Improvement of Work Inspection First Pass Yield (FPY)

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Abstract *— The First Pass Yield is useful metric to determine the percentages of process that pass through a process without defects. For an aerospace industry that provide engineering services in the area of system and software, having a lower FPY represents an increase of rework time which will result on an increment of delivery time and client cost. This paper shows the application of Six-Sigma DMAIC methodology with the purpose of improving the First Pass Yield of the work inspections from a 70% to a 80% or greater.*

In order to improve the work inspection FPY, the root causes of product defects were identified and categorized. It was found that there were defects that can be prevented with corrective actions. Three preventive plans were implemented, resulting in an effective result, which improve the First Pass Yield percentages from 70% to a 92%. As a result of improving the FPY percentages, the rework time and client cost were reduced and an improvement of delivery time was noticed.

Key Terms *— Corrective Actions; Defects Preventions; DMAIC Six Sigma; Improving Product Quality; Root Cause.*

INTRODUCTION

As part of the Aerospace Industry that provides engineering services to aircraft engines, the quality deliveries and client requirements are a critical part of the process. Due to the importance of this subject, the company requires that all products should pass through an inspection process before being delivered to the client. The data of this inspection is recorded through a Work Inspection Tool (WIT), which is based on key questions that will finally lead to review the work requested by the client.

The First Pass Yield (FPY) is a metric that provides the percentage of products that pass through a process without defects. As a result of improving the FPY percentages, it will minimize the rework time, which will result in an improvement of delivery time and reduction on client cost.

This paper presents the application of Six-Sigma DMAIC methodology with the aim of improving the team First Pass Yield from a 70% to a 80% or greater of the work inspections.

LITERATURE REVIEW

The First Pass Yield (FPY), also known as First Time Through, is a measure of the number of products that are delivered correctly the first time they come through the implementation process. Today for many organizations the improvement of quality in different processes and products has become an important business. Development and implementation of an effective quality strategy is a critical factor in long-term business success [1].

How important is for companies to eliminate defects and improve the FPY?

A high First Pass Yield (FPY) is achieved by identifying the root causes of quality issues that are then quickly rectified at the source. Optimized processes must then be controlled so that the high FPY is maintained. Every percentage point of improvement in FPY represents a substantial reduction in process costs and also a reduction on rework.

Six-Sigma is one of the most powerful strategies used in companies to improve quality and capability in processes, by reducing systematically the process variation which can result in unwanted defect rates and customer dissatisfaction. By eliminating or minimizing the defects during the process, the rework will be minimized once the product is release. Also, the software development cycle will be reduced. The benefit obtained by improving the First Pass Yield of a process will also benefit the customer perception, which is important in business success [1].

How can defects be prevented?

The most common and frequent defects in software design documentation are in the phase of requirements and design, which are the more severe and difficult to remove. The key is to prevent defects in early stage of the process, such as the development stage. The earlier diagnosed the easier and cheaper is the rectification of the defect. The end result in prevention or early detection is a product with zero or minimal defects. The vital process of the defect prevention methodology is to analyze defects to get their root causes, to determine a quick solution and preventive action. Also the self-review is one effective way to uncover defects and increase the quality of the product [2].

Current practices of software quality control are mostly reactive and consist of after the fact inspection activities. These inspection activities are effective. The major benefit of the result of this activity is the detection of defects before it is passed to the customer. Once the defect is produced, the damage is already done and it increases costs of inspection, and rework is passed to the customer. To prevent these situations, six sigma methodologies is a good approach to encourage software developers to be proactive [3].

To prevent defects, it is important to make an extensive data collection, and a good organization of the data collected. This will help in seeing more clearly the problems that can be causing defects in a process [1]. Data must be sorted and categorized to identify