based Innovation by IAF

The proposed framework aims at fostering AA implementation by targeting the critical challenges hindering AA implementation. The resulting framework, including the key elements proposed from the evaluation, incorporates the elements of technological innovation not only from a technological standpoint but also from an organizational perspective and its surrounding. Therefore, from technology-based innovation point of view, the framework can also be reflected on the Technology-Organization-Environment (TOE) paradigm. TOE describes how each component influences the innovation process and interacts with each other (Oliveira & Martins, 2011). This reflection aligns with and affirms other studies in AA-related fields that use similar paradigms (e.g., Krieger et al. 2021, Li et al. 2018). Moreover, the TOE paradigm focuses on technology use in an organization while considering its contextual factors and environment (Praditya et al., 2016).

This perspective helps to understand the challenges and the principles to overcome those challenges from different contextual elements and develop the prescriptive framework. In the context of this research, the resultant theory (i.e., the framework) aligns with the TOE paradigm by acknowledging the interactions among each aspect (i.e., technology, organization, and environment), as visualized in Figure 37 below, instead of viewing each aspect as an independent element. It also enriches the paradigm by connecting the element with challenges (of AA implementation).

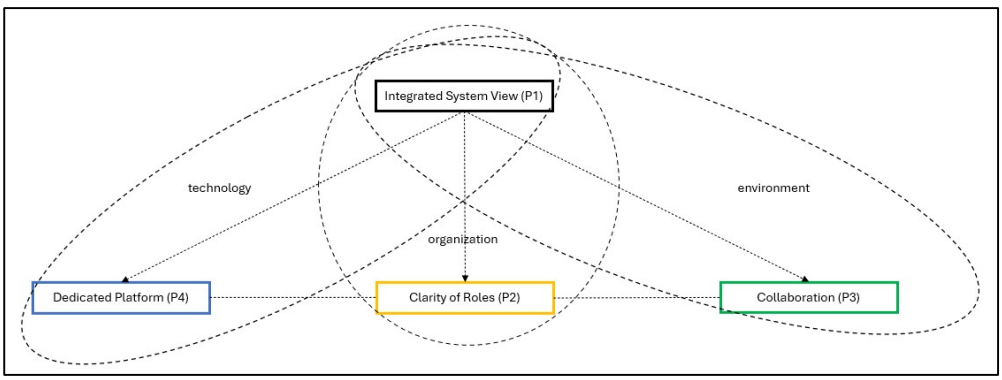

Figure 37. TOE Perspective of the Proposed Framework

In addition, the developed framework and its enhancement from the evaluation incorporate the change management (CM) perspective. This perspective resulted from the practical application of the framework. CM perspective prescribes how to embark on a transformational change in an organization, encompassing both individual and organizational perspectives (Kotter, 1995). In the context of this study, the transformation guidelines of the framework reflect the CM perspective and assist the framework's practical translation for professionals (see Figure 36). However, CM

focuses on internal factors and how to influence those internal factors in a transformational change like AA implementation by IAF. Therefore, this research extends the CM perspective by incorporating external factors. The proposed framework and principles include the external factors (from the IAF perspective) rather than focusing only on IAF as an entity.

The extant literature in this field uses various lenses in viewing AA implementation phenomena. Aligning with this research, some studies use TOE to describe the elements of AA implementation (e.g., Krieger et al., 2021; Li et al., 2018). This paradigm helps to understand why AA implementation is low from the organizational perspective (Krieger et al., 2021) and what aspects influence the usage level (i.e., application level or feature level) of AA by auditors (Li et al., 2018). Other research focuses on understanding individual stances in using (or not) AA technology in audit activities (Al-Ateeq et al., 2022; Handoko et al., 2021). Further, other discourses view this phenomenon from the diffusion of innovation (DOI) theory to comprehend the process of AA as a technology adoption issue (e.g., Austin et al., 2018). Another notion regarding AA use concerns legitimation, reflecting institutional theory's perspective to help apprehend why AA implementation is limited (e.g., Eilifsen et al., 2020).

Therefore, this study enriches the practical discourses by bringing an alternative perspective. This research views AA implementation from the TOE combined with the CM perspectives. It encompasses technology, organization, and environment aspects and is equipped with process guidelines based on the change management approach. The resultant theory (i.e., the framework) extends the understanding of the ‘why’ aspect of AA phenomena built by previous literature. It adds an understanding of the ‘how’ aspect, which contributes to fostering AA implementation by IAF.

9.3. Contributions

9.3.1. Scientific Contributions

This research is not the first to be interested in AA implementation and its complexities. Nevertheless, the approaches and strategies employed by this research, based on its philosophy to answer the main research question and achieve the objective, offer many scientific insights. This (sub) section restates and summarizes these insights obtained from each research phase.

Contribution to the Audit Analytics Literature

This research’s findings substantiate and expand the existing debates in the scientific literature in the AA field.

Building from the identified key challenges from the literature, this research theorizes the contextual relationships and interrelations among challenges to understand how those challenges simultaneously affect AA implementation. This understanding results in hierarchical models and categories of challenges (based on driving power and dependence). These findings shed some light on why AA implementation is low despite its promised benefits. This research also answers the

suggestions for future studies by some research, like uncovering contextual issues related to AA implementation or the need to consider training and hiring strategies to address skills-related issues (Eilifsen et al., 2020; Krieger et al., 2021; Michael & Dixon, 2019; Wang & Cuthbertson, 2015).

