Implementation of ISO/IEC 17025:2017 in Indian Testing and Calibration Laboratories – A Multiple Regression Analysis for Sustainable Development

Manikandan.V[1], Dr.Harihara Shanmugam[2], Dr.P.R.Ramakrishnan[3]

[1] Ph.D. Research Scholar in Management Studies, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Pallavaram, Chennai, Tamil Nadu, India-600117.
[2] Assistant Professor, School of Management Studies, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Pallavaram, Chennai, Tamil Nadu, India-600117.
[3] Former Professor and Dean, School of Management Studies and Commerce, Vels Institute of Science Technology and Advanced Studies (VISTAS), Pallavaram, Chennai, Tamil Nadu, India-600117.
Email: [1] mani.venkatesh@revaphoenix.com, [2] rnrhari@gmail.com, [3] prrrkmvc@gmail.com
ORCID: [1] https://orcid.org/0009-0003-9413-1545, [2] https://orcid.org/0000-0001-6619-0335, [3] https://orcid.org/0000-0003-1030-2523

Abstract: Objective: Article attempt to investigate the factors influencing "ISO/IEC 17025: 2017" implementation in experimenting with calibration labs in India. **Approach:** We employed a cross-sectional survey method in this study. The responses were collected from managing directors/CEO, laboratories in charge, quality managers technical managers through structured questionnaires. The "National Accreditation Board for Testing and Calibration Laboratories (NABL)", India, released a list from which the sample was chosen. 525 usable responses were collected during the study. **Findings:** Observation gives execution of ISO/IEC 17025: 2017 was positively impacted by the attitudes, motivation, awareness, perceived internal and external benefits, and motivation. **Repercussion:** This study shows that the calibration and testing laboratories need gain sufficient knowledge to assure implementation, good attitude towards implementation, high enthusiasm to implement and understanding benefits of both internal and external following the adoption of "ISO/IEC 17025: 2017".

Keywords: ISO IEC 17025, Attitude, Awareness, Motivation, Perceived internal benefits, perceived external benefits, Implementation, sustainable development, environmental

1. INTRODUCTION:

The foundation for guaranteeing proficiency and dependability of testing and calibration facilities across the globe is ISO/IEC 17025. Through adherence to this criterion, laboratories exhibit their dedication to accuracy, quality, and ongoing progress.

To demonstrate the competence and the validity of the results, organisations involving testing and calibration laboratories need to comply with certain standards established by the legal body both domestically and internationally.As a prerequisite for the results of any testing and calibration laboratory to be accepted by other nations without the need for additional testing, such certification is crucial. As a result, the calibration and testing labs are now pursuing ISO/IEC 17025: 2017 accreditation.

Globalisation makes products available across the globe. A new need has evolved to improve the product and the services in the direction of global standards. And the emerging need to establish a global standardisation was the prominent criteria to make the products import or export across boundaries. Any brand should rely on its quality of their products besides mere marketing and the brand name no longer fetches customer satisfaction and market leader. Quality is the strategic tool for any business to succeed in competition, to achieve fulfilment for the customers, quality for achieve competitive advantages.Companies that were founded for standardized the field playing by all products globally developed standards for product quality.

1.1 Research Questions:

1. "Which variables influence the implementation of ISO/IEC 17025: 2017?

1.2 Research Objective:

To find the effect of Attitude, Awareness, Motivation, Perceived internal benefits, Perceived external benefits towards implementation.

2. REVIEW OF LITERATURE

Grochau,Caten, & de Camargo Forte, (2018) carried out an investigation at certified HEI laboratories across the American continent. The three main drivers of accreditation were external clients, institutional decisions, and regulatory needs. Lack of funding and manpower were regarded as the biggest obstacles, but an established laboratory organization and a driven workforce were seen as the key enablers for accreditation.

Martínez-Costa, M., Martínez-Lorente, A. R., & Choi, T. Y. (2008) used informations from the SABI (Sistema de Analisis de Balances Ibéricos) database to study with 100 employees in Spanish industrial enterprises. The results shows to implementing ISO 9000 with internal motivation produced high performance, while external motivation (customers/marketing tools) did not correlate with high performance.

