Improving banking performance in Saudi banks by using Lean Six Sigma methodology

تحسين الأداء المصرفي في البنوك السعودية باستخدام منهجية ستة سيجما الرشيقة

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Abstract:

This study aimed to spotlight the role of the lean Six Sigma approach to reduce the errors in Saudi banks consistent with the adoption of lean six sigma methodology and also the selection of lean Six Sigma teams (Team Improvement).

The results of the study indicate the significance of implementing lean Six Sigma methodology in banking sector in Saudi Arabia is used on projects to improve the process by eliminating the variations and creating workflow in a process, Increase Customer Satisfaction, Increase Profitability and Decrease Costs, Monitor performance, Eliminate processing delays Analyze performance and avoid banking errors.

KEYWORDS: *lean Six Sigma (DMAIC) Model, Saudi central bank (SAMA), Performance Improvement .*

ملخص:

تهدف هذه الدراسة إلى تسليط الضوء على منهجية ستة سيجما الرشيقة ودورها في تحسين الأداء و تقليل أخطاء العمليات المصرفية في البنوك السعودية و محاولة تطبيق هذه المنهجية بمراحلها وأدواتها على بنك سعودي.

وقد توصلت الدراسة إلى أهمية تطبيق منهجية ستة سيجما الرشيقة في القطاع المصرفي السعودي وفي البنوك السعودية كأداة فعالة لتحسين سير العمليات المصرفية، وزيادة رضا العلاء، وزيادة ربحية الأصول المصرفية وتقليل التكاليف، وتحسين كفاءة الأداء وتقليل الأخطاء المصرفية.

الكلمات المفتاحية: منهجية ستة سيجما الرشيقة، القطاع المصرفي السعودي، الأخطاء المصرفية، البنك المركزي السعودي، تحسين الأداء.

1. INTRODUCTION

In recent years, lean six sigma has become the most popular tool for improving product in manufacturing and non-manufacturing companies, including service industry in places like hospitals, office buildings, and even banking sector. Lean Six Sigma is an application which combined methodology of lean in six sigma methodology, represents a effective way for driving innovating processes inside a corporation so as to forecast uncertainties and maintain

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competitiveness. It involves a practical analysis supported facts, aiming to reduce variation in business processes, reduce costs and improve performance.

Lean six sigma has been used in Japan since 1990 to eliminate eight kinds of waste: defects, overproduction, waiting, non-utilized talent, transportation, inventory, motion, extra-processing to improve performance by systematically removing wastes.

In contrast, Six Sigma emerged in the USA in the 1980s with the same function to reduce costs and defects in any operation in manufacturing companies.

The combination of these two tools to make enterprise more efficient and effective could be obtained through the adoption of each tool In isolation.

There are a many companies that used lean six sigma methodology successfully, include GE, Motorola, Johnson & Johnson, Allied-Signal (Honeywell) and Cummins.

Further, After the unprecedented success in manufacturing sector, this idea was adopted by service sector like Banking, insurance, health care to attenuate the defects, improve the operational efficiency and most significantly to extend the customer.

Banking industry in Saudi Arabia is facing immense competition from local as well as foreign banks, customers choices regarding banks are expanding.

Our study focuses on lean six sigma and its application in banking. We can adopt lean six sigma by Saudi banks partly or fully to improve the process management by reducing the defects and errors in that process which will increase the operational efficiency and profit of Saudi Banks.

The aim of this study is to overcome the problem of human-computer manipulations errors when filing requests from the Saudi Arabian monetary authority (SAMA) by data entry operator, to avoid serious mistakes including seizing accounts of non-concerned clients and missing concerned ones.

Statement of the Research

Seizing clients' accounts operation under the request of the Saudi central bank (SAMA)consists significant amount of errors, that starts from <start point> to <end point>. The execution of one operation requires several computer manipulations and client data transfer between different platforms, which entails a great risk of entry errors and inaccuracy.

Besides, no efficient error detection and monitoring method is implemented. Indeed, internal method for operations double-check, which is ensured by the team manager, concerns only the category of the operations that lead to positive detection of a client in the source database. Thus, only false positive operation are detected by the manager double-check, while false negative ones go undetected, and are only noted by the Saudi Arabian Monetary Authority (SAMA) feedback in the feedback report. Additionally, no data about the frequency and factors of such errors or other in the process are available.

The present work suggests an application of Lean Six Sigma in the bank under study, to reduce financial risk and eradicate erroneous data entry. The six sigma standard achieves 99.997% of the total achievement of the SIX SIGMA. In other words, the error is 3.4 million, thus achieving the best level in all the work done.

Research Methodology: This course is based on the analytical descriptive approach in addressing the problem of research, which is based on the examination and analysis focused on accurate information.

hypotheses: The banks in this study currently have not applied Lean Six Sigma methods into their system. This paper assumes that a standard Lean Six Sigma approach would be expected for an organization that seeks to reduce error operations banking and defects.

2.Review of Literatures: In this section, literature review on Lean and Six Sigma is presented, as well as theory on the combination of these two approach Lean Six Sigma. It is investigated how Lean and Six Sigma can be implemented to the process that is discussed in this report. Lastly, since this project aims at finding improvements and implementing them, studies on how to implement lean six sigma in banking Industry.

