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A Comparative Study on User Satisfaction from Manual to Online Information System Using Define-Measure-Analyze-Improve-Control (DMAIC) in Service Administrative Process

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ABSTRACT

Efficient application processes are crucial for enhancing user satisfaction in organizational systems. However, manual processes often result in inefficiencies, user dissatisfaction and delays, as observed in this case study. This research aimed to improve the application process by leveraging the Online Information System (OIS) and utilizing the Define, Measure, Analyze, Improve, Control (DMAIC) methodology to address identified inefficiencies systematically. The study adopted a structured approach through the DMAIC phases to identify root causes of dissatisfaction, prioritize issues and implement targeted solutions. Key findings indicated significant improvements in user satisfaction metrics, with usability increasing by 70.21 %, accessibility by 61.04 %, consistency by 44.12 % and response time by 51.95 %. The implementation of OIS played a significant role in these outcomes by automating processes, reducing errors, eliminating redundant steps, simplifying the application process and making it more reliable and accessible. The discussion highlighted the critical role of DMAIC in guiding the improvement efforts, particularly in aligning solutions with user needs and ensuring sustainability through standardization and training. Despite these successes, the study faced limitations such as the restricted scope of user testing to a specific context and potential adaptability issues in broader applications. Future research should explore the scalability of the OIS and its integration with other organizational processes to ensure comprehensive usability and effectiveness.

1. Introduction

Pursuing continuous improvement has become essential in the service sector to address the evolving needs and expectations of the public. This goal drives organizations to implement innovative solutions and administrative advancements that improve operational efficiency and effectiveness.

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Innovation, which introduces new ideas, processes or tools, can significantly shift performance trajectories and yield transformative outcomes. In a rapidly changing economy, continual innovation has become critical for maintaining competitiveness, and well-developed knowledge management systems are central to supporting this ongoing improvement. By enhancing the ability of the organization to create and manage technological, market, and administrative knowledge, such systems enable sustainable growth and excellence [1].

Many service industries face a key challenge in managing administrative processes that often involve high waiting times and inefficiencies. Tasks such as managing applications for licenses, permits, or certifications are typically complex, involving extensive form-filling and manual document processing. Historically, these processes relied heavily on manual information systems (MIS), leading to prolonged waiting times, unclear procedures, and user dissatisfaction [2]. User satisfaction is, therefore, a critical metric for evaluating the effectiveness of administrative systems, as it reflects how well these systems meet user expectations.

Over the past two decades, continuous improvement approaches such as Lean and Six Sigma have significantly enhanced quality and efficiency in manufacturing and service industries [3-5]. However, despite these successes, the application of such methodologies within administrative processes in service sectors has been limited. Many fields, such as healthcare, are only beginning to explore the potential benefits of Lean Six Sigma (LSS), and its role in improving user satisfaction in administrative settings remains under-researched [5].

One solution that holds promise for addressing these challenges is the implementation of an OIS. OIS substantially improves process efficiency by automating labor-intensive tasks, reducing paperwork, and expediting data entry and retrieval. Additionally, it minimizes human errors, enhances data accuracy, and improves accessibility, all contributing to higher levels of user satisfaction [6,7].

Despite these advancements, a significant knowledge gap persists regarding the structured implementation of OIS, supported by the DMAIC methodology, and its specific impact on user satisfaction within administrative processes. While research has demonstrated the general effectiveness of OIS, limited studies have explored its application alongside LSS principles in the administrative domain of service sectors. Most existing studies focus on either technology adoption or process improvement without addressing the integrated approach of OIS and DMAIC to address inefficiencies and dissatisfaction. This gap highlights the need for targeted research to understand how such an approach can transform administrative workflows, enhance user experiences and sustain improvements.

This study investigates how user satisfaction in administrative processes can be improved by implementing OIS and DMAIC, explicitly focusing on the License Manufacturing Warehouse application processes. Using the DMAIC framework, the study compares the existing MIS with an OIS to evaluate potential improvements. The Define phase identifies current issues within the MIS, and the Measure phase gathers baseline user satisfaction data. During the Analyze phase, root causes of dissatisfaction are identified. The Improve phase centers on implementing OIS, while the Control phase ensures that improvements are sustained over time.

By explicitly addressing this research gap, the study aims to provide valuable insights into the underexplored integration of LSS and OIS within administrative processes. The findings will contribute to the broader body of knowledge on continuous improvement in service-based administrative tasks and provide a framework for broader application in similar administrative contexts.

2. Literature review

2.1 Lean Six Sigma

The success of Lean in the manufacturing sector has inspired service sectors to adopt Lean for waste identification and elimination to improve their organization and processes. Over the past decade, most service sectors have adopted Lean thinking to transform their organizations, including financial, transactional, and education services, especially in higher education and public services such as local government departments and healthcare [8,9]. Lean principles enhance efficiency and user satisfaction within the services sector [10,11].

Lean and Six Sigma are two powerful methodologies that, when integrated with LSS, create powerful tools for enhancing process improvement in the service sector [12]. Lean originated at the Toyota Production System in Japan, and Motorola founded Six Sigma in the United States of America. Lean focuses on eliminating waste, while Six Sigma emphasizes reducing process variability and defects through statistical analysis [13].

Administrative organizations face pressure to improve efficiency and quality for their customers [14,15]. To achieve these goals, public administrations have begun to adopt LSS, which was previously used in healthcare [11,16], information technology [15,17], financial services [18], education [19], banking [20] and other service sectors such as public sector and administration [21,22] were only used. However, Radnor & Osborne [23] reported that successful implementation in the administrative sector is often a short-term success and lacks sustainability. A McKinsey study on transformation in the public service found that only 39 % of 974 public sector leaders achieved full impact from their transformation efforts [24]. Although LSS has been implemented in public administration for several years, improvements take time and are often limited to one-off projects. Therefore, sustainable and widespread adoption of LSS practices in public administration is needed to achieve long-term improvements in efficiency and service quality [3].

