

Transforming an Audit into a KPI Tool to Promote Continuous Process and Project Improvements

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Abstract. Process audits on projects tend to be unpopular among project team members as not only do they consider it as “extra work” for them to be part of but they are unable to regard audits as a (proactive) means for a qualitative output. This is usually the case if the results of the audits are utilized to order the project teams to rectify any non-compliance rather than demonstrate to them the added value. It is to their advantage in knowing how an audit can contribute to the seamlessness of a project’s operations, encourage enhancements and improve practices within the project, and, ultimately, increase a project’s bottom-line. In this paper it is shown how an audit procedure was transformed to quantify and improve a project’s performance thus contributing towards having fewer bugs and a higher profit margin.

Keywords: Audit · Key Performance Indicator · Process Improvement · Quality Assurance · Bugs · Profitability

1 Introduction

The Geospatial Systems Integration (GSI) division of Khatib & Alami (K&A), is certified from the Capability Maturity Model Integration (CMMI) Institute as Level 3 in Development v1.3. [1] Practices in the implementation of quality procedures stem from the Process and Product Quality Assurance (PPQA) process area that encourages to establish a Quality Assurance Group (QAG) which harnesses the implementation and maintenance of K&A’s quality management system.

Process audits on projects tend to be unpopular amongst project team members as not only do they consider it as “extra work” for them to be part of but they are unable to regard audits as a (proactive) means for a qualitative output.

This paper presents how an audit procedure was transformed from a routine activity with a normal checklist into an evaluation tool (Audit KPI Tool) that can quantify and improve a project’s performance thus contributing towards having fewer bugs and a higher profit margin at the end of a project’s lifecycle.

2 Quality Assurance Process

2.1 Definition

The Quality Assurance Process covers process and product audits at the project and organizational level. Audits of compliance to the Khatib and Alami GSI Division processes (G-QMS) are a critical component of software/project quality. [2] The objectives of the Internal Process audit are to establish compliance to the defined processes and determine ways to improve effectiveness of the deployed processes.

The audits take place on a quarterly basis and the feedback given by the auditing process provides a self-correcting mechanism to improve the G-QMS. The Quality Assurance Group (QAG) performs the quarterly audits, and the QAG normally consists of auditors who are volunteers from within the GSI division. The head of the QAG overlooks all activities, reports, and evaluation related to the audits.

2.2 Flowchart

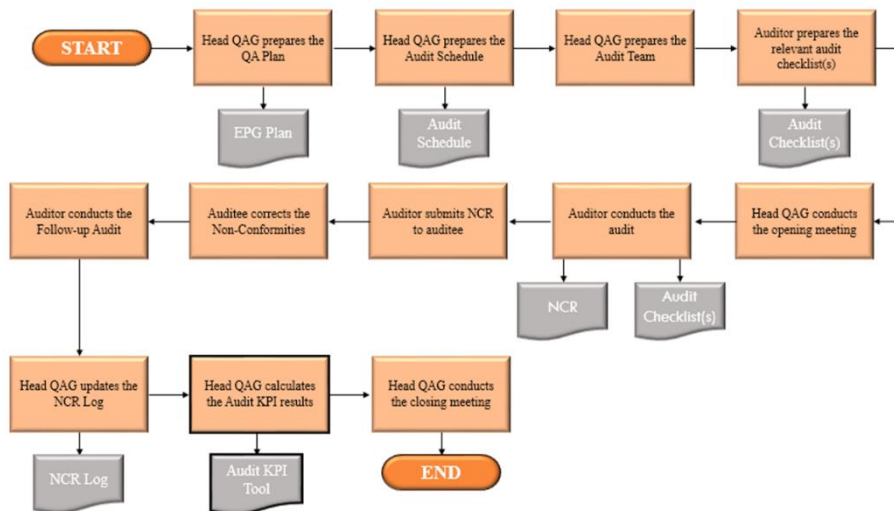


Fig. 1. Process and Product Quality Assurance Flowchart [2]