Buttle, F. (1997) conducted asurvey.This survey was carried out among 4250 accredited organizations; 1220 of them answered. Factor analysis was conducted to understand the Motivation behind the implantation of ISO certification were process improvement and marketing benefits was identified as key principle motivators involved in implementation

Panagiotidou et al. (2024) studied the complex effects of ISO/IEC 17025 certification in experimenting with calibration facilities for civil engineering.The researchers used semi-structured interviewing techniques to get information from twenty-three business experts. The study involves clients, quality managers, technical managers, and external auditors.

Thematic analysis was employed to measure information. Outcome resulted the fact accreditation possesses a major influence on raising awareness of quality. Accreditation significantly improved other criteria like client happiness, process standardization, and ongoing improvement. The report highlights the difficulties the sector has in getting accredited, such as rising resource costs and administrative roadblocks.

Anyonga, Masinde and Maseses (2022) studied the attitudes of the staff at Kenyatta National Hospital regarding the acceptance ISO 9001: 2015 Quality Management Systems.Using a stratified sampling technique, 291 valid replies were obtained for samples. SPSS 20 was utilized to analyze the gathered data.The study's conclusions showed that employees had a favorable and comparatively strong opinion regarding the execution of ISO compliance.

In order to ascertain the crucial elements of ISO/IEC 17025: 2005 with accomplishment identifiers of laboratories for calibration and testing, Karthiyayini and Rajendran (2017) carried out a study. A survey questionnaire is prepared and administered to the quality/technical supervisors. To investigate the impact of important factors regarding the accomplishment indicators, multiple regression analysis is performed. The study's conclusion shows that accreditation had a significant impact on a number of factors, including customer and employee contentment, labefficiency, public image, and the number of recurring customers. Ultimately, this led to an improvement in the laboratory's performance.

Ingason, H. T. (2015) conducted research on Icelandic ISO 9001 standards accreditation organizations. Quality managers or managing directors were questioned for the study regarding how ISO 9001 was implemented in their company. The main success factors that contribute to the adoption of ISO 9001 have been identified as management support, staff participation, and employee involvement.

Alshahrani and Husain (2023) examined the efficacy of ISO 9001 standards implementation on achievements of SMEs. A study was conducted in Saudi Arabia. The effectiveness of implementation through the components of ongoing improvement, inhibition of eccentricity and clientcontentment. Performance is calculated with lens operational performance and product/service quality.263 SMEs were involved in the study, where the samples were selected through simple random sampling. The product quality or service, customer happiness, continual improvement, and the avoidance of nonconformities were all found to be importantly positively interacted operational performance.Performance by business showed a strong and positive correlation with an efficacy component of the ISO 9001 QMS.

The effects of ISO/IEC 17025 laboratory accreditation was examined by Okezue et al. (2020) with a particular emphasis on NMRA Labs for quality control in sub-Saharan Africa. The research' findings demonstrated that laboratory accreditation increases test report accuracy.These study findings confirm that the accreditation of the laboratory enhances the system for quality managementand also the researchers observed that the considerable drop in the frequency of nonconformities during the years following accreditation.

Naveh, E., & Marcus, A. (2005) investigates the impact implementation with 9000 on business avtion and operation performance.Hierarchical linear models were used to experiment the hypothesis, and the outcomes were confirmed by contrasting the long-term performance of the accrediting company with that of other, unvalidated firms. The study revealed that the experimentation with 900 improved operating performance of the organisation, but this does not necessarily improves the business performance.

Wickramasuriya, P., & Dharmasiri, A. S. (2010) do a study with packaging companies who were iso 9000 certified and all have 200 employees and have similarity in technology and machinery used. recorded interviews on audio tapes.They were transcribed and coded under 79 themes, Company image , management initiatives, Customer satisfaction, employee involvement were factors distressing the implementation effectiveness with respect toISO 9000 principles in Sri Lanka.