2.2 Define-Measure-Analyze-Improve-Control (DMAIC)

By integrating Lean principles to eliminate waste and improve flow with Six Sigma, LSS provides a comprehensive framework for enhancing process performance in service sectors by reducing variation and bringing structure to process improvement through the DMAIC cycle [25]. Guo *et al.,* [26] investigated the implementation of Lean in an assembly line, utilizing the DMAIC methods to identify waste and offering a structured approach to reduce and manage it effectively. Sahbaz *et al.,* [27] studied the DMAIC to minimize complications during and after laser-assisted surgery at a private eye care center in Turkey, and the DMAIC approach was utilized. They determined that 16 of 17 complications could be significantly reduced. Vijay [28] implemented the DMAIC approach to enhance the discharge process at a multidisciplinary hospital in India, successfully reducing patient discharge cycle time by 61 % and maintaining the improvements achieved. The technique used in DMAIC to improve user satisfaction is based on five phases: Define, Measure, Analyze, Improve and Control. Each phase is logically related to the next and previous phases. The DMAIC definition and the action plan are shown in Table 1.

Table 1
DMAIC phases

Phase	Definition
Define	This phase involves a systematic exploration to precisely define the issue, laying the groundwork for finding a solution [29].
Measure	Identify key metrics to measure and determine the appropriate methodologies for measurement [30].
Analyze	This phase focuses on uncovering the underlying reasons for the gap between current performance and the goals set in the initial phase. This can be achieved by analyzing the production process to identify the main types of waste and determining the underlying factors contributing to these inefficiencies [31].
Improve	The Improve phase aims to generate potential solutions, propose various alternatives to optimize performance, and execute the selected solutions within the allocated budget and anticipated costs for each alternative [32].
Control	The final stage of the DMAIC is the control phase, and it is crucial to ensure that the improvements obtained in the previous phases are sustained for the long term [33].

2.3 User Satisfaction in Administrative Processes

User satisfaction reflects the degree to which a system, service, or product meets the requirements and expectations of the user. It involves perceptions of quality, reliability in fulfilling promises, and responsiveness to inquiries [34]. In administrative processes, user satisfaction is a critical indicator of the effectiveness and efficiency of the system [35]. In this context, a central satisfaction aspect is accessibility, ensuring users can easily access information and services. High accessibility means that services are available to all users, including those with disabilities, and are accessible across various platforms like websites and mobile applications [36]. User-friendly administrative systems feature intuitive interfaces, streamlined processes and seamless interactions, all enhancing satisfaction [37].

A coherent system further boosts satisfaction by reducing confusion and improving efficiency, helping users understand how the system functions. Parallel service steps in the administrative process can clarify functional workflows, enabling smoother user interactions and a more cohesive experience [38]. Moreover, timely responsiveness is crucial, particularly in high-demand administrative services, as users rely on these systems for essential information and quick service access.

As the global economy increasingly embraces digitalization, its impact on service delivery continue to grow. By 2030, the digital economy is expected to represent 24.3 % of global GDP, up from 15.5 % [39]. Digitalization enables the integration of new technologies, improving employee workflows and enhancing user satisfaction [39]. In the public sector, digital transformation aims to improve various aspects of institutional operations, including internal communication, staff development, logistics and public service delivery [40].

2.4 Current Administrative Process

Administrative processes are vital to the efficient operation of service-oriented organizations, supporting essential tasks like data management, document processing and customer service. Traditionally, these processes relied heavily on MIS, paper-based workflows and in-person interactions, introducing numerous efficiency, scalability and accuracy challenges. Laudon and Laudon [41] note that MIS was time-consuming, prone to errors and often lacked transparency, leading to delays in operations and impacting service quality. Similarly, Turban *et al.,* [42] emphasize that paper-based systems complicate data retrieval and tracking, making it difficult to ensure timely

service delivery and organizational responsiveness. Rosenbloom [2] highlights that such inefficiencies contribute to customer dissatisfaction, as lengthy waiting times and procedural bottlenecks hinder smooth service delivery.

Many organizations are shifting toward digital transformation in administrative processes in response to these limitations. Digitalization involves replacing manual tasks with automated systems that streamline workflows, enhance data accessibility, and improve operational efficiency. Cordon *et al.,* [44] argue that digital systems reduce human error, minimize dependence on physical documentation, and allow for more accurate and timely information handling. Cloud-based data storage, an integral part of digital transformation, enables remote access and supports collaboration across departments, significantly improving organizational flexibility and responsiveness. Within the public sector, digital transformation is seen as a move toward greater transparency and operational efficiency. Eric [45] explains that digital tools enhance internal communication, simplify performance evaluations, and facilitate public service delivery, which aligns with broader objectives of improved accessibility and user satisfaction.

2.5 OIS for Administrative Process

An OIS is a digital platform designed to manage, process and store information efficiently, streamlining traditional, paper-based administrative tasks that often involve delays and inaccuracies [41,42]. OIS aims to improve the accuracy, accessibility and speed of information handling, ultimately supporting better decision-making and operational effectiveness [43]. A well-implemented OIS enhances service delivery, automates processes, supports data storage and sharing and improves user experience [44].

OIS has become essential in healthcare, finance and education for efficiently managing extensive data and documentation. Key applications include Customer Relationship Management systems, which improve customer satisfaction by managing interactions and data; Document Management Systems for efficient document storage; and Human Resource Information Systems to streamline employee data management [46-48]. Real-time data processing and automated workflows are critical OIS features, allowing for timely decision-making and reducing human error [49,50]. OIS systems also promote paperless operations, enhancing efficiency through reduced reliance on physical documents [51].