In developing the hierarchical model and categories of challenges, this research is the first to employ the MICMAC-ISM method to decompose the intertwined challenges of AA implementation. This method suits the study (phase) objective to answer the second research question, compared to other methods, for instance, DEMATEL, which focuses on cause-effect analysis instead of relationships between problems, PCA, with its virtual variables instead of existing empirical factors, or MCDM methods like AHP or BWM (as exemplified by Rajput & Singh 2019; Goyal et al., 2015; van de Kaa et al. 2018; Janssen et al. 2019; S.K. Sharma et al. 2021). Therefore, this research offers a novel approach to viewing issues related to AA implementation.

Moreover, this research's results add nuances to the challenges of AA implementation beyond what has been discussed in the literature. For instance, the case experiences some non-technical challenges like cultural barrier and concern for independence impairment related to AA implementation. It also encounters technical challenges like AA-related skills for auditors and data access issues. However, the case study and MICMAC-ISM analysis exhibit that cultural barrier issues appear not only from the auditors' side but also from the other actors' side. Given the involvement of those actors in AA implementation, this notion is essential for consideration. Another insight is that the skills problems encompass both technical and managerial skills. While AA technical skills have been discussed in many studies (de Freitas et al., 2020; Wang & Cuthbertson, 2015), this case study shows that AA managerial skills are equally critical for AA implementation, as discussed in the first principle. The case study and the external practitioners' experience also suggest a more profound role of the 'innovation unit'. This notion offers a novel insight and extends to the practice of AA implementation already mentioned in the literature (Krieger et al., 2021). This notion will be further discussed in the following subsection regarding the practical implications of this research's findings.

Overall, this research's answers expand the scientific discourses in AA-related research. While the extant literature mostly focuses on technology adoption at the project level, this research offers principles for AA implementation by IAF at the organizational level. First, this research acknowledges the need to take an integrated system approach, instead of a series of siloed projects. This view thus implies the need to revisit the roles of IAF and other involved actors. This study also suggests the possibility of collaboration among actors, in which the IAF can utilize a dedicated team to connect all involved parties and foster collaboration. This study shows the importance of a dedicated, reliable, and secure platform to facilitate AA implementation and ensure all actors' concerns are satisfied. Secondly, by theorizing the connection among challenges and between principles and the challenges, this research results in a prescriptive 'theory' that considers and connects the vital challenges with principles of AA implementation. In devising the framework from an

in-depth, real-world experience, this study also enriches the discourses by elucidating some nuances related to AA implementation principles, like the managerial AA-related skills as a related yet distinct 'issue' with technical AA-related skills. Moreover, the proposed framework provides interlinked principles that target critical challenges of AA implementation. While it serves as a means-end knowledge with its enduring, normative, and directive yet high-level statements, the framework is complemented with examples of practices to illuminate the 'abstract' forms of the principle(s). The proposed framework fills the gap in the literature by providing a prescriptive theory to guide AA implementation that addresses issues at the organizational level, which complements the existing frameworks in the literature.

Contribution to Theory

Hazaea et al. (2023) show that Agency theory is the most used theory in analyzing internal audit. Agency theory primarily focuses on explaining the origin of internal audit, i.e., to bridge the contradicting interests between the principal and the agent, and by extension, other related discourses, such as to analyze IAF's quality or expansion strategy (Krane & Eulerich, 2020; Sarens & Abdolmohammadi, 2011). Agency theory puts AA implementation (and other technology-based audit innovations) at the periphery of its discussion. By focusing on how IAF serves the principal, the Agency theory views technology-based audit innovation as a mere mechanism to improve the internal audit's quality (e.g., Ismael & Kamel, 2021). The case study demonstrates the value of AA from the perspective of Agency theory to provide 'better' services (i.e., faster, larger sample, and foresight). For instance, while the reporting requirement for each project is different (e.g., project 1: semi-annually, project 2: monthly, project 3: quarterly), AA in its various forms allow the analysis to be performed real-time or near real-time (e.g., daily) so that any errors can be detected (and corrected) much earlier. These projects also cover larger samples or even population data for analysis. In particular, project 4 enables foresight through the prediction of potential problems based on historical data. This perspective highlights the role of IAF's intermediary relationship with other parts of the organization, i.e., as the principal or the agent.

However, this one-dimensional relationship of IAF with the principal and agent as the stakeholders have been challenged in the literature. Contemporary research (Erasmus & Coetzee, 2018; Lenz & Hahn, 2015; Vadasi et al., 2019) underscores the multi-dimensional relationships between the IAF and its multiple stakeholders with equivalent influence (and sometimes contradicting interests). In particular, AA implementation by IAF results in these multiple roles and relationships with its stakeholders. For example, the dual role of business unit as audit client and data owner, significantly influences the development and the sustainability of the AA project as shown in projects 1 and 3. Meanwhile, project 4 was initiated from an assurance project,; but it was delivered as a pilot project for predictive analytics to be further developed by the business unit (the auditee/client), exhibiting the obscured barrier between assurance and advisory services and its impact on the audit team's roles for this project.

This research further pushes this notion through its empirical accounts of the case (including evaluation with external practitioners) and the resulting framework, as presented in Chapters 7 and 8. Instead of viewing other actors as the IAF's single or multiple stakeholders, the framework suggests that the IAF and other actors are interacting elements of a system with its social and technical aspects, which reflect the STS perspective. Furthermore, the framework suggests that IAF's relationship with other elements of the system is reciprocal and, therefore, co-evolve along with the implementation effort as, for instance, indicated by the risk of independence impairment due to the obscured separation between assurance and advisory tasks, or the need for re-clarification of roles among actors in AA implementation.

