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APPLING THE LEAN SIX SIGMA METHODOLOGY IN OF THE COSTMANAGEMENT & CONTINUOUS IMPROVEMENT OF PERFORMANCE (APPLIED RESEARCH IN THE BLOOD LABORATORY OF THE HUSSEIN TEACHING HOSPITAL)

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ABSTRACT

Purpose: This study aims to enable measuring performance and its quality and seeks to improve performance, is that the research problem emerged in the emergence of poor results for patients' blood test cases due to delayed results of the analysis.

Theoretical framework: This study adopted the deductive approach by relying on sources and references related to the literature of the topic directly, to benefit from them in enriching the theoretical aspect of the research.

Design/methodology/approach: The inductive approach through the application of the applied analytical aspect, where the financial data for the year 2021 was obtained through financial accounts, production reports, inventory cards, quality reports, observations, and personal interviews, study sample at the Hussein Teaching Hospital's blood laboratory in the service sector represented by the Lean Six Sigma methodology.

Findings: The blood laboratory at Al-Hussein Teaching Hospital did not rely on modern quality systems, including the agile Six Sigma methodology. There is a lot of wastage and loss in the specified standard time, which causes a lot of delay in the time of analysis, and this indicates the discrepancy and decentralization of the process. The laboratory testing equipment breaks down many times because of its old age (these devices were obtained from the Japanese grant during the year 2003), and this causes two or three re-examinations, which drains additional time. As well, the small area of the laboratory compared to the number of visitors.

Research, Practical & Social implications: The research enables measuring performance and its quality and seeks to improve performance, is that the research problem emerged in the emergence of poor results for patients' blood test cases due to delayed results of the analysis. The Hussein Teaching Hospital's blood laboratory is the service sector represented by the Lean Six Sigma methodology. In order to implement continuous improvement in the area of medical staff quality and to simultaneously provide the right environment for continuous improvement,

Originality/value: This study is one of the very few studies that focus on the concept of Six Sigma as one of the tools of the modern quality management system, which is concerned with diagnosing and treating deviations to improve the performance of the blood test process, an attempt to manage cost through the use of accounting and statistical concepts, to achieve the highest levels of sigma.

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APLICAÇÃO DA METODOLOGIA LEAN SEIS SIGMA NO GERENCIAMENTO DE CUSTOS E MELHORIA CONTÍNUA DE DESEMPENHO (PESQUISA APLICADA NO LABORATÓRIO DE SANGUE DO HOSPITAL UNIVERSITÁRIO HUSSEIN)

RESUMO

Objetivo: Este estudo visa permitir medir o desempenho e sua qualidade e procura melhorar o desempenho, é que o problema da pesquisa surgiu no surgimento de maus resultados para os casos de exames de sangue de pacientes devido ao atraso nos resultados da análise.

Estrutura teórica: Este estudo adotou a abordagem dedutiva, baseando-se em fontes e referências relacionadas diretamente à literatura do tema, para beneficiar-se delas no enriquecimento do aspecto teórico da pesquisa.

Desenho/método/abordagem: A abordagem indutiva através da aplicação do aspecto analítico aplicado, onde os dados financeiros para o ano 2021 foram obtidos através de contas financeiras, relatórios de produção, cartões de inventário, relatórios de qualidade, observações e entrevistas pessoais, amostra de estudo no laboratório de sangue do Hospital Universitário Hussein no setor de serviços representado pela metodologia Lean Six Sigma.

Conclusões: O laboratório de sangue do Hospital Universitário Al-Hussein não contou com modernos sistemas de qualidade, incluindo a ágil metodologia Seis Sigma. Há muito desperdício e perda no tempo padrão especificado, o que causa muito atraso no tempo de análise, e isto indica a discrepância e descentralização do processo. O equipamento de teste de laboratório avaria muitas vezes por causa de sua velhice (estes dispositivos foram obtidos a partir da concessão japonesa durante o ano de 2003), o que causa duas ou três reavaliações, o que drena tempo adicional. Além disso, a pequena área do laboratório em comparação com o número de visitantes.

Pesquisa, implicações práticas e sociais: A pesquisa permite medir o desempenho e sua qualidade e procura melhorar o desempenho, é que o problema da pesquisa surgiu no surgimento de maus resultados para os casos de exames de sangue dos pacientes devido ao atraso nos resultados da análise. O laboratório de sangue do Hospital Universitário Hussein é o setor de serviços representado pela metodologia Lean Six Sigma. A fim de implementar a melhoria contínua na área da qualidade do pessoal médico e, simultaneamente, proporcionar o ambiente certo para a melhoria contínua,

Originalidade/valor: Este estudo é um dos poucos que se concentra no conceito de Seis Sigma como uma das ferramentas do moderno sistema de gestão da qualidade, que se preocupa com o diagnóstico e o tratamento de desvios para melhorar o desempenho do processo de exame de sangue, uma tentativa de administrar os custos através do uso de conceitos contábeis e estatísticos, para alcançar os níveis mais altos de sigma.

Palavras-chave: Seis-sigma, Lean, Lean Seis-Sigma, Melhoria Contínua, Controle Estatístico do Processo, Índice de Capacidade do Processo.

APLICACIÓN DE LA METODOLOGÍA LEAN SIX SIGMA EN LA GESTIÓN DE COSTES Y LA MEJORA CONTINUA DEL RENDIMIENTO (INVESTIGACIÓN APLICADA EN EL LABORATORIO DE SANGRE DEL HOSPITAL UNIVERSITARIO HUSSEIN)

RESUMEN

Propósito: Este estudio tiene como objetivo permitir la medición del rendimiento y su calidad y busca mejorar el rendimiento, es que el problema de la investigación surgió en la aparición de los malos resultados de los casos de análisis de sangre de los pacientes debido a los resultados retrasados del análisis.

