Improving the Calibration Certificate Approval Process for Metrology Industry in Accordance with ISO 17025 by Using VBA

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Abstract

The metrology industry is heading towards digitalization and automation. Calibration reports provided by the metrology organizations are frequently used to establish compliance with the quality management system and legal obligations. Each calibration report requires manual approval, which is often time consuming and inefficient. This study focuses on developing a certificate approval system for a metrology organization using VBA. The new system will be developed using Visual Basic for Application in Excel and deployed into a metrology organization. The data will be extracted from the organization system, and a survey will be conducted after the implementation. This research uses the waterfall model which is a software development process that is carried out sequentially. The findings of this study indicate that the system has successfully integrated with the organization's process and has shown a significant impact on the time required to complete and approve a calibration report. According to the survey, users believe that it is easier and faster, accessible, adaptable, and overall, it complements the requirements needed by the organization. The practical use of these results can assist the company in increasing its productivity and efficiency in providing calibration reports hence, adding competitive value to its brand.

Keywords: Digitalization, Calibration Reports, VBA Automation, Workflow Efficiency, Metrology Organizations, ISO/IEC 17025, Certificate Approval

Introduction

Background of Study

The science of measuring and its application, with the International System of Units (SI) as its base, is known as metrology. According to (Newell & Tiesinga, 2019), the SI unit is defined as a consistent system of units for use in all aspects of life, including international trade, manufacturing, security, health and safety, protection of the environment, and in the basic science that underpins all of these. All scientists, technologists, and engineers are familiar with the system of quantities that underpins the SI and the equations that relate to them because they are based on the current description of nature. The SI unit system provides a

globally recognized and standardized system for measurement, ensuring consistency and accuracy in the scientific and technological field. Therefore, SI unit system is widely adopted and serves as the foundation for measurements in science, engineering, and a variety of other sectors around the world, resulting in the establishment of metrology.

Each country has its own metrology institutes that provide essential services that are related to measurement standards and traceability. These services include calibration services, development and dissemination of measurement standards to represent a country in international metrology organizations. To ensure the technical competence and reliability of the calibration result, the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) developed ISO/IEC 17025 specifically for testing and calibration laboratories. This standard is derived from ISO Guide 25 and ISO 9001, explicitly addresses the technical aspect for a metrology organization, including personnel qualifications, equipment calibration, testing methodologies, and quality assurance practices. ISO/IEC 17025 is an international standard, but the accreditation process and specific implementation may vary slightly between countries, as it is overseen by the national accreditation bodies such as UKAS in the United Kingdom, NATA in Australia, KOLAS in South Korea, SAMM in Malaysia, etc. Although the national regulations and guidelines that laboratories need to adhere may vary between accreditation bodies, each country are allowed to have mutual recognition across border through international agreement such as ILAC MRA to further facilitate the global acceptance of test results. In Malaysia, the National Metrology Institute (NMI) is knowns as National Metrology Institute Malaysia (NMIM) and the accreditation is governed by the Malaysia Laboratory Accreditation Scheme (SAMM).

A calibration is a process of comparing a measurement instrument to a known standard and the standard is traceable to SI unit system. Besides that, the process able to identify the accuracy of the instrument and ensure the measurement that taken from the instrument is reliable and consistent. Each calibration of an instrument will result is calibration report indicating the records of the result of measurement made on the instrument during a calibration process. The expression of uncertainty in measurement is a systematic approach that involves statistical calculation to determine the expanded uncertainty, coverage factor, confidence level etc. Hence, most of the metrology organizations will require a spreadsheet to compute the result before tabulating to the calibration report. Microsoft Excel is widely used to perform calculations due to its accessibility, flexibility and ability to handle structured data analysis. Its integration with Visual Basic for Applications (VBA) enables laboratories to build automated templates that support calculations, generate graphs, and produce standardized calibration reports.

