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IMPROVING ADMINISTRATIVE TRAINING PROCESSES USING THE SIX SIGMA DMAIC METHODOLOGY: A CASE STUDY OF A PRIVATE TRAINING INSTITUTION

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تحسين العمليات التدريبية الإدارية باستخدام منهجية DMAIC- 6 سيجما: دراسة حالة لمؤسسة تدريبية خاصة

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الملخص

يمكن أن تؤدي الكفاءة الإدارية المنخفضة في مؤسسات التدريب الخاصة إلى زيادة وقت إنجاز الخدمات، والتكاليف التشغيلية، وعدم رضا العملاء، مما يؤثر سلباً على الكفاءة الإجمالية للعمليات. وعلى الرغم من التطبيق المتزايد لمنهجية "6 سيجما الرشيق (Lean Six Sigma) " في القطاعين الصناعي والخدمي، إلا أن البحوث التي تناولت دورها في تحسين العمليات الإدارية الداعمة لتقديم الخدمات التدريبية ما زالت محدودة. تطبق هذه الدراسة منهجية DMAIC- 6 سيجما، لتحسين العمليات التدريبية الإدارية من خلال دراسة حالة لمؤسسة خاصة للتدريب الهندسي في ليبيا. تم اعتماد المنهج الوصفي للحالة الدراسية باستخدام بيانات تشغيلية لمدة ستة أشهر جُمعت من خلال الملاحظات المباشرة، والسجلات التنظيمية، وخرائط العمليات، والمقابلات شبه المنظمة. ولتقييم أداء العمليات، تم تطبيق أدوات "6 سيجما الرشيق"، تشمل مؤشرات الأداء الرئيسية (KPIs)، والتحليل الرشيق الهدر (Lean Waste Analysis)، وتحليل باريتو، ومخطط عظم السمكة، وتحليل الأسئلة الخمسة (Five Whys)، وحساب العيوب لكل مليون فرصة (DPMO)، وتقييم مستوى سيجما، وتكلفة الجودة الرديئة (COPQ)، بالإضافة إلى تقييم العائد على الاستثمار القائم على السيناريوهات.

أظهرت النتائج أن أوجه القصور الرئيسية تعود إلى الأنشطة الإدارية ما قبل التدريب، وخصوصاً عند تسجيل المشاركين، ومتابعة العملاء، والتنسيق الجدولي، وإعداد الشهادات. وأوضح التقييم الأولي أن 60% فقط من الدورات المجدولة بدأت في وقتها المحدد، وهو ما يقابل نحو 400,000 عيب لكل مليون فرصة (DPMO)، ومستوى سيجما يبلغ 1.8، والتكلفة التقريبية للجودة الرديئة تبلغ 25,700 دينار ليبي.

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وبناءً على هذه النتائج، تم اقتراح إطار عمل لتحسين العمليات الإدارية يدمج الحلول الرقمية العملية ضمن منهجية DMAIC. ويقدم النهج المقترح مساراً مهيكلاً لتحسين عمليات الخدمات الإدارية في مؤسسات التدريب ذات الموارد المحدودة؛ ومع ذلك، فإن فوائد الأداء المتوقعة منه تتطلب التحقق من صحتها من خلال التطبيق المستقبلي.

الكلمات المفتاحية: 6 سيجما، DMAIC، 6 سيجما الرشيق، عمليات التحسين، العمليات الإدارية، المؤسسات التدريبية، جودة الخدمة، التحويل الرقمي.

ABSTRACT

Administrative inefficiencies in private training institutions can increase service lead times, operational costs, and customer dissatisfaction, negatively affecting overall process efficiency. Despite the extensive application of Lean Six Sigma in manufacturing and service sectors, limited research has examined its role in improving administrative processes supporting training service delivery. This study applies the Six Sigma DMAIC methodology to improve administrative training processes through a case study of a private engineering training institution in Libya. A qualitative case study approach was adopted using six-month operational data collected through direct observations, organisational records, process mapping, and semi-structured interviews. Lean Six Sigma tools, including KPIs, Lean Waste Analysis, Pareto Analysis, Fishbone Diagram, Five Whys Analysis, DPMO, Sigma Level assessment, COPQ, and scenario-based ROI evaluation, were applied to assess process performance. The findings revealed that the main inefficiencies originated from pre-training administrative activities, particularly participant registration, customer follow-up, scheduling coordination, and certificate preparation. The baseline assessment showed that only 60% of scheduled courses commenced on time, corresponding to approximately 400,000 DPMO, a Sigma Level of 1.8, and an estimated COPQ of LYD 25,700.

Based on these findings, an administrative process improvement framework integrating practical digital solutions within the DMAIC methodology was proposed. The proposed approach provides a structured pathway for improving administrative service processes in resource-constrained training organisations; however, its expected performance benefits require validation through future implementation.

KEYWORDS: Six Sigma; DMAIC; Lean Six Sigma; Process Improvement; Administrative Processes; Training Institutions; Service Quality; Digital Transformation.

INTRODUCTION

Service organizations increasingly recognize that operational competitiveness depends not only on service quality but also on the efficiency of administrative processes supporting service delivery. In training markets, ineffective registration, delayed communication, poor scheduling coordination, and inefficient certification processes can increase lead time, operational costs, and customer dissatisfaction. Therefore, improving administrative workflows has become essential for operational excellence.

Six Sigma is a data-driven methodology for reducing process variation, identifying root causes, and improving organisational performance [1]. Originally developed for manufacturing, Lean Six Sigma (LSS) has evolved into an improvement approach applicable to both manufacturing and service

organisations by integrating Lean waste reduction with Six Sigma analysis [2]. The DMAIC (Define, Measure, Analyse, Improve and Control) framework provides a structured approach for process improvement: Define establishes the problem and project objectives; Measure evaluates current process performance and establishes the baseline; Analyse identifies the root causes of inefficiencies; Improve develops and implements appropriate solutions; and Control monitors the improved process to sustain performance over time [1,3,4]. Successful implementation also depends on organisational factors such as leadership, employee involvement, and change management capability [1,3,4,5].

