International Journal of Academic and Applied Research (IJAAR)
ISSN: 2643-9603
Vol. 5 Issue 4, April - 2021, Pages: 3-14

The Impact of Accreditation on Laboratories Performance Regarding ISO/IEC 17025:2017 (A Case Study: Nano for Measurement and Calibration Center, Khartoum State- Sudan)

[1] Shareef Mohmoud Hassan Mohamed, [1]* Tayseer Elamin Mohamed Elfaki, [2] Ammar M. S. Abdalla

[1] M.Sc. student in Total Quality Management and Excellence, Sudan University of Science and Technology, Khartoum, Sudan
[1*] Department of Parasitology and Medical Entomology, College of Medical Laboratory Science, Sudan University of Science and Technology, Khartoum, Sudan
[2] Department of Crop Protection, Faculty of Agricultural Sciences (FAS), University of Dongola, P. O. Box 47, Dongola, Sudan
Email: [1] shareefmahmood19@gmail.com, [1]* tayseeralfaki5@gmail.com
[2] ammarsorag@gmail.com, dr.ammar@uofd.edu.sd
***Corresponding Author**: tayseeralfaki5@gmail.com

Abstract: *This study aimed to assess the impact of accreditation on laboratories performance regarding ISO/IEC 17025:2017 in Nano for Measurement and Calibration Center, Khartoum State- Sudan. A descriptive case study was conducted during the period from November 2020 to March 2021. A questionnaire was used as data collection tool to achieve the study objective. Thirty four questionnaires were distributed to all laboratory employees in Nano for Measurement and Calibration Center, the laboratory employees were responded with percentage of (100.0%). The data were analyzed using Statistical Package for Social Sciences (SPSS); the methodology used was the descriptive correlation by using Chi-square test. The study showed that there was a statistically significant relationship between accreditation and validity of results issue by laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. The study reflected that there was a statistically significant relationship between accreditation and* the performance and efficiency of employees *according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. In addition to, there was a statistically significant relationship between accreditation and customer satisfaction according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. The study revealed that there was a statistically significant relationship between accreditation and financial returned to the laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. The study concluded that accreditation improved laboratories performance regarding ISO/IEC 17025:2017 in Nano for Measurement and Calibration Center, Khartoum State- Sudan.*

Keywords— Impact; Accreditation; Laboratories performance; Nano for measurement and calibration center

1. INTRODUCTION

International organization for standardization/international electro technical commission (ISO/IEC 17025) is the global quality standard for testing and calibration laboratories. ISO/IEC 17025 was developed by laboratory experts from all over the world, along with 18 liaison organizations, such as the international laboratory accreditation cooperation (ILAC), and many associations representing laboratories [1]. ISO is an independent, non governmental international organization with membership of 162 national standards bodies. ISO has published international standard and related documents, covering almost every industry, from technology, to food safety, to agriculture and health care [2] . ISO/IEC 17025 was first issued in 1999 by the international organization for standardization (ISO) and the international electro technical commission (IEC). It is the single most important standard for calibration and testing laboratories around the world [1]. There have been three releases; in 1999, 2005 and 2017. The most significant changes between the 1999 and 2005 release were a greater emphasis on the responsibilities of senior management, explicit requirements for continual improvement of the management system itself, and communication with the customer. It also aligned more closely with the 2000 version of ISO 9001 [3]. The two main sections in ISO/IEC 17025 are management requirements and technical requirements. Management requirements are primarily related to the operation and effectiveness of the quality management system within the laboratory. Technical requirements include factors which determine the correctness and reliability of the tests and calibrations performed in laboratory [4]. Laboratories use ISO/IEC 17025 to implement a quality system aimed at improving their ability to consistently produce valid results. It is also the basis for accreditation from an accreditation body. Since the standard is about competence, accreditation is simply formal recognition of a demonstration of that competence. A prerequisite for a laboratory to become accredited is to have a documented quality management system. The usual contents of the quality manual follow the outline of the ISO/IEC 17025 standard [4]. Accreditation is an objective way to assure customers that technical competence has been fully implemented to provide reliable and accurate test or calibration results [5]. ISO/IEC 17025 is an ideal management system model for laboratories because it aims to control quality costs, improve measurement accuracy and guarantee consistency of results. It is also customer-driven when implemented correctly. Furthermore, when your company achieves ISO/IEC 17025 accreditation, you will be

presented with a certificate of accreditation. This certificate can be used in advertising, promotional literature and stationary to show current and potential customers that your laboratory is committed to quality and has demonstrated technical competency to perform calibration or testing services [6]. The general objective of the current study was to assess the impact of accreditation on laboratories performance regarding ISO/IEC 17025:2017 in Nano for Measurement and Calibration Center, Khartoum State-Sudan. The specific objectives of this study were to identify a relationship between accreditation and validity of results issued by laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center, to identify a relationship between accreditation and the performance and efficiency of employees according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center, to identify a relationship between accreditation and customer satisfaction according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center and to identify a relationship between accreditation and financial returned to laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center.