In the current technology and digital era, many organizations are seeking solutions for automation and digitalization for their operation and processes. In accordance with the trends, Malaysian government had initiated Industrial 4.0 since 2018, which aims to digitally transform manufacturing and related services. Such initiative has shown that digitalization is able to increase efficiency and promotes innovation while reducing operational costs. Digitalization and automation could bring a significant impact to the metrology industry. Implementing automation to the metrology system could eliminate manual measurements, leading to a high degree of repeatability, accuracy, and reduce human error. Besides that, it could lead to faster throughput and shorter production cycle. Digitalization and automation

are not merely technological advancements but a fundamental focus shaping our world. The importance spans across business, daily life, and society, offering efficiency, innovation, and progress.

Research Questions
This research addresses the subsequent issues:
1. How can an automated certificate approval system enhance the security, usability and efficiency of multi-level approval process in organizational settings.

Problem Statement
In Malaysia, metrology organizations provide accredited calibration services to industries such as aviation, oil and gas, manufacturing, and pharmaceuticals to ensure measurement accuracy and compliance with MS ISO/IEC 17025. Calibration reports issued by these organizations are essential documents for demonstrating traceability to the SI system, meeting quality management requirements, and fulfilling legal obligations.

ISO/IEC 17025:2017 specifies that each calibration report must include key information such as customer details, calibration dates, standards used, and the names of the personnel who performed and approved the calibration (ISO/IEC 17025:2017, 2017). The approval must be carried out by an authorized signatory who is technically competent and recognized by the national accreditation body. Most organizations still rely on manual processes, where staff prepare reports and physically sign each certificate to meet these requirements.

As certificate volume increases often reaching 100 to 200 reports per day manual approval becomes time-consuming and inefficient. This paper-based workflow leads to poor data integrity, higher risk of human errors, and increased operational costs. Moreover, the rising workload places pressure on laboratory staff, contributing to stress and job dissatisfaction. Khomariah (2020) highlights that heavy workloads increase turnover intentions, while Paramarta and Setiyowati (2024) also note that job stress significantly raises the likelihood of employee turnover.
Therefore, digitizing the calibration report approval process is necessary to improve efficiency, ensure accuracy, reduce staff burden, and enhance overall productivity within metrology organizations.

Research Objectives
The objective of this research is to:
1. To implement a certificate approval system for a metrology organization.
2. To evaluate the security, usability and efficiency of the system in an organizational setting.

Research Scope
The target of this study is a metrology organization that is in Malaysia with a total of 80 employees. This metrology company is using Excel spreadsheet to compute its measurement uncertainty. Besides that, the customer details and instrument information are all located in the spreadsheets. Hence, this study will be focusing on the process of certificate approval after a calibration report is ready for approval. It will not cover the process of generating certificates, management of certificates and other processes. The target group of the study is from the technical department and are only applicable to approved signatory who are the

personnels involved in authorizing certificates. This study should not target personnel from administration, finance, logistics, sales department and non-technical related department.

Literature Review

The important challenges of ISO/IEC 17025

ISO/IEC 17025 outlines requirements for competence, impartiality, and consistent operation of testing and calibration laboratories. It ensures accurate, reliable, and traceable measurement results. Miguel et al. (2021) highlights that ISO/IEC 17025:2017 strengthens laboratory quality management systems by emphasizing technical competence, result validity, and risk-based thinking. The standard helps laboratories implement systems suited to their operational scale and improve risk monitoring. Achieving accreditation is not an easy task, especially for organizations that providing testing and calibration services. Despite its benefits, implementing ISO/IEC 17025 can present challenges. Hullihen et al. (2009) report that accreditation requires significant cost, time, and personnel commitment. They also note issues such as staff fatigue, turnover, and the ongoing need for system improvement. Similarly, Panhwar et al. (2020) state that accreditation increases paperwork, workload, and operating costs, and that continuous improvement requires finding efficient ways to enhance processes and reduce resources. To successfully execute, laboratories must identify activities or elements that may affect expected findings, consider their culture and aim. The difficulty of continuous improvement is determining the best approach to change processes, goods, or services to save resources, improve output quality, or cut prices. It also requires a mindset that everything can be improved to better meet the needs of customers with fewer resources.