Service processes differ from manufacturing due to intangible outputs, customer interaction, and higher variability; therefore, LSS requires adaptation to service contexts [2,3,6]. Previous studies in educational environments have demonstrated the effectiveness of Lean Six Sigma in reducing administrative delays and improving process performance; however, most research has focused on universities and higher education institutions, with limited attention given to private training organisations [7,8,9]. Studies within the Libyan context have explored Just-in-Time (JIT) applications in education and training, but these studies remained conceptual and did not apply DMAIC-based improvement or quantitative performance evaluation [10,11].

Recent research highlights the potential of digital transformation and Quality 4.0 in enhancing LSS practices. In particular, the integration of Industry 4.0 technologies with DMAIC can strengthen data collection, process monitoring, and data-driven decision-making [12,13]. However, digital solutions can be integrated with structured improvement methodologies to ensure sustainable results [14,15,16,17,18]. Despite growing interest in LSS applications, limited empirical evidence exists regarding the integration of DMAIC with affordable digital solutions in small and medium-sized service organisations, particularly in developing-country contexts [13,16,17]. Therefore, this study applies Six Sigma DMAIC to improve administrative training processes within a private engineering training institution in Libya. The study extends existing LSS research by examining a complete service workflow and proposing a practical improvement framework integrating Lean principles with accessible digital transformation mechanisms [15,17].

AN OVERVIEW OF SIX SIGMA IN SERVICE AND TRAINING PROCESSES

Lean Six Sigma has been increasingly adopted as a systematic approach for improving operational performance in service organisations due to its ability to combine Lean waste reduction principles with Six Sigma statistical analysis. Previous research indicates that LSS has evolved from a manufacturing-focused quality improvement methodology into a broader management philosophy supporting customer value creation, process excellence, and continuous improvement across different organisational contexts [1,2]. The application of LSS in service environments requires adaptation because service processes differ from manufacturing systems in terms of customer involvement, intangible outputs, information dependency, and process variability. Therefore, researchers have emphasised the importance of developing service-oriented LSS frameworks that consider organisational maturity, cultural factors, and implementation challenges [3,6]. Several studies have investigated the application of Lean Six Sigma

within educational environments. Shamsuzzaman et al. applied Lean Six Sigma to improve the admission process in a higher education institution and demonstrated that DMAIC-based improvement can reduce administrative delays, improve process visibility, and enhance service performance [7]. Similarly, Šimonytė et al. explored Lean implementation experiences in higher education institutions and highlighted the importance of process standardisation, employee engagement, and continuous improvement culture for successful Lean adoption [8].

Kokkinou and van Kollenburg [9] examined critical success factors for Lean implementation in higher education and found that leadership support, organisational readiness, employee involvement, and effective communication are essential for sustaining improvement initiatives. However, these studies mainly focused on universities and higher education institutions with relatively stable administrative structures, while private training organisations operating under market-driven conditions remain insufficiently investigated Within the Libyan educational context, Hokoma et al. [10] investigated the potential application of Just-in-Time (JIT) principles in education and training institutions. Their study suggested that demand-driven approaches could improve scheduling efficiency and resource utilization; however, it remained conceptual and did not employ a structured improvement methodology such as DMAIC or quantitative performance measures.

El Dabee and Hokoma [11] examined the application of JIT principles for reducing waste and improving supply chain synchronization. Although their study demonstrated the effectiveness of waste reduction approaches, it focused on manufacturing supply chain operations rather than administrative service processes. Recent research has also highlighted the importance of integrating digital technologies with LSS practices. Digital transformation mechanisms, including customer relationship management systems, automated workflows, dashboards, and electronic documentation, can improve process transparency, data availability, and decision-making capability [14,15,16]. However, researchers emphasise that digitalisation should be integrated within structured improvement methodologies rather than implemented as an independent solution, because technology may reinforce inefficient processes if underlying problems are not analysed first [14,15]. The emergence of Quality 4.0 and LSS 4.0 has further expanded research interest toward combining continuous improvement methodologies with Industry 4.0 technologies [12,16,17,18].

Despite these developments, several gaps remain evident. Firstly, most empirical studies have concentrated on manufacturing, healthcare, and higher education sectors, while limited attention has been given to private training organisations where operational processes are highly dependent on customer demand, flexible scheduling, and rapid administrative response [7,8,9]. Secondly, although digital transformation has become an important research direction, many existing studies investigate large organisations with greater financial and technological capabilities. Limited evidence exists regarding the integration of affordable digital solutions with DMAIC within small and medium-sized service organisations, particularly in developing-country environments [13,15,16]. Thirdly, previous studies frequently examined individual administrative activities, such as admission or registration, rather than analysing the complete service delivery workflow from customer inquiry to post-training

evaluation. Therefore, further empirical research is required to develop practical improvement frameworks that integrate Lean Six Sigma principles with accessible digital technologies for private training institutions.

Accordingly, this study addresses these gaps by applying the Six Sigma DMAIC methodology to improve administrative processes within a private engineering training organisation in Libya. Unlike previous studies, this research evaluates the complete administrative workflow, identifies operational waste, measures process performance using quantitative indicators, and proposes a practical improvement framework integrating Lean Six Sigma and low-cost digital transformation mechanisms.

METHODOLOGY

This study employed a qualitative case study design to investigate the application of Six Sigma DMAIC for improving administrative training processes within a private training institution in Libya. A case study approach was selected because it enables an in-depth investigation of complex organisational processes within their real operational context and supports the development of practical improvement strategies based on empirical evidence [19].