2. Materials and methods

2.1 Study design:
It is a descriptive case study.

2.2 Study area:
The study was conducted at Nano for Measurement and Calibration Center, Khartoum state, Sudan.

2.2.1 Nano for Measurement and Calibration Center:
Nano for Measurement and Calibration Center started with the purpose of providing measurement and calibration services in 2006. In the year 2017, 21 values (parameters) were accredited from among the activities of the center's laboratories on the basis of the requirements of the standard ISO17025:2005 from the National Council for Accreditation in Egypt (EGAC). The scope of accreditation was expanded to (40) values (parameters) in the various laboratories of the center in the year 2018. During the years 2018 and 2019, the management system was reestablished based on the requirements of the standard ISO 17025:2017. The center provides its services to all industrial, service and medical establishments operating in Sudan. The accredited laboratories in the Nano for Measurement and Calibration Center are: Temperature Laboratory, Medical Instruments Laboratory, Dimensions Laboratory, Radio Frequency and Electrical Laboratory, Pressure Laboratory, Force Laboratory and Mass and Balance Laboratory **[7]**.

2.3 Study population:
The study was conducted on all staff at Nano for Measurement and Calibration Center, Khartoum state, Sudan.

2.4 Sample size:
The targeted sample of this research was the total population of the laboratory staff (34) who were responded to fulfill the questionnaire.

2.5 Study period:
The study was conducted during the interval from November 2020 to March 2021.

2.6 Data collection tools:
Self-administrated questionnaire (appendix) was used as the basic tool in this study. The quantitative survey consisted of questionnaire contained four hypotheses that covered the research questions which were distributed to all Nano for Measurement and Calibration Center staff. The study depends on the questionnaire as a key to offer gathering information from the study population.

2.7 Data analysis:
The data obtained were analyzed using the Statistical Package for Social Sciences (SPSS). To achieve the objectives of the study, statistical methods were used the frequency distribution of the answers, the percentages and Chi-square test for the significance of differences between the test results considering all other variables. Then data were presented in tables.

2.8 Ethical consideration:
Study permissions were obtained from College of Graduate Studies- Sudan University of Science and Technology, then from management of Nano for Measurement and Calibration Center. Also, permission was taken from all individuals before being included in the study. Each individual was informed on the nature of the study.

3. Results

The study was conducted on 34 study subjects, 22 (64.7%) were males and 12 (35.3%) were females. The age ranged between 20-44 years old. Regarding the academic level of study subjects, 19 (55.9%) were having a bachelor degree. Regarding the years of experience, 14 (41.2%) were having experience less than 10 years. Regarding the job title, 12 (35.3%) were engineer. Regarding the level of training on ISO 17025:2017, 18 (52.9%) were very good. Reliability and validity of questionnaire were shown in table (1). Table (2) showed: The laboratory management committed to impartiality by the strongly agree (85.3%) and agree by (14.7%) and neutral by (0.0%) and disagree by (0.0%) and strongly disagree by (0.0%). The information about the customer confidential between customer and laboratory by the strongly agree (79.4%) and agree by (17.6%) and neutral by (2.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The facilities and environmental condition suitable for the laboratory activities by the strongly agree (67.6%) and agree by (23.5%) and neutral by (8.8%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory monitor, control and record environ mental conditions by the strongly agree (73.5%) and agree by (23.5%) and neutral by (2.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory implements an intermediate