Table 1. Key for the Process and Product Quality Assurance Flowchart

KEY	
EPG	Engineering Process Group
KPI	Key Performance Indicator
NCR	Non-Compliance Report
QA	Quality Assurance
QAG	Quality Assurance Group

3 The Birth of the Audit KPI Tool

3.1 Purpose

The goal of the Audit KPI Tool is to increase adherence to G-QMS processes by becoming a factor in the yearly staff evaluation. The project team members are responsible for implementing the processes thus we need to identify the strengths and weaknesses, and ultimately resolve those weaknesses, in a proactive manner.

3.2 Objectives

- Increase client satisfaction by delivering on time with immediate approval.
- Reduce the number of all types of defects by adhering to the G-QMS processes.
- Improve a project team’s teamwork through cross-functional collaboration.
- Link a team member’s metrics with their project’s metrics.
- Expand a project’s profit margin by reducing cost of rework.

3.3 Audit KPI Tool – Walkthrough

Audit Ref.	Project	Audit Scope	Project Manager	Evaluation Criteria										Evaluation		
				Maj. NCs	Min. NCs	Resolved NCs	% Resolved	Previous Audit Pending NCs	Critical PMGT NCs closed?	Current Audit Closed on Time?	Previous Audit Closed on Time?	# of PIs	# of Positive Obs.	Ratio	KPI Result	
2019-Q1	Project A	G-QMS	PM 1	2	2	1	25%	2			No	No	6	0	1.31	Fail
2019-Q1	Project B	Start-up	PM 2	2	4	6	100%		Yes	Yes		0	0	3.00	Pass	
2019-Q1	Project C	Requirements	PM 3	8	8	12	75%	4	No	No	No	1	1	1.04	Fail	
2019-Q1	Project D	Application	PM 4	5	13	9	50%	0	Yes	No	Yes	2	1	1.22	Pass	
2019-Q1	Project E	Project Closure	PM 5	10	4	6	43%	0	No	No	Yes	4	0	1.36	Fail	
2019-Q1	Project F	Configuration	PM 6	4	7	8	73%	15	Yes	No	No	2	1	0.71	Fail	

Fig. 2. Audit KPI Tool [3]

Table 2. Key for the Audit KPI Tool

KEY			
G-QMS	GSI – Quality Management System	PI	Process Improvement
KPI	Key Performance Indicator	PM	Project Manager
NC	Non-Compliance	PMGT	Project Management

The formula used to calculate the Evaluation Ratio is the following:

$$L = (A+B+C+2*D+2*E)/(F+G/2+2*H+2*I)$$

Below is a short description on each factor of the Audit KPI Tool and its Evaluation Ratio:

- A. **Organizational Standard:** A specific number of points are allocated to each of the Audit Scope's three categories. If the audit scope is G-QMS (organizational processes) then A=5, for Start-up audits A=10 and for project management audits (Requirements, Data, Design, Application, Configuration, and Project Closure) A=25.
- B. **Closing the Current Audit on Time:** Two points are awarded if all non-compliances of the current audit were closed on time (Auditees have a maximum of two weeks).
- C. **Closing the Previous Audit on Time:** Five points are awarded if all non-compliances of the previous audit were closed on time.
- D. **Number of Process Improvements:** To encourage the implementation of process improvements, two points are awarded for every valid process improvement (that has an assigned or a rolled-out status) within the project's life-cycle.
- E. **Number of Positive Observations:** Two points are awarded for every valid positive observation noted by the auditor during a project's audit.
- F. **Total Number of Major Non-Compliances:** This is the (final) total number of major NCs during the current audit e.g. missing an important artifact or having several minor NCs within the same requisite on a check-list.
- G. **Total Number of Minor Non-Compliances:** This is the (final) total number of minor NCs divided in half because minor NCs tend to be abundant compared to major NCs. Minor NCs are considered as long as they are less severe than what is defined as a major NC.
- H. **Open/Unresolved Non-Compliances from Current Audit:** This is the total number of unresolved NCs after the current audit. To encourage project teams to resolve as many NCs as possible two points are attributed for every unresolved NC.
- I. **Open/Unresolved Non-Compliances from Previous Audit:** This is the total number of open or unresolved NCs that were incurred during the previous audit. To encourage project teams to resolve as many NCs as possible, two points are attributed for every unresolved NC.
- M. **KPI Status:** For an audit to pass, it has to meet all of the following three criteria:
 - J. **Resolving 50% of Current NCs:** Percentage of resolved NCs must be at least 50%.
 - K. **No NCs related to Critical Project Management Items:** There should not be a single unresolved NC related to critical project management items or artifacts e.g. Project Schedule, Project Estimation Sheet, Project Cost Tracking Sheet, Deliverables List, and Progress Reports.
 - L. **Evaluation Ratio ≥ 1.00 :** Ratio must be greater than or equal to 1.00