Studies demonstrate the effectiveness of integrating OIS with Lean principles across various administrative functions. For example, Lean-inspired OIS implementation in invoicing reduced errors by 49 %, while the integration of SAP software streamlined data management across departments, eliminating unnecessary tasks and reducing waste [52,53]. Other studies also highlight significant benefits in efficiency and user satisfaction with Lean-OIS integration. Implementing Lean principles through an electronic health records (EHR) system improved patient flow and reduced documentation time by 30 % [54]. Similarly, in the public sector in Dutch, the study found that participants completed 80 % of operational, 72 % of formal, 62 % of information and only 22 % of strategic Internet tasks, highlighting a digital skills gap [55]. The combination of Lean and OIS in HR processes has been shown to reduce onboarding time by 40 % and improve data accuracy, contributing to better resource management and faster decision-making [56]. These findings collectively underscore the potential of Lean-integrated OIS to drive efficiencies, minimize errors and improve responsiveness across sectors.

Despite the benefits of OIS, their implementation carries significant risks, particularly concerning cybersecurity and cost. OIS is vulnerable to cyber threats such as data breaches, hacking and ransomware, which can compromise sensitive data, disrupt operations and damage the reputation

of the organization [57]. These cybersecurity risks require robust protective measures, regular security updates and advanced protocols to safeguard information. While the initial costs of OIS, including software, training and system migration, can be a barrier, advancements in scalable, cost-effective solutions make OIS more accessible to organizations, including small and medium-sized enterprises [58]. Cloud-based platforms, for instance, offer flexible pricing and reduce the need for expensive physical infrastructure. The complexity of integrating OIS with existing workflows and overcoming employee resistance also presents challenges, requiring careful planning, training and ongoing maintenance. Thus, while OIS can significantly improve efficiency, organizations must navigate these risks and invest in appropriate measures to ensure successful implementation.

2.6 Literature Findings

Lean focuses on eliminating waste, reducing inventory, and improving throughput to address inefficiencies. At the same time, Six Sigma emphasizes data-driven decision-making and process control to reduce variation and improve quality, ultimately enhancing customer satisfaction. The DMAIC model of Six Sigma is commonly used to improve processes and performance. LSS has been widely implemented in the manufacturing sector, where strict Standard Operating Procedure (SOP) is in place to streamline operations and improve product quality. However, the service sector, which lacks such rigid SOP, has seen limited adoption of LSS. Despite this, a few studies have recorded improvements in government services after LSS adoption, suggesting potential for broader application in service sectors. The gap analysis also reveals a scarcity of research on LSS in administrative processes, often involving considerable paperwork and documentation. Effective OIS can significantly improve administrative processes by enabling remote access, efficient data storage and seamless report generation. These technological solutions can streamline workflows, reducing delays and enhancing user satisfaction. However, integrating OIS with cloud computing requires strong data security measures to safeguard user information. As user satisfaction is a critical factor in evaluating administrative processes, further research is needed to explore how adopting LSS and OIS in administrative systems can improve user experiences, particularly regarding accessibility, convenience and response time. This creates a valuable link to research on user satisfaction in administrative processes.

3. Methodology

The methodology for this study follows the DMAIC phased approach to investigate user satisfaction and improve administrative processes through the implementation of OIS. The process begins with a literature review to formulate the research objectives, explore existing studies, and identify the problems within administrative processes. This review will also help define the scope of the study and guide the development of research questions. Following the literature review, Phase 2 focuses on understanding the administrative service sectors selected for the study. This will involve defining the specific problems faced in these sectors and conducting a Gemba walk, where real-time observations of current administrative processes will be made to identify inefficiencies and areas for improvement. In Phase 3, data will be collected through a survey to measure user satisfaction with the current administrative processes. The survey will gather feedback on factors such as ease of use, accessibility, convenience, response time and overall satisfaction [59], providing a baseline for understanding user experiences and highlighting key areas requiring attention. The data collected in Phase 3 will be analyzed in Phase 4, where a root cause analysis will be conducted using a Fishbone diagram to identify the factors contributing to user dissatisfaction visually. This analysis will help

pinpoint the primary issues to address, such as process inefficiencies, system usability or delays in response time. Phase 5 will focus on implementing improvements by introducing an OIS designed to streamline administrative tasks, automate processes and enhance data accessibility. After implementing the OIS, a follow-up survey will assess user satisfaction with the new system to evaluate whether the improvements have had the desired effect on administrative processes. In Phase 6, the OIS will be closely monitored to ensure its continued effectiveness. Key performance indicators will be established, and regular audits and feedback loops will track the system's performance, ensuring that improvements are sustained over time. Finally, Phase 7 will analyze the user satisfaction survey results conducted before and after the OIS implementation. A radar chart using the mean score will be used to compare the pre- and post-implementation data to assess the significance of changes in user satisfaction. The results will provide insights into the effectiveness of the OIS in improving administrative processes and user satisfaction, allowing for a comprehensive evaluation of the impact of the systems. This methodology combines qualitative and quantitative approaches to systematically improve administrative processes and measure the outcomes of the OIS implementation.

3.1 Survey Setting and Questionnaire

The survey assessed user satisfaction with the current administrative processes and the subsequent implementation of OIS for improvement. Participants were selected from the application process of the Licensed Manufacturing Warehouse at the selected Customs Department, specifically targeting employees, staff and other individuals directly involved with or impacted by the administrative processes. To ensure accessibility for all participants, the survey was administered in person. Online surveys were distributed *via* Google Forms, while paper-based surveys were available for those without internet access. The survey was conducted over two weeks, providing participants ample time to complete it at their convenience. The survey setting was carefully structured to minimize disruptions and encourage honest, thoughtful responses. Participants were fully informed about the purpose of the survey, the confidentiality of their responses and the voluntary nature of their participation. The data collected from this survey will offer valuable insights into the current state of administrative processes and help gauge user satisfaction. It also compares pre- and post-OIS implementation, assessing user satisfaction and process efficiency improvements.