2.1 introduction to six sigma : Six sigma is "technique that helps companies to remove variation from process and improve their performance by monitoring everyday business activities in order to reducing amount of waste and resources" (Harry and Schroeder, 2000, p.VII). (Snee, 2004, p.8) defines Six Sigma as "a business improvement approach that seeks to find and eliminate causes of mistakes or defects in business process by focusing on process out puts that are of critical importance to customers".

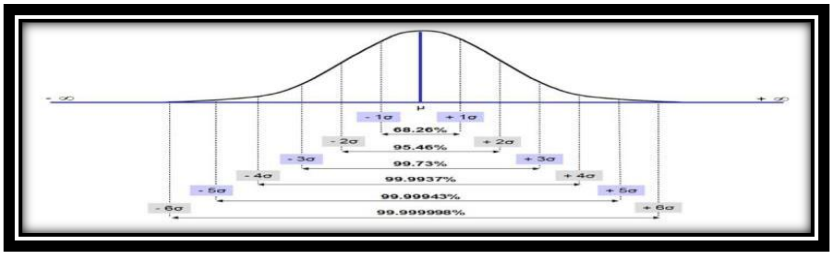
Six Sigma tool was created by Bill Smith at the Motorola Research Centre within the US between 1979 and also the early 1980s. (Gijoa et al., 2011; Goh, 2010; Harry and Schroeder, 2000; Pepper and Spedding, 2010; Snee and Hoerl, 2003; Timans et al., 2012).

Six Sigma aims to remove variation in any process and improving performance (Banuelas et al., 2005), reduce product costs in manufacturing and services, increase customer satisfaction (Drohomeretski et al., 2013), improve productivity and quality, efficiency of process (Harry and Schroeder, 2000), reduce uncertainties, reduce the amount of waste , and reduce defects to 3.4 parts per million opportunities in an organization (Chen and Lyu, 2009).

For the process to be six sigma certified the defect rate must be 3.4 defects per million opportunities and process yield should be of 99.99966%.(Harry, 1998).

Below is the six sigma table which is showing the defect rate and yield as per the sigma level, as shown in Figure 1.

Fig.1 Six Sigma Curve



***Source** : (Antony and Banuelas, 2002).*

The defects per million opportunities (DPMO) is calculated by:- DPMO = (Number of defects*1,000,000)/(Number of opportunities/unit *Number of units) Number of units signify the sample size or the units tested during the process.

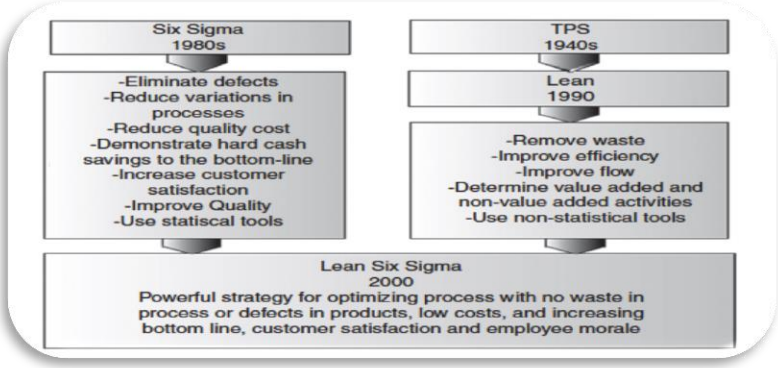
2.2.Introduction to lean: The term "Lean thinking" was first introduced by Womack, et al. (1990) and it include a set of lean practices. The aim of the Lean technique is to eliminate waste from every possible process in an company.

The fundamental principle behind lean is the elimination of waste from a process to promote using the least amount of capital or other investments to produce the most amount of gain.(David and Arnela: 2012):

- ✓ Over production – Producing parts that there is no customer for "in case it will be needed"
- ✓ Waiting - Staff waiting for the next action, or an operator having to observe an automated machine.
- ✓ Unnecessary transportation - Short or long movements of goods or personnel that does not add any value.
- ✓ Over-processing – Producing higher quality than what is needed.
- ✓ Excess inventory – Too much raw material or work in progress, WIP, hides problems and reduces cash flow .
- ✓ Unnecessary movement – Wasted motion done by an operator such as bending, reaching, stacking or walking to get material.
- ✓ Defects – Causing rework, scrap, replacement production and wasted time.
- ✓ Unused employee creativity – Lost involvement from and ideas generated by the employees.

2.3.Lean and Six Sigma: Six Sigma is majestic tool to upgrade the company performance quality improving, and Lean thinking can reduce defects and wastes, maintain competitiveness, forecasting uncertainties. Therefore, integrate Lean thinking and Six Sigma to improve quality and efficiency in the same time to achieve the lowest cost.