examination program by the strongly agree (47.1%) and agree by (47.1%) and neutral by (5.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory ensures that measurement results are traceable to the international system of unit (SI) by the strongly agree (82.4%) and agree by (14.7%) and neutral by (2.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory has a procedure to ensure the suitable external provider products and services by the strongly agree (70.6%) and agree by (20.6%) and neutral by (8.8%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory uses appropriate methods and procedures for all laboratory activities by the strongly agree (67.6%) and agree by (32.4%) and neutral by (0.0%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory uses the last valid version of standard methods by the strongly agree (82.4%) and agree by (14.7%) and neutral by (2.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory validates of non-standard methods by the strongly agree (67.6%) and agree by (26.5%) and neutral by (5.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory has a procedure to evaluation of the measurement uncertainty by the strongly agree (82.4%) and agree by (17.6%) and neutral by (0.0%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory has a procedure for monitoring validity of the results by the strongly agree (70.6%) and agree by (23.5%) and neutral by (5.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory has a program to participant of inter laboratory comparisons by the strongly agree (70.6%) and agree by (26.5%) and neutral by (2.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The results of table (3) interpreted as follows: the value of Chi-square calculated to signify the differences between "The laboratory management committed to impartiality" was (16.94) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The information about the customer confidential between customer and laboratory" was (33.58) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The facilities and environmental condition suitable for the laboratory activities" was (19.11) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory monitor, control and record environ mental conditions" was (26.88) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory implements an intermediate examination program" was (11.52) with p-value (0.003) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory ensures that measurement results are traceable to the international system of unit (SI)" was (37.47) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory has a procedure to ensure the suitable external provider products and services" was (21.94) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory uses appropriate methods and procedures for all laboratory activities" was (4.23) with p-value (0.040) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory uses the last valid version of standard methods" was (37.47) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory validates of non-standard methods" was (20.17) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory has a procedure to evaluation of the measurement uncertainty" was (14.23) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory has a procedure for monitoring validity of the results" was (22.82) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory has a program to participant of inter laboratory comparisons" was (24.05) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. Table (4) showed: All laboratory employees have a clear job description that defines responsibilities and authorities by the strongly agree (58.8%) and agree by (29.4%) and neutral by (8.8%) and disagree by (2.9%) and strongly disagree by (0.0%). The laboratory trains employees according to a procedure that determines the training need by the strongly agree (26.5%) and agree by (29.4%) and neutral by (35.3%) and disagree by (5.9%) and strongly disagree by (2.9%). The laboratory supports the training program and the development of personal skills by the strongly agree (38.2%) and agree by (32.4%) and neutral by (26.5%) and disagree by (2.9%) and strongly disagree by (0.0%). The laboratory measures the effectiveness training program by the strongly agree (29.4%) and agree by (29.4%) and neutral by (32.4%) and disagree by (5.9%) and strongly disagree by (2.9%). The laboratory measures the returner of training by the strongly agree (35.3%) and agree by (32.4%) and neutral by (26.5%)

and disagree by (2.9%) and strongly disagree by (2.9%). The laboratory has a procedure for monitoring and evaluation of personnel performance by the strongly agree (67.6%) and agree by (17.6%) and neutral by (8.8%) and disagree by (2.9%) and strongly disagree by (2.9%). Accreditation according to ISO/ IEC 17025 requirements increases employees' confidence in doing their jobs by the strongly agree (73.5%) and agree by (23.5%) and neutral by (2.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The results of table (5) interpreted as follows: The value of Chi-square calculated to signify the differences between "All laboratory employees have a clear job description that defines responsibilities and authorities" was (26.00) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory trains employees according to a procedure that determines the training need" was (14.52) with p-value (0.006) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory supports the training program and the development of personal skills" was (9.76) with p-value (0.021) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory measures the effectiveness training program" was (13.94) with p-value (0.007) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory measures the returner of training" was (17.17) with p-value (0.002) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory has a procedure for monitoring and evaluation of personnel performance" was (50.70) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "Accreditation according to ISO/ IEC 17025 requirements increases employees' confidence in doing their jobs" was (26.88) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. Table (6) showed: The laboratory has the resources and capability to meet customer request by the strongly agree (38.2%) and agree by (50.0%) and neutral by (11.8%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory has a clear contract with the customer before beginning the calibration process by the strongly agree (64.7%) and agree by (32.4%) and neutral by (2.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory informs the customer of any deviation from contract by the strongly agree (64.7%) and agree by (35.3%) and neutral by (0.0%) and disagree by (0.0%) and strongly disagree by (0.0%). The laboratory commits with the agreed delivery time by the strongly agree (8.8%) and agree by (47.1%) and neutral by (26.5%) and disagree by (17.6%) and strongly disagree by (0.0%). The laboratory provides the calibration service at an appropriate cost compared to accredited laboratories by the strongly agree (38.2%) and agree by (41.2%) and neutral by (14.7%) and disagree by (5.9%) and strongly disagree by (0.0%). The laboratory responds to comments, complaints and suggestions and is handled with caution by the strongly agree (26.5%) and agree by (67.6%) and neutral by (5.9%) and disagree by (0.0%) and strongly disagree by (0.0%). The results of table (7) interpreted as follows: The value of Chi-square calculated to signify the differences between "The laboratory has the resources and capability to meet customer request" was (7.82) with p-value (0.020) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory has a clear contract with the customer before beginning the calibration process" was (19.47) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory informs the customer of any deviation from contract" was (12.94) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory commits with the agreed delivery time" was (10.94) with p-value (0.012) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory provides the calibration service at an appropriate cost compared to accredited laboratories" was (12.35) with p-value (0.006) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "The laboratory responds to comments, complaints and suggestions and is handled with caution" was (20.17) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. Table (8) showed: Accreditation of laboratory according to ISO/IEC17025:2017 helps in achievement of the planned strategic objectives by the strongly agree (58.8%) and agree by (32.4%) and neutral by (8.8%) and disagree by (0.0%) and strongly disagree by (0.0%). Accreditation of laboratory according to ISO/IEC 17025:2017 helps in controlling and reduces undesired activities by the strongly agree (70.6%) and agree by (26.5%) and neutral by (2.9%) and disagree by (0.0%) and strongly disagree by (0.0%). Accreditation of laboratory according to ISO /IEC 17025:2017 increases the market share by the strongly agree (67.6%) and agree by (26.5%) and neutral by (5.9%) and disagree by (0.0%) and strongly disagree by (0.0%). Accreditation of laboratory according to ISO/IEC 17025:2017 increases the value of revenue by the