Marco teórico: Este estudio adoptó el enfoque deductivo apoyándose en fuentes y referencias relacionadas con la literatura del tema directamente, para beneficiarse de ellas en el enriquecimiento del aspecto teórico de la investigación.

Diseño/metodología/enfoque: El enfoque inductivo a través de la aplicación del aspecto analítico aplicado, donde los datos financieros del año 2021 se obtuvieron a través de cuentas financieras, informes de producción, tarjetas de inventario, informes de calidad, observaciones y entrevistas personales, muestra de estudio en el laboratorio de sangre del Hospital Docente Hussein en el sector de servicios representado por la metodología Lean Six Sigma.

Resultados: El laboratorio de sangre del Hospital Docente Al-Hussein no se basaba en sistemas de calidad modernos, incluida la metodología Seis Sigma ágil. Hay mucho desperdicio y pérdida en el tiempo estándar especificado, lo que provoca mucho retraso en el tiempo de análisis, y esto indica la discrepancia y descentralización del proceso. El equipo de análisis del laboratorio se estropea muchas veces debido a su antigüedad (estos aparatos se obtuvieron de la subvención japonesa durante el año 2003), y esto provoca dos o tres reexámenes, lo que consume tiempo adicional. Además, la pequeña superficie del laboratorio en comparación con el número de visitantes.

Investigación, implicaciones prácticas y sociales: La investigación permite medir el rendimiento y su calidad y busca mejorar el rendimiento, es que el problema de la investigación surgió en la aparición de malos resultados para los casos de análisis de sangre de los pacientes debido a los resultados retrasados de los análisis. El laboratorio

de sangre del Hospital Universitario Hussein es el sector de servicios representado por la metodología Lean Six Sigma. Con el fin de aplicar la mejora continua en el ámbito de la calidad del personal médico y de proporcionar simultáneamente el entorno adecuado para la mejora continua,
Originalidad/valor: Este estudio es uno de los pocos que se centran en el concepto de Seis Sigma como una de las herramientas del moderno sistema de gestión de la calidad, que se ocupa de diagnosticar y tratar las desviaciones para mejorar el rendimiento del proceso de análisis de sangre, un intento de gestionar el coste mediante el uso de conceptos contables y estadísticos, para lograr los niveles más altos de sigma.

Palabras clave: Six-sigma, Lean, Lean Six-Sigma, Mejora continua, Control estadístico de procesos, Índice de capacidad de procesos.

INTRODUCTION

The Six Sigma method is one of the most important scientific methods and tools that have emerged in the recent period, as it has proven its efficiency in helping organizations to provide flawless services that achieve the satisfaction of the beneficiaries (Horngren, 2014). Where this method represents the fifth step of the quality stages that started with the examination step, and the production was monitored through it according to the specifications of the organization in advance with the aim of determining the deviation, error or defect and determining the responsible and then the step of statistical quality control and it sought to lay foundations for measuring quality control statistically, as well as laying foundations Analytical data of knowledge The difference between the specification set and the isolation of defective units and work to treat them, followed by the step of confirmation or quality assurance, which is a preventive system that seeks to prevent the occurrence of errors and defects, and then the step of total quality management that appeared after that and continues to this day and finally came a step (Six-Sigma) to benefit from all the previous stages and include them all in order to strive towards a high level of quality in institutional performance (Shathri,:2010; Albliwi, 2015). Six Sigma should therefore be considered as a broad concept of optimization rather than a simple examination of process variance, although this is still an important part of process control, learning, and improvement (Slack, et al., 2013).

It is also an extension of the development of management accounting science and its practices, especially in developed countries such as Japan, where it has been applied since the end of the seventies of the last century (Ali, 466:2011). In 1922, Walter created Three Sigma as a measurement standard based on an accuracy rate of 99.733% or (2,600) errors per million (Raisinghani, 2005;Hanoon et al., 2020b) .

In this regard, it is possible to identify the problem of the study represented by the blood laboratory at Al-Hussein Teaching Hospital, as it was noticed through field visits that there were deviations in the time specified for completing the blood test process according to the standard time specified for examining the patient's blood sample and diagnosing the

pathological condition, as this deviation in time led to a delay The patient refuses to give him treatment in the necessary time, as well as the patient's dissatisfaction, and this situation may lead to a deterioration in his health.

Therefore, Six Sigma is the tool that will be adopted in evaluating and improving performance by diagnosing deviations and reducing the variance in the outputs of the process through the use of accounting and statistical methods, to achieve the highest levels of performance (Deeb, et al., 2018; Al-Waeli, Ismail, et al., 2021).

Hence, the idea of the study came to use the Lean Six Sigma methodology in continuous improvement of performance and cost management, which seeks to achieve the following objectives:

- Shedding light on the aspects of the theoretical concepts and the intellectual foundations of the concept of Six Sigma with the intent of applying these concepts and foundations in practice.
- Diagnose the state of defect and deviation at the time of examining the patient's blood sample, which appears in cases of blood testing in the laboratory, and according to the standard times of the examination process, to treat it in the light of the results of the application.

RESEARCH METHODOLOGY

This study adopted the following approaches:

- The deductive approach: by relying on sources and references related to the literature of the topic directly, to benefit from them in enriching the theoretical aspect of the research.
- The inductive approach: through the application of the applied analytical aspect, where the financial data for the year 2021 was obtained through financial accounts, production reports, inventory cards, quality reports, observations, and personal interviews.