The study was conducted at Al-Roya Company for Engineering Consulting and Training, Benghazi, Libya. The Training Department was selected because it manages the complete administrative workflow associated with training delivery, including marketing activities, participant registration, customer follow-up, trainer coordination, scheduling, certificate issuance, and post-training evaluation. Data were collected over six months (July–December 2025) through direct observations, organisational records, registration logs, process mapping, and semi-structured interviews with relevant administrative personnel. The interview protocol focused on identifying operational challenges, sources of delays, communication issues, and improvement opportunities within the existing workflow. The main themes included administrative responsibilities, enrolment challenges, causes of non-value-added activities, coordination effectiveness, and potential digital improvement solutions. Interview findings were analysed together with operational records and observations to validate identified problems and root causes. Data from 25 scheduled training courses were also analysed to establish baseline performance indicators and identify process bottlenecks. The use of multiple data sources enhanced the reliability of findings through methodological triangulation. DMAIC was selected as the improvement framework because it provides a structured approach for analysing process problems, identifying root causes, implementing improvements, and sustaining performance through continuous monitoring [1,20]. Since this study focuses on improving an existing administrative process rather than designing a new process, DMAIC was considered more appropriate than Design for Six Sigma (DFSS). The DMAIC cycle guided all research phases, including problem definition, performance measurement, root-cause analysis, improvement planning, and future process control. This study will adopt the following tools:

- **Process Mapping:** to provide a clear visual representation of the administrative workflow, facilitating the rapid identification of value-added and non-value-added activities.

- **Key Performance Indicators (KPIs):** to provide objective, quantifiable measures for evaluating operational performance before and after the improvement phase.
- **DPMO and Sigma Level:** to quantify process capability, evaluate baseline process performance, and provide standardised Six Sigma metrics for measuring process improvement.
- **Lean Waste Analysis:** to enable the systematic identification of non-value-added activities (waste) that directly inflate lead times and operational costs.
- **Pareto Analysis:** to prioritize action by identifying the vital few critical causes responsible for the majority of process defects, according to the 80/20 principle.
- **Fishbone Diagram:** a structured analytical tool used to categorize potential root causes into logical groups, facilitating the systematic identification of factors contributing to administrative delays and process inefficiencies.
- **Five Whys Analysis:** a systematic root cause analysis technique used to investigate the underlying causes of administrative delays and process inefficiencies rather than focusing solely on their observable symptoms.
- **Cost of Poor Quality (COPQ) & ROI:** COPQ quantifies the financial drain of process inefficiencies, while ROI evaluates the economic feasibility and long-term financial viability of the proposed digital framework.

RESULTS AND DISCUSSION

The results of this study are presented and analysed in accordance with the five phases of the DMAIC methodology: Define, Measure, Analyse, Improve, and Control. The analysis begins by defining the scope and key administrative challenges, followed by establishing baseline process performance and identifying the principal sources and root causes of inefficiency. Based on these findings, improvement actions and a future control framework are proposed to address the identified process weaknesses and support sustainable performance improvement. The findings are subsequently discussed in relation to previous LSS research, with particular consideration of their implications for administrative process improvement and digital transformation in private training organisations.

1. Define Phase

The Define phase established the project scope, objectives, and responsibilities by identifying the main operational problems within Al-Roya Company. The assessment showed that inefficiencies primarily occurred during the administrative preparation stage, including enrolment delays, weak customer follow-up, repeated advertising, and coordination issues. Accordingly, the administrative workflow was selected as the focus of the DMAIC-based process improvement effort. The improvement objectives were to reduce waiting time, enhance registration and follow-up efficiency, improve on-time course commencement, increase customer satisfaction, and minimise repeated advertising activities. The process scope and project team responsibilities are presented in Tables 1 and 2.

The training process scope was defined to cover the main administrative activities from trainee registration to post-training evaluation. As presented in Table 1, the process comprises six key stages: trainee registration, advertising and promotion, course date confirmation, coordination with trainers, certificate issuance, and post-training evaluation. These stages establish the process boundaries for the subsequent measurement and analysis of administrative performance.

Table 1: The Training Process Scope.

NO	Item
1.	Trainee registration
2.	Advertising and promotion
3.	Course date confirmation
4.	Coordination with trainers
5.	Certificate issuance
6.	Post-training evaluation

Table 2: Proposed Six Sigma Project Team and Responsibilities.

Role	Proposed Responsible Person/ Department
Executive Sponsor	Executive Manager of Al-Roya Company
Champion	Training Department Manager
Black Belt/ Project Leader	Quality or Process Improvement Officer
Green Belt	Registration and Follow-up Officer
Team Members	Marketing, Training, Finance, Customer Service, Trainers

2. Measure Phase

The Measure phase evaluated the current performance baseline of the administrative training process by documenting the existing workflow, collecting operational data, and quantifying process capability. Baseline data were obtained from direct observations, organisational records, registration logs, and semi-structured interviews conducted over the six-month study period. The collected data shown in Table 3 were used to calculate process metrics and establish the performance benchmark.

Table 3: Current Training Process Cycle Time & Waiting Time.

Stage	Actual Processing Time (C/T)	Waiting Time (W/T)	Observation
Registration	10 minutes per trainee	14–21 days	Delay due to waiting for the required number of participants
Advertising	2 days	Continuous	Repeated and ineffective campaigns
Schedule Confirmation	1 day	7 days	Poor coordination with trainers and companies
Training Delivery	6–14 days	None	Core value stage

Certificates	1 day	None	Ready on the last day
Follow-up and Evaluation	Around 15 minutes	Irregular	Weak digital tracking

*Source: Developed by the authors based on field data (2025).