This research offers empirical insight on the entanglement of social and technical aspects and the dynamic interaction of IAF with its stakeholders in AA implementation effort. On the one hand, organizational unit is the audit client which (in many instances) mandated to provide access to the data for (internal audit purposes); on the other hand, this business unit also act as the data owner which can influence how the IAF (the audit team) get the necessary data for AA project. In the traditional approach, data access is mostly provided on an ad hoc and sample basis; in AA, this might vary from batch, continuous, or population, depending on the project type (as shown in the case study). This change implicates how the IAF (the audit team) interacts with the business unit, both as the audit client and data owner. This interaction is more critical for both parties AA as it influences the development and sustainability of the project (from the auditor side) and it influences the ongoingness of the business process (which relies on data stream) and the confidentiality of their data (from the business unit side). Moreover, IAF must intensively and reciprocally interact with supporting units for AA implementation, such as with HR to design and execute the necessary training (and keep up with the technological advancement) program for auditors; or with IT to initiate, develop, and maintain data access procedure based on the agreement with data owner. In the traditional approach, these types of interaction occur but are not as intensive and are considered a part of the overall organisational process, while in AA, these types of interaction are a critical part of the AA implementation effort. The case study exemplifies this notion through the different approach (communication and interaction) between different audit teams and audit clients for each project with different technical solutions. By acknowledging the socio-technical complexity of IAF's interaction in serving its stakeholders, one of which is through AA, this study offers real-world practices to the notion of IAF as a part of a complex system. Therefore, this study reflects its findings on the system view.

From the perspective of STS theory, the principles and the associated challenges reflect a system's social and technical elements (i.e., the organization). However, while AA implementation is a technology-driven innovation, this research affirms the entanglement between the social and technical elements for AA implementation as a digital transformation for IAF. This notion is indicated by this study's results. First, analysis of the relationships among challenges of AA implementation shows that the fundamental challenges with strong driving power are from social aspects, such as cultural barriers and different interests among

stakeholders, while technical issues like skills and data access have low driving power. Secondly, while there is a principle specific to the technology, it entangles and is influenced by other principles.

Furthermore, the developed framework represents and incorporates the result of reciprocal interactions between the IAF and the organization, reflecting the IAF view from CAS theory. While AA implementation encounters the dynamic and complex interaction between IAF and other actors, the framework acknowledges the nature of IAF as a risk and compliance-oriented entity. On the one hand, the study shows how the reciprocal relationships influence AA implementation initiatives, like how the audit team and the client 'learn' how to 'collaborate' in an AA project. On the other hand, the nature of the IAF as a governance mechanism for the organization implies that this 'collaboration' requires safeguards to maintain the IAF's independence and objectivity in performing its roles. The case study and the evaluation exemplify this notion through various practices, such as a written roadmap and practical guidelines.

Building on STS and CAS perspectives, this research proposes principles for AA implementation. First, the integrated system approach reflects the intertwined social and technical aspects of AA implementation and acknowledges IAF's dynamics and interactions with other parts of the organization. Second, the dynamic interactions between IAF and its stakeholders in general and for AA implementation in particular may result in changes in the interaction of each involved actor. This dynamic enables collaboration on the one hand and warrants the clarity of roles on the other hand. The clarity of roles also encompasses the necessary safeguards for AA implementation by IAF. Finally, the social and technical elements of AA implementation suggest the need for a dedicated infrastructure for AA and general purposes that meet the security, confidentiality, and performance requirements and can be scaled up for many projects. In this regard, relying on agency theory may limit the understanding of this complex entanglement of social and technical elements and the dynamic interaction of IAF with multiple stakeholders, as well as its implications for AA implementation.

This research offers alternative lenses in viewing IAF and its activities, including AA implementation, through STS and CAS perspectives besides the commonly used agency theory. On the one hand, these perspectives enrich the discourse by viewing IAF and AA implementation as a part of a complex socio-technical system, in addition to the intermediary role between principal and agent, as viewed from the agency theory. On the other hand, these alternative views may be incongruent with the nature of AA implementation by IAF. For instance, a fully STS perspective requires multidisciplinary research encompassing a multitude of points of view. In response, this research, captured a relatively comprehensive perspective incorporating various social and technical aspects of AA implementation, as shown in the findings, like the various measures in dealing with social (e.g., NDA, practical guideline, coordinating unit, etc.) and technical aspects (e.g., various data access mode such as through data warehouse or VPN) for AA implementation. In addition, the dynamic and co-evolution of IAF interactions with other parts of the organization

for AA implementation may overlook the compliance nature of IAF (or the need for independence and objectivity). This research also shows that through the CAS perspective, IAF and the organization managed to maintain their nature by co-evolving together to address the challenges of AA implementation. The role adjustment or the development of safeguards (albeit imperfect) demonstrates how this view helps IAF and the organization adapt to the change due to the dynamic interactions among them.

Therefore, this study enriches the theoretical discourse through the use of these theories in viewing IAF and AA implementation, which expands the existing view of IAF, from the original view of the one-dimensional interaction with principal and agent (Adams, 1994). Moreover, this study's findings strengthen and provide the empirical reference for the conceptual insights of analyzing IAF from CAS theory by Nuijten et al. (2015) and Costan and Popa (2017). These views also expand the theoretical landscape in analyzing IAF, as presented by Hazaea et al. (2023), by providing novel empirical accounts of the use of STS and CAS in analyzing IAF. Therefore, this finding opens up a new horizon for further examination of the IAF's roles and relationships with other actors in the organization and complements the Agency theory, which is the most common theory in examining IAF's roles and relationships in the organization (Hazaea et al., 2023).