3. RESEARCH METHODOLOGY:

For this investigation, the methodology used was a quantitative research technique. The details for this investigation were gathered using a basic random sampling technique. The respondents were managing directors/CEO, Quality Managers, Technical Managers, laboratory Incharges were surveyed for responses to be collected for the research. A carefully developed questionnaire survey was used to gather the responses.8521 businesses received questionnaires by mail. Questionnaire were mail to the list supplied by the National Testing and Calibration Laboratory Accreditation Board (NABL, India), these companies were selected. A total of 525 usable questionnaires were successfully retrieved from 8521 labs.

Part1: Some of the information we need about the respondents for this study were age, gender, educational qualification and the designation they are in the laboratory.

Part 2: The purpose of this part is to comprehend the respondent and laboratory profiles. The location of the laboratory, types of laboratories, firm turnover, size, and age of the company.

Part3: This section is designed to know detailed information regarding the accreditation status with respect to ISO/IEC 17025/2027, training regarding ISO/IEC 17025:2017 attended or not. To understand the details related to documentation, we framed some questions like who is doing the documentation process, is that an external expertise,consultancyservices,third party assistance or employees of the laboratory. Also to understand whether employees alone or the management of the external agency is involved in the implementation process.

Part 4: In this section we intended to understand the attitude of the reactions towards ISO/IEC 17025:2017. Items were modified according to the Indian scenario.

Part 5: This section is designed to capture the awareness that the respondent is having towards Implementation ISO/IEC 17.25:2017.

Part 6: This is designed to understand the facts that are motivating them to implement ISO/IEC 17025:2017.The items were adopted from Magd 2008.

Part 7: The purpose of this section is to determine if the responders are meeting needs in the ISO/IEC 17025:2017 handbook. Every item was created using guidelines from manuals, requirements listed under general requirements, requirements for structures, resources, processes, and management systems to gauge execution.

Part 8: The purpose of this is to find out how respondents feel about the advantages they would experience (perceived benefits, including internal and external) after ISO/IEC 17025:2017 is implemented in their labs.

Scales : The collections of reactions on a 5-point Likert scale from 1 to 5 measuring from 1 as Strongly Disagree to 5 as supported.

Methods of gathering responses: An electronic mail was preferred to send surveyquestionnaire and whatsapp the questionnaire in google forms. Telephone interviews and personal interviews were conducted to collect data. SPSS 24.0 was used to conduct data analysis.

4. RESULTS OF DATA ANALYSIS

This section: "Results of Data Analysis" presents the outcomes from analyzing the data using SPSS, a software tool for statistical analysis. It includes tables, charts, and summaries that show patterns, trends, or relationships in the data. These results help us understand what the data is telling us and support conclusions based on statistical measures like averages, correlations, and significance tests.

4.1 Reliability

Reliability has consistency in scaling. Cronbach's Alpha, which shows how well a set of items assesses a single, consistent construct, is frequently used in SPSS to evaluate reliability. Speaking, a Cronbach's Alpha score higher 0.7 shows that informations is consistent and dependable enough for additional investigation.

Table 1: Reliability for each construct

Dimensions	cronbach Alpha value	Items
Attitude	.816	7
Awareness	.767	6
Motivation	.805	4
Perceived internal benefits	.744	6
Perceived external benefits	.729	4
Implementation	.827	10

4.2 Validity

Experimenting or measurement instrument evaluvate to supposed to calculate is known as validity. High validity indicates that the results accurately reflect the concept or phenomenon being studied, ensuring the findings are meaningful and applicable in real-world settings.

Table 2 validity for each construct

Dimensions	cronbach Alpha value	Bartlett's test of Sphericity
Attitude	.804	.000
Awareness	.816	.000
Motivation	.746	.000
Perceived internal benefits	.803	.000
Perceived external benefits	.758	.000
Implementation	.759	.000

4.3 Testing of the hypothesis

H_1: Psychological factors such as awareness, attitude and motivation are not dependent on implementation of ISO/IEC 17025:2017.