LITERATURE REVIEW

Study The establishment of a methodology for the Six Sigma system to be used as a mechanism to enhance and develop the supply chain was discussed by Knowles et al. (2005). They also developed a model that supports the idea of the study in developing a methodology to reduce performance deviations and remove activities that do not add value. In an effort to

connect Six Sigma to the balanced scorecard, the study concentrated on it as a tool for enhancing the benefits offered to professional organizations. This study's flaw is that it ignores the challenges and barriers that organizations face when it comes to measurement and evaluation. According to Albright and Lam's (2006) study, Six Sigma differs from other quality improvement programs in that it uses target performance and connects it to increasing quality and financial output. The study discussed the development of a framework to understand the similarities and differences between continuous improvement systems that increase product quality, reduce cost, and improve performance (Al-Waeli, Khalid, et al., 2021). This study dealt with the relationship between measurement systems from a theoretical perspective, but this study did not clarify the system that can be applied in practice. The study of Bozanic & Pavloic (2012) clarified the mechanism of using the Six Sigma method in the pharmaceutical manufacturing industries and its contribution to reducing costs and improving the quality of the medicinal product. Ultimate with high quality and efficiency. Enoch (2013) study discussed the impact of the Lean Six Sigma approach on small and medium enterprises as an attempt to achieve continuous quality improvement, customer satisfaction, and increased achievement at the lowest cost. The study concluded that adopting the Lean Six Sigma method contributes to reaching a competitive production efficiency to secure a position in the markets. the study discussed Albliwi, et al (2014) the Lean Six Sigma methodology and prepared it as a means of continuous improvement aimed at reducing poor quality costs, improving performance and creating value for customers and shareholders, and exploring critical failure factors in the services sector, higher education and others, and the study discovered several common factors in the failure, including lack of commitment and participation In decision-making, the lack of training and education, limitations and gaps to be explored in future research. The study of Murmura, et.al (2021) reviewed a project to improve processes using Lean Six-Sigma, which focuses on improving the supply process through the establishment of an automatic system for sending supply orders and supplying production lines, to achieve effective and optimal use of the company resources, and to ensure that the company achieves a sustainable competitive advantage(Al-waeli et al., 2020).

As for the current study, it is distinguished from previous studies, as it is one of the very few studies that are applied in the health sector, and the first study applied in a blood test laboratory, which attempts to demonstrate the possibility of the concept of Six Sigma to accurately diagnose and treat deviations to improve the performance of the examination process in the blood laboratory, to achieve The highest degree of sigma.

CONCEPTUAL FRAMEWORK

History of Methodology six-sigma

Sigma is the eighteenth letter of the Greek alphabet. It also represents the statistical symbol for the standard deviation of a set of data for a particular society. Thus, it provides a measure of variance, where the sigma refers to the quality of the data. The probability of the institutions being able to manufacture or produce any given unit of products or services without defects at all. The beginning of Six Sigma is due to one of the scientists (statistics) (Carl Frederick Gauss 1777-1855) Who introduced the normal distribution methodology as a measure of calibration in product changes, which also dates back to 1920, where (Walter Shewhart) showed that three Sigma of the average is the main point that requires correcting the process (Dennis, 2002; Hanoon et al., 2021). Six Sigma is one of the quality concepts that Motorola came up with because it requires the normal distribution of processes (3 standard deviations) to be half of its specification range. In other words, the specification range for any part of a product or service must be 6 The standard deviation of a process, the Greek letter sigma is often used to denote the standard deviation of a process hence the name Six-Sigma. Now the definition of Six Sigma has expanded beyond this rather narrow statistical perspective of General Electric which perhaps She was the most famous adopter of Six-Sigma, defined as "a disciplined methodology for identifying, measuring, analyzing, improving, and controlling quality in every one of a company's products, processes, and transactions-with the ultimate goal of eliminating virtually all defects". (Slack, et al., 2013).

Concept of six-sigma

Beliefs (Hilton & Platt, 2020) that the concept of (Six-Sigma) has many approaches around it that define the concept according to the researchers' vision. Free from defects to satisfy the customer, while others see that it is an integrated administrative system with a high degree of structure to improve the activities of the various operations. Which are carried out within the institution, whether they are administrative, financial, or technical operations, to reach a defect-free product with a percentage of (3.4) errors per million to reach customer satisfaction while reducing waste in time and material and human capabilities. (Slack, et al., 2013), indicated that Six Sigma is an approach to quality improvement and management that it has established in Motorola, but which has been widely used by GE in America. Although it is based on a statistical process Traditional process and process control, it is now a philosophy broader than the improvement recommended by any particular approach to measuring, improving, and managing quality and performance measurement processes in general. And