Contribution to Methods

From the methodological perspective, this study advances the method being used. In this regard, it is among the first to provide in-depth insights for MICMAC-ISM analysis through FGD sessions, in contrast with the questionnaire, which is commonly used for this method in the existing literature. This approach enriches the analysis by capturing qualitative insights (e.g., participants' reasoning) in addition to the quantified responses. This study also provides a comparative analysis of MICMAC-ISM by using two groups of participants instead of a single group of experts. This approach enhances the analysis by incorporating different perspectives from different parts of the organization. This approach also allows for affirming or expanding the findings. Overall, this study exhibits a novel strategy for conducting MICMAC-ISM analysis for technology-based innovation research in general and AA implementation in particular.

In evaluating the proposed framework, this study synthesizes the conceptual modelling quality framework (CMQF) and introduces it as a reference in evaluating a framework that works at the organizational level. This reference encompasses 'input' and 'output' quality attributes to sufficiently assess the framework's relevance, completeness, consistency, clarity, accuracy, and eventually its practical value and usability. In this regard, this study offers a novel approach through the use of CMQF to assess an organizational-level framework, instead of a project or process level framework as it was originally intended.

9.3.2. Practical Suggestions

The experience observed in the case study and evaluation through internal and external practitioners is filled with practical examples of how to engage in AA

implementation and address its quandaries. This section revisits the practices found in the case study or shared by external practitioners.

The roadmap, perhaps, reflects the widest representation of the framework. It translates the essence of the framework into a tangible and measurable artefact to gauge such transformative endeavor, as indicated in the AA or the broader analytics literature (Alles et al., 2009; Malik, 2013; Stippich & Preber, 2016). Moreover, moving beyond the exemplified practice in this study, while it mainly accounts for the "Integrated System View" principle by incorporating the involved actors in AA implementation, this artefact may be applied to include other principles like the "Clarity of Roles" by explicitly defining each actor's roles and responsibilities and communication strategies to foster "Collaboration". The roadmap may also encompass infrastructure-related targets to cover the principle of a "Dedicated Platform" implicitly. The case study also equips the practice with an initial assessment as the basis for the roadmap's development and periodic evaluation to maintain its relevance.

The case study offers insight into other practices. For instance, it enacts a series of practical guidelines for AA use in internal audit activities that explicitly state the roles of some actors in the AA project, including (part of) the external counterparts (from the audit team perspective). Although incomplete, it also partially defines the relationship between the internal audit team's analytic projects (AA) and the clients' analytics. Another novel practice is the use of a dedicated team to orchestrate AA implementation initiatives and bridge vertical and horizontal interactions among actors to enable better "Collaboration". This unit coordinates the AA implementation program, including devising and suggesting implementation strategies to the board, bridging communication among actors (horizontal communication) and levels (vertical communication), and even supervising and assisting AA project development by audit teams. This practice expands the existing notion of an 'innovation unit' to support the ideation phase of the AA project, as indicated in the literature (Krieger et al. 2021 Finally, given its already established infrastructure, the case study exemplifies the "Dedicated Platform" through a centralized data warehouse (and exchange) infrastructure and protocols.

Practically, this research suggests combining a top-down and bottom-up approach and long-term and short-term efforts to address challenges and implement AA as a transformational effort. From a broader perspective, this research finds that AA implementation requires action beyond IAF as an organization and the organization to which the IAF belongs, and hints at the need to reach policymakers and professional bodies, such as to develop a sound internal audit standard to mitigate emerging risks associated with AA implementation and to improve academic and professional curricula for the internal auditor.

Nevertheless, as explicitly expressed in Chapter 7, the exemplified practices are primarily derived from government institutions, which may be perceived as a 'bureaucratization'. Hence, considering the nature of the framework as a means-end knowledge and the high-level and normative statements, the practical use of the principles should consider the actual context in which it will be applied. These

examples should not detract from the essential notion of the principles. The elements and guidelines provided in Chapter 8 help to adapt the high-level statements in the framework into a more tangible action beyond the examples from the case study. Additionally, in utilizing this framework and applying the principles, it is critical to recognize the potential caveats or contingencies of the principles and the (exemplified) practices, as outlined in the case study and the evaluation results.

9.4. The Future of Digitalization for Internal Audits

This research focuses on AA as one of the digitalizations in the organization that impact internal audit practices, resulting in a digital transformation for the IAF and the organization. This study, however, is aware of other opportunities and challenges of technological advancements for internal audit activities. In particular, two technologies have already permeated and revolutionized business processes, namely blockchain and artificial intelligence (AI). Without digging deeper into these technologies, this section briefly highlights the potential interesting avenues, both scientific and practical, in the field of internal audit.

Blockchain is a "distributed digital ledger of cryptographically signed transactions that are grouped into blocks. Each block is cryptographically linked to the previous one (making it tamper-evident) after validation and undergoing a consensus decision. As new blocks are added, older blocks become more difficult to modify, creating tamper resistance)." (NIST in Popchev et al., 2021, pp.1 -2). This technology has the potential to transform business processes and enable the solid integrity of business transactions' records. However, it implies an entirely different set of governance, control, and techniques in which internal auditors are concerned regarding their tasks (Hugh et al., 2017).