To establish the quantitative baseline of the administrative process, data were collected from 25 scheduled training courses over a six-month period (July–December 2025). Each course was considered a process unit, with one defect opportunity assigned when a course failed to commence on its planned date due to administrative delays or insufficient registration. The results showed that 15 courses started on time, while 10 were delayed or cancelled, resulting in a baseline on-time commencement rate of 60% (Table 4). Accordingly, the Defects per Million Opportunities (DPMO) were calculated using the standard Six Sigma equation:

$$\text{DPMO} = \frac{\text{Number of Defects}}{\text{Number of Units} \times \text{Opportunity}} \times 1{,}000{,}000 \quad (1)$$

Substituting the collected operational data:

$$DPMO = \frac{10}{25 \times 1} \times 1{,}000{,}000 = 400{,}000$$

The calculated DPMO corresponds to a 40% defect rate, indicating that only 60% of scheduled courses commenced on time. Based on the standard Six Sigma conversion table with the conventional 1.5-sigma shift, this performance level corresponds to an estimated Sigma Level of 1.75–1.80, indicating low process capability and significant improvement opportunities.

The Cost of Poor Quality (COPQ) was calculated as the sum of the direct financial losses resulting from process inefficiencies using the following equation:

$$\text{COPQ} = \text{WC} + \text{AW} + \text{AOC} \quad (2)$$

where WC represents Trainee Withdrawal Cost, AW represents Advertising Waste, and AOC represents Additional Operating Cost.

$$\text{AOC} = \text{Average Hourly Wage} \times \text{Hours Wasted} \times \text{Number of Staff} \quad (3)$$

$$\text{AW} = \text{Number of Repeated Advertisements} \times \text{Cost per Advertisement} \quad (4)$$

Substituting the estimated financial losses:

$$\text{COPQ} = 20{,}000 + 4{,}500 + 1{,}200 = 25{,}700$$

Therefore, the total Cost of Poor Quality (COPQ) was estimated at LYD 25,700

Based on the baseline performance assessment, key performance indicators (KPIs) were established to quantify the current state of the administrative training process and define the desired improvement targets. These indicators focus on course commencement, registration completion time, customer satisfaction, certificate readiness, and repeated advertising activities.

Table 4 summarises the current key performance indicators and the corresponding improvement targets used to guide the subsequent DMAIC phases

Table 4: Current Key Performance Indicators and Targets.

KPI	Current State	Target
On-time course commencement	60%	95%
Registration completion time	3 weeks	1 week
Customer satisfaction	85%	95%
Certificate readiness	Last day	Maintain
Repeated advertising campaigns	High	Reduce by 50%

*Source: Developed by the authors based on field data (2025).

Figure 1 illustrates the current administrative workflow from participant registration to certificate issuance. The process map identifies key waiting points in registration, customer follow-up, and trainer coordination, representing non-value-added activities that increase lead time. It provides the baseline for process evaluation and subsequent DMAIC analysis.

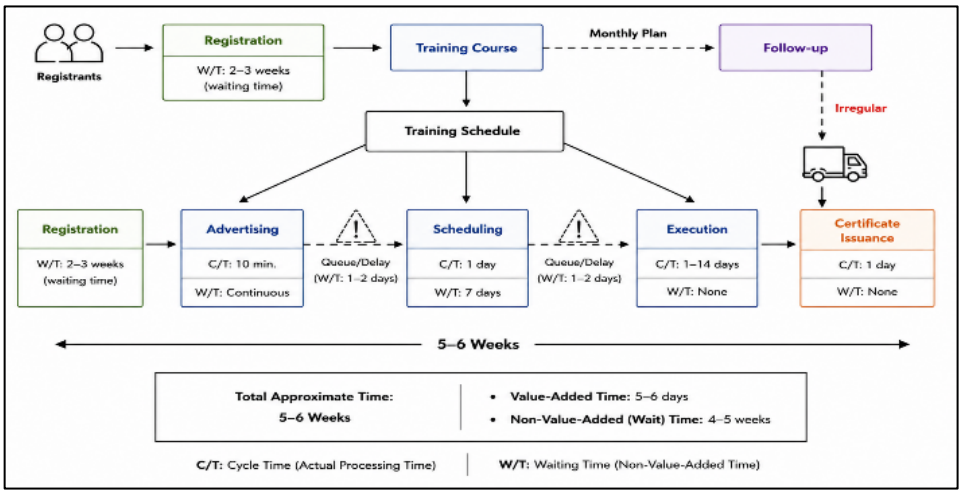

Figure 1: Current Training Process Flow Map.

*Source: Developed by the authors based on field data (2025).

In this study, a defect was defined as any deviation from customer requirements or organisational performance objectives affecting administrative process efficiency. As shown in Table 5, the identified defects included delayed course commencement, inadequate follow-up, repeated advertising, poor coordination, and irregular evaluation practices. These defects contributed to increased costs, customer dissatisfaction, and process inefficiencies, providing the basis for root cause analysis.

Table 5: Identified Defects and Their Impacts.

Defect	Impact
Delayed course start	Reduced customer satisfaction
Weak follow-up	Loss of potential trainees

Defect	Impact
Repeated advertising	Increased cost
Poor coordination	Course postponement
Irregular evaluation	Weak continuous improvement

*Source: Developed by the authors based on field data (2025).

3. Analyse Phase

The Analyse phase identified the root causes of process inefficiencies using baseline data from the Measure phase. Gemba Walk, Root Cause Analysis, Pareto Analysis, Fishbone Diagram, and Five Whys Analysis were applied to prioritise major delays and non-value-added activities. The identified types of waste are summarised in Table 6.

Table 6: Lean Waste Analysis in the Training Process.