Role of Laboratory Information Management System (LIMS) in Certificate Approval

LIMS plays a critical role in supporting laboratory certification by enabling automation, traceability, and reliable data management. The WHO notes that LIMS improves access to high-quality testing, enhances data accuracy, and supports regulatory compliance. In regulated environments, LIMS automates workflows, instrument integration, and sample tracking, contributing to faster and more consistent results. Boyar et al. (2021) show that LIMS has become essential for compliance tasks, including electronic chain-of-custody, audit logs, and automated Certificate of Analysis (COA) generation. They also emphasize the need for adaptable LIMS due to constantly changing regulations. More advanced systems now include intelligent features such as lifecycle certificate management and alerts for calibration or qualification expiry (Zhu & Liu, 2019). In summary, LIMS strengthens certification processes, but effectiveness depends on organizational readiness, user competence, and appropriate system customization.

Visual Basic for Applications (VBA) Implementation

VBA continues to be used in many organizations for automating manual tasks. It improves efficiency by reducing repetitive work, calculation errors, and reporting time.
Program Studi et al. (2024) show that VBA automation improves sales reporting accuracy and reduces human error. Chaudhry et al. (2021) report a 50% reduction in data management time through a VBA-based platform for data organization and retrieval. Khan et al. (2021) also demonstrate that automated reporting with VBA reduced processing time by 88.56%. Although interest in Visual Basic research has declined with the rise of languages such as Python and C#, Nurjaman et al. (2024) find that VBA remains relevant for legacy systems and

continues to influence newer application development. Its strength lies in supporting existing infrastructure and enabling custom automation within Microsoft Office.

Digitalization and Automation in Malaysia
Malaysia's IR4.0 agenda aims to boost competitiveness through smart manufacturing and high-tech industries. However, digital adoption among SMEs remains limited. Tham and Yaakub (2021) note that SMEs must transform across organizational, cultural, and technological dimensions to remain competitive. Key barriers include low awareness, lack of strategic planning, skills gaps, high implementation costs, and integration difficulties (Abdulaziz et al., 2023; Balakrishnan et al., 2021). In contrast, SMEs that have adopted digital solutions report improved efficiency, cost reduction, and stronger customer relationships (Jaish et al., 2023). Thus, digitalization in Malaysia is progressing but still early in many organizations. Workforce upskilling, cybersecurity improvement, and strategic planning are essential to accelerate adoption.

Organizational Culture Challenges in Automation and Digitalization
Organizational culture strongly influences the success of automation initiatives in SMEs. Resistance to change, preference for traditional practices, and lack of training often hinder digital adoption (North et al., 2019; Perzylo et al., 2019). Many SMEs prioritize stability over innovation, causing employees to hesitate in using new technologies (Snieška et al., 2020). Managers may also lack awareness of digital transformation's strategic value (Wang, 2023). Risk-averse cultures further slow adoption efforts (Van Tonder et al., 2023).

Skill gaps remain a major barrier. Abu Bakar et al. (2024) note that limited technical knowledge often results from cultures that do not support continuous learning. Supportive organizational culture can ease digitalization, and digital transformation can, in turn, shift culture toward innovation (Raharjo, 2019).

Electronic Signature Implementation in Malaysia
Malaysia supports electronic signatures through the Digital Signature Act 1997 (DSA) and Electronic Commerce Act 2006 (ECA). These laws provide legal recognition for digital signatures and support secure electronic transactions (Kadir, 2012; Wong & Muhamad, 2022). However, the ECA excludes certain documents such as wills, trusts, and powers of attorney. Despite a clear legal framework, challenges remain, including interoperability issues and industry-specific requirements. Addressing these gaps is essential to strengthen e-signature adoption and support Malaysia's broader digital transformation goals.