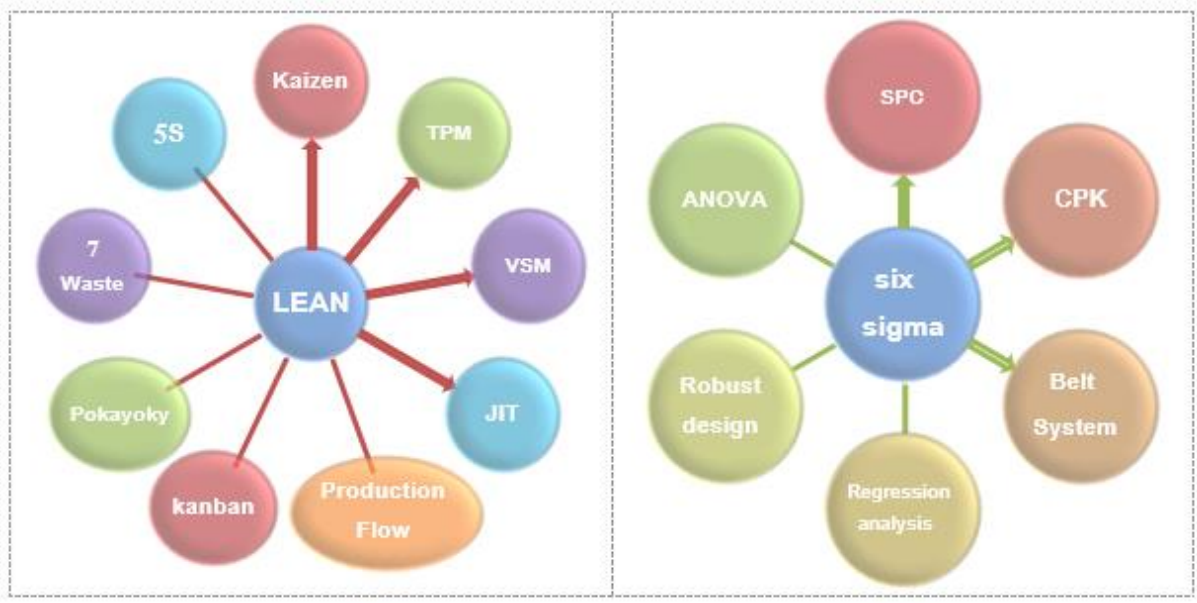
(Krajewsky, 2018) indicated that (Six-Sigma), which relies heavily on the principles of total quality management TQM, is a comprehensive and flexible system to achieve, maintain and maximize business success by reducing defects and variance in operations to a minimum. Six Sigma has a different focus on TQM and is oriented with a close understanding of customer needs, disciplined use of facts and data, statistical analysis, and diligent attention to managing, improving, and reinventing business processes.

The researchers consider Six Sigma to be an aggressive and rigorous technique for standardizing operations with targeted performance measures with low variance.

Tools and techniques related to six-sigma

The most important tools and techniques used in the Six Sigma and Fitness methodology can be illustrated (see Figure 1) as follows: (Sawsan, 2012; Nuce, 2008)

Figure-1. A Lean Tools, Techniques, and Six Sigma



Source: Kumar, et al. (2006)

In light of Six Sigma tools and techniques and lean, the researchers decided to use one of the Six Sigma techniques, which is statistical control over SPC operations and process capability analysis, to be practically applied in the blood laboratory to ensure the quality of performance and try to improve it and how to manage the cost for laboratory operations, as well as one of the tools of the lean methodology, will be addressed It is nailed improvement or Kaizen to improve performance. The researcher used a tool from the Six Sigma methodology

and a tool from the tools and techniques of lean, which resulted in the research using two tools to apply lean Six-sigma.

Lean is a philosophy that seeks to eliminate waste from all aspects of the activities of any institution and defined lean as a set of actions that must be done correctly according to a correct sequence at the right time to create value for customer satisfaction (Womack, 2010).

Definition Lean Six-sigma

Six-Sigma, according to the American Society for Quality, is known as the philosophy of improving dots based on facts, which prefer to prevent defects on disadvantages and lead to customer satisfaction and final results by reducing waste, loss, and time, and at the moment encourages the use and workflow for the goal Create a Competitive advantage (Kubiak & Benbow, 2016). Another definition of Lean Six Sigma is systematic and disciplined for Six Sigma in conjunction with speed and loving lean which will take great solutions is looking for excellence in business and processes (Antony, et al., 2003). Six Sigma uses many terms and standards related to evaluating processes of operations:

- Defect: is a failure to meet the required performance of customers (identify performance standards from the customer's point of view and is an important part of Six-Sigma).
- Defect Unit or Item: is an output unit containing defects (Output units only) with no defective defects, defective units have one or more defects.
- A defect opportunity: The number of different ways that the output unit can fail for customers' requirements (products or simple services will have a few imbalances, but the products or services may contain very complex on hundreds of different ways of damage).
- Proportion Defective: The percentage or part of the units with one defect or more. Defective ratio = (defects number) / (number products) × 100%.
- Process Yield: The percentage of the total units produced by defects for example (1 - a defective ratio).
- Defect per Unit DPU: is the average number of defects in the output unit (the number of defects divided on the number of items produced).
- Defects Per Opportunity DPO: Defect per Unit = number of defects ÷ (Number of units produced × number the opportunity)

- Defects per Million Opportunities DPMO: Exactly the number of defects that will be produced if there are 1 million Opportunities to do so. Defects per Million Opportunities DPMO = defects per opportunity DPO × 10^6
- The Sigma Measurement: - DPMO is derived from DPMO, the number of standard deviations of the variation of the process that will fit with customer specification limits.

Statistical Process Control (SPC)

SPC: Statistical Process Control Whether a firm produces a service or a product, it is crucial to make sure that the operations meet the needs of the clientele. The fundamental principles of TQM and Six Sigma are increasing our ability to track the performance of our operations so that timely remedial action may be taken. Assessment of operations performance necessitates a variety of data gathering techniques. Control of statistical processes SPC is the use of statistical techniques to assess if the process is successful in achieving customer satisfaction and his desires. In the SPC, tools are primarily used to identify subpar services or to make it clear that the process has changed and that, unless something is done to remedy the situation, services or products will be determined by design specifications. The SPC can also be used to update management on changes to the improved process (Kumar, et al., 2006).

Output Variation

Even when procedures are being used as intended, there are several causes of variation, so no two services or products are exactly alike. However, since output variance is typically what customers see and experience, it is crucial to keep it to a minimum.

Performance measurements

The measurement of "variables," or qualities of the service or product that can be measured, such as weight, length, volume, or time, is one of the two methods for evaluating performance. Measuring the characteristics of a service or product that may be quickly computed to determine acceptable performance is another approach of performance appraisal. This method enables inspectors to quickly determine if a service or product complies with standards (yes or no) (Buffa & Sarin, 1987).