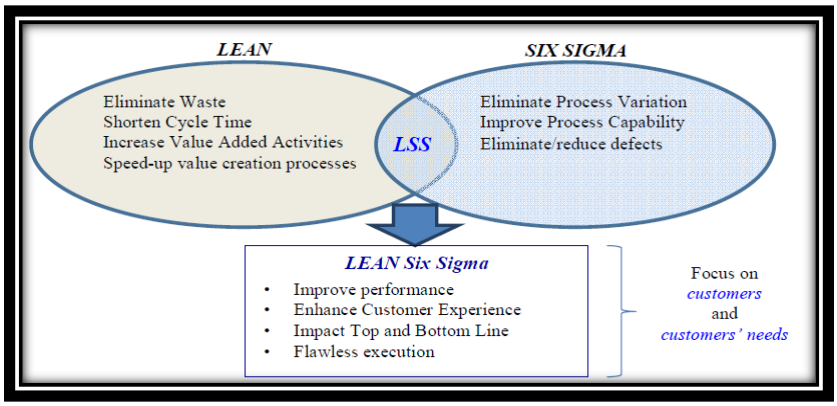
Figure 2. The origin of Lean and Six Sigma integration



Source*(Shahin and Alinavaz, 2008).*

Lean Six Sigma is a methodology that depend on a collaborative team effort to improve process management and performance by systematically eliminating waste, combining lean manufacturing and Six Sigma to remove waste, such as: time, inventory, motion waiting, over production, over processing, defects, and skills.

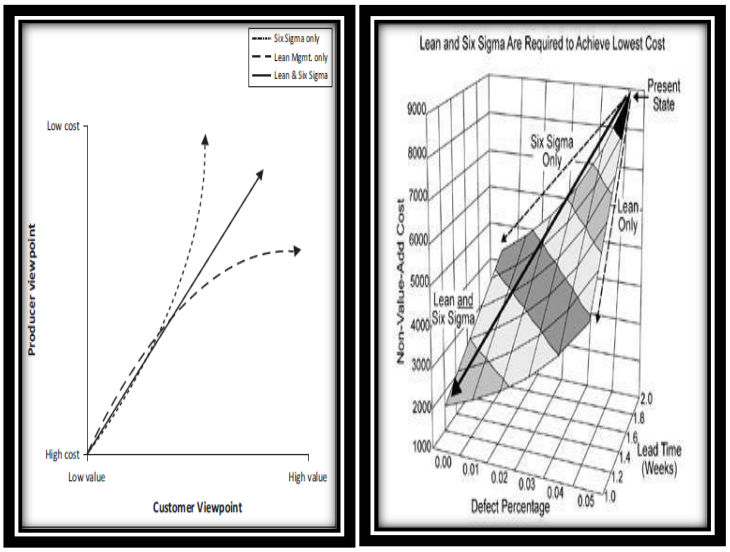
Figure 3: The concept of Lean six sigma



Source: *(federico et al, 2016).*

The justification of the Lean Six Sigma integration is represented in Figure 4 to highlight the summary and nature of improvements that would be gained by combining the two techniques.

Figure 4: Lean and Six Sigma are required to achieve lowest cost



Source*: (Raveenand Shalini, 2017).*

From figure 2.5 only Lean + Six Sigma = Lowest Cost. This figure shows the output from these calculations. The horizontal axis represents the defect rate (the target of Six Sigma); the axis that goes into the page shows cycle time (the target of Lean). The amount of biggest interest on this chart is the vertical axis, depicting costs that add no value to the product or service. The perfect state is in the lower left front corner—where costs are lowest. minimizing defects alone or reducing lead time alone bring some benefits, but process can attain the lowest cost only if managers improve both quality and speed.

2.6 .Lean Six Sigma methodology, tools and techniques:

2.6.1. Lean Six Sigma Tools and Techniques:

According to Vinodh et al. (2012) and Salah et al. (2010), LSS tools have the power to help an organisation achieve zero defects. LSS tools can be defined as practical methods and skills

employed by Six Sigma project teams to tackle quality related problems for accompanying performance improvement (Aboelmaged, 2010). Examples of Six Sigma tools include Pareto analysis, root cause analysis, process mapping or process flow chart, Gantt chart, affinity diagrams, run charts, histograms, quality function deployment (QFD), brainstorming, etc. Moreover, a Six Sigma technique can use various tools. For example, control charts, histograms, root cause analysis, etc.Below is the statistical tools of LSS table which is showing:

Table 2.2: Statistical tools of LSS

Six sigma	**Lean**
Statistical methods: ANOVA, regression, sigma calculation, process capability indices	Lean transformation
Design of Experiments	Demand flow management
Both Six Sigma and Lean	Cycle time Reduction
Control charts	Setup reduction
Poka-Yoke	Waste identification
Procedure documentation	Product segmentation
Visual management	KaizenBiltz
Problemsolvingmethod	Value Tree
Qualitytools and techniques	Value Stream

***Source**: adapted from Corina and Marilena (2011)*

2.6.2. Lean Six Sigma Methodologies (DMAIC and DFSS):

Lean Six Sigma uses the DMAIC phase similar to that of Six Sigma. Lean Six Sigma project include aspects of Lean's waste removing and the Six Sigma focus on reducing defects, based on critical to quality characteristics.