strongly agree (50.0%) and agree by (41.2%) and neutral by (8.8%) and disagree by (0.0%) and strongly disagree by (0.0%). Accreditation of laboratory according to ISO/IEC 17025:2017 helps in customer loyalty by the strongly agree (67.6%) and agree by (32.4%) and neutral by (0.0%) and disagree by (0.0%) and strongly disagree by (0.0%). Accreditation of laboratory according to ISO/IEC 17025:2017 consider the advantage in the market competition by the strongly agree (67.6%) and agree by (29.4%) and neutral by (2.9%) and disagree by (0.0%) and strongly disagree by (0.0%). Accreditation of laboratory according to ISO/IEC 17025:2017 helps the laboratory to accept the results nationality an abroad by the strongly agree (76.5%) and agree by (23.5%) and neutral by (0.0%) and disagree by (0.0%) and strongly disagree by (0.0%). The results of table (9) interpreted as follows: The value of Chi-square calculated to signify the differences between "Accreditation of laboratory according to ISO/IEC17025:2017 helps in achievement of the planned strategic objectives" was (12.76) with p-value (0.002) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "Accreditation of laboratory according to ISO/IEC 17025:2017 helps in controlling and reduces undesired activities" was (24.05) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "Accreditation of laboratory according to ISO /IEC 17025:2017 increases the market share" was (20.17) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "Accreditation of laboratory according to ISO/IEC 17025:2017 increases the value of revenue" was (9.58) with p-value (0.008) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "Accreditation of laboratory according to ISO/IEC 17025:2017 helps in customer loyalty" was (4.23) with p-value (0.040) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "Accreditation of laboratory according to ISO/IEC 17025:2017 considers the advantage in the market competition" was (21.58) with p-value (0.000) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. The value of Chi-square calculated to signify the differences between "Accreditation of laboratory according to ISO/IEC 17025:2017 helps the laboratory to accept the results nationality an abroad" was (9.52) with p-value (0.002) which was lower than the level of significant value (5%), these refer to the existence of statistically differences. Table (10) showed that the value of the Chi-square test (29.52) by significant value (0.00) it was less than the probability value (0.05) and coefficient correlation (0.67), this means that there was a statistically significant relationship between accreditation and validity of results issue by laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. Table (11) showed that the value of the Chi-square test (14.70) by significant value (0.00) it was less than the probability value (0.05) and coefficient correlation (0.51), this means that there was a statistically significant relationship between accreditation and the performance and efficiency of employees according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. Table (12) showed that the value of the Chi-square test (21.88) by significant value (0.00) it was less than the probability value (0.05) and coefficient correlation (0.66), this means that there was a statistically significant relationship between accreditation and customer satisfaction according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. Table (13) showed that the value of the Chi-square test (24.05) by significant value (0.00) it was less than the probability value (0.05) and coefficient correlation (0.63), this means that there was a statistically significant relationship between accreditation and financial returned to the laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center.