Waste Type	Description	Impact
Waiting	Waiting for minimum participants in a single course	Delayed course start
Overprocessing	Repeated ineffective advertising	Waste of time and money
Defects	Lost trainees due to weak follow-up	Loss of potential clients
Inventory /Work-in-Process (WIP)	Accumulation of courses awaiting minimum enrolment	Lost revenue
Motion	Manual handling of records	Slow processing
Underutilized People	Idle staff during waiting periods	Low productivity

*Source: Developed by the authors based on field data (2025).

Figure 2 indicates that insufficient participant numbers represent the main source of delay, accounting for approximately 35% of identified causes. This finding confirms that the primary bottleneck occurs before course delivery, highlighting the need to focus improvement efforts on participant registration, customer follow-up, and demand forecasting.

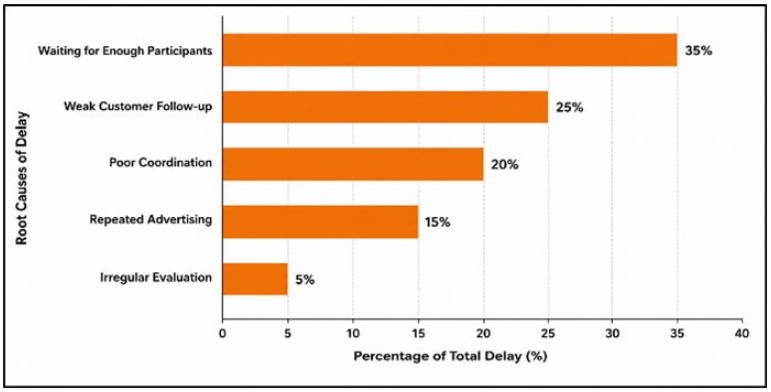

Figure 2: Main Causes of Delay in Al-Roya Training Process.

*Source: Developed by the authors based on field data (2025).

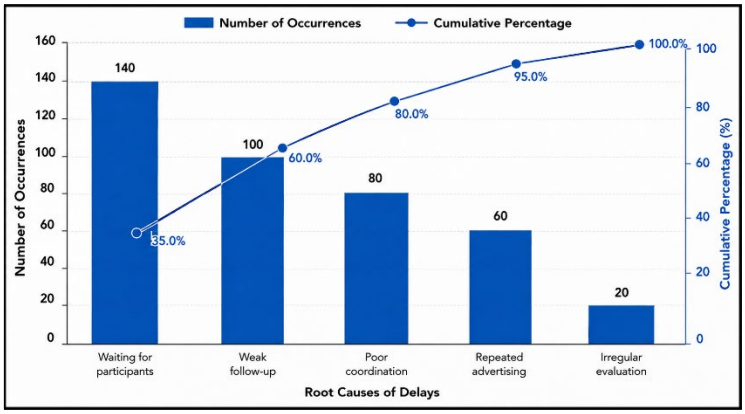

Figure 3: Pareto Chart of Delay Causes in the Training Process.

*Source: Developed by the authors based on field data (2025).

The Pareto analysis identified the major contributors to administrative inefficiencies. As shown in Figure 3, approximately 80% of delays were associated with three main causes: insufficient participants (35%), weak customer follow-up (25%), and poor coordination (20%). These findings indicate that improvement efforts should focus on priority areas, particularly digital registration systems and automated customer follow-up, to address the dominant sources of administrative delay.

To further investigate the root causes of administrative delays, a Cause-and-Effect (Fishbone) Diagram was developed based on discussions with administrative staff and trainers.

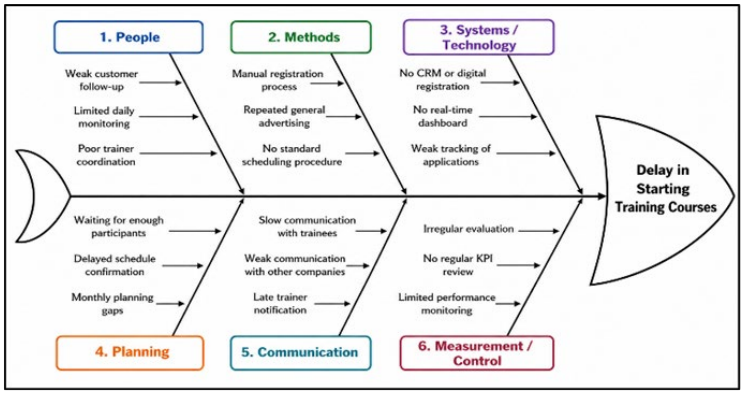

Figure 4: Fishbone Diagram of Root Causes of Delay.

*Source: Developed by the authors based on field data (2025).

As shown in Figure 4, the root causes of delays were categorised into six main areas: People, Methods, Systems/Technology, Planning, Communication, and Measurement/Control. The analysis revealed several interrelated weaknesses, including weak customer follow-up, manual registration procedures, the absence of Customer Relationship Management (CRM) and real-time monitoring systems, planning gaps, ineffective communication with trainees and partner companies, and limited performance monitoring. These findings indicate that delays in starting training courses are not attributable to a single factor but result from interconnected administrative, technological, planning, communication, and control deficiencies within the existing process.

To further trace the underlying cause of delayed course commencement, a Five Whys Analysis was conducted, as illustrated in Figure 5.