The first step to adopt LSS is to identify the pivotal elements of a process. Then team analyzes its capability and tries to move it by reducing or eliminating variations. The LSS methodology uses the DMAIC (Define, Measure, Analyze, Improve, Control) or DMADV (Define, Measure, Analyze, Design and Verify) model. DMAIC strategy consists of (Brue &Howes, 2006):

 Define - the projects, the goals, describing the current problem on process and quantify the waste and the anticipatedimprovement;

 Measure – identify the baselines, the current performance of the process; methods used: pareto chart histogram, control charts, process mapping, descriptive statistics and matrices, capability studies, measurement systems;

 Analyze - and determine the source(s) of defects using specific tools; narrow the causal factors to the vital few; potential solutions; methods used: distribution analysis, non value –added, graphics, fishebone- diagrams, multivariate analysis, hypothesis testing, plan project applications;

 Improve - the process to eliminate defects; optimize the vital few and their interrelationships based on the analysis of the previous step; methods used: brainstorming, benchmarking, setup reducation, kaisen, and continue executing and improving the project plan;

 Control – ensure the performance of the process and lock down the gains; statistical methods of control are used: visual process control, mistake-proofing.

2.6.Lean Six Sigma in Banking Service Industry:

A numerous banks have adopted lean 6 sigma and have attained big success. Bank of America, bank of Montreal, DSB bank etc are some of the major banks that have achieved huge success through lean six sigma applications.

Several studies have cited the benefits of adopting Six Sigma (Hahn et al., 1999; Hendricks and Kelbaugh, 1998; Lanyon, 2003; Robinson, 2005). These studies mentioned different benefits like improving the market share and building competitive advantage for a business. Furterer & Elshennawy, (2005), presented a case study of adopting Lean and Six Sigma tools and recommendations to improving the quality and timeliness in a city's finance department. After applicating a LSS program, the time to process payroll, purchasing and accounts payable were reduced by 60%, 40% and 87%, respectively.

Doran (2003) clarified several benefits of Six Sigma particularly for banking industry. These benefits includes ensuring accuracies in distribution of cash to reduce service charges, ensuring accuracies in daily reports through an effective information system, minimizing number of defects in loans provision processes, decreasing number of defects in cheque payments and collections and reducing inefficiencies in routine.

Delgado, et al, (2010) presented the advantages of application Lean Six Sigma in financial services organizations. The results showed that the LSS methodology can decrease cycle time, reduce the costs customer returns and inventory, and increase in production capacity.

Stoiljkovic et al (2010) concluded that with the help of Six Sigma philosophy and DMAIC model bank has improved quality of its processes and also shortened time period needed for credit approval.

Kumar R. Dhakshayani (2014) concluded that the application of lean 6 Sigma has proved to be a effective way to many banks in introduce top quality services to their customers in an efficient and enhanced manner. Banks that use lean 6 Sigma applications enjoy an edge over their competitors and mark a huge success even in the highly competitive banking world.

Athawar V.S. and Lunge H.S. (2016) concluded about the benefits that Six Sigma can offer to the banking sector. The findings illustrated that implementing Six Sigma in the banking sector has increased the growth of financial sector by reducing cycle time in all areas to meet the customer expectation.

Nilda et al (2018) mentioned six recommendations of improvement with in lean Six Sigma to minimize the seven wastes which is strongly associated with human aspects in Indonesian banking sector. These recommendations are obtained from brainstorming within the5-Whys, FMEA, and improve phases: achieve defect-free services without reducing job satisfaction of employees, reduce the certificate of lack of tax ID number holding costs, reduces the registration time ±1 min/customer, increasing security job satisfaction, and significantly increasing system efficiency and customer loyalty.

In Arab countries, the are few studies discussed the benefits of application lean six sigma, Abdullah (2012) identify the adherence to the Six Sigma approach in controlling the quality of internal auditing banks operating in Gaza by focusing on the following independent variables: Effective adherence to higher management, feedback, measurement, continuous improvement,

operations and systems, human resources. And the dependent variable: Quality standards of internal auditing (professional competence, management of internal audit activities, field of work, planning and implementation of the internal audit process, delivery of results), the study found a statistically significant relationship between the commitment of banks operating in the Gaza Strip Internal Audit Quality operations.

Qutait (2018) discussed the effect of application Six Sigma approach on the performance of Syrian Islamic banks according .The results showed that there is a statistically significant effect application of six sigma model elements (DMAIC) on the performance improvement process of Syrian banks.

Bakri (2019) discussed the benefits generated from the application of lean tools in Small Lebanese Bank. The main findings illustrated the great role of the lean tools to embrace disruptive technologies and create better experiences for customers and employees.

After reading all these studies we found that application of Six Sigma gives the competitive advantage to the banks

In addition, the are numerous benefit can be generated with using lean six sigma in banks such as: Reducing Financial Risk, Simulation for financial decisions, New product design of financial instruments, Improving portfolio strategy On operational level, Reducing documentation errors, Improving the reconciliation processes.

Moreover the application of LSS in banks contribute to Reduce or eliminate invoicing errors, Eliminate the possibility of erroneous data entry, Reduce audit non conformities and Reduce salary issue turn around time. Also the implementation of LSS in banks Controlling spending over time, Reducing electronic financial transaction costs, Reducing complaints, Enhancing (internal or external) customer satisfaction, Improving customer feedback and response processes.