Table 1: Reliability and validity of questionnaire

No.	The hypotheses	Reliability	Validity
1	There is a statistically significant relationship between accreditation and validity of results issue by laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center.	0.93	0.96
2	There is a statistically significant relationship between accreditation and the performance and efficiency of employees according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center.	0.89	0.94

3	There is a statistically significant relationship between accreditation and customer satisfaction according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center.	0.65	0.81
4	There is a statistically significant relationship between accreditation and financial returned to the laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center.	0.87	0.93
Total		0.92	0.96

Table 2: The frequency distribution for the respondents' answers about the questions of the first hypothesis

No.	Phrases	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	The laboratory management committed to impartiality.	29	5	0	0	0
		85.3%	14.7%	0.0%	0.0%	0.0%
2	The information about the customer confidential between customer and laboratory.	27	6	1	0	0
		79.4%	17.6%	2.9%	0.0%	0.0%
3	The facilities and environmental condition suitable for the laboratory activities.	23	8	3	0	0
		67.6%	23.5%	8.8%	0.0%	0.0%
4	The laboratory monitor, control and record environ mental conditions.	25	8	1	0	0
		73.5%	23.5%	2.9%	0.0%	0.0%
5	The laboratory implements an intermediate examination program.	16	16	2	0	0
		47.1%	47.1%	5.9%	0.0%	0.0%
6	The laboratory ensures that measurement results are traceable to the international system of unit (SI).	28	5	1	0	0
		82.4%	14.7%	2.9%	0.0%	0.0%
7	The laboratory has a procedure to ensure the suitable external provider products and services.	24	7	3	0	0
		70.6%	20.6%	8.8%	0.0%	0.0%
8	The laboratory uses appropriate methods and procedures for all laboratory activities.	23	11	0	0	0
		67.6%	32.4%	0.0%	0.0%	0.0%
9	The laboratory uses the last valid version of standard methods.	28	5	1	0	0
		82.4%	14.7%	2.9%	0.0%	0.0%
10	The laboratory validates of non-standard methods.	23	9	2	0	0
		67.6%	26.5%	5.9%	0.0%	0.0%
11	The laboratory has a procedure to evaluation of the measurement uncertainty.	28	6	0	0	0
		82.4%	17.6%	0.0%	0.0%	0.0%
12	The laboratory has a procedure for monitoring	24	8	2	0	0
		70.6%	23.5%	5.9%	0.0%	0.0%

	validity of the results.					
13	The laboratory has a program to participant of inter laboratory comparisons.	24	9	1	0	0
		70.6%	26.5%	2.9%	0.0%	0.0%

Table 3: Chi-square test results for respondents' answers regarding the questions of the first hypothesis

No.	Phrases	Chi-square value	Df	Sig.	Median	Interpretation
1	The laboratory management committed to impartiality.	16.94	1	0.000	5.00	Strongly agree
2	The information about the customer confidential between customer and laboratory.	33.58	2	0.000	5.00	Strongly agree
3	The facilities and environmental condition suitable for the laboratory activities.	19.11	2	0.000	5.00	Strongly agree
4	The laboratory monitor, control and record environ mental conditions.	26.88	2	0.000	5.00	Strongly agree
5	The laboratory implements an intermediate examination program.	11.52	2	0.003	5.00	Strongly agree
6	The laboratory ensures that measurement results are traceable to the international system of unit (SI).	37.47	2	0.000	5.00	Strongly agree
7	The laboratory has a procedure to ensure the suitable external provider products and services.	21.94	2	0.000	5.00	Strongly agree
8	The laboratory uses appropriate methods and procedures for all laboratory activities.	4.23	1	0.040	5.00	Strongly agree
9	The laboratory uses the last valid version of standard methods.	37.47	2	0.000	5.00	Strongly agree
10	The laboratory validates of non-standard methods.	20.17	2	0.000	5.00	Strongly agree
11	The laboratory has a procedure to evaluation of the measurement uncertainty.	14.23	1	0.000	5.00	Strongly agree
12	The laboratory has a procedure for monitoring validity of the results.	22.82	2	0.000	5.00	Strongly agree
13	The laboratory has a program to participant of inter laboratory comparisons.	24.05	2	0.000	5.00	Strongly agree

Table 4: The frequency distribution for the respondents' answers about the questions of the second hypothesis