Multiple Regression: The findings are provided in overview of the study is given in table No. 1, which is designated Model Summary-1.R as well as R Square values, are.691 with.477, separately, are the most significant. These show that the weighted combination of the predictor factors accounted for 47.7% of the variation in implementation.

Table No. 3 - Model Summary-1

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.691[a]	.477	.474	.21671

a.Predictors: (Constant), Attitude, Awareness, Motivation.

Model's significance test is displayed in Anova Table No. 4. The total number of degrees of freedom is 525 (N - 1). There are three predictors and three degrees of freedom for the regression effect. The regression fitting the data well, as evidenced with fact statistically agreed the predict by dependent variables(F = 158.263, p <.0005). The combination of predictors can account for

a larger portion of the dependent variable's variance than chance alone since the regression effect is statistically significant.

Table No. 4- ANOVA-1

ANOVAª						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22.298	3	7.433	158.263	.000ᵇ
	Residual	24.468	521	.047		
	Total	46.766	524			

a. Represents the dependent variablewhich is Implementation

b. Represents predictorswhich are (Constant), Attitude, Awareness, Motivation

Important information on the link between the predictors (Attitude, Awareness, and Motivation) and the dependent variable (Implementation) may be found in the ANOVA table. They show as follows: Regression Sum of Squares (22.298): This indicates the extent to which the three predictors (Attitude, Awareness, and Motivation) account for the entire variance in the Implementation variable. Important predictors amount with overall variation (46.766), suggesting that they have a significant impact on implementation. The fraction of the overall variance that cannot be gives the predictors is represented by the squares residual sum (24.468). The better the model explains, the smaller this value is in relation to the regression sum of squares. F-value (158.263): A high F-value indicates a highly significant regression model. This implies that the Implementation variable is significantly predicted by the combination of Attitude, Awareness, and Motivation. Additionally, the high F-value gives the mothods has better job of data fitting. p-value (Sig. =.000): The results are statistically significant because the p-value is incredibly low (less than 0.05). This demonstrates that the combination of the predictors (motivation, attitude, and awareness) significantly affects the implementation variable and that this effect is not the result of chance.

Interpretation:

- **Attitude, Awareness, and Motivation** are strong predictors of **Implementation** in this study.

- This study model details about a significant amount of variationwith regard to Implementation, which is evidenced from high F-value and low p-value.

- Predictors used in the study provide a meaningful explanation for changes or differences in the Implementation variable, making them valuable for understanding and predicting implementation outcomes.

In summary, the analysis confirms that Attitude, Awareness, and Motivation significantly influence the Implementation variable in this study.

Table No. 5- Coefficients-1

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.744	.150		11.612	.000
	Attitude	.137	.017	.271	7.947	.000
	Awareness	.175	.027	.211	6.376	.000
	Motivation	.339	.027	.447	12.663	.000

Estimated model coefficients

The general form of the equation to implementation from Attitude, Awareness, and Motivation, is:

$$Implementation = 1.744 + 0.137(Attitude) + 0.175(Awareness) + 0.339(Motivation)$$

- H_2: Psychological factors such as awareness, attitude, motivation and perceived benefits are not dependent on the experimentation of ISO/IEC 17025:2017.
  The analysis' findings are displayed in Table No. 6 the R and R Square values (.727 and.529, respectively) in the model summary-2 table provide a overview of the conclusions. These show that the weighted combination of the predictor factors accounted for 52.9% of the variation in implementation.

Table No 6- Model Summary-2

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.727[a]	.529	.524	.20608

a.Predictors: (Constant), Perceived external benefits,Perceived internal benefits, Awareness, Attitude, Motivation.

The model's significance test is displayed in Anova Table No. 7. The total number of degrees of freedom is 524 (N - 1). Three factors and five degrees of freedom make up the regression effect. The regression methods sutiable for   the information, as evidenced with fact of the independent factors agree the dependent variable   predict (F = 116.426, p <.0005). The combination of predictors can account for a larger portion of the dependent variable's variance than chance alone since the regression effect is statistically significant.