This technology has huge implications for internal audit. While the full extent of the impact of this phenomenon seems to be still expanding, internal audit, at the very least, has to be ready for a new technical environment and 'data format' for performing data analysis and examining evidence for internal audit tasks (Hugh et al., 2017). Hugh et al. (2017) further argue that internal auditors must adapt to encounter different criteria of appropriate transaction controls as a basis for audit techniques, as opposed to the ones used, for instance, in the 'traditional' relational database. Therefore, this advancement invites many interesting avenues for future research in this field.

Another intriguing and rapidly spreading technology is artificial intelligence (AI). Similar to AA, AI can be perceived as a tool to improve IAF's effectiveness and efficiency (Omoteso, 2012). In this perspective, AI can be used to assist auditors in performing their tasks (e.g., data analysis). Nevertheless, in this assessment, Omoteso (2012) warned about one of the risks of overreliance and how it may influence the output of internal audit tasks. This research identified some issues in this matter, namely potential bias and the risk of counter-analytics. Additionally, technological advancements also go hand-in-hand with technological risks like cybersecurity, which influence technology-driven audit practices, including AA and the use of AI. While these risks are omitted in this dissertation, given their limited relevance in the

research's context, their significance and impact may be elevated as AI becomes more ubiquitous in internal audit tasks and thus may require a specific principle to overcome it. Hence, it may be relevant for future AI-related internal audit research.

Moreover, AI can also be perceived as another area for internal audit tasks (or 'object') (Raji et al., 2020). The immediate risk from this technology is its negative social impact, which is presumably unintended, although in some cases, it creates a huge backlash and allegations of its intentional nature then emerge, e.g., as investigated by Hadwick & Lan (2021). In addition, IAF may also be 'requested' to assist the organization in implementing AI and harnessing its potential. Von Richthofen et al. (2022), for instance, assert some prompt issues to be considered by the organization and, by extension, the IAF for its service, like the change in skillset and business routines (that may influence the effectiveness of internal control system), and the importance of leadership and management supports. Besides its practical quandaries, this technology also opens up prospective research agendas, like developing an AI audit framework to capture its benefits and avoid its possible negative consequences.

9.5. Research Limitations

This research achieves its objective and answers the research questions as mentioned in Section 1.4. Nevertheless, this study, including its findings and the insights derived from the findings, should be viewed with consideration of its limitations and the implications for the research results.

The initial part of this research relies on the concepts found in the extant literature. Nevertheless, the search strategy and the literature source may limit the number of relevant articles. In particular, the use of Google Scholar and Semantic Scholar as database sources serves a breadth of coverage while, at the same time, it may suffer from the lack of more targeted literature. Therefore, while this research can be considered to encompass sufficient notions, particularly related to challenges of AA implementation, as demonstrated from the subsequent phases of the study, the possibility of other challenges omitted cannot be fully nullified, which implicates the possible additional principles not incorporated in the framework.

Building from the accumulated knowledge from the extant literature and discourses, this study aims to capture the lessons learned from the AA implementation phenomena. Several limitations regarding this matter are acknowledged in this research.

First, the specific context of the research provides an in-depth view of the research setting. Nevertheless, this choice may suffer from the findings' limited generalizability and external validity. In addition, the identified key challenges and the proposed principles in this study were derived from the respondents within this study context, which may be different in another setting. This study conducts external evaluations of the proposed framework to address this limitation. Nevertheless, the external practitioners come from arguably similar contexts to ensure their understanding of the matters and maintain the relevance of their view with the resulting framework.

Another shortcoming is the use of practitioners as the data source. This choice provides a first-hand and real-world experience. However, the analysis may be influenced by the respondents' limited expertise and possible subjectivity. Moreover, this research approach also suggests that the result depends considerably on the respondents' knowledge and experience of the analyzed matter and may limit its applicability in their particular context. In addition, the observations of the phenomena were made through memory recollection from the study participants of each phase and case. Therefore, although mitigated by the combination of measures like the use of multiple respondents and consensus among respondents (for MICMAC-ISM analysis), diverse projects and actors (for the case study), and internal and external calibrations of the result (for the evaluation), this method also acknowledges the nature of possible subjectivity and memory recollection from the respondents.

Related to the previous premise, the participants' selection also encountered its own limitations. There are limited numbers of diverse projects and individuals as research objects and participants with sufficient dynamics and experience in AA implementation. However, this study was fortuitous in finding an institution that was willing to be observed and interviewed, securing sessions with practitioners from different industries, including startups (fintech), banking, and logistics, in addition to participants from government agencies to observe and unravel the framework and to evaluate the developed framework.

Another possible issue is related to the research bias, i.e., distortion in the research process that may influence its results, both from the researcher's and respondents' side. This research utilized several approaches, as mentioned in Chapters 3, 7, and 8 of this dissertation. Generally, this research used a pilot test for the data collection protocol (e.g., interview guiding questions), clarification of the transcript and summary or key notion to the interviewees, and intercoder assessment to mitigate this issue. Particularly for the evaluation phase, this research further enhanced the approach through the use of scenario-based questions, disconfirmation, probing, and asking for examples based on the interviewees' experiences. These measures may reduce the risk of bias. However, we are aware that they may not fully eliminate such risk entirely.

Another constraint is the dynamic nature of the domain, which is inherently related to technological advancement and its implications and contextually related to internal audit activities. Digitalization and technological advancement are rapidly advancing, with various formats and applications. However, the impact of other technological advancements may not be considered in the developed framework. Therefore, it may be fruitful for future studies to reckon the principles' applicability to the use of nascent technologies like artificial general intelligence or pioneering technologies like blockchain for internal audit activities, which will be further elaborated on in the next and last section of this dissertation.