No.	Phrases	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	All laboratory employees have a clear job description that defines responsibilities and authorities.	20	10	3	1	0
		58.8%	29.4%	8.8%	2.9%	0.0%
2	The laboratory trains employees according to a procedure that determines the training need.	9	10	12	2	1
		26.5%	29.4%	35.3%	5.9%	2.9%
3	The laboratory supports the training program and the development of personal skills.	13	11	9	1	0
		38.2%	32.4%	26.5%	2.9%	0.0%
4	The laboratory measures the	10	10	11	2	1

	effectiveness training program.	29.4%	29.4%	32.4%	5.9%	2.9%
5	The laboratory measures the returner of training.	12	11	9	1	1
		35.3%	32.4%	26.5%	2.9%	2.9%
6	The laboratory has a procedure for monitoring and evaluation of personnel performance.	23	6	3	1	1
		67.6%	17.6%	8.8%	2.9%	2.9%
7	Accreditation according to ISO/ IEC 17025 requirements increases employees' confidence in doing their jobs.	25	8	1	0	0
		73.5%	23.5%	2.9%	0.0%	0.0%

Table 5: Chi-square test results for respondents' answers regarding the questions of the second hypothesis

No.	Phrases	Chi-square value	Df	Sig.	Median	Interpretation
1	All laboratory employees have a clear job description that defines responsibilities and authorities.	26.00	3	0.000	5.00	Strongly agree
2	The laboratory trains employees according to a procedure that determines the training need.	14.52	4	0.006	4.00	Agree
3	The laboratory supports the training program and the development of personal skills.	9.76	3	0.021	4.00	Agree
4	The laboratory measures the effectiveness training program.	13.94	4	0.007	4.00	Agree
5	The laboratory measures the returner of training.	17.17	4	0.002	4.00	Agree
6	The laboratory has a procedure for monitoring and evaluation of personnel performance.	50.70	4	0.000	5.00	Strongly agree
7	Accreditation according to ISO/ IEC 17025 requirements increases employees' confidence in doing their jobs.	26.88	2	0.000	5.00	Strongly agree

Table 6: The frequency distribution for the respondents' answers about the questions of the third hypothesis

No.	Phrases	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	The laboratory has the resources and capability to meet customer request.	31	17	4	0	0
		38.2%	50.0%	11.8%	0.0%	0.0%
2	The laboratory has a clear contract with the customer before beginning the calibration process.	22	11	1	0	0
		64.7%	32.4%	2.9%	0.0%	0.0%
3	The laboratory informs the customer of any deviation from contract.	22	12	0	0	0
		64.7%	35.3%	0.0%	0.0%	0.0%
4	The laboratory commits with the agreed delivery time.	3	16	9	6	0
		8.8%	47.1%	26.5%	17.6%	0.0%
5	The laboratory provides the calibration service at an appropriate cost compared to accredited laboratories.	13	14	5	2	0
		38.2%	41.2%	14.7%	5.9%	0.0%
6	The laboratory responds to comments, complaints and suggestions and is handled with caution.	9	23	2	0	0
		26.5%	67.6%	5.9%	0.0%	0.0%

Table 7: Chi-square test results for respondents' answers regarding the questions of the third hypothesis

No.	Phrases	Chi-square value	Df	Sig.	Median	Interpretation
1	The laboratory has the resources and capability to meet customer request.	7.82	2	0.020	4.00	Agree
2	The laboratory has a clear contract with the customer before beginning the calibration process.	19.47	2	0.000	5.00	Strongly agree
3	The laboratory informs the customer of any deviation from contract.	12.94	1	0.000	5.00	Strongly agree
4	The laboratory commits with the agreed delivery time.	10.94	3	0.012	4.00	Agree
5	The laboratory provides the calibration service at an appropriate cost compared to accredited laboratories.	12.35	3	0.006	4.00	Agree
6	The laboratory responds to comments, complaints and suggestions and is handled with caution.	20.17	2	0.000	4.00	Agree

Table 8: The frequency distribution for the respondents' answers about the questions of the fourth hypothesis

No.	Phrases	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	Accreditation of laboratory according to ISO/IEC17025:2017 helps in achievement of the planned strategic objectives.	20	1	3	0	0
		58.8%	32.4%	8.8%	0.0%	0.0%
2	Accreditation of laboratory according to ISO/IEC 17025:2017 helps in controlling and reduces undesired activities.	24	9	1	0	0
		70.6%	26.5%	2.9%	0.0%	0.0%
3	Accreditation of laboratory according to ISO /IEC 17025:2017 increases the market share.	23	9	2	0	0
		67.6%	26.5%	5.9%	0.0%	0.0%
4	Accreditation of laboratory according to ISO/IEC 17025:2017 increases the value of revenue.	17	14	3	0	0
		50.0%	41.2%	8.8%	0.0%	0.0%
5	Accreditation of laboratory according to ISO/IEC 17025:2017 helps in customer loyalty.	23	11	0	0	0
		67.6%	32.4%	0.0%	0.0%	0.0%
6	Accreditation of laboratory according to ISO/IEC 17025:2017 considers the advantage in the market competition.	23	10	1	0	0
		67.6%	29.4%	2.9%	0.0%	0.0%
7	Accreditation of laboratory according to ISO/IEC 17025:2017 helps the laboratory to accept the results nationality an abroad.	26	8	0	0	0
		76.5%	23.5%	0.0%	0.0%	0.0%