The survey was designed to assess user satisfaction with the current administrative processes and the implementation of the OIS. It includes questions on four key areas: accessibility, usability, consistency and response time. Each area is further broken down into specific sub-attributes, with four targeted questions per attribute. The questionnaire uses a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) to gauge user satisfaction. It is presented in English and Malay to ensure clarity for all participants, including Customs officers and company representatives.

3.2 Company Background and Selected Administrative Process

This research focuses on the Royal Malaysian Customs Department (RMCD) in Northern Malaysia (hereforth known as Company A), which oversees import and export activities and enforces customs laws in Malaysia. Company A is key in trade facilitation, revenue collection and preventing illegal activities. The study targets the Licensed Manufacturing Warehouse (LMW) application, which supports export-oriented companies by providing customs duty exemptions on imported raw materials and machinery, provided 80 % of their products are exported. In Company A, 79 LMW-

licensed companies rely on this system, which includes 23 application types to aid manufacturers in meeting both domestic and international demands.

The current LMW application process relies on an MIS involving customers (company representatives), support officers and customs officers. Customers (typically manufacturing or export companies) start by submitting applications and necessary documents. Support officers guide customers through the process, assisting with documentation and clarifying requirements. They input information, verify documents and organize applications before forwarding them to customs officers. Customs officers then review and assess applications for LMW eligibility, ensuring compliance with customs regulations. The process is managed across multiple stages and requires moving between various areas within the customs building, such as the registration counter and officers' rooms on different floors. This MIS, involving activities like searching registration books, completing forms, verifying information and organizing paperwork, can be time-consuming and limits efficiency in application handling.

4. Results

4.1 Define

In the Define phase, a team comprising the main researcher and officers conducted a comprehensive Gemba Walk to gain an in-depth understanding of the current LMW application process at Company A. This on-site observation allowed the team to examine each step involved and identify the key challenges faced by applicants. The Gemba Walk revealed the manual process, requiring customers to visit Company A to obtain the necessary application forms personally. After obtaining these forms, customers would complete them manually and return them to the office for submission. Additionally, they often had to return multiple times to check the status of their applications due to a lack of real-time updates.

The standard application processing time was up to seven working days, which could extend by an additional three days when queries or issues required further clarification. These delays affected customer satisfaction and underscored inefficiencies within the system. During this phase, the project team set clear goals to streamline the process and defined problem statements to guide improvement efforts. Four key attributes of user satisfaction were established as focal points for assessing the existing system and proposed improvements: usability (ease of use), accessibility (ease of access and convenience), consistency (reliability and standardization) and response time (speed and efficiency in application processing).

4.2 Measure

In the Measure phase, a survey was conducted among Customs officers and company representatives involved in the LMW administrative process to assess user satisfaction regarding accessibility, usability, consistency and response time. Four targeted questions were designed for each attribute, focusing on specific aspects of the MIS of the LMW application. The bilingual questionnaire (English and Malay) ensured clarity for both Customs officers and company representatives. Surveys were distributed randomly to minimize bias: company representatives received forms directly at Kulim Customs, while a designated officer distributed them among Customs staff. Using SPC XL software, pre-data analysis calculated the mean satisfaction levels for each sub-attribute and the overall mean for each attribute to gauge satisfaction with the MIS.

The survey result of the MIS within the LMW, based on responses from 50 participants, indicates a low level of user satisfaction across the four assessed attributes: usability, accessibility, consistency

and response time. With mean scores of 2.08 for usability (Figure 1(a)), 2.96 for consistency (Figure 1(b)), 2.51 for accessibility (Figure 1(c)) and 2.44 for response time (Figure 1(d)), each attribute scores below the target satisfaction threshold of three. These scores, derived from the averages of four sub-attributes for each category, underscore notable deficiencies in the ability of MIS to meet user expectations effectively. The results imply that the users in the LMW process perceive the MIS as inadequate in delivering a satisfactory user experience across these critical dimensions.