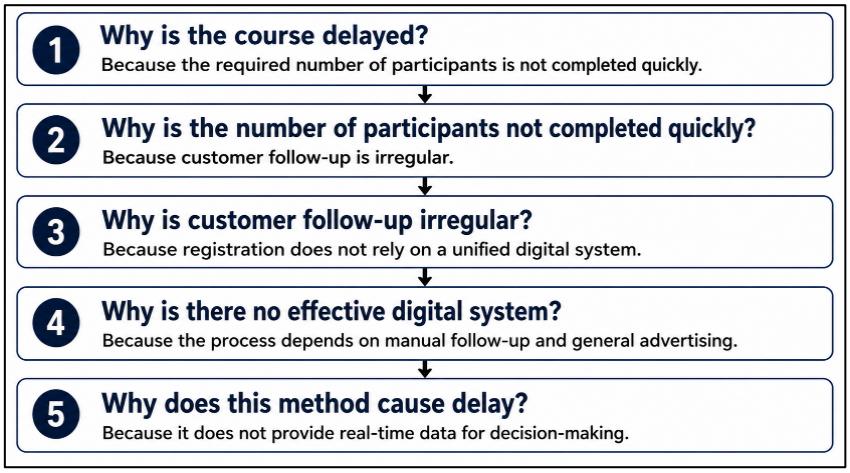

Figure 5: Five Whys Analysis of Delay in Starting Training Courses.

*Source: Developed by the authors based on field data (2025).

The Five Whys Analysis (Figure 5) showed that delayed course commencement was primarily linked to insufficient participant enrolment, which was associated with irregular customer follow-up. Further analysis indicated that the lack of a unified digital system and reliance on manual follow-up limited the availability of real-time information for decision-making. These findings highlight the need for a more structured and digitally supported administrative process.

COPQ analysis was conducted to quantify the financial impact of administrative inefficiencies, including delayed course commencement, weak customer follow-up, repeated advertising, and excessive manual work. Based on an average training fee of LYD 500 per trainee, the estimated losses over the six-month period were calculated using Equation (2) and summarised in Table 7.

Table 7: Direct Financial Analysis of Cost of Poor Quality (COPQ).

Financial Waste Category	Operational Description and Calculation Basis	Estimated Loss (LYD)
Trainee Withdrawal Cost	Average withdrawal of 4 trainees from each of the 10 delayed courses due to waiting periods of 3–5 weeks (10 courses × 4 trainees ×500 LYD)	20,000
Advertising Waste	Repeated and ineffective marketing campaigns. Monthly advertising budget of 1,500 LYD with an estimated 50% waste rate due to poor follow-up (LYD 750 × 6 months)	4,500
Additional Operating Cost	Extra staff time spent on repeated manual follow-up activities, phone calls, and rescheduling efforts caused by trainee withdrawals and delays	1,200

Financial Waste Category	Operational Description and Calculation Basis	Estimated Loss (LYD)
Total Cost of Poor Quality (COPQ)	Total direct financial losses resulting from the inefficiency of the current administrative process before improvement	**25,700**

*Source: Developed by the authors based on field data (2025).

The COPQ analysis estimated that current process inefficiencies generate approximately LYD 25,700 in direct financial losses during the six-month study period. These findings highlight the economic impact of administrative deficiencies and provide justification for improving the existing process and targeting improvement initiatives to reduce operational waste.

4. Improve Phase

The Improve phase focuses on developing targeted improvement action plans to address the root causes of administrative inefficiencies identified during the Analyse phase. Since full-scale implementation was beyond the scope and timeframe of this study, the Improve phase presents a proposed implementation framework and projected performance outcomes rather than validated operational results. Proposed improvement actions include eliminating non-value-added activities, standardizing processes, improving scheduling and communication, optimising resources, and integrating selected tools such as Failure Mode and Effects Analysis (FMEA), Poka-Yoke, brainstorming, and pilot testing. The proposed actions and expected outcomes are presented in Table 8

Table 8: Expected Outcome Following Full Implementation.

Solution	Application Method	Projected Outcome
Electronic registration system	Using Google Form or CRM	Reduce registration time
Dashboard	Real-time monitoring of registrants and course status	Speed up decision-making
Targeted advertising	Directing advertisements only to interested segments	Reduce advertising cost
Daily follow-up	Assigning an employee to follow up with customers	Reduce loss of trainees
Automatic scheduling	Setting the course date when the required number is reached	Reduce delays
Electronic certificates	Issuing certificates via email or Quick Response QR code	Preventing delays and errors
Electronic evaluation	Evaluation form after each course	Data-driven continuous improvement

*Source: Developed by the authors based on field data (2025).

1. Calculation of the Expected Return on Investment (Expected ROI): A scenario-based ROI analysis was conducted to evaluate the economic feasibility of the proposed digital process improvement initiative. The estimated one-time investment cost of LYD 1,500 includes software configuration, basic CRM customisation, dashboard development, staff training, and minor system integration activities. Major hardware investments and commercial enterprise software were excluded, as the improvement plan was designed as a low-cost solution suitable for resource-constrained training organisations.

The projected financial savings of approximately LYD 6,000 during the first six months were conservatively estimated based on the partial recovery of the identified COPQ. The estimate assumes that only a proportion of losses related to trainee withdrawals, repeated advertising, manual administrative activities, and scheduling inefficiencies would be reduced during the initial adoption period of the proposed digital solution.

To quantify these projected economic benefits, the expected ROI was calculated using the following equation:

$$\text{ROI} = \frac{\text{Expected Savings} - \text{Implementation Cost}}{\text{Implementation Cost}} \times 100 \qquad (5)$$

where Expected Savings represents the estimated financial benefits generated by the proposed process improvement plan, and Implementation Cost represents the estimated one-time investment required for deploying the proposed digital solutions.

Substituting the estimated values:

$$\text{ROI} = \frac{6{,}000 - 1{,}500}{1{,}500} \times 100 = 300\%$$

The projected ROI of approximately 300% should be interpreted as a scenario-based financial estimate derived from the expected reduction in COPQ rather than a guaranteed organisational outcome. Actual financial benefits will depend on successful implementation, staff adoption, and sustained use of the proposed improvement plan. Compared with previous studies focusing mainly on operational indicators, this study integrates process performance, financial evaluation, and digital transformation within a single DMAIC-based improvement framework.