Distributions of sampling

On this scale, the process will result in an output that can be defined by distributing the process with a mean and variance that can only be determined by a thorough inspection that is 100% accurate. For instance, the length of time needed to process samples at an ICU lab in a hospital will vary. The evidence will typically take the shape of a pattern known as the process distribution if you measure the time it takes a large number of patients to finish the study and plot the results. Using statistics like the sample mean, sample range, or sample standard deviation, we estimate the sample distribution's characteristics (Schroeder & Goldstein, 2018).

1. The average sample Mean: is the sum of the divided notes on the total number of notes:

$$\bar{x} = \frac{\sum_{i=1}^{n} xi}{n} \quad \text{..... Equation (1)}$$

Whereas:
XI = Quality feature (like time).
N = total number of notes
$\bar{x}$ = average

2. The range is the difference between the larger note in the sample and the smaller note, the standard deviation is the square root of distributive contrast. The standard deviation of the process is provided based on the sample (Heizer &Render, 2013).

$$\sigma = \sqrt{\frac{\sum (xi-\bar{x})^2}{n-1}} \quad \text{..... Equation (2)}$$

Whereas:
σ = square root for sample
n = total number of notes in the sample
$\bar{x}$ = Medium
xi= Quality feature (like time) that relatively small values for scope or standard deviation include that notes are gathered near the average (Schroeder & Goldstein, 2018).

Process Capability

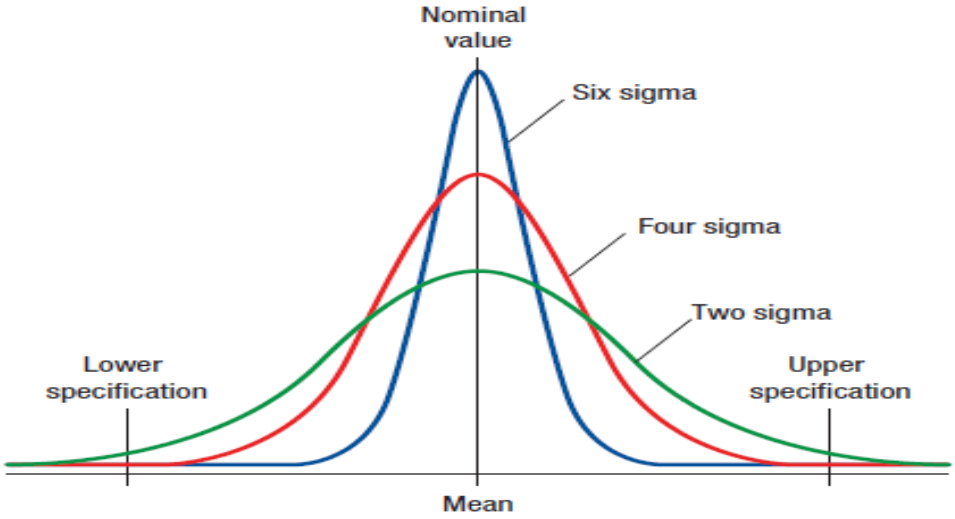
Techniques for process capability control assist managers in achieving and maintaining process distribution such that its mean and variance do not change. When the process' mean or variance changes, control limits are visible on control charts. However, because control limits are based on the mean and variance in the sampling distribution rather than the design specifications, a process under statistical control might not deliver goods or services in accordance with its design specifications. Process Capability is the capacity to fulfill design

requirements for a good or service. The target value, also known as the nominal value or tolerance, or an allowance above or below the face value, is how the design specification is typically expressed.

Determining the capacity of the process

Shows Figure 2. the effect of reducing variance on the ability of the process in the project, as the lower the variance (represented by fewer standard deviations), the less bad output was produced. As the relationship between the distribution of the process and the upper and lower specifications for the time of transformation in the project process is shown below in the figure under three cases. A project with a quality of 2 sigmas (specification limits = process distribution mean ± 2 standard deviations) produces defects of (4.56%) defects per million. And a project with a quality of 4 sigma produces a percentage of defects of only (0.0063%) or 63 defects per million, and finally, a project of quality six sigma produces a percentage of defects of only (0.0000002%) or 0.002 defects per million.

Figure-2. The effect of variance reduction on process capability



Source: Johnston & Clark (2005).

How does the manager quantitatively determine whether the process is capable or not? There are two scales commonly used in practice for assessing process capability. (Schroeder & Goldstein, 2018; Stevenson, 2005).

Process Capability Index (C_{pk}) is defined as

$$C_{pk} = \text{lower specification}, \left[\frac{\text{lower specification} - \bar{\bar{x}}}{3\sigma}, \frac{\text{Upper specification} - \bar{\bar{x}}}{3\sigma}\right] \ldots\ldots\ldots \text{Equation (3)}$$

Where: σ = standard deviation of the process distribution.

The Process Capability Index measures how well the process is focused, as well as whether the variance is acceptable or not. As a general rule, most values of any process distribution lie within ± 3 standard deviations from the mean. Hence, ±3 standard deviations are used as a deviation.

Process Capacity Ratio: (C_p)

If unsatisfactory results are shown in the Process Capability indicator test, another test can be conducted, which is the Process Capability ratio test, which is a quick test to see whether the process discrepancy causes the problem or not.

$$C_p = \left[\frac{\text{lower specification} - \bar{\bar{x}}}{3\sigma}, \frac{\text{Upper specification} - \bar{\bar{x}}}{3\sigma}\right]$$

DATA ANALYSIS AND RESULTS

Application of Six Sigma in the hospital hematology laboratory

The following table 1 shows the actual times required for blood tests as well as the types of laboratory tests and their standard times, which will be an analogy for choosing and using Six Sigma technology. The actual times required for the blood test were recorded through field visits, living in the laboratory, and reviewing the records and laboratory statements for examining the blood of patients.