Research Methodology
Strategies of inquiry are the guidance on how the research will be conducted, and specific methods are the procedures and tools of data collection, analysis, and interpretation (Creswell et al., 2018). This research aims to improve the certificate approval process within the metrology organization by implementing Excel macros in each Excel template available in the organization. The existing Excel template has been equipped with several macro that aims to execute the measurement uncertainty calculation and certificate presentation. This research will focus on a new Excel macro to digitalize the approval process for certificates. The digitalization process includes inserting personnel names and signatures and approval authentication for each template. Lastly, the Excel macro will push to production for real-

time usage and the practicability of the new process will be observed based on the number of days between the start of calibration and the end of calibration, which will be captured by the organization's ERP.

Software Development

Software Development Life Cycle (SDLC) is the backbone of software engineering practices, guiding the systematic and structured approach to creating high-quality software products (Pargaonkar, 2023). This research required to develop an excel macro to digitalize the approval process. The requirement for this research is well-understood, and the testing will be carried out when the macro is fully developed before integrating with the existing template. Therefore, waterfall model will be a more suitable for SDLC for this research.

Data Collection and Analysis

The data that is used in this research is primary data that is extracted from the organization ERP system. This research will adopt the data from previous month and the month after the system is implemented to visualize the effectiveness of this research. Furthermore, to have an overview of the personnel perspective, a short survey will be conducted to these personnel to understand the acceptance of the new feature. The survey will adapt and adopt from Technology Acceptance Model (TAM) develop by Davis in 1980s. The Technology Acceptance Model (TAM) is a widely recognized and influential theoretical framework in the field of information systems. It aims to explain and predict how users come to accept and use technology with three variable, perceived usefulness, perceived ease of use and attitude towards using. Table 3.1 shows the survey question for this research.

Table 3.1
Survey Question

Variable	Survey Question
Bibliography	a) Department b) Role c) Number of template use
Perceived Usefulness	d) Using Excel would enable me to accomplish task more quickly (Q2) e) Using Excel would increase my productivity. (Q3) f) Using Excel would make it easier to do my job. (Q4)
Perceived Ease of Use	g) Learning to operate Excel would be easy for me.(Q5) h) My interaction with Excel would be clear and understandable. (Q6) i) I would find Excel flexible to interact with. (Q7)
Attitude Towards Using	j) I like the idea of using this Excel. (Q8) k) I think using this Excel is a good idea. (Q9)

The survey question will be publish using Microsoft Forms and distributed in the organization to gather respondents. Each respondent will only be able to answer once.

Population and Sample Size

This research will be carried out with a metrology company. The company has multiple domains and over 100 excel templates to be considered. With the approval from the organization, this research will focus on production templates that are available in 6 different

laboratories with a total number of 90 templates. These 90 templates are Excel workbooks and cover almost 80% of template that is available in the company. The remaining template is in different format which is not applicable for this research. Besides that, there will be a total of 30 employees that are lab technician, engineer and approved signatory. This research will only focus on technical personnel that involve with the certificate report.

System Design

Personnel Database File

This personnel database file is designed to include the authentication of each template for each technical personnel that is available in the organization. The file is designed using Microsoft Excel instead of other database software (SQL server, MySQL, etc). Choosing Microsoft Excel often because it's simpler, and more straightforward for small data management activities. Microsoft Excel is frequently preferred over specialized database software due to its familiarity, usability and instant accessibility. Besides that, Microsoft Excel can be quickly set up for simple computations which are suitable for this research and easier to management by the organization because most of the users are already familiar with its interface. The database table is as shown in Figure 4.1.