2. Human Change Management Strategy: To support the adoption of the proposed digital process improvement initiative and reduce potential resistance to change, a human change management strategy was proposed. The strategy includes three main components: awareness sessions to communicate the objectives and benefits of the proposed system, practical training to develop staff competencies in using digital tools, and pilot testing with technical support to identify implementation challenges and facilitate future adoption.

These proposed actions address the improvement opportunities identified during the analysis phase, including registration automation, dashboard monitoring, targeted advertising, trainer coordination, and

dedicated customer follow-up. Poka-Yoke was incorporated into the proposed improvement plan to prevent human errors through error-proofing mechanisms. Its applications in registration, scheduling, customer follow-up, and administrative coordination are presented in Table 9.

Table 9: Poka-Yoke Applications for Error Prevention.

Potential Error	Prevention Method
Forgetting to follow up with a customer	Automatic reminder in CRM
Incomplete data entry	Form cannot be submitted until all required data are completed
Forgetting to notify the trainer	Automatic notification when the required number is reached
Certificate delay	Automatic certificate issuance before the end of the course
Evaluation not completed	Automatic evaluation link sent after the course

*Source: Developed by the authors based on field data (2025).

A pilot test was proposed to evaluate the practicality of the digital process improvement plan under actual operating conditions before full-scale implementation. The pilot aims to identify potential challenges and refine the proposed solutions prior to wider organisational adoption. The proposed pilot application for one training course is presented in Table 10.

Table 10: Pilot Test Plan for the Improved Training Process.

Pilot Test Element	Application
Test duration	One month
Selected course	A high-demand course
Tools	Google Form, simple CRM, Dashboard
Indicators	Registration time, number of registrants, customer satisfaction, course start time
Success criterion	Reduced registration time and increased schedule commitment

*Source: Developed by the authors based on field data (2025).

As the pilot study has been proposed rather than implemented, the anticipated operational improvements should be considered preliminary projections based on process analysis and the proposed digital process improvement plan. Full implementation and post-implementation evaluation are required to validate the proposed solutions under actual operating conditions.

5. Control Phase

The Control phase presents a proposed monitoring framework to sustain the proposed process improvements and prevent the recurrence of administrative inefficiencies. Since the improvement plan has not yet been implemented, Control Plans and Key Performance Indicators (KPIs) are proposed to support future performance monitoring and continuous improvement. The proposed control plan is presented in Table 11.

Table 11: Control Plan for Monitoring Process Performance.

KPI	Measurement Method and Scope	Responsible Party	Frequency
Registration	Tracking the duration from the request confirmation	Registration Officer	Daily

KPI	Measurement Method and Scope	Responsible Party	Frequency
Time	date to the final digital entry in the system.		
Number of Registrants on Dashboard	Real-time and continuous monitoring of applicant numbers compared to the target threshold to launch the course.	Training Department	Daily
Course Start Date	Comparing the actual start date with the pre-scheduled date in the monthly plan to detect any variation.	Training Manager	Each course
Customer Satisfaction	Analyzing and processing the results of electronic evaluation forms sent automatically to trainees.	Customer Service	After each course
Advertising Cost	Balancing marketing campaign costs against the number of actual registrants to ensure a 50% reduction in expenses.	Marketing Department	Monthly
Certificate Readiness	Ensuring certificates are reviewed and approved digitally before the final day of the training course.	Training Coordinator	Each course
Customer Acquisition Cost (CAC)	Total targeted marketing and advertising expenses are divided by the number of actual registrants to ensure spending efficiency.	Finance / Marketing Department	Monthly
Lost Opportunities Cost	Monitoring and tracking any withdrawal cases of registered trainees and documenting their financial and temporal reasons to prevent recurrence.	Customer Service / Finance	Monthly

*Source: Developed by the authors based on field data (2025).

The target on-time course commencement rate of 95% was established as a managerial objective based on the baseline analysis and identified delay factors, including registration inefficiencies, weak customer follow-up, scheduling issues, and repeated advertising. Since the proposed process improvement plan addresses these factors through digital automation and monitoring mechanisms, 95% was considered a realistic performance target. The projected indicators are summarised in Table 12.

Table 12: Projected Process Performance Before and After the Proposed Improvement Framework.

Area	Baseline State (Current)	Projected Performance after Full Implementation	Analytical Justification/ Mechanism
Total process lead time	3–5 weeks	7 days	Elimination of manual schedule delays and coordination gaps.
Registration time	Around 3 weeks	Minutes or hours	Shift from manual batching to instantaneous digital input.
On-time course commencement	60% (1.75-sigma)	95% (3.15-sigma)	Execution based on a demand driven "Pull System".

Area	Baseline State (Current)	Projected Performance after Full Implementation	Analytical Justification/ Mechanism
Customer satisfaction	85%	More than 95%	Drastic reduction in customer waiting times.
Repeated advertising	High	Reduced by 50%	Implementation of automated CRM targeted marketing.
Customer follow-up	Manual and irregular	Digital and regular	Transition to automated real-time dashboard notifications.
Certificate issuance	Ready on the last day	Instant and digital	Automation of the verification and delivery pipeline.

*Source: Developed by the authors based on field data (2025).

The projected Sigma Level of approximately 3.15 was estimated from the targeted 95% on-time course commencement rate using the standard Six Sigma conversion approach. As this value represents the expected performance of the proposed process improvement plan, it should be considered a projected indicator rather than a validated post-implementation result.