Table No 7- ANOVA-2

ANOVAa						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.724	5	4.945	116.426	.000b
	Residual	22.042	519	.042		
	Total	46.766	524			

a: Represents dependent variable which is Implementation
b.Represents predictors which are (Constant), Perceived external benefits,Perceived internal benefits, Awareness, Attitude, Motivation.

The ANOVA table details about the outcome of a regression analysis where **Implementation** is dependent variable, and the predictors are **Attitude**, **Awareness**, **Motivation**, **Perceived Internal Benefits**, and **Perceived External Benefits**. Here's a breakdown of values:

Explanation of Values:

1. **Sum of Squares**:

The degree of variation in implementation that can be accounted for by the five—attitude, awareness, motivation, perceived internal benefits, and perceived external benefits—is represented by regression (24.724). A larger sum of squares here indicates that the predictors are explaining a predictorssubstantial part of the variability in the dependent variable.**Residual (22.042)**: This reflects the unexplained variance or error in the model, which denotes the part of total variance of**Implementation**that predictors do not account for.**Total (46.766): Addition of regression with residual sums of squares represents the overall variance of implementation.**
df (Degrees of Freedom):
   - o **Regression (5)**: Related with the five predictors used in the methods.

   - o **Residual (519)**: Remaining freedom degree, evaluated as the entire count of observations (524) control with count of predictors as well as the stable in the model.

2. **Mean Square**:

3. **o Mean Square Regression (4.945)**: Identified to separation of squares of the regression sum by the number of freedom degree in the model, this is tDetermined by dividing he average amount of   variation   evaluated   each   predictor.
    o **Mean Square Residual** (0.042): Identified to separation the residual sum of squares by its freedom, this pictures degrees representing the average variance cannot be explained.
4. **The F-value** (116.426) shows whether the model of regression is agrees is important overall. A high F-value represents the   amount variance with dependent   variable can be shows the

predictors taken together. The methods fits the data well in this instance, as evidenced the large F-value of 116.426.

5. **p-value (Sig. = .000)**: The valueindicates whether the outcomes of this study are statistically significant. A value of **.000** means the methods is highly important, indicating with five predictors together important predict **Implementation**. The likelihood of this result happening by chance is extremely low.

Interpretation of the Table:

- The regression model, which includes **Attitude**, **Awareness**, **Motivation**, **Perceived Internal Benefits**, and **Perceived External Benefits** as predictors, significantly explains the variability in the **Implementation** variable.

- The calculated**F-value** (116.426) corresponding the **p-value** of **.000**describes that these five predictors jointly have a statistically significant effect on **Implementation**.

- According to the regression total of squares (24.724), the account of predictors significant variance amount in implementation, with only a comparatively modest residual sum of squares (22.042) remaining unexplained.

CONCLUSION:

The model shows that **Attitude**, **Awareness**, **Motivation**, **Perceived Internal Benefits**, and **Perceived External Benefits** are important and statistically significant predictors of **Implementation**. The model is dependable for comprehending the components impacting implementation because the computed F-value as well as its corresponding p-value verify with predictors collectively noted the sizablevalues of the variation in the dependent variable.

Table- Coefficients-2

Coefficients[a]						
		Unstandardized Coefficients		**Standardized Coefficients**		
Model		**B**	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	1.069	.168		6.351	.000
	AT	.117	.017	.232	7.038	.000
	AW	.143	.026	.172	5.379	.000
	MOT	.276	.027	.364	10.302	.000
	PBI	.136	.032	.157	4.246	.000
	PBE	.119	.031	.139	3.811	.000

Estimated model coefficients

The general form of the equation to implementation from Attitude, Awareness, and Motivation, Perceived internal benefits, Perceived external is:

$$Implementation = 1.069 + 0.117(Attitude) + 0.143(Awareness) + 0.276(Motivation) + 0.136(Perceived\ internal\ benefits) + 0.119(Perceived\ external\ benefits)$$

5. Discussion and Conclusion:

When the people involved in executing ISO /IEC 17025: 2017 with the right attitude, better awareness and motivation towards the implementation process which eventually leads to the implementation of internal standards to a larger extent. Above all, when people perceive internal and external benefits of implementation, then there is a great positive impact in the implementation process.