Table-1. Types of examinations and their standard times

	Pathological Status/Blood Test	Standard Time
1	Knowing the percentage of blood CBC	5 minutes
2	ESR arthritis	One hour and a half
3	Acute Arthritis CRP	25minutes
4	The level of salts in the body U.A	One hour and a quarter
5	RBS blood glucose level	One hour and a quarter
6	thyroiditis TSH	6 hours
7	Pregnant test	20minutes
8	The level of urea in the blood, UREA	One hour and a quarter
9	To know the blood cells in the body GREATINIE	One hour and a quarter

Calculation of defective checks

Defective percentage

It is the percentage or part of the units that have one or more defects.

Defective percentage = (number of defects) / (number of Test) x 100%

Defective percentage = (6)/ (9) × 100% = 66%

The number of defects was calculated based on the number of times the test was performed and as in Table 2. Acute Arthritis CRP.

Process yield

It is the percentage or fraction of the total units produced by the process that is free from defects (which is: 1 - defective percentage).

Operation yield = 1-0.66 = 0.44 success rate of laboratory tests.

Defects per Opportunity DPO

It is the percentage or percentage of defects divided by the total number of defects opportunities. The number of defects is divided by (number of items produced × number of opportunities for each test).

Defect per Unit= number of defects ÷(Number of units produced × number the opportunity)

Defect per Unit= 6 ÷(9 × 3) = 0.222

Defects per million opportunities = Defects per opportunity x 10^6

Defects per million opportunities = 0.222 x 10^6 = 222000

We note that the defects lie between σ2 and σ3 and the defects are up to 222000 out of a million.

The sample will be taken through Table 2. measuring the times for the tests of acute osteoarthritis disease listed below:

Table-2. Acute Rheumatoid Arthritis CRP

The Patient's Name	Blood Draw Time	Time Of Receipt	Actual Time (Minutes)	Standard Time (Minutes)	Difference ± (Minutes)	The Number Of Times The Test Is Taken
1-M.S	9.15	10.00	45	25	+20	1
2-A.M	9.35	10.20	55	25	+30	2
3- A.H	8.35	9.15	40	25	+15	1
4- F.A	8.50	9.40	50	25	+25	1
5- B.D	9.15	9.40	85	25	+60	2
6- A.N	9.40	10.10	30	25	+5	1
7- W.A	9.55	10.30	35	25	+10	1
8-D.A	10.10	10.45	95	25	+70	3
9-F.K	11.30	11.55	85	25	+60	3

Application of the statistical method

Sampling method

The most accurate way to check the service at every stage of the process is in terms of its accuracy. This technique, called a complete inspection, is used when the costs of passing on the defects to the patient outweigh the costs of the examination. The hospital usually uses automated examination equipment that can record, summarize or display data. The sample will be taken through Table 3. Measuring the times for examining acute inflammatory arthritis CRP and the reasons for the delay are listed below.

Table-3. Acute Rheumatoid Arthritis CRP

The Patient's Name	Blood Draw Time	Time Of Receipt	Actual Time (Minutes)	Standard Time (Minutes)	Difference Min±	Reason For The Delay
1-M.S	9.15	10.00	45	25	+20	Device malfunction and lack of staff
2-A.M	9.35	10.20	55	25	+30	Device malfunction
3- A.H	8.35	9.15	40	25	+15	Device malfunction
4- F.A	8.50	9.40	50	25	+25	Device malfunction and lack of staff
5- B.D	9.15	9.40	85	25	+60	Device malfunction
6- A.N	9.40	10.10	30	25	+5	Device malfunction
7- W.A	9.55	10.30	35	25	+10	Device malfunction and lack of staff
8-D.A	10.10	10.45	95	25	+70	Device malfunction and lack of staff
9-F.K	11.30	11.55	85	25	+60	Device malfunction and lack of staff

Sampling Distributions

On this scale, the process will result in an output that can be defined by distributing the process with a mean and variance that can only be determined by a thorough inspection that is 100% accurate. An example of a variable scale is the amount of time needed to process samples

in a hospital blood laboratory. The evidence will typically take the form of a pattern that can be referred to as the process distribution if you measure the time it takes a large number of patients to finish a blood test analysis and plot the findings. From the sample mean and sample range, we attempt to calculate the standard deviation.

The sample mean

Is the sum of the tests divided by the total number of tests:

$$\bar{x} = \frac{\sum_{i=1}^{n} xi}{n}$$

Whereas.

xi = note the quality characteristic (time).

n = total number of tests.

$\bar{x}$ *= mean.*

$$= \frac{45+55+40+50+85+30+35+95+85}{9} = 57.7\ minut\bar{x}$$

It is noted that the average deviated greatly from the standard time, which is 25 minutes, and this is an indication that the process is outside the limits of the specification in a very large time (that is, the process is not centralized, as the average is very far from the standard time of about 32 minutes, which is a difference in time is not a little) and it was supposed that The average is located somewhat close to the standard time of 25 minutes, but the result of the negatives that were diagnosed in the field reality through the defect of the device and the small number of workers from the analysts and the small number of devices, and all this is accompanied by an increase in the number of patients.