The findings across the five DMAIC phases reveal that the primary sources of operational inefficiency within the investigated training institution are concentrated in the administrative processes preceding training delivery rather than in the instructional process itself. Delays in participant registration, insufficient customer follow-up, scheduling coordination, and repeated advertising activities collectively increased process lead time and negatively affected on-time course commencement. This indicates that the greatest opportunity for process improvement lies in strengthening the administrative workflow supporting training service delivery and addressing the interconnected inefficiencies identified across the process.

These findings are consistent with previous studies demonstrating that DMAIC-based approaches improve process capability, reduce operational waste, and enhance service quality across different organisational contexts [1,20]. Previous research indicates that structured DMAIC problem-solving enables organisations to identify root causes, prioritise improvement opportunities, and establish systematic continuous improvement mechanisms [1,20,21].

Similarly, Lean Six Sigma applications in educational environments have shown that process standardisation and evidence-based decision-making contribute to improved administrative performance [7,8,9]. However, unlike many previous studies that evaluated completed improvement implementations, the present study focuses on diagnosing existing inefficiencies and developing a DMAIC-based process improvement plan within a private training institution. Therefore, the projected improvement in on-time course commencement should be interpreted as a scenario-based estimate derived from process analysis rather than a validated post-implementation outcome.

The findings further highlight the importance of organisational context when applying Lean Six Sigma methodologies. Previous applications have mainly focused on manufacturing, universities, healthcare, and large service organisations, where operational structures and resource availability differ from those of private training institutions [2,3,7,8,9]. In contrast, private training providers operate under dynamic conditions characterised by fluctuating customer demand, flexible scheduling, dependence on trainee enrolment, and coordination with external trainers. These characteristics make administrative activities such as registration management, customer follow-up, and scheduling coordination critical determinants of service performance. Consequently, this study extends existing Lean Six Sigma research by demonstrating the relevance of administrative process improvement within an underexplored private training context.

The results also support previous research on Lean Six Sigma applications in educational administration [7,8,9]. Nevertheless, important differences exist between higher education institutions and private training organisations. Universities typically operate within stable academic structures and predefined calendars, whereas private training providers must continuously adapt to market demand and customer expectations. This difference explains why enrolment management, marketing coordination, and customer communication emerged as major sources of operational constraints in the present study.

Another important contribution of this research concerns the integration of digital transformation with continuous improvement. Previous studies have demonstrated that digital technologies can improve information flow, communication effectiveness, and managerial decision-making [12,13,14,15,16].

The present study extends this perspective by demonstrating that digital solutions, including electronic registration, automated scheduling, dashboards, CRM systems, and digital certification, should be implemented as components of a structured DMAIC-based improvement framework rather than as isolated technological interventions. This supports the emerging Lean Six Sigma 4.0 perspective, where digital technologies act as enablers of systematic process improvement, real-time monitoring, and data-driven decision-making [15,16,17,22,23].

From a theoretical perspective, this study contributes to Lean Six Sigma and Quality 4.0 literature by extending the application of DMAIC-based process improvement to a resource-constrained private training institution. From a practical perspective, the proposed improvement plan provides managers with a structured approach for identifying administrative waste, improving process visibility, and supporting digital transformation through affordable and accessible solutions.

Despite these contributions, several limitations should be acknowledged. First, this research was conducted as a single case study within one private training institution in Libya, and the empirical assessment was based on data from 25 scheduled training courses over a six-month period. Although these data provided a practical foundation for identifying process inefficiencies and developing the proposed improvement plan, the limited sample size and organisational context may restrict the generalizability of the findings. Second, the proposed DMAIC-based Lean Six Sigma improvement plan

has not yet been fully implemented; therefore, the expected improvements in process performance, financial benefits, and Sigma Level should be considered projected outcomes derived from process analysis and scenario evaluation rather than validated post-implementation results. Future research should conduct longitudinal implementation studies involving multiple training institutions and other service organisations to validate the proposed solutions, assess their sustainability, and examine their broader applicability, consistent with recent research emphasizing the importance of implementation frameworks and sustainability in Lean initiatives [24, 25].

CONCLUSIONS

This study developed a DMAIC-based Lean Six Sigma process improvement framework for diagnosing and improving administrative processes within a private engineering training institution in Libya. The analysis revealed that the main sources of operational inefficiency originated from pre-training administrative activities, particularly participant registration, customer follow-up, scheduling coordination, and certificate preparation. Based on these findings, a digital process improvement plan integrating electronic registration, automated scheduling, dashboard monitoring, CRM systems, and electronic certification was proposed. The proposed framework demonstrates the potential of combining structured process improvement with digital technologies to enhance service performance; however, these outcomes require validation through future implementation.

The study contributes to Lean Six Sigma literature by extending its application beyond manufacturing and higher education contexts to private training service organisations. Furthermore, this supports the emerging Lean Six Sigma 4.0 perspective, in which digital technologies act as enablers of systematic process improvement, real-time monitoring, and data-driven decision-making [15,16,17,22,23].

From a practical perspective, the proposed improvement framework provides managers with a structured approach for identifying administrative waste, improving process visibility, and supporting digital transformation. The COPQ analysis highlights the financial impact of existing inefficiencies, while the scenario-based ROI evaluation indicates the potential economic value of implementing the proposed improvement actions.

This study is limited by its single-case context and the absence of full-scale implementation. Therefore, the reported operational and financial improvements should be interpreted as projected outcomes derived from process analysis rather than validated post-implementation results. Future research should evaluate the proposed framework through longitudinal implementation across multiple training institutions and other service organisations to assess its effectiveness, sustainability, and generalizability.

Overall, this research demonstrates that integrating DMAIC-based Lean Six Sigma with practical digital solutions provides a structured approach for diagnosing and improving administrative service processes. The proposed framework offers a foundation for continuous improvement and digital-enabled operational excellence within small and medium-sized service organisations.

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DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the authors used ChatGPT-4 to improve language and grammatical correctness. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the final content of the publication.

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