3.Implementation of Lean Six Sigma in Saudi banks

From the literature review on studies on LSS application and its benefits in banking industry and other industries there is need to carry out a study on implementation of LSS in banking industry in Saudi Arabia in order to fill the existing knowledge gap and better understand the operations strategies employed by financial institutions in Saudi Arabia together with the critical success factors in their implementation.

3. The Saudi banking system& SAMA regulation:

The banking sector in the Kingdom of Saudi Arabia occupies the second place among the Arab sectors in terms of the volume of assets, which constitute about 18.2 percent of the total assets of the Arab banking sector, and reached at the end of the second quarter of the current year (2018) 616.5 billion dollars, an increase of 0.3 percent from the year 2017 This confirms the strength, durability and safety of this sector.

The number of banks in Saudi Arabia reached 26 banks operating a network of branches amounting to 2,078 branches at the end of the first quarter of 2020. The 26 banks include 13 domestic banks, 6 foreign banks, and 7 Arab banks. The local banking system in Saudi Arabia also consists of 9 conventional banks and 4 Islamic banks.

The Saudi Arabia Monetary Authority (SAMA, Saudi Arabia's central bank), was established to supervise banks and financial institutions, manage monetary policy, oversee the financial and insurance systems, and to maintain soundness within the banking system.

The Saudi Arabian monetary authority (SAMA) follows the transactions of operating banks in the Kingdom throw The electronic portal user for banks which provide to the judicial authorities and security and investigative bodies With the required information, bank documents pertaining to the client of the implementing agencies, according to the nature of each service for each application, and information.

Banking sector in Saudi Arabia can adopt lean Six Sigma in their operations to Increase Customer Satisfaction and improve process management. Investing in lean Six Sigma will not only improve the quality of their products and services, this will also Increase Profitability and Decrease Costs operations, Monitor and Analyze performance, Eliminate processing delays as well avoid banking errors.

The bank under study is a small Saudi financial institution fully governed and controlled by the SAMA. The bank has e-solutions via internet and several ATM throughout the country. Bank Aljazira is a Joint Stock Company incorporated in the Kingdom of Saudi Arabia and formed pursuant to Royal Decree No. 46/M dated 1395H (i.e. June 21, 1975). Bank Aljazira commenced its business (1976) with the takeover of The National Bank of Pakistan's (NBP) branches in the Kingdom of Saudi Arabia. Bank Aljazira began a restructuring process in 1992 with subsequent increases in capital in 1992 and 1994. The increased capital has come entirely from the Saudi shareholders, which resulted in significantly diluting NBP's shareholding.

In 1998, Bank Aljazira's Board of Directors took a strategic decision to convert the Bank from conventional banking into Shari'ah-compliant banking. This is the greatest challenge that any traditional bank can take as it requires mass changes to its infrastructure, offerings, legal environment, staff potentials, corporate values, etc. Bank Aljazira with its consistent endeavors succeeded in turning all its branches in 2002 to operate as per Shari'ah rules and principles.

During the researcher's work, in the Bank under study, he noticed a significant amount of errors in the seizing (holding) and un-holding clients' accounts under the request of the SAMA. This operation consists of a chain process that starts from the request receipt on the SAMA platform to the final validation and sending of the execution report. The execution of one operation requires several computer manipulations and client data transfer between different programs, which entails a great risk of entry errors and inaccuracy. On the other hand, several cost-effective solutions can be proposed to prevent and track the errors by controlling the risks stepwise and enabling more suitable check and validation system.

The next structure follows the phases of the DMAIC-cycle. The methodology was chosen based on the researcher's observation.

3.1. Define phase - Describing the current state and tools of the process on study

The Define phase is the first phase of lean Six Sigma process, which aims at stating the problem by focusing on manageable issues that impact the outcome of the process on study, including quality, efficiency, etc.

The Hold and Un-hold operations carried out by the bank, under the request of the SAMA, consist of a chain process that starts from the request receipt on the SAMA platform to the final validation and sending of the execution report. The execution of one operation requires several computer manipulations and client data transfer between different programs, which entails a great risk of entry errors and inaccuracy.

Further, no error tracking system is used to date by the bank, notably for this type of process, which further complexifies the assessment of the process quality and eventual corrective and or improvement measures.

This issue is of high priority to the bank, as such errors give rise to fines and penalties from the SAMA due to processing errors or delays, as well as complaints from clients and eventual legal issues which may be incurred by the bank or the operator himself.

In real world application, the team should introduce to the management the current process map situation. The description of Hold and Un-hold requests is presented at different levels:

3.1.1. Hold and Un-hold requests

The two processes on study consist of judiciary procedures on a given amount of money that should be held (hold request) from or released (un-hold request) to the account number of the concerned subject, which might be an individual or a company. Requests are received on a daily basis via Tanfeeth, the SAMA national electronic portal. Each request is identified with a unique ID number shared by the SAMA, which is related to the concerned subject ID name and number and the amount of money to be seized in case of Hold. Such procedures are subsequent to justice decisions regarding frauds, indebtedness, or any infractions requiring reparation. In average, the bank on study receives 4,000 to 4,200 Hold and Un-hold requests daily. A two-hour delay is allowed by SAMA to process the request from receipt time to final validation.