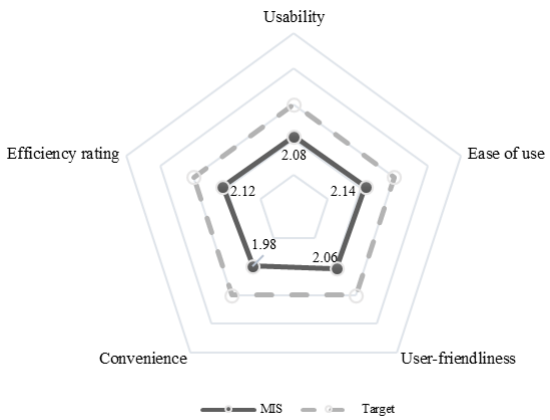

Fig. 1(a). Mean score of MIS in terms of usability of user satisfaction

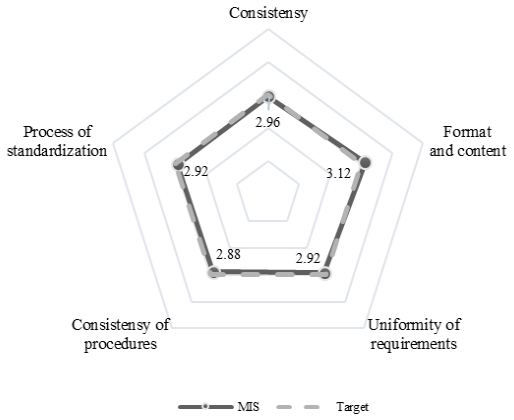

Fig. 1(b). Mean score of MIS in terms of consistency of user satisfaction

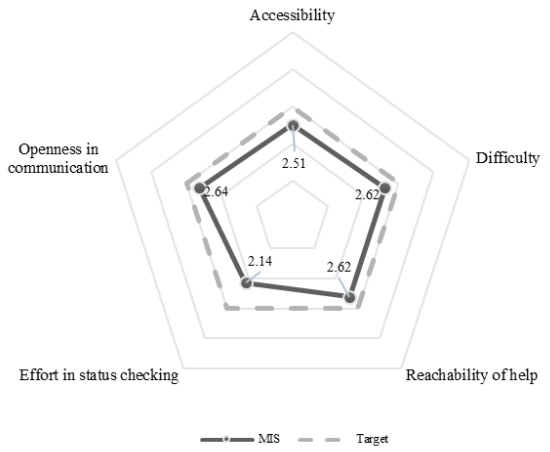

Fig. 1(c). Mean score of MIS in terms of accessibility of user satisfaction

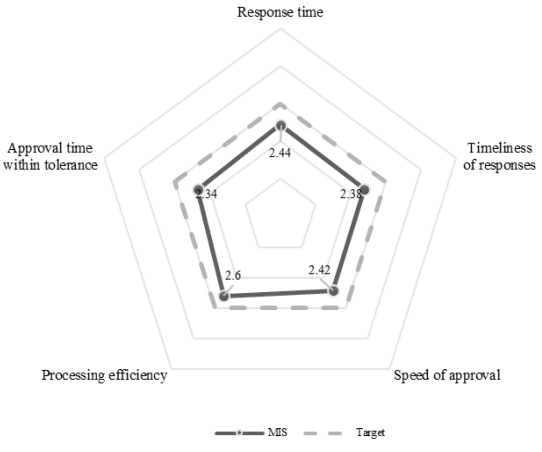

Fig. 1(d). Mean score of MIS in terms of the response time of user satisfaction

4.3 Analyze

Root cause analysis, depicted in the Fishbone diagram (Figure 2), helps identify underlying issues causing low user satisfaction with the MIS. The causes are categorized into six main areas: process, people, material, technology, environment and administration. In the process category, key issues include the need for company representatives to make multiple trips to the Kulim Customs office, which is highly inconvenient. Applications often require at least two visits, sometimes more, due to queries and corrections. Additionally, the time taken for application review could be reduced, but this needs further investigation through experimental observations. The people category reveals those errors in form-filling by company representatives and Customs officers, along with miscommunication between the two parties, leading to incorrect or missing data in the system. These

issues can be controlled through better guidance and communication. In the materials category, the reliance on hardcopy documents creates a cumbersome and error-prone process. The large volume of paperwork increases the risk of mismanagement and document damage. The technology category highlights the reliance on manual processes, such as handwriting on forms and manual data entry into the LMW database. This lack of real-time synchronization creates inefficiencies, making it difficult for company representatives to track the status of their applications. Transitioning to a paperless system would resolve many of these issues. The environment category shows that the long travel distances to the Customs office, peak season congestion, and long waiting times significantly affect user satisfaction. While these issues are external and beyond direct control, they still contribute to frustration. The administration category points to limited office hours and inadequate staffing, which result in more extended review periods and overworked officers. These factors contribute to delays and dissatisfaction, though they are challenging to address due to the standardized operating hours and staffing limitations of a government agency.

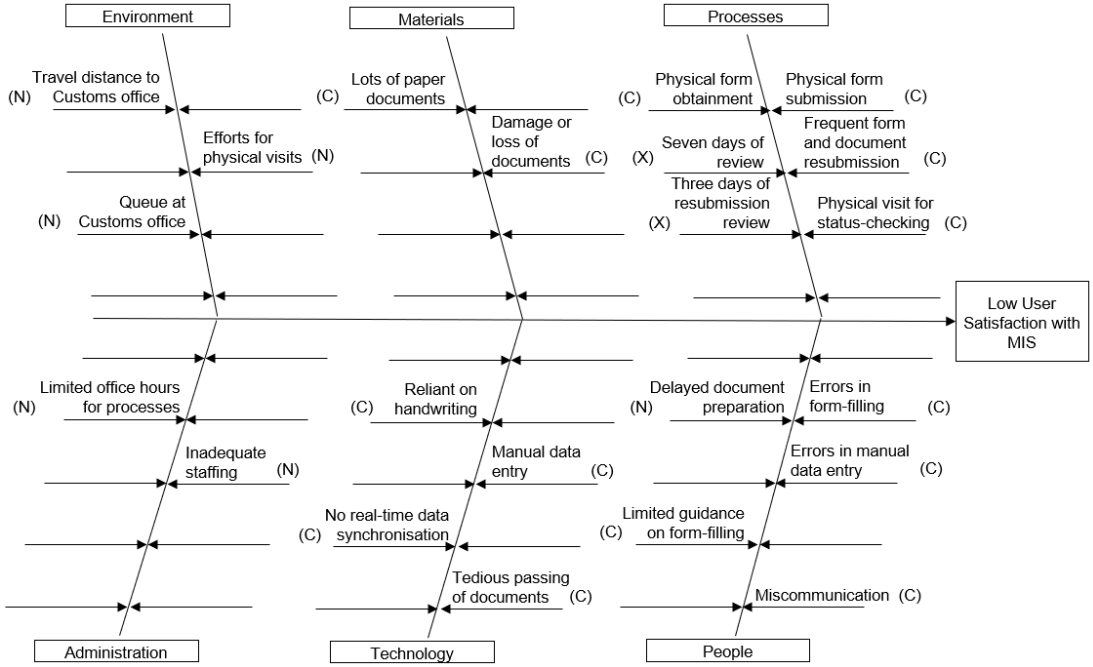

Fig. 2. Fishbone diagram

The causes identified in the analysis are categorized into three groups: C (Constant), N (Noise) and X (Experimental). C (Constant) causes should be controlled or improved more efficiently. These include human errors in form-filling and data entry, which can be addressed through training and better communication. N (Noise) causes uncontrollable or costly factors, such as long travel distances or peak season crowding, which impact user satisfaction but cannot be directly managed. X (Experimental) causes require further testing to understand their impact. For instance, the time taken to review applications could be experimented with to determine if it can be reduced.