User Name	Display Name (max 12 char)	Calibrated By	Approved Signatory	Signature Picture (Size: 100 x 40 pixel)	Authorised for Calibrated By	Authorised for Approved by
				Browse	Register Procedure	
desmond.leong	VBA Admin	TRUE	TRUE	\\sg-s-sing-nas01\CertOps\Common\E-signature\Signature File\Sample.png	A001a, A002a, A003a, A004a, A005a, A006a, A007a, A008a, A009a, A010a, A011a, A012a, A012b, A013a, A014a, A015a, A016a, A017a, A018a, A019a, A020a, A021a, A023a, A024a, A024b, A025a, A027a, A028a, A029a, A030a, A031a, A032a, A033a, A034a, A035a, A036a, A036b, A037a, A038a, A040a, A041a, A042a, A043a, N001a, N004a, N005a, N006a, N007a, N008a, N009a, N010a, N011a, N012a, N013a, N014a, N017a, G001a, B011a, B012a, B013a, B014a, B015a, B016a, B017a, B018a, B019a, B019b, B020a, B021a, N002a, N003a, N015a, N016a, P001a, P002a, P003a, P004a, P005a, P006a, P007a, P008a, P009a, P010a, P011a, P012a, E001b, E002b, E003b, E001a, E002a, E003a, E004a, E005a, E006a, E007a, E008a, E004b, T001,	A001a, A002a, A003a, A004a, A005a, A006a, A007a, A008a, A009a, A010a, A011a, A012a, A012b, A013a, A014a, A015a, A016a, A017a, A018a, A019a, A020a, A021a, A023a, A024a, A024b, A025a, A027a, A028a, A029a, A030a, A031a, A032a, A033a, A034a, A035a, A036a, A036b, A037a, A038a, A040a, A041a, A042a, A043a, N001a, N004a, N005a, N006a, N007a, N008a, N009a, N010a, N011a, N012a, N013a, N014a, N017a, G001a, B011a, B012a, B013a, B014a, B015a, B016a, B017a, B018a, B019a, B019b, B020a, B021a, N002a, N003a, N015a, N016a, P001a, P002a, P003a, P004a, P005a, P006a, P007a, P008a, P009a, P010a, P011a, P012a, E001b, E002b, E003b, E001a, E002a, E003a, E004a, E005a, E006a, E007a, E008a, E004b, T001,
vincent.lim	V. Lim	TRUE	TRUE	\\sg-s-sing-nas01\CertOps\Common\E-signature\Signature File\vincent.lim.png	A001a, A002a, A003a, A004a, A005a, A006a, A007a, A008a, A009a, A010a, A011a, A012a, A012b, A013a, A014a, A015a, A016a, A017a, A018a, A019a, A020a, A021a, A023a, A024a, A024b, A025a, A027a, A028a, A029a, A030a, A031a, A032a, A033a, A034a, A035a, A036a, A036b, A037a, A038a, A040a, A041a, A042a, A043a, N001a, N004a, N005a, N007a, N008a, N009a,	A003a, A005a, A018a, A020a, A023a, A024a, A025a, A027a, A029a, A031a, A032a, A034a, G001a, B019a, B019b, E001b, E002b, E003b, E001a, E002a, E003a, E004a, E005a, E006a, E007a, E008a, E004b,

Figure 4.1 Snapshot of personnel table.