3.1.2. Personnel and parties of the execution

Seven bank agents and one manager are involved in the daily hold and un-hold operations. The agents have the responsibility to perform the whole operation and send it to the manager, who has the responsibility to final check it and validate it via the SAMA platform. Agents divide the number of requests to be processed on a daily basis; thus, theoretically, each agent processes seventh (1/7) of the total requests (~580-600) daily (Figure 3.1). Each of the operators (agents and manager) run the SAMA platform Tanfeeth under a personal username. This enables tracking each user for each single operation; thus, each agent is individually accountable for each operation he executes.

Figure 3.1. Operators involved in processing the hold and un-hold requests

Source: adopted by author's

3.2. Measure phase – Identifying different types of errors and quantifying their respective risks

This stage of lean Six Sigma implementation involves collection of data and use of measurement methods to quantify the quality and efficacy of the current practices and processes against predefined standards of quality. Thus, this phase enables defining a baseline status regarding the current process performance, and determining milestones for the implementation of the improvement system and assessment of its efficacy.

However, given the lack of quantitative data about the frequency and amount of errors generated by the current practice, due to absence of an error tracking system, the Measure phase will focus on qualitative assessments of failure types and the evaluation of their respective risks. Additionally, a quantitative measurement tool will be proposed in the Improvement phase. Thus, this phase will be tackled by considering three dimensions: 1) identification and categorization of the most frequent errors and their respective adverse events; 2) estimation of the risk level for each error using a numerical risk level scale (1=low, 2= intermediate, 3=high risk) based on the researcher's empirical observation; 3); 3) importance of an error/failure tracking system.

3.2.1. Error identification and categorization

The table below (Table 3.2) presents the different types of errors possible at the key steps of the hold and un-hold processes execution, and provides insight into the dreaded consequences resulting from each error or failure.

Step	Error description	Risk score	Dreaded consequence
Hold			
Copy the ID form the excel file	Skipping one request by jumping on line when copying ID; example when subject being just processed is in third line, the following subject's ID may be picked from the 5th line instead of the 4th by mistake.	2	Skipped request not processed on time or gone unnoticed completely, which leads to receiving penalty from SAMA.
Collect all the necessary information	The subject name in the SAMA request may not match exactly the name in the bank database, but the Hold request is executed (the operator does not notice the difference in the names)	1	Complaint from SAMA and eventually a penalty.
Collect all the necessary information	If the client has more than one account, the operator may omit to collect information from one of the accounts.	2	The Hold will not be properly executed and client continue using that account normally, which may be subject to fine and penalty if discovered by SAMA.
Collect all the necessary information and making the Hold	Collect information about wrong account and making the Hold. Example for wrong account is a joint account, which is an account own by more than one person, and which is not subject to Hold.	2	Complaint from SAMA and eventually a penalty.
Making the Hold	Wrong amount of money entered for Hold by the operator, or operator not noticing the difference in currency between the Hold request and the account currency.	1	Wrong information provided to SAMA, which cannot be rectified once the request is sent. In case that the amount entered is less than the Hold request amount, the bank will pay the difference. Otherwise, a penalty will be paid.
Making the Hold	Seizure of sums not to be seized	1	Wrong information provided to SAMA, which cannot be rectified once the request is sent. In case that the amount entered is less than the

			Hold request amount, the bank will pay the difference. Otherwise, a penalty will be paid.
Un-hold			
Collect all the necessary information	If the client has more than one account, the operator may omit to collect information from the one of the accounts.	2	The Un-hold operation will not be executed properly, leading to penalty by SAMA
Making the Un-hold	Wrong Hold removed (the reference number does not match)	2	The Un-hold operation will not be executed properly, leading to penalty by SAMA
Making the Un-hold	Omit to remove the Hold	1	The Un-hold operation will not be executed properly, leading to penalty by SAMA
Risk score: 1=low, 2=intermediate, 3= high			

Source: adopted by author's

No efficient error detection and monitoring method is implemented in the bank for the process on study. Indeed, internal method for operations double-check, which is ensured by the team manager, concerns only the category of the operations that lead to positive detection of a client in the source database. Thus, only false positive operations are detected by the manager double-check, while false negative ones go undetected, and are only notified later by the SAMA in the feedback report. Additionally, no quantitative data about the frequency and factors of such errors, their consequences or other adverse events in the process are available. Consequently, it is difficult to assess the efficacy of any corrective of improvement system that may be implemented to enhance the efficacy and quality of the hold and un-hold process execution.

The interest of having a reliable error tracking system before the implementation of any improvement system is to have a baseline status that would enable more accurate analysis of the failure risks and effects, thereby increasing awareness about these risks and establishing priority order in their management according to their frequency and the severity of their effects. Further, the tracking system will be used as reference to assess the efficacy of that improvement system. It also enables fixing milestones and measurable objectives. Therefore, the researcher suggests the creation of a "Daily Failure Report Form (DFRF)", which will be used as the major tool to collect the frequency, type, and factors for failure in the hold and un-hold process execution. This proposal will be detailed in the Improvement phase, as it is part of the improvement ideas proposed in this work.