4 Situational Analysis on the Impact of the Audit KPI Tool

This section will illustrate the projects' performance before the Audit KPI Tool's implementation and assess the impact the Audit KPI Tool had by showing how the improvements developed over time. This will allow the reader to have an understanding on the circumstances we faced and how we progressed. As a result, several determinants will be looked at as key indicators throughout this section.

A total of 61 individual projects underwent process audits from the second quarter of 2015 to the fourth quarter of 2018. Of the 61 projects, 14 were selected for the situational analysis because six of those projects went through enough number of audits before and after the implementation of the Audit KPI Tool and this is critical for an impartial and insightful study. The remaining eight began after the implementation of the Audit KPI Tool and they are selected to illustrate the continuous improvement as a result of the Audit KPI Tool.

The 14 projects were divided into two groups with the first group (consisting of six projects) having satisfied the following criteria:

1. Project life-cycle must be Full-Development
2. Projects must have gone through at least 50% of the quarterly process audits between 2015-Q2 and 2016-Q1
3. Projects must have gone through at least 25% of the quarterly process audits between 2016-Q2 and 2018-Q4
4. Projects must have implemented the Waterfall Methodology

The second group (consisting of eight projects) satisfied the following criteria:

1. Project life-cycle must be Full-Development
2. Projects must have gone through at least 50% of the quarterly process audits between 2016-Q2 and 2018-Q4
3. Projects must have implemented the Waterfall Methodology

4.1 Non-Compliances and Profitability

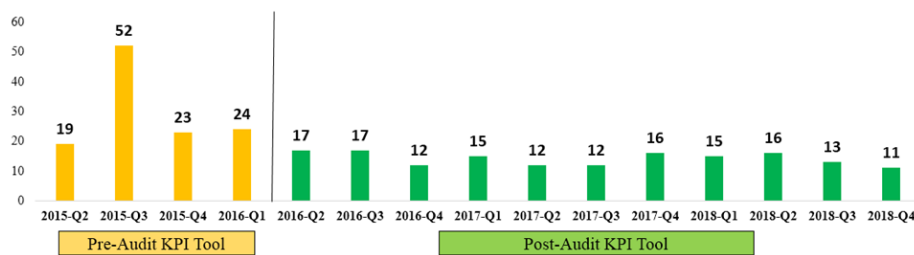


Fig. 3. Average Number of Non-Compliances per Project per Quarter

The overall average number of non-compliances during the Pre-Audit KPI Tool phase was 25 per project per quarter while during the Post-Audit KPI Tool phase the average was reduced to 15 non-compliances per project per quarter.

A total of 18 process audits took place before the implementation of the Audit KPI Tool, and only 6% had non-compliances fully resolved within the allotted time. Whereas after the implementation, 67 process audits in total, 28% of the audits fully resolved their non-compliances.