Approval Process Excel Macro

Excel macro will be designed to enhance the process for approved signatory by digitalizing certain processes. The macro is designed to perform various user authentication verification and follow by applying signature images into the footer of the selected sheets in the excel workbook. A button will be assigned to this macro to have better interface on the worksheet. The overall workflow of the macro for approval process is shown in Figure 4.2 below.
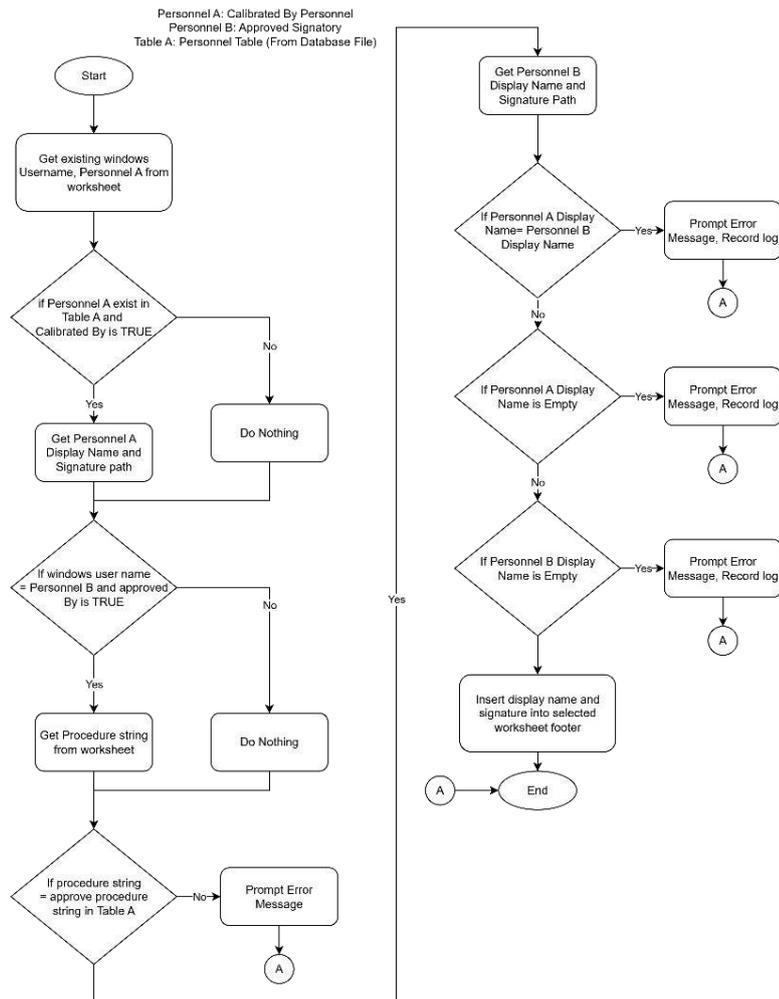
Figure 4.2 Approval process workflow

VBA code was developed for the processes for example for user authentication process as shown in Figure 4.3

```vba
'Initialize variable
pointer_done = False
target_cal_name = ""
target_cal_sign = ""
target_as_name = ""
target_as_sign = ""
x = 0

'Get Request Cal by and AS by
target_cal = Sheets(swms_sheet).Cells(39, 7)
target_as = Sheets(swms_sheet).Cells(40, 7)
swms_id = Sheets(swms_sheet).Cells(4, 20)

'Check AS entry
If target_as = "" Then
Else
    MsgBox "This ceritificate have been signed!", vbInformation, "System"
    Call log_entry("attempt to sign certificate.")
    GoTo ErrorHandler
End If

'Get Microsoft User Name
log_on_user = Environ("Username")

'Get Name and Signature
'Get Cal Information
For x = 3 To 300
    display_name = Sheets(user_sheet).Cells(x, 3)
    cal_by_approve = Sheets(user_sheet).Cells(x, 4)
    If display_name = target_cal And cal_by_approve Then
        target_cal_name = Sheets(user_sheet).Cells(x, 3)
        target_cal_sign = Sheets(user_sheet).Cells(x, 6)
        Exit For
    Else
    End If
Next x

'Get AS Information
For x = 3 To 300
    microsoft_name = Sheets(user_sheet).Cells(x, 2)
    as_approve = Sheets(user_sheet).Cells(x, 5)
    as_by_auth = Sheets(user_sheet).Cells(x, 8)
    If microsoft_name = log_on_user And as_approve Then

        For y = 37 To 46
            If y > 45 Or Sheets("Listing&Constant").Cells(y, 11).value = "" Then
                MsgBox microsoft_name + " not allow to sign this scope. Please contact Technical Manager.", vbCritical, "System"
                GoTo ErrorHandler

            ElseIf InStr(as_by_auth, Sheets("Listing&Constant").Cells(y, 11).value) Then
                target_as_name = Sheets(user_sheet).Cells(x, 3)
                target_as_sign = Sheets(user_sheet).Cells(x, 6)
                Exit For
            Else
            End If
        Next y
        If target_as_name = "" Or target_as_sign = "" Then
        Else
            Exit For
        End If

    Else
    End If
Next x

'Check AS Name and Cal Name, STOP if both same name
If target_cal_name = target_as_name Then
    MsgBox "Duplicated Personnel Detected!", vbInformation, "System"
    Call log_entry("is the calibration personnel for this item.")
    GoTo ErrorHandler
Else
End If

'Verify Signature Availability
If target_cal_sign = "" Then
    MsgBox "Calibrated By Personnel Not Found", vbExclamation, "System"
    GoTo ErrorHandler
ElseIf target_as_sign = "" Then
    MsgBox "Approved Signatory Personnel Not Found", vbExclamation, "System"
    GoTo ErrorHandler
Else
End If
```