Table 9: Chi-square test results for respondents' answers regarding the questions of the fourth hypothesis

No.	Phrases	Chi-square value	Df	Sig.	Median	Interpretation

1	Accreditation of laboratory according to ISO/IEC17025:2017 helps in achievement of the planned strategic objectives.	12.76	2	0.002	5.00	Strongly agree
2	Accreditation of laboratory according to ISO/IEC 17025:2017 helps in controlling and reduces undesired activities.	24.05	2	0.000	5.00	Strongly agree
3	Accreditation of laboratory according to ISO /IEC 17025:2017 increases the market share.	20.17	2	0.000	5.00	Strongly agree
4	Accreditation of laboratory according to ISO/IEC 17025:2017 increases the value of revenue.	9.58	2	0.000	4.50	Strongly agree
5	Accreditation of laboratory according to ISO/IEC 17025:2017 helps in customer loyalty.	4.23	1	0.040	5.00	Strongly agree
6	Accreditation of laboratory according to ISO/IEC 17025:2017 considers the advantage in the market competition.	21.58	2	0.000	5.00	Strongly agree
7	Accreditation of laboratory according to ISO/IEC 17025:2017 helps the laboratory to accept the results nationality an abroad.	9.52	1	0.002	5.00	Strongly agree

Table 10: Result of first hypothesis (There is a statistically significant relationship between accreditation and validity of results issue by laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center)

No.	Coefficient correlation	Chi-square	Df	Sig.	Median	Scale	Statistical significant
34	0.67	29.52	3	0.000	5.00	Strongly agree	Significant

Table 11: Result of the second hypothesis (There is a statistically significant relationship between accreditation and the performance and efficiency of employees according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center)

No.	Coefficient correlation	Chi-square	Df	Sig.	Median	Scale	Statistical significant
34	0.51	14.70	3	0.000	4.00	Agree	Significant

Table 12: Result of the third hypothesis (There is a statistically significant relationship between accreditation and customer satisfaction according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center)

No.	coefficient correlation	Chi-square	Df	Sig.	Median	Scale	Statistical significant
34	0.66	21.88	3	0.000	4.00	Agree	Significant

Table 13: Result of the fourth hypothesis (There is a statistically significant relationship between accreditation and financial returned to the laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center)

No.	Coefficient correlation	Chi-square	Df	Sig.	Median	Scale	Statistical significant
34	0.63	24.05	3	0.000	5.00	Strongly agree	Significant

4. Discussion

The current study showed that the most frequency distribution for the respondents' answers regarding the questions of the first hypothesis was strongly agree for the statement (The laboratory management committed to

impartiality), in general, means that most of the respondents have strongly agreed with all what mentioned about the first hypothesis. Regarding the first hypothesis, the results showed that the value of the Chi-square test by significant value it was less than the probability value and coefficient correlation, this means that there was a statistically significant relationship between accreditation and validity of results issue by laboratory according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. The results reflected that the most frequency distribution for the respondents' answers regarding the questions of the second hypothesis was agree for the statement (The laboratory supports the training program and the development of personal skills), in general, means that most of the respondents have agreed with all what mentioned about the second hypothesis. The results of second hypothesis showed that the value of the Chi-square test by significant it was less than the probability value and coefficient correlation, this means that there was a statistically significant relationship between accreditation and the performance and efficiency of employees according to requirements of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. The present study showed that the most frequency distribution for the respondents' answers regarding the questions of the third hypothesis was agree for the statement (The laboratory responds to comments, complaints and suggestions and is handled with caution), means that most of the respondents have agreed with all what mentioned about the third hypothesis. The results of third hypothesis showed that the value of the Chi-square test by significant value it was less than the probability value and coefficient correlation, this means that there was a statistically significant relationship between accreditation and customer satisfaction according to requirement of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. The present study illustrated that the most frequency distribution for the respondents' answers regarding the questions of the fourth hypothesis was strongly agree for the statement (Accreditation of laboratory according to ISO/IEC 17025:2017 helps in controlling and reduces undesired activities), means that most of the respondents have strongly agreed with all what mentioned about the fourth hypothesis. The results of fourth hypothesis showed that the value of the Chi-square test by significant value it was less than the probability value and coefficient correlation, this means that there was a statistically significant relationship between accreditation and financial returned to the laboratory according to requirement of ISO/IEC17025:2017 in Nano for Measurement and Calibration Center. The findings of the present study were in agreement with the findings of Ahmed (2018) [8] who found that there was a positive relationship between implementing of ISO/IEC17025 standard and increase customers satisfaction. Also, the findings of the present study were in agreement with the findings of Abbas (2018) [9] who found that the work environment inside the laboratory was suitable and helped in correct results and provided implementing ISO system enhanced the performance and the quality of the laboratory. The findings from the present study were in agreement with findings of Hamza (2015) [10] who found that the awareness and perception of top managers of ISO helped them in the process of evaluation and measuring the system as well achieving intended results, work environment inside the laboratory was suitable and helped in correct testing results and provided implementing ISO system enhanced the performance and the quality of the laboratory. The results obtained from the current study were in agreement with the results obtained by Elhuni (2016) [11] who found that there was a statistically positive or significant effect of accreditation on laboratory performance. The findings obtained from the current study were in agreement with the findings obtained by Andargie (2019) [12] who found that the accreditation have a positive impact on laboratory processes and have improved the level of competitive advantage; prevent retesting problems, an effective marketing tool, market share, customer trust. Moreover, the majority agreed that there was a better communication from management and they were satisfied to work in an accredited laboratory.