After conducting a multi-voting exercise with five officers, each officer cast three votes to identify the most critical root causes impacting the application process. This voting process focused on factors marked with "C" in the fishbone diagram, representing issues within processes, materials, technology and people affecting user satisfaction and efficiency. The three root causes that received the highest votes were manual data entry, frequent form and document resubmissions and errors in form filling. Manual data entry is time-consuming and prone to errors, causing delays and requiring corrections that frustrate users. Frequent resubmissions arise from physical-form errors, forcing applicants to

return to the office repeatedly and slowing down processing. Errors in form-filling, such as incomplete or incorrect entries, lead to submission rejections and processing delays. Frequent resubmissions occur when users must correct these errors, wasting time and resources.

4.4 Improve

To address these root causes, an OIS was designed and implemented with targeted features to eliminate manual inefficiencies and reduce errors in MIS, as in Table 2. For the issue of manual data entry, the OIS incorporates automated, real-time data entry with auto-population of fields, integration with existing databases and an intuitive user interface. Built using Microsoft Access for database management, SharePoint for data storage and Microsoft PowerApps as the user interface, this system enables users to complete forms efficiently, with data stored simultaneously across platforms. To prevent frequent form and document resubmissions, the OIS includes a digital submission system with real-time error-checking, field validation, automatic feedback for missing or incorrect information and a confirmation notification upon successful submission. The OIS provides interactive form-filling assistance with step-by-step instructions, mandatory field checks and real-time alerts for incorrect data entries to minimize errors in form-filling. This guidance helps users correct errors immediately, ensuring accurate and complete submissions. Figure 3 illustrates the example of OIS implemented in Company A.

Table 2
Root cause and potential solutions of current issues in MIS

Root Cause	Potential Solution	OIS requirements	OIS implementation
Manual data entry	Implement an automated OIS for data entry and processing.	Real-time data entry, auto-population of fields, integration with existing databases, and user-friendly interface for easy access and data entry.	The OIS has been developed using various software tools, including Microsoft Access, SharePoint, and Microsoft PowerApps. Microsoft Access is the database management system, SharePoint handles data storage, and Microsoft. PowerApps provides the user interface. Users fill in the forms through Microsoft PowerApps, and the input data is stored simultaneously in both SharePoint and Microsoft Access.
Frequent form and document resubmissions	Develop a digital form submission system with OIS features.	Real-time error-checking, field validation, automatic feedback for missing or incorrect information, and a submission confirmation system.	
Errors in form-filling	Integrate guided form-filling assistance in OIS.	Integrate guided form-filling assistance in OIS.	

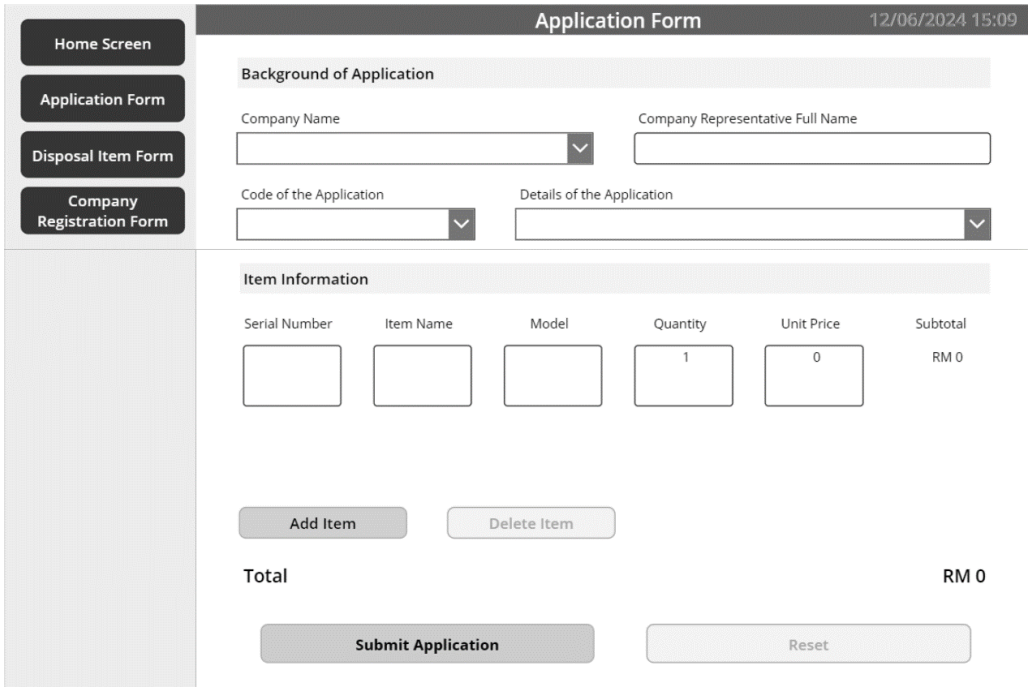

Fig. 3. Example of OIS in Company A

The OIS was implemented for a two-week trial period, specifically focusing on streamlining the application process within the LMW at Company A. To evaluate the impact of the OIS on user satisfaction, a follow-up survey was conducted, using the same set of user satisfaction attributes as in the initial assessment: usability, accessibility, consistency and response time. With 50 respondents participating, the survey aimed to capture the experiences and satisfaction levels of the users with the OIS compared to the previous manual process.