In general, the qualitative approach used in various parts of this study offers a rich and in-depth insight into the phenomena being studied. Particularly, a case study's primary value is to capture the in-depth essence from real-world experiences

of phenomena of interest and not necessarily establish generalizable facts (van der Voort et al., 2019). Furthermore, the proposed framework, developed from the case study and evaluated by internal and external professionals, strengthens the cohesiveness of the results. This choice, however, may limit the breadth of this paper's possible scope. On the one hand, the principles' nature as normative statements is valuable as they allow for different practical translations in various contexts; however, on the other hand, this characteristic entertains the possibility of unintended impact of the practice in different settings, as outlined in the caveats or contingencies of each principles mentioned in Chapter 7.

The above limitations assert the possible constraints of this study. However, this notion does not entirely negate the value of the framework and its validity and the evaluation results. The limitations, nonetheless, open up for further exploration to enrich the framework and enhance its value for the field.

9.6. Further Research

9.6.1. Future Improvement of the Framework

This research offers an exploratory prescriptive theory for AA implementation by IAF developed in a particular context. For this purpose, this study combines the appropriate methods using pragmatism philosophy. Building on this study's findings, further research can expand the framework of this research. Hence, while this study's results are empirically well-grounded and evaluated, it opens for future research to reaffirm or expand the framework developed in this research.

Revisiting this Research

The pragmatic philosophy allows this study to use various methods in each phase that suit both the overall and each phase's objectives. This approach aligns with the research nature of this exploratory study to develop a principle-based framework to address the challenges based on real-world experience (i.e., the existing studies in this field either provide conceptual analysis, descriptive framework, principle-based but disconnected from the challenges, or project-level/based). Hence, this pragmatic approach enables this research to achieve its objective and deliver the initial principle-based framework as one of its outputs. Nevertheless, this research may suffer from limited generalizability from this approach, as the main contents (i.e., the key challenges, the principles) resulted from the specific context. Although the result is evaluated with practitioners, the selected practitioners are also coming from a similar setting to ensure the relevance of their experience.

Therefore, building on the above notion, future research can utilize the Design Science Research (DSR) methodology to 'calibrate' the proposed framework from this study. A comprehensive approach like DSR can refine the initial exploratory principle-based framework resulting from this research to deliver a (possibly more) coherent framework and improve its 'value' (relevance, completeness, accuracy, clarity, and practical usability). Building from the identified principles and challenges from this study, future research can aim to calibrate the framework by determining the requirements (or criteria) for the framework in the relevance cycle, re-design (or

improve) the framework in the design cycle, and empirically re-test in the rigor cycle; referring to DSR steps (vom Brocke et al., 2020).

Methodologically, future research may bring alternative approaches for each phase, extending the methods employed in this study. First, in the relevance cycle, future research can utilize, for example, a large-scale survey with a broader and diverse pool of practitioners to calibrate the challenges identified from the literature in this research. The survey can be conducted in a similar setting to this study (e.g., Indonesian internal audit community) or in a different contextual setting or settings (e.g., comparative surveys of internal audits in different countries). The quantitative analysis from the survey will affirm, expand, and update this study's findings on the challenges of AA implementation. The survey can also target broader aspects, such as additional concerns for technology-driven matters, such as cybersecurity or privacy issues, and the criteria for an effective framework as a baseline for later evaluation. Second, the design cycle can use methods like prototyping or apply the same method, such as case studies, across different settings to gain broader insights. Alternatively, building on this research, future studies can collaborate with the relevant regulatory bodies in Indonesia (such as BPKP for government internal audit and OJK for finance and banking internal audit) to optimize and enhance the initial exploratory framework or to design the 'prototype'. This approach will also expand the framework's applicability beyond the single setting of the selected case. Finally, considering that the exploratory study has been performed (through this research), the rigor cycle can use a stronger approach to test the framework, such as an experiment or quasi-experiment. Similarly, a large-scale survey in a similar setting (Indonesia) or a broader setting (internal audit community from various countries with different characteristics) will improve the generalizability of the updated framework.

Alternative Method(s) for Research Phases

Some limitations in each step of this research also open up alternative approaches in future studies. First, by working on the limitations of the literature review and considering the rapid advancement of analytics in the field of auditing, this study encourages future reviews of AA-related studies using different methods and databases for article sources. Future reviews can employ different analysis techniques to enhance the field, such as textual analysis, as suggested by Singh & Singla (2021). Considering the rapid advancement of technology, future reviews can observe if there are any emerging significant challenges requiring additional principles to overcome. Secondly, future studies can strive for participant groups that may not be captured in this research, such as audit committee or relevant professional bodies[38] committee members. Alternatively, professionals from regulatory bodies, as also suggested above, such as BPKP or OJK (in Indonesia, or SEC, for example, in the US setting), may also be involved as participants for future studies (i.e., in MICMAC-ISM analysis or evaluation phase). Moreover, to address the possible

[38] For example, global, regional, or local chapters of the Institute of Internal Auditor (IIA) or ISACA.

limited expertise of practitioners, future works may opt to use experts who meet the criteria suggested by Shanteau et al. (2002).