3.3. Analyze phase – Determining the causes of the failure and stratifying the risk

The Analysis phase of lean Six Sigma involves investigating the potential causes for the errors defined in the Measure phase and estimating their proportional impact. It has the purpose to define alternative practices, processes and or tools that could be designed and implemented to reduce the risk and impact of failure by controlling its causes. Additionally, the stratification of the failure effects enables prioritizing the improvement objectives and conducting cost-effectiveness analysis of the eventual improvement tools.

Based on the current Hold and Un-hold process map, a potential Failure Mode and Effect Analysis is applied to create awareness for and prioritization of different failure causes and effects. This is done by: 1) defining failure modes; 2) the highlighting the modifiable and non-modifiable causes of failure; 3) stratifying the severity of their effect; and 4) estimating the probability of detection before failure occurs in different sub processes.

3.3.1. Failure modes: By analyzing the errors and failures mentioned in the Measure phase the researcher proposed to group the failures into 5 modes as follows:

1) Inaccuracy: relating to failures resulting in handling or sharing wrong data, such as mistyping an ID number, entering a wrong balance credit, holding incorrect amount, etc. This mode of failure is due to several mechanisms such as misreading, mismatching, typing error, confusing data, etc.

2) Incompleteness: relating to partial execution of a process by omitting one or more of its components, such as omitting to process one of the many client's accounts, or skipping one request from the list. This mode is highly linked to lack of concentration by the operator, stress and work pressure.

3) Impunctuality: which stands for requests not processed and send back on deadline. Several mechanisms may underly this mode, including omission, fatigue, accumulation of requests, etc.

4) Heterogeneity: which relates to non-uniform execution method between the different operators of the team, rendering difficult any attempt of peer-review or back-up. This is

due to low teamwork engagement, which may require consideration by the top decision makers.

5) Uncontrol: in the case of the process on study, this failure mode is more relatively specific to the manager's role, who has the mission to supervise and validate all the requests processed by the 7 operators. Consequently, due to the load, several requests may go uncontrolled, especially those with negative outcome (no client match). The other mechanism for such failure is absence of a palliative solution to detect the errors.

3.3.2. Modifiable and non-modifiable causes of failure

By analyzing the process steps and handlings related to the execution of the SAMA Hold and Un-hold requests and the failure modes, several failure causes were identified at different levels. Analysis of the causes for each failure mode is done on the light of the available data and based on the researcher's observation. For practical purpose, failure causes are divided into modifiable versus non-modifiable causes, depending on the opportunity to be modulated in the improvement phase.

3.3.2.1. Modifiable causes of failure: Modifiable causes of the current method of execution of the Hold and Un-hold requests that were highlighted by the researcher are:

1- Absence of standardized procedure to execute the process in the bank

2- Absence of connection between SAMA and the bank platforms, resulting in huge number of steps and handlings to process one request

3- Shift between 3 systems/programs including bank and Tanfeeth systems and Microsoft Excel

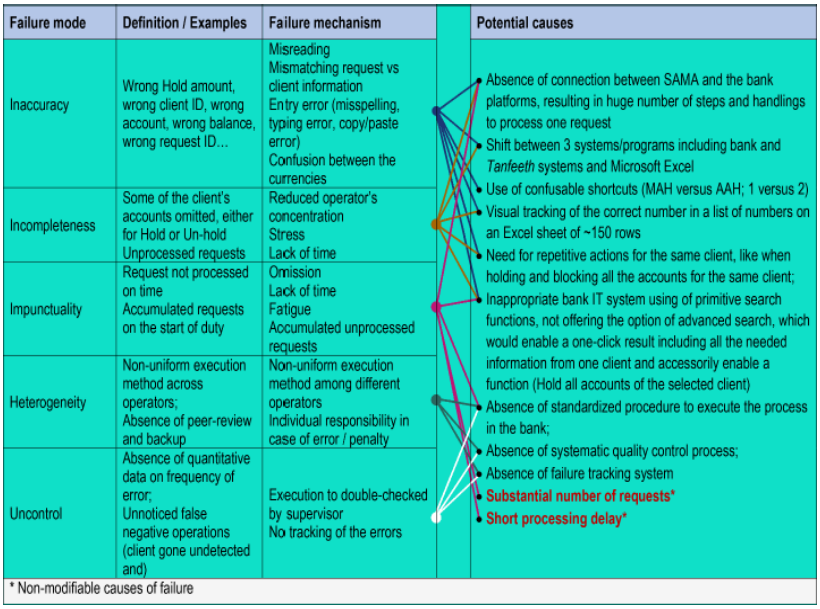
4- Use of confusable shortcuts (MAH versus AAH; 1 versus 2)

5- Visual tracking of the correct number in a list of numbers on an Excel sheet of ~150 rows

6- Need for repetitive actions for the same client, like when holding and blocking all the accounts for the same client;

7- Use of primitive search functions, not offering the option of advanced search, which would enable a one-click result including all the needed information from one client and accessorily enable a function (Hold all accounts of the selected client) .

Figure 3.3. Modes, mechanisms and potential causes of failure



Source: adopted by author's

3.4. Improve phase – Solutions to reduce failure risk by alleviating causes

Based on previous analysis of failure modes and causes, the researcher proposes a set of solutions (tools and procedures) to be included in the process to improve its quality, efficacy and time-effectiveness. In parallel, a comprehensive and efficient evaluation and self-feedback system should be implemented to prevent, detect, and track any failure; this will be discussed in the Control phase.