The survey results provide a comparative analysis of satisfaction ratings for the manual process versus the OIS. The survey results reveal notable improvements in user satisfaction across all measured attributes following the implementation of the OIS. Usability experienced the most significant increase, with the mean score rising from 2.08 under the manual system to 4.13 with the OIS, indicating a 70.21 % improvement (Figure 4(a)). Consistency also improved, with the mean score increasing from 2.96 to 3.86, reflecting a 44.12 % gain (Figure 4(b)). Accessibility also showed a marked increase, from a mean score of 2.51 to 4.03, representing a 61.04 % enhancement (Figure 4(c)). The response time indicated an improvement, with the mean score advancing from 2.44 to 3.77, amounting to a 51.95 % increase (Figure 4(d)). All mean scores for the OIS surpass the target mean score, demonstrating that the system has successfully met or exceeded expectations across all evaluated areas.

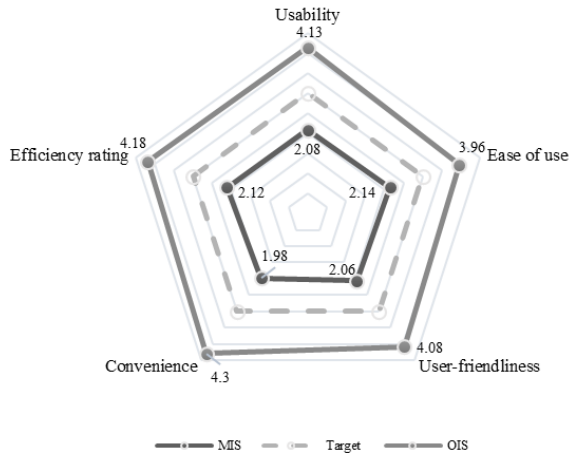

Fig. 4(a). Comparison between MIS and OIS in terms of usability of user satisfaction

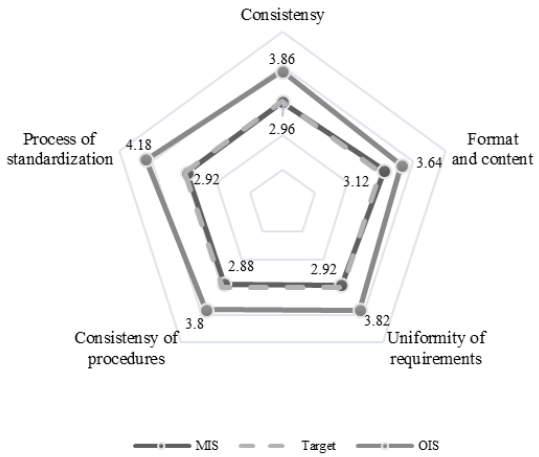

Fig. 4(b). Comparison between MIS and OIS in terms of accessibility of user satisfaction

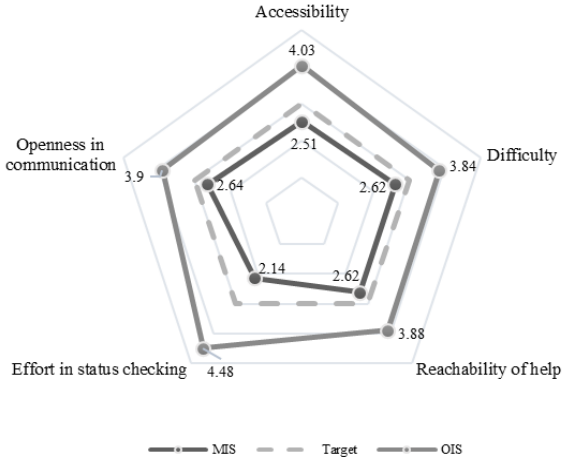

Fig. 4(c). Comparison between MIS and OIS in terms of consistency of user satisfaction

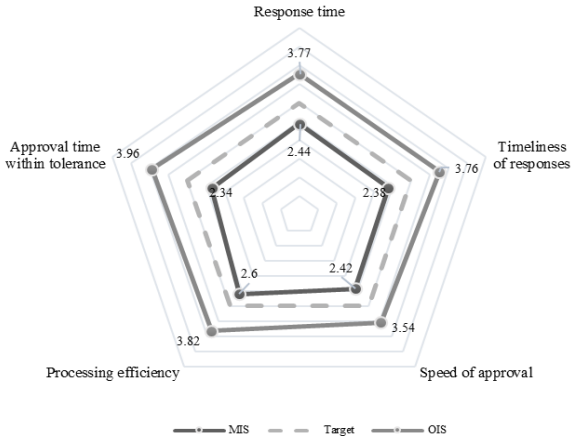

Fig. 4(d). Comparison between MIS and OIS in terms of response time of user satisfaction

4.5 Control

In the Control phase, sustaining improvements in the administrative process involves closely monitoring the implementation of the OIS system within the application process and sharing successful outcomes across other administrative functions at Company A. The new method is documented and standardized as part of the SOP of the company, ensuring consistency and minimizing deviations. Several training sessions for officers and customers have been conducted to enhance the usage of the new OIS, reinforcing uniformity and improving proficiency.

5. Discussion

Implementing the OIS significantly improved user satisfaction across all measured attributes: usability, accessibility, consistency and response time. This outcome reflects a successful transition from the application process to an efficient digital solution. The OIS strongly aligns with user expectations by addressing user dissatisfaction and fulfilling the initial goals of the project. The high improvement rates in user satisfaction confirm the effectiveness of the system, with the most significant gains observed in usability and accessibility, underscoring the user-friendly design and

enhanced ease of access. These findings are consistent with the literature on digital transformation, which emphasizes the role of automation and standardization in improving service quality [34,35].

5.1 User Satisfaction Improvement

The survey results highlight the transformative impact of transitioning from the MIS to the OIS, as evidenced by substantial improvements in all user satisfaction attributes. Usability, which recorded a 70.21 % increase, underscores the limitations of the MIS, where manual data entry was time-consuming and prone to human error. In contrast, the OIS introduced automated data entry and guided form-filling features, simplifying the process and minimizing errors. For instance, in the MIS, users had to manually complete forms with limited guidance, often resulting in incomplete or incorrect entries that led to rejections and resubmissions. The OIS mitigated this by integrating real-time validation and providing instant feedback, ensuring form accuracy before submission.