5. Conclusion

The study concluded that accreditation have a positive impact on validity of results issue by laboratory, the performance and efficiency of employees, customer satisfaction and financial returned to the laboratory in Nano for Measurement and Calibration Center.

References

[1]- Kim-Soon, N. (2012). Quality management system, SAI global limited, ISBN: 987-953.

[2]- Hahn, R., and Christian, W. (2016). Definition of ISO, international organization of standardization. *Business and Society*, 55 (1):90-129.

[3]- SAI Global Limited ABN (2012). ISO/IEC 17025 Comparison- 1999 to 2005. Annual report 14. Available at: http://us.training.saiglobal.com/iso-iec-comparison-free-downlaod.

[4]- Honsa, J. D. and Deborah, A. M. (2003). ISO 17025: Practical benefits of implementing a quality system. *Journal of AOAC International*, 86 (5):1038-1044. Available at: http://aoac.publisher.ingentaconnect.com/content/aoac/jaoac/2003/00000086/00000005/art00023.

[5]- Borsting, C., Rockenbauer, E. and Morling, N., (2009). Validation of a single nucleotide polymorphism (SNP) typing assay with 49 SNPs for forensic genetic testing in a laboratory accredited according to the ISO 17025 standard. *Forensic Science International: Genetics*, 4(1):34-42.

[6]- Metha, B. B. (2013). Implementing ISO/IEC 17025:2005. A practical guide, Kindle Edition. ASQ Quality Press.

[7]- Nano for Measurement and Calibration Center (NMCC) (2019). NMCC Quality Manual.

[8]- Ahmed, N. A. (2018). Impact of implementation of ISO 17025 in laboratories performance (Case study of Nano for Measurement and Calibration Center- Khartoum Bahri-Sudan). M.Sc. thesis in Total Quality Management and Excellence. Sudan University of Science and Technology. Available at: http://repository.sustech.edu/bitstream/handle/123456789/22871/Impact%20of%20Implementation.....pdf.

[9]- Abbas, M. D. A. (2018). Impact of implementation of ISO/IEC 17025 in DNA laboratory in Sudanese forensic laboratories. M.Sc. thesis in Total Quality Management and Excellence. Sudan University of Science and Technology. Available at: http://repository.sustech.edu/bitstream/handle/123456789/22764/Impact%20of%20Implementation%20....pdf?sequence=1&isAllowed=y.

[10]- Hamza, L. K. (2015). Impact of implementing ISO/IEC 17025 and its role in improving performance of laboratories of Sudanese Standards and Metrology Organization. M.Sc. thesis in Total Quality Management and Excellence. Sudan University of Science and Technology. Available at: http://repository.sustech.edu.

[11]- Elhuni, R. M. (2016). Quality Management System Audit and its Impact on Company's Performance in Libyan Petroleum Institute, Tripoli-Libya. Available at: https://www.researchgate.net/publication/306347106\.

[12]- Andargie, W. (2019). Challenges and impact of ISO/IEC 17025 accreditation in Ethiopian Conformity Assessment and Ethiopian National Metrology Institute. Available at: http://www.repository.smuc.edu.et/bitstream/123456789/5174/1/Master%20Thesis%20by%20Wondale%20%20Final.pdf