Moreover, as suggested earlier, future studies can employ different strategies for a case study. For instance, it can be a single case in a different setting (e.g., a government agency in a different country) or comparative case studies from different entities/industries, such as comparing Indonesian internal audits in government agencies and state-owned enterprises (SOEs), or government internal audits in different countries. This approach will be beneficial for identifying opportunities to adapt and extend the principles' use in various contexts or even in a broader field. This approach can investigate if other case studies have different challenges and different principles, and if this framework only applies to IAF or if it might also apply to external audits.

9.6.2. Future Research on Technology-Based Innovation in Internal Audits

From an even broader standpoint, this field is rich with various forms of digitalization in internal audit or general audit topics, like the use and impact of blockchain or AI for internal or general audit, as presented in Section 10.4. Therefore, it will be interesting to explore those technologies and their implications for the field.

Blockchain for Internal Audits

Hsieh & Li (2024) list numerous research opportunities worthy of future examinations of blockchain's impact on auditing. From a technical perspective, research in designing a framework for internal (or external) audit projects in dealing with blockchain environments is a fruitful avenue. This type of research focuses on a framework at the project level, similar to project-level frameworks in AA-related research by No et al. (2019) or Yoon et al. (2021). From a more conceptual perspective, research on blockchain can aim to understand the impact of blockchain on organizations' governance, risk management, and control pertinent to the role of IAF. This perspective may also include the ethical and legal implications of this technology, which (internal) auditors should consider. On a broader or higher level, future research may aim to develop a framework or capabilities for IAF in implementing blockchain audits at the organizational level. This type of (future) study may take inspiration from this research's results and answer the question: Will the same principle(s) be applicable?

Artificial Intelligence: Tool and Object for Internal Audits

Unlike blockchain, which is treated as an 'object' to internal audit activities, AI can be an object as well as a tool for internal audits (as mentioned in Section 9.4.). Therefore, it invites more research avenues for this field.

As a tool, AI is the advancement of AA, albeit with different characteristics and possibly involves more profound socio-technical complexities. Therefore, for starters, all research directions presented in the previous subsection for AA (Section 9.6.1.) are applicable to this phenomenon (AI as a tool for internal audit). While conceptual or literature-based frameworks for AI use in internal audits are available

(Shivram, 2024), this field may benefit from an empirically grounded prescriptive framework. Moreover, considering the limited discourse of this type of framework in this AI for internal audit, an exploratory approach in all its phases, similar to this dissertation, may still be relevant. In general, conceptual and empirical examinations to better understand the implications of AI use for internal audits (e.g., the ethical and legal impact of audit projects performed entirely or partially with AI) are interesting directions for this field.

Conversely, research on AI as an object for internal audits (or general audits) is relatively more mature. Several professional bodies have already developed frameworks[39] for AI audit (with various terms, such as algorithm audit or ML audit), albeit some are still in the draft version for consultation (Algemene Rekenkamer, 2024; ICO, 2020; the IIA, 2024). Nevertheless, scientific inquiries are still open in this domain. For instance, while frameworks for AI audit exist, each framework derives from a practical standpoint and has different emphases, such as on the organization and roles surrounding AI use by organizations or on the process of developing an AI project. Therefore, comparative analysis based on a relevant theory (or theories) on those frameworks may yield a coherent perspective to advance this field further.

9.6.3. Summary of Research Directions

This research is an exploratory study to develop a principle-based framework for AA implementation. Building on this research's result, further research can re-examine and improve the framework using different methodologies. Furthermore, the limitations of this research also invite future studies of this phenomenon.

Finally, AA implementation is one of the many technology-driven innovations in internal audits. Therefore, further research may examine other phenomena of technology-driven innovations like blockchain and AI and their implications for the future digitalization of internal audits.

[39] For instance: https://www.rekenkamer.nl/onderwerpen/algoritmes/toetsingskader, last accessed 04-11-2024, 21:03 CET;
https://www.theiia.org/en/content/tools/professional/2023/the-iias-updated-ai-auditing-framework/ (member only), last accessed 04-11-2024; or
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Online Appendices

Online appendices can be accessed online at:

https://doi.org/10.4121/fcfdd1db-b653-4647-9533-11d9231d3e7d

The online appendices consist of:

1. Informed Consent Forms
2. Summary of Focused Group Discussion (FGD) Results for MICMAC-ISM Analysis
3. Interview Guiding Questions for the Case Study
4. Requested Documents for the Case Study
5. Codebook (formatted) from the Case Study analysis
6. Interview Guiding Questions for the Framework Evaluation
7. Summaries of Interviews for Framework Evaluation

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Curriculum Vitae

Mochammad Gilang Ramadhan (**Gilang**) was born in Jakarta on June 1st, 1985. In 2010, he received his *Bachelor of Applied Sciences in Accounting with a specialization in Government Sector* from **PKN-STAN** (formerly known as "Sekolah Tinggi Akuntansi Negara" or "State College of Accounting"), Indonesia. In 2015, he was awarded a *Master of Public Administration with a specialization in Public Sector Management* from **Flinders University of South Australia**, Australia. Before starting his doctoral study and joining TU Delft, Gilang already held relevant professional certifications in the internal auditing and technology-related auditing domains (i.e., Certified Internal Auditor (CIA) from the **Institute of Internal Auditor**; and Certified Information System Auditor (CISA) and Certified in the Governance of Enterprise IT (CGEIT) from **ISACA**).