Accessibility improved by 61.04 %, highlighting the inefficiencies of the MIS, which required users to physically visit the Customs office multiple times for form submissions and status checks. The OIS addressed this by enabling online submissions and real-time status tracking, eliminating the need for travel. For example, a company representative previously had to visit the office twice or more to submit and verify application documents, causing delays and logistical challenges. With the OIS, users could submit forms online and receive status updates instantly, saving time and improving convenience.

Consistency, with a 44.12 % improvement, reflected the challenges in maintaining uniformity in the MIS. Under the manual system, variability in form handling and the reliance on hard copies often resulted in inconsistent processing. For instance, misplaced or damaged paper forms frequently delayed the process, while the lack of standardization in application reviews led to unpredictable outcomes. The OIS introduced standardized digital workflows and centralized data management, ensuring uniformity in form processing and reducing errors.

Response time, which improved by 51.95 %, directly addressed delays inherent in the MIS, where manual reviews and data entry prolonged application processing. For example, under the MIS, officers manually verified forms and entered data into the system, a time-intensive process that extended the processing time to seven working days or more. The OIS automated many of these tasks, reducing the processing time significantly. Real-time data synchronization and automated notifications ensured users received prompt updates, enhancing their experience.

5.2 Benefits of Implementing OIS in the Administrative Process

Implementing the OIS significantly enhanced user satisfaction by addressing inefficiencies in the application process and aligning it with user expectations for convenience and reliability. For instance, the automated data entry and guided form-filling features in the system, which emerged as critical solutions during the DMAIC improvement phase, directly improved usability by reducing the complexity of completing applications. This simplification minimized errors and eliminated redundant steps, enabling users to navigate the system quickly. Accessibility was another key area of improvement, as the OIS eliminated the need for multiple in-person visits by allowing users to submit applications online at their convenience. This enhancement and features, such as 24/7 availability, responded directly to user needs identified in the initial Measure and Analyze phases.

The consistency in application handling improved due to the ability of OIS to standardize processes and reduce errors through automation. For example, real-time validation checks ensured that applications were complete before submission, minimizing back-and-forth corrections. The

response times were significantly shortened, as the OIS automated processing steps that were previously manual, such as verifying applicant details and sending status updates. Automated notifications, a feature added based on user feedback, ensured that users were promptly informed about their application progress, fostering transparency and trust. These improvements, collectively driven by the insights and structured changes implemented through the DMAIC methodology, highlight how the OIS effectively addressed user dissatisfaction and delivered a streamlined, efficient and satisfying application experience.

5.3 The Effectiveness of the DMAIC Approach for User Satisfaction

The DMAIC methodology played a crucial role in improving user satisfaction by providing a systematic framework for identifying and resolving inefficiencies in the application process. By focusing on data-driven analysis and iterative problem-solving, DMAIC ensured that every intervention directly addressed the root causes of user dissatisfaction. For instance, the methodology facilitated the identification of critical issues such as redundant manual tasks, inconsistent processing, and extended approval times, which were directly linked to poor usability and accessibility. Through structured improvements, such as introducing an OIS, the methodology streamlined operations and enhanced the overall user experience.

DMAIC emphasizes the measurable outcomes that enable precise evaluation of improvements, ensuring that changes translate into tangible user benefits. For example, implementing automated features and standardized workflows reduced errors and improved response times, directly contributing to higher satisfaction scores. Additionally, the iterative nature of DMAIC allowed continuous refinement, ensuring that the system evolved to meet user needs effectively. This approach underscored the strength of the methodology in aligning operational efficiency with user expectations, ultimately fostering a more consistent, accessible and responsive application process.

6. Conclusion

This study aimed to improve the user satisfaction of the administrative application process at Company A through implementing an OIS guided by the DMAIC methodology. The objectives were to identify inefficiencies within the existing manual process, develop a systematic solution and evaluate its effectiveness in addressing user satisfaction: usability, accessibility, consistency and response time.

The findings revealed significant improvements across all user satisfaction metrics following the introduction of the OIS. Usability improved by 70.21 % due to features like automated data entry and guided form-filling. In comparison, accessibility increased by 61.04 %, facilitated by online submissions that eliminated the need for multiple in-person visits. Consistency rose by 44.12 % due to reduced errors and standardized processes, and response time was enhanced by 51.95 % as the system accelerated application processing. These results demonstrate the effectiveness of the OIS in addressing critical pain points in the manual system and enhancing the overall user experience.

The study contributes to the field of process improvement by showcasing the practical application of the DMAIC methodology in administrative functions, particularly in government-linked processes. This research highlights the value of structured frameworks in addressing operational inefficiencies by integrating tools like root cause analysis, multi-voting and targeted solutions. The study also provides empirical evidence supporting the role of digital transformation in improving service quality, which has broader implications for organizations considering similar transitions.

Despite its strengths, this study is not without limitations. It focused on a single case study, which may limit the generalizability of the findings to other contexts. The short trial period for the OIS implementation may not fully capture long-term challenges or user adoption behaviors. Future research should explore the scalability of the OIS in different administrative settings by conducting multiple case studies across various organizations. This would enhance the generalizability of the findings and provide a more comprehensive understanding of the effectiveness of the OIS. Future research also should explore the scalability of the OIS in different administrative settings, conduct longitudinal studies to assess sustained impacts and investigate the integration of advanced technologies such as artificial intelligence (AI) and machine learning (ML). These technologies could further enhance the functionality and efficiency of the OIS by enabling predictive analytics, intelligent decision-making and adaptive learning mechanisms.

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