To be very specific along with psychological factors when combined alongside perceived internal and external benefits adds up an increased effect in the process of implementation is observed from the study. This study is in line with Magd, (2008) who studied Egyptian manufacturing organisations.

REFERENCES:

1. Alshahrani, M.A. and Husain, K.S. (2023), "The effectiveness of the implementation of ISO 9001 on SMEs performance: the case of an emerging economy", *International Journal of Quality & Reliability Management*, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/IJQRM-08-2022-0233

2. Anyong'a, K. B., Masinde, J., & Masese, E. (2022). THE EMPLOYEES 'ATTITUDE TOWARDS ISO 9001: 2015 QMS AT KENYATTA NATIONAL HOSPITAL, KENYA. *EPRA International Journal of Research and Development (IJRD)*, *7*(3), 96-101.

3. Buttle, F. (1997). ISO 9000: marketing motivations and benefits. *International journal of quality & reliability management*, *14*(9), 936-947.

4. Grint, K. (1997). TQM, BPR, JIT, BSCs and TLAs: managerial waves or drownings?.*Management Decision*, *35*(10), 731-738.

5. https://doi.org/10.1016/j.ijpe.2003.10.018

6. Ingason, H. T. (2015). Best project management practices in the implementation of an ISO 9001 quality management system. *Procedia-Social and Behavioral Sciences*, *194*, 192-200.

7. Karthiyayini, N., & Rajendran, C. (2017). Critical factors and performance indicators: accreditation of testing-and calibration-laboratories. *Benchmarking: An International Journal*, *24*(7), 1814-1833.

Magd, H. A. (2008). ISO 9001: 2000 in the Egyptian manufacturing sector: perceptions and perspectives. *International Journal of Quality & Reliability Management*, *25*(2), 173-200.

8. Martínez-Costa, M., Martínez-Lorente, A. R., & Choi, T. Y. (2008). Simultaneous consideration of TQM and ISO 9000 on performance and motivation: An empirical study of Spanish companies. *International journal of production economics*, *113*(1), 23-39.

9. Martínez-Costa, M., Martínez-Lorente, A. R., & Choi, T. Y. (2008) conducted a study among Spanish industrial companies with more than 100 employees listed under SABI ((Sistema de Analisis de Balances Ibericos) database which reveals that an implementation of ISO 9000 when done with

the internal motivation has resulted in high performance where external motivation(customers/marketing tool) is not associated with high performance

10.Naveh, E., & Marcus, A. (2005). Achieving competitive advantage through implementing a replicable management standard: Installing and using ISO 9000. *Journal of operations management*, *24*(1), 1-26.

11.Okezue, M. A., Adeyeye, M. C., Byrn, S. J., Abiola, V. O., & Clase, K. L. (2020). Impact of ISO/IEC 17025 laboratory accreditation in sub-Saharan Africa: a case study. *BMC health services research*, *20*, 1-9.

12.Okezue, M. A., Adeyeye, M. C., Byrn, S. J., Abiola, V. O., & Clase, K. L. (2020). Impact of ISO/IEC 17025 laboratory accreditation in sub-Saharan Africa: a case study. *BMC health services research*, *20*, 1-9.

13.Panagiotidou, E., Chountalas, P. T., Magoutas, A. I., & Kitsios, F. C. (2024). The multifaceted impact of ISO/IEC 17025 accreditation: a sector-specific analysis in civil engineering testing and calibration laboratories. *The TQM Journal*.

14.Wickramasuriya, P., & Dharmasiri, A. S. (2010). Factors Affecting the Implementation Effectiveness of ISO 9001 (2000) Standard and its Impact on Business Results. *Sri Lankan Journal of Management*, *15*(2-4), 1-12.