Figure 4.3 VBA code for user authentication

System Implementation and Analysis
Result and Analysis
Template implementation
Figure below shows the analysis on number of days required to complete a calibration report on May 2025 and June 2025 before the template is modified and July 2025 after the implementation.

Count of Working Days Difference	Column Labels																																						
Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	31	32	33	34	35	39	41	42
CLIMATIC		24	4	8		13		11	3	2		1		2			1		3	2		1	1														
DIMENSIONAL		55	191	203	172	128	41	36	19	17	6	4	3	4	2	3	2		4	10	7		1	2	1		1	5			3	1			9		
FORCE-TORQUE	4	27	49	55	63	37	14	7	4	10	6	5	7	4		5	2	1	1		2	1															
MASS - WEIGHT		4	6	20	11	13	16		7	2		1		1			2			1				1					1		1						1
PRESSURE	3	46	33	38	18	43	31	20	8	13	4	2	8	2	1	3	1				1	1															
TEMPERATURE - HYGROMETRY	4	44	61	75	72	30	27	6	22	21	9	4	2	3		4	4			1	2		5		4					1	1						
Grand Total	11	200	344	399	336	264	129	69	71	66	27	16	20	14	4	15	6	5	12	10	1	2	7	2	7	2	5	5	1	1	3	2	1	1	9	1	

Figure 5.1 Number of working days difference in May 2025

Count of Working Days Difference	Column Labels																								
Row Labels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	23	30	31
CLIMATIC	2	5	15	15	8	4	7	5	2	3	4	1	1	1	1		3			1				
DIMENSIONAL	41	91	146	208	109	67	50	27	19	28	3	5	1	8			5						1	1
FORCE-TORQUE	5	60	48	36	13	18	10	8	1	1	1	7	4			2			1		2	1		
MASS - WEIGHT		7	12	10	25	11	8	7	8	3		4	4	1										
PRESSURE		21	51	66	27	39	49	33	19	13	1	1	3	3	2	4	6		1	11	1			
TEMPERATURE - HYGROMETRY	2	33	58	42	44	57	21	11	32	12	6	2	10	11	2	2			1			2	2	
Grand Total	50	217	330	377	226	196	145	91	81	60	15	20	23	24	7	6	11	3	3	11	3	5	2	1

Figure 5.2 Number of working days difference in June 2025

Count of Working Days Difference	Column Labels								
Row Labels	1	2	3	4	5	6	7	8	0
CLIMATIC	1		1	2	3				4
DIMENSIONAL	107	86	36	43	11	7			63
FORCE-TORQUE	25	26	3	4	6	3	6		36
MASS - WEIGHT	3	1	5		3				3
PRESSURE	9	20	10	1	16	12	9	12	32
TEMPERATURE - HYGROMETRY	24	21	8	6	16			2	38
Grand Total	169	154	63	56	52	25	15	14	176

Figure 5.3 Number of working days difference in July 2025

Based on Figure 5.1 to 5.3, the data extracted from ERP system shows that during May and June 2025 where before the implementation of this research, the number of days for approvals is typically 3-5 working days. After the implementation of this research, the number of days significantly reduced to 0 for various laboratories. There is a notable shift, with 176 same day approvals from the Dimensional laboratory, demonstrating an increase in processing speed when compared to earlier months, which had peaks on 3 and 4 working days. Other laboratories, such as Force-Torque and Temperature-Hygrometry, exhibit consistent processing within the first 5 working days across all 3 months, while the quantity of calibration reports is lower. While the improvements in same-day or next-day approvals for these categories are not as substantial as those for Dimensional.