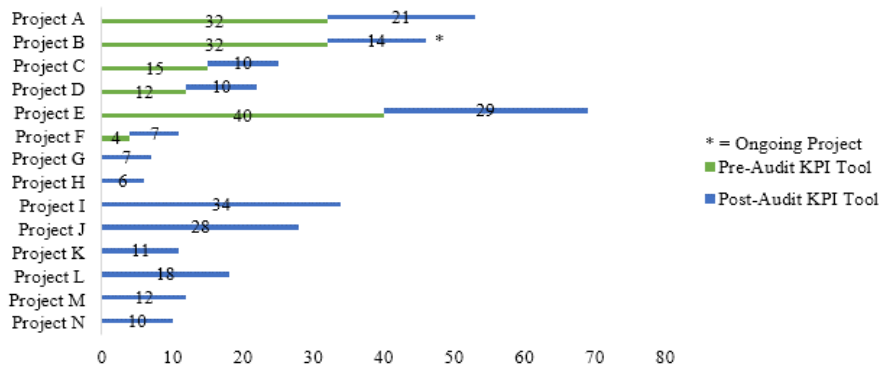


Fig. 4. Timeline of the Average Number of Non-Compliances per Project

64% of the projects in Figure 4 made a profit and the average number of NCs per quarter for each project was 11. The remaining 36% of the projects that made a loss had an average of 27 NCs per quarter for each project.

Projects A to E showed, to a large extent, an improvement in the reduction of their non-compliances after the implementation of the Audit KPI Tool while Project F still managed to keep a low average of non-compliances despite the small increase. Out of those projects, projects A and E incurred a loss at the end of their project life-cycle and we can link their high average of non-compliances with the loss. On the other hand, projects B, C, D, and F made a profit and have a lower average of non-compliances compared to projects A and E.

As for Projects G to N, of those projects G, H, K, M, and N made a profit and have a lower average of non-compliances when compared to projects I, J, and L that made a loss with a higher average of non-compliances per quarter.

To sum it up, before the implementation of the Audit KPI Tool 50% of the projects made a profit. After the implementation, the percentage increased to 66%.

4.2 Process Improvements

Process improvements are suggestions from employees to reduce defects, time & cost overruns, improve risk management, improve decision making, or reduce non-compliances to processes. The suggestions can result from lessons learned during the project, an employee's own creativity or even from the audits.

Figure 5 will show how the number of valid process improvements increased after the implementation of the Audit KPI Tool:

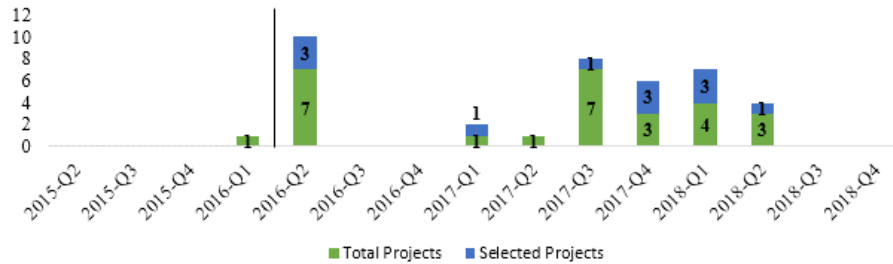


Fig. 5. Timeline of the Number of Submitted Process Improvements per Quarter

Before the implementation of the Audit KPI Tool there was a lack of contribution for continuous improvement which resulted, on average, zero submitted process improvements per quarter. Whereas after the Audit KPI Tool there is (to date) at least one valid process improvement submitted each quarter.