The range

Is the difference between the largest test in the sample and the smallest test, and the standard deviation is the square root of the distributive variance. An estimate of the standard deviation of the process is provided based on the sample by**:**

$$\sigma = \sqrt{\frac{\sum (xi - \bar{x})^2}{n-1}}$$

Whereas:

σ = standard deviation.
n = the total number of tests in the sample.
$\bar{x}$ *= mean.*
*xi = observation or tests time***.**

Relatively small values of the range or standard deviation imply that the observations cluster near the mean.

x	85	95	35	30	85	50	40	55	45	$\sum$ 4705.61
$x-\overline{x}$	27.3	37.3	22.7	27.7	27.3	7.7	17.7	2.7	12.7	
$\sum(xi-\overline{x})^2$	745.29	1391.2	515.2	767.2	745.2	59.29	313.2	7.29	161.2	

$$\sigma = \sqrt{\frac{4705.61}{9-1}} = 24.25 \text{ standard deviations amount min}$$

These sample statistics have their distribution which we call the sample distribution. In the application of Table 2. Above for acute osteoarthritis, an important performance variable is a time it takes to communicate the results of the examination to the patient. As the standard time for results is available with an average of 25 minutes, meaning they want the average distribution of the operation to be 25 minutes. The process showed actual results of the analysis with an average of 57.7 minutes with a standard deviation of 24.25 minutes.

We note that the standard deviation is very large between the time variations (minimum 30 minutes and maximum 95 minutes), and this indicates a very large discrepancy, as well as the average process, which is very large compared to the standard time.

The result of the operation indicates that the laboratory tests for blood, which is the performance of the operation, lead to three negative results:

The process variance is very large and is a standard deviation of 24.25 minutes.

No centralization of the process, which is 32.7 minutes (30 minutes minimum time - 95 minutes maximum time).

The average operation is very large, which is 57.7 minutes.

Operation capacity

Techniques for statistical process control assist observers, including the laboratory manager, in achieving and maintaining process distribution such that its mean and variance do not vary. When the process' mean or variance changes, control limits are visible on control charts. However, because the control limits are based on the mean and variance in the sample distribution rather than the design requirements, the process that is under statistical control

might not produce laboratory services in accordance with their design specifications or their standard time.

Process capability relates to the ability to fulfill design requirements for a service or product, as we defined it in the theoretical section. A notional value, tolerance, or an allowance above or below the face value is typically used to convey the design specification. When using Table 2. CRP blood test, the blood laboratory administration may have a nominal value of duration of 25 minutes for communicating results to patients and a 5-minute indulgence due to the requirement for quickness in life-threatening situations. The tolerance specifies a 30-minute maximum. The laboratory manager is also interested in identifying the occurrence of M transformation times, therefore the blood laboratory process must be able to produce the results of the analyses in a minimum of 20 minutes and otherwise infer a particular proportion of (defects) from these specifications.

Less than 20 minutes because maybe something will be learned that can be incorporated into the lab process in the future. For now, analysts are pleased with the results, which arrive in 20-30 minutes.

Determining the capacity of the process

In this step, we explain the relationship between the distribution of the process and the upper and lower specifications for the transition time in the laboratory testing process, where it will be known whether the process is capable of achieving the best performance, which falls within the limits of the upper and lower specifications. In the application of Table 2. Is the process unable because the process of laboratory tests produces very many examination statements at different and different times?

The laboratory manager and analysts seek to reduce process variance. The lower the variance (represented by fewer standard deviations), the lower the output from poor laboratory tests.

How do the laboratory manager and quantitative analysts determine whether the examination process is capable or not? There are two commonly used measures in practice to assess process capability - the Process Capability Index and the Process Capability ratio.

Process Capacity Index (C_{pk})

The Cpk Process Capability Index equation is as follows:

$$C_{pk}= \text{lower specification}, \left[\frac{\text{lower specification} - \bar{\bar{x}}}{3\sigma}, \frac{\text{Upper specification} - \bar{\bar{x}}}{3\sigma}\right]$$

Where:

σ = standard deviation of the process distribution.

The Process Capability Index evaluates the process' centralization and determines whether or not the variance is tolerable. The majority of the values of any actual distribution, as we discussed in the theoretical part, lie between 3 standard deviations from the mean. Therefore, a cut-off of 3 standard deviations is utilized. It is also tested to determine if the process average is at least three standard deviations away from the upper and lower standards because the Process Capability indicator is related to how well the process distribution is focused on in relation to the specifications. We choose the lower ratio since it represents both cases in their worst-case scenarios.

$$C_{pk}= \text{lower specification}, \left[\frac{\text{lower specification} - \bar{\bar{x}}}{3\sigma}, \frac{\text{Upper specification} - \bar{\bar{x}}}{3\sigma}\right]$$

$$\text{Lower specification } \frac{\text{lower specification} - \bar{\bar{x}}}{3\sigma} = \frac{57.7-20.0}{3(24.25)} = \frac{37.7}{72.75} = 0.518$$

$$\text{Upper specification } \frac{\text{Upper specification} - \bar{\bar{x}}}{3\sigma} = \frac{57.7-30.0}{3(24.25)} = \frac{27.7}{72.75} = 0.380$$

$$C_{pk}= \text{lower specification}, \left[\frac{\text{lower specification} - \bar{\bar{x}}}{3\sigma}, \frac{\text{Upper specification} - \bar{\bar{x}}}{3\sigma}\right]$$

C_{pk}=0.380 , [0.518 , 0.380]= 0.380 Minimum process capacity index

The process capability indicator indicates that the blood laboratory is at a critical value level of 0.380. When we compare it with table 4. Below, we note that the process for the blood laboratory is going at a slightly higher level than the level of sigma 1, as in the following table:

Table-4. Critical values

Sigma Level	Defects Per Million Opportunities (DPMO) 1000,000	%GOOD	Critical Value	Rate of Improvement
σ 1	697672	68.26	0.33	-
σ 2	308770	95.46	0.67	2 once
σ 3	66810	99.73	1	5 once
σ 4	6210	99.9937	1.33	11 once
σ 5	232	99.98	1.67	27 once
σ 6	3.4	99.99966	2	68 once

We note that the examination process in the Process Capability Index test showed that the examination process is very weak, which is 1 cm. If the laboratory management desires to produce its processes at a quality level of 4 Sigma - carrying out the process of continuous improvement - that is, if the C_{pk} is greater than or equal to the critical value of (1.33), we can say that the process is capable of performance, but if the C_{pk} is less than the critical value, either The process average is very close to one of the tolerance limits or the target value (which in our application is 25 minutes), and a defective output is produced or the process variance is too large. To find out whether the variance is calibrated or not, we need another test which is the Process Capability ratio.