In early 2020, he received a scholarship from the Indonesia Endowment Fund for Education (**LPDP**). With this scholarship, Gilang joined the Information and Communication Technology Section at the Department of Engineering, Systems, and Services (**ICT-ESS**), Faculty of Technology, Policy, and Management at Delft University of Technology (**TPM-TU Delft**) in July 2021 and began his research on developing a principle-based framework for audit analytics implementation by internal audit function. This interest was driven by his education and professional experience and the limited discourse on the matter in the (then) extant literature of audit analytics and the internal audit field. His research enriches the theoretical lenses in viewing internal audit and audit analytics and advances the methods in this field.

During his period as a PhD candidate, Gilang published several journal and conference articles pertinent to his research. He also served the scientific community as the web administrator for the **EGOV Conference series and IFIP WG8.5** from August 2021 to May 2024 (https://dgsociety.org/egov-XXXX/), volunteer/supporting organizer at the **23rd International Digital Government Research Conference DG.o 2022**, and reviewer at the 22nd **I3E Conference in 2023**. In June 2024, Gilang was also invited as one of the speakers in a panel session titled "Navigating Topics in Digital Technologies and Methodological Diversity in Business Research" at the **3rd International Conference of the Journal of Information Systems** with other esteemed academics in accounting and information system fields. He also wrote and published popular articles related to the use of analytics for auditing and governance of digitalization. During the summer of 2022, Gilang also contributed directly to the practical domain by developing a technical internal audit guideline for **LPDP**. In 2024, he served as a reviewer for the Indonesian Student Congress (**KPI**), organized by the Indonesian Student Association in the Netherlands **(PPI Belanda**).

Apart from his academic and professional roles, Gilang has also been active in community leadership. He served as the chairperson for the Indonesian Muslim Community in Delft (**KMD**) for two consecutive terms (2022 and 2023) and as the coordinator of awardees sponsored by the Indonesia Endowment Fund for Education (**LPDP**) from October 2022 to August 2024.

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List of Publications

Articles

Published

Ramadhan, M. G., Janssen, M., & van der Voort, H. (2023). Driving and inhibiting factors for implementing audit analytics in an internal audit function. *Journal of Emerging Technologies in Accounting*, *20*(2), 135-163. https://doi.org/10.2308/JETA-2022-035

Work in Progress

Yustiani, S., Sholihat, N. I., Putra, H. H., & **Ramadhan, M. G.** The Many Faces of Internal Audit Function. (planned submission to the *Accounting, Auditing, and Accountability Journal*)

Ramadhan, M. G., Janssen, M., & van der Voort, H. Principle-based Framework for Audit Analytics Implementation. (planned submission to the *International Journal of Accounting and Information Management*)

Conference Publications

Published

Ramadhan, M. G., Janssen, M., & Van Der Voort, H. (2023). Transforming the internal audit function (IAF): An integrated MICMAC-ISM approach for unravelling the relationship among challenges. In *Conference on e-Business, e-Services and e-Society* (pp. 139-155). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-50040-4_11

Ramadhan, M. G., Janssen, M., van der Voort, H., Radarma, T. R. I., & Pratama, R. R. (2024). Hackathon for Skills Development: An Unorthodox Approach for Audit Analytics Implementation. In *Conference on e-Business, e-Services and e-Society* (pp. 272-283). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-72234-9_23

Under Review

Ramadhan, M.G., Janssen, M., & Wahana, A. S. More Than Just a Project! Guidelines for Transforming Audit Analytics in Action. (submitted to and under review at the *International Federation of Information Processing (IFIP) 2025 Conference*)

Workshop and Presentation

Ramadhan, M. G., Continous Auditing and Predictive Analytics Architecture. (2021). Abstract presentation at the 2nd Faculty of Management, Law and Social Sciences (FoMLSS) Annual Doctoral Conference, 24-25 February 2021, University of Bradford, UK.

Ramadhan, M. G., Challenges in Transforming to Audit Analytics. (2022). Research plan presentation at the Accounting, Auditing, and Accountability Special Issue Online Workshop, 19-20 May 2022, Kozminski University, Poland. 🗎

Ramadhan, M. G., Janssen, M., & van der Voort, H. Principle-based Framework for Audit Analytics Implementation. (2024). Research in progress presentation at the 3rd International Conference of the Journal of Information Systems, 24-25 June 2024, Monash University, Indonesia. 🗎

Note:

🗎 : Publications included in this dissertation

A Principle-Based Framework for Audit Analytics Implementation

M.G. Ramadhan

"Once a new technology rolls over you, if you're not part of the steamroller, you're part of the road."
– Stewart Brand –

As organizations increasingly embrace data-driven decision-making, internal audit functions (IAF) face growing pressure to move beyond traditional approaches. Audit Analytics (AA) holds significant potential to enable more proactive, continuous, and forward-looking services. Yet, its implementation has lagged behind, inhibited by a multitude of challenges, including technological, organizational, and cultural. In response, this study explores AA not as a mere technology adoption issue, but as a digital transformation, a catalyst for revisiting the IAF's role, structure, and relationships within the organization to which it belongs.

Along with a principle-based framework grounded in real-world practice, the study invites a broader inquiry: What does AA truly mean for the IAF? By engaging with real-world practice, this study opens a new perspective on understanding how IAF responds and embraces shifts in an environment shaped by rapid technological change.

Beyond the practical framework, the study also invites a more profound reflection: How well do established theories, like agency theory, explain the evolving realities of IAF? Through the lens of Socio-technical Systems (STS) and Complex Adaptive Systems (CAS) theories, this study not only offers empirical grounding for the conceptual and theoretical discourses in this field, but also raises new questions worth exploring, especially in the ever-advancing technologies for the internal audit to embrace.