4.3 KPI Status and Bugs Report

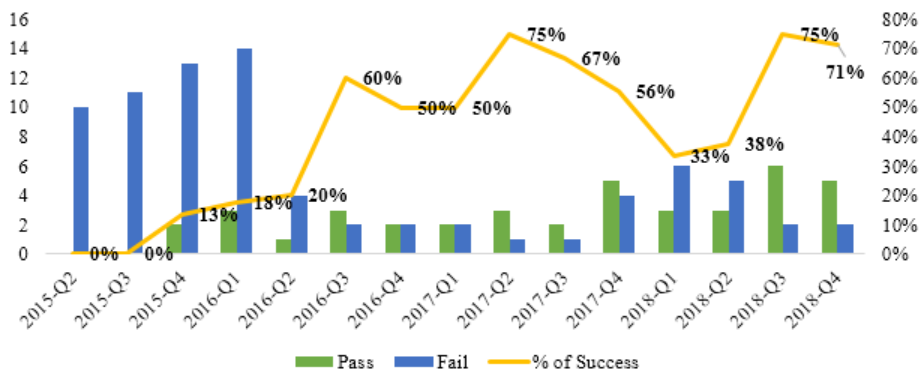


Fig. 6. Number and Percentage of Projects that Passed the Audits

Hypothetically if the Audit KPI Tool was implemented between 2015-Q2 and 2016-Q1, 22% of the projects would have passed their audits every quarter. However, after the Audit KPI Tool was implemented 55% of projects passed their audits. What is interesting, after the implementation of the Audit KPI Tool, is that the projects that made a loss had a 6% passing rate whereas those that made a profit had a 68% passing rate.

Before the implementation of the Audit KPI Tool, a project, on average, would report 68 bugs per project. Whereas after the implementation a project reported 26 bugs on average.

5 Conclusion

5.1 Bringing it all Together

Below is a summative assessment on how impactful the Audit KPI Tool has been:

Table 3. Summative Assessment

Impacted KPIs	Pre-Audit KPI Tool	Post-Audit KPI Tool
Avg. number of NCs per project per quarter	25	15
% of audits with on-time fully resolved NCs	6%	28%
% of Projects that made a Profit	50%	66%
Avg. number of valid PIs per quarter from selected projects	0	1
KPI Status: Avg. % of audits that passed	22%	55%
Avg. number of bugs per project	68	26

Based on our analysis from the data over the past 15 quarterly audits, we are confident to state that a project that has an average of more than 15 NCs per quarterly audit is very likely to incur a loss by the end of its life-cycle while a project that has 15 NCs or less is very likely to make a profit.

5.2 Challenges

Developing the Audit KPI Tool did not happen without many challenges such as:

- **Resistance to Change:** Many did not view the Audit KPI Tool as a means for improved results in the short and long run so we faced resistance from many of the staff grew who accustomed to their own comfort zone.
- **New staff need time to adjust to our QMS:** New employees would require three to six months to settle in at work, and in the case of going through the audits they would have to go through at least two quarterly audits to become familiar with the process, the Audit KPI Tool, and how they can succeed.
- **Lack of Automation:** During and after the audits, it takes time to manually collect, sort, and analyze the data from a large number of files and make sure all related items are documented properly and updated regularly.
- **Data integrity:** To assess the situation before the implementation of the Audit KPI Tool, we had to rely on (valid) audit reports from 2015-Q2 to 2016-Q1 and consider the four quarterly audits as our references. It is difficult to judge if projects were doing well before that time because data was not readily available.

5.3 Future Developments

- **Automating the Auditing Process and the Audit KPI Tool:** There is a need to implement portals that not only records data (during or after the audits) but also performs the necessary analysis and provides an evaluation report using dashboards.
- **Develop a Generic KPI Dashboard to include Audit Results:** Potential KPIs that are being studied for the future:
 - Submitting deliverables on time e.g. actual v/s planned time
 - Reducing rework in order to reduce cost
 - Increase rate of first-time approval from clients

5.4 Closure

There is always room for improvement and any major improvement should be regarded as a Work-In-Progress so that further developments can be encouraged. These developments could then act as catalysts to encourage even more developments. We have to refrain from remaining stationary in an industry that is constantly changing.

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