Process Capacity Ratio: (C_p)

If unsatisfactory results are shown (which is what happened in the Process Capability Index) in the Process Capability indicator test, another test can be conducted, which is the Process Capability ratio test, which is a quick test to see whether the process discrepancy causes the problem or not. If the process is capable, then it has a distribution below the maximum values as it falls within the specifications or upper and lower limits of the service. In our application, if the process distribution was normal, 99.74% of the values fall within the range of ± 3 standard deviations. In other words, the range of quality scale values resulting from the process is approximately 6 standard deviations of the process distribution. Therefore, if the process is capable of a 3-sigma level, the difference between the upper and lower bounds is called the width of the leniency and it must be greater than 6 standard deviations. The process capacity ratio C_p can be measured as:

$$C_p = \left[\frac{\text{lower specification} - \bar{x}}{3\sigma}, \frac{\text{Upper specification} - \bar{x}}{3\sigma}\right]$$

$$C_p = \left[\left[\frac{\text{lower specification} - \text{Upper specification}}{6\sigma}\right] =\right.$$

$$C_p = \frac{30.0 - 20.0}{6(24.25)} = 0.0687$$

The Process Capability ratio scale also showed a weakness in the process performance, as it indicated 0.0687 percentage, which is less than the standard critical value referred to in the table above. By studying the reasons, it was found that the reasons attributed to this poor performance are due to the obsolescence and inefficiency of the equipment, as the test and examination of the patient's blood are repeated two or three times to ensure its health, and this takes a long time for laboratory examination, in addition to the small number of analysts and their inexperience.

The process capability indicator shows that the process is not capable, but the problem is whether it is in the variation of the processor in the focus of the processor in both, that the options available to improve the process depend on the ability of the laboratory management to improve the equipment by purchasing modern equipment and training employees (analysts) and this is done through Manage the cost that will be spent.

If we assume that the laboratory management wants a higher level of sigma in its operations to improve its performance and to reach target values for performance, for example, 2, 3, 4, or more with critical values of 0.67, 1.00, 1.33 respectively, it must take measures. If spending is made through purchase and training, the laboratory management aspires To reach the SCMA target level 4, which has a critical value of 1.33. This situation requires the management of the laboratory costs of capital costs represented in the purchase of examination equipment, the purchase of equipment, machines, and computers necessary for the examination process, the purchase of furniture, and the availability of appropriate buildings that accommodate the increasing numbers of auditors, especially in our time due to the Corona pandemic, as well as to study its operational costs from salaries to new employees. Training workers and developing their skills in the use of modern equipment, as well as purchasing laboratory analyzes of chemicals and purchasing laboratory supplies needed for laboratory work.

The rest of the tests can be applied to measure the extent to which the laboratory process can improve its performance. Samples of the tests for the rest of the tests have been taken.

IMPLICATIONS OF THE STUDY

Conclusions

The blood laboratory at Al-Hussein Teaching Hospital did not rely on modern quality systems, including the agile Six Sigma methodology.

There is a lot of wastage and loss in the specified standard time, which causes a lot of delay in the time of analysis, and this indicates the discrepancy and decentralization of the process.

The laboratory testing equipment breaks down many times because of its old age (these devices were obtained from the Japanese grant during the year 2003), and this causes two or three re-examinations, which drains additional time.

The small area of the laboratory compared to the number of visitors, as the hospital was built in 1985, that is, nearly 40 years ago when the population of the province was small, and as a result of the increase in population, the laboratory became not compatible with the numbers of the population of the province at present.

The application of the statistical processes of the Six Sigma methodology showed that the laboratory operates with low levels of sigma, as specified in the practical aspect of the research.

The absence of training courses for the existing analysts, as it was not clear that any of them had entered the skills development and laboratory courses.

Recommendations

The necessity of relying on modern methodologies to improve the quality of performance, including the application of the agile Six Sigma methodology, which guarantees the highest performance and continues to improve it and eliminate waste and waste in time and requirements.

The necessity of improving the time of the examination process by using the Six Sigma agile methodology and its statistical and cost methods.

The necessity of supplying the laboratory with modern laboratory equipment in numbers commensurate with the needs, with periodic maintenance

The necessity of strengthening the laboratory with a staff of analysts whose numbers are proportional to the number of devices and the number of auditors provided that there is a direct proportion between them and the increasing number of auditors.

Working on the establishment of an expansion of the current laboratory, or the establishment of a laboratory with an appropriate area commensurate with the number of auditors.

The necessity of working to raise the level of Six Sigma through the continuous improvement methodology, which is one of the lean tools, and this is done through the mechanism in place in the research body.

The necessity of engaging employees with training courses that improve their performance and enable them to work efficiently and effectively to improve their work and develop themselves is done through diligence, dedication, sincerity, and teamwork that aims to achieve the goals of the service institution represented by the hospital.

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