3.4.1. Improvement strategic design

The improvement strategy should be designed to respond to two crucial issues: 1) failure effect prioritization; 2) managing the major causes of failure, in a cost- and time-effective manner.

3.4.1.1. Failure effect prioritization

The improvement plan should be design to prevent and eradicate all severe failure effects and reduce significantly less severe ones. However, addressing this issue necessitates reliable quantitative and qualitative baseline data, which are not available in the current case. Therefore, the researcher proposes conducting a pre-interventional study to collect key data on failures effects over a significant period. This study will enable measuring the extent of failure effects on the bank and the most frequently incriminated factors and causes. A non-exhaustive list of key variables as well as their utility are summarized in Table 3.4.

Table 3.4. Key variables for the pre-improvement study and their significance in the improvement strategic design

Variable	Relevance and significance
Failure mode	Classification of failures to correlate with the potential causes
Failure severity	Qualitative evaluation of the risk by providing objective measurement of the failure consequences. This evaluation may use a numerical score (severity score)
Incidence (e.g. frequency by 10,000 requests)	Quantitative evaluation of the risk
Risk level	May be computed as the severity score * incidence. Provides an overall insight into the significance of the risk, thereby enabling risk stratification and prioritization.
Request characteristics: type (hold un-hold), number of accounts, type of account (individual/company), etc.	For each failure detected, to identify request features that are associated with higher risk of failure.
Number of requests processed on the failure date, overall and by the concerned operator	To estimate the effect of the number of requests processed by day on the risk

Source: adopted by author's

3.4.1.2. Managing causes of failures

Further, the improvement strategy differs depending on whether the failure cause is modifiable or non-modifiable. For modifiable causes, the appropriate improvement strategy is to eliminate the cause. For non-modifiable ones, an adaptative process may be implemented to cover the scope of variations of the causes (e.g. adapt the work process to the number of requests received by day, using a specific protocol).

Ideally, failure causes should be alleviated using the simplest improvement procedure with the least number of tools possible. Therefore, the researcher attempted to further group the failure causes into three broad categories, which is a solution-oriented categorization as presented in Figure

3.5. Control phase – Management and Monitoring of the Solutions

The Control phase provides the evidence to the effectiveness of the improvement strategy and constitutes the warranty for its performance and good implementation. To tackle this objective, the researcher proposes the design and implementation of a systematic performance evaluation and failure tracking system using one unique support, the Daily Failure Report Form (DFRF).

The main objectives of the DFRF are:

- To timely report any failure or adverse event related to the execution of the SAMA requests on study

- To report further consequences for failures: fines, penalties, complaints, rework, time lost for rework, etc.

- To classify the failures into respective modes

- To classify failure effects into levels of severity

- To quantify the frequency of failures

- To collect data for all related factors (date, number of requests processed, , whether in occurrence of an adverse event or not

- To enable accurate analysis of the failure causes including operator- and non-operator related factors

- To audit the process quality and tools including the IT program, its usage simplicity, etc., on a regular basis

- To settle milestones for performance and have a strategic vision for future development

- To monitor the performance of the team and explore the impact of further factors on performance (seasonal variations, conflicts, absenteeism, personal factors, etc.)

- To enable adaptive strategies and procedures in case of exceptional situations (e.g. exceedingly huge number of requests, several sick leaves in the same period, etc.)

- To improve HR management such as hiring new candidates, planning days off, team constitutions, etc.

- To increase self-confidence and reduce stress among operators by having a reliable feedback on their own performance, weaknesses and strengths

- To enhance competitiveness between operators while encouraging team work

- To facilitate supervisor's task by providing a daily situational report.

Conclusion & Recommendations

Lean Six Sigma implementation is a performant method for assessing and improving the banking processes. By applying this method in the bank and process on study we could define, classify and stratify the failures, analyze their effects, stratify the risk, and explore and analyze the modifiable and non-modifiable causes. This enabled proposing tailored solutions to improve the process and reduce their effect, while achieving considerable time-saving and cost-saving and reducing personnel stress and risk of burn out.

The solutions proposed include an integrative IT program that will execute the key process commands on the bank system, which will considerably decrease the number of handlings as well as the variability and probability of handling errors. Different design options have been proposed depending on the bank top management vision and the IT Department possibilities. An eventual transition tool was proposed to support the feedback report on the SAMA platform, which aims at reducing the causes of failure related to this phase and simplifying its execution.

Besides, standard operating procedures (SOPs) should be established to describe the tools and provide a step-by-step user's guide. Such SOPs will help achieving a harmonized practice and a better evaluation of the deficiencies. Further, SOPs include implementing the proposed Daily Failure Report Form (DFRF), which should be filled systematically and which will enable recording, tracking and analyzing failure overtime and providing an accurate measurement tool for the performance of the process and tools both at the operator and bank levels.

A pre-improvement study phase was proposed by the researcher to provide accurate insight into baseline status, before implementation of the above-mentioned solutions, by reference to which the efficacy of these solutions will be evaluated.

Lean Six Sigma method should be generalized to all other banking process in the Kingdom of Saudi Arabia.

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