Survey Analysis

This section presents the analysis of data collected through a survey to evaluate the user perspective on the implementation. The primary objectives are to assess the user acceptance of a new feature on the template. The survey targeted key personnel involved in certificate approvals, also known as approved signatories, including calibration engineers and calibration technicians. The data is analyzed in relation to the research objectives. Total of 30 participated in the survey. The survey is divided into three different variables; the first variable is perceived usefulness. Perceived usefulness is to analyze the degree to which a user believes that using a specific system would enhance job performance. (see Figure 5.4)

	Minimum	Maximum	Mean	Standard Deviation
Using Excel would enable me to accomplish task more quickly (Q2)	2	4	3.33	0.55
Using Excel would increase my productivity. (Q3)	2	4	3.36	0.55
Using Excel would make it easier to do my job. (Q4)	2	4	3.43	0.57

Figure 5.4 Perceived usefulness analysis

The figure shows that there are 3 questions in the survey for variable perceived usefulness. The mean ratings of 3.33, 3.36, and 3.43 for Q2, Q3, and Q4 are all greater than 3 ("Agree"), indicating that respondents generally agree that using Excel increases productivity, allows them to complete work more quickly, and simplifies their employment. The low standard deviations (0.55 and 0.57) imply that the replies were tightly packed around the mean, with little diversity in opinion. In short, the research indicates that respondents strongly agree on the merits of Excel.

The second variable is perceived ease of use. This variable focuses on how well a user believes he or she able to use the system effortlessly. The Figure 5.5 below shows the result for perceived ease of use from the survey.

	Minimum	Maximum	Mean	Standard
Learning to operate Excel would be easy for me. (Q5)	2	4	3.2	0.48
My interaction withExcel would be clear and understandable. (Q6)	3	4	3.26	0.45
I would find Excel flexible to interact with. (Q7)	2	4	3.2	0.48

Figure 5.5 Perceived ease of use analysis

This question's lower standard deviation of 0.45 further emphasizes the high level of agreement among the respondents. The last variable in the survey is to measure the attitude towards using a new system. The identical numbers for both questions suggest that the studied group has a strong and consistent positive attitude about using Excel.

	Minimum	Maximum	Mean	Standard Deviation
I like the idea of using Excel. (Q8)	2	4	3.33	0.55
I think using this Excel is a good idea. (Q9)	2	4	3.36	0.55

Figure 5.6 Attitude towards using analysis

Conclusion

The objective of this research is to implement a certificate approval system for a metrology organization and to evaluate the security, usability and efficiency of the system in organizational settings. This research had successfully provided a system that can be integrated with an existing template to augment it with the new function of digitally approving calibration reports. The implementation of a certificate approval system for the organization has proven to be both viable and efficient. By digitizing the approval process, the organization was able to expedite certificate management, eliminating reliance on manual paperwork and the possibility of human error. The solution successfully streamlined key approval workflows, ensuring that certificates were reviewed, signed, and issued in a timely fashion. This not only improved operational efficiency but also bolstered the organization's dedication to meeting metrology standards and client expectations.

In terms of security, the system provided effective safeguards for critical calibration data and approval records. Another important consideration was usability, and user feedback suggested that the system's was simple to use and useful for the organization operation. Employees were able to swiftly adjust to the new digital workflow. The improvements in efficiency were significant. The turnaround time for certificate approval was significantly reduced, with some approvals completed the same day, as opposed to the lengthier delays in the manual procedure.

Looking ahead, future enhancements such as integrating formal digital signatures could provide stronger authentication, automated authorization control, and more comprehensive audit trails. Modern digital signature solutions that integrate with Microsoft applications, web platforms, or mobile devices would further extend accessibility, enabling signatories to perform approvals from any device. Such advancements would continue to strengthen the organization's digital transformation and elevate its certificate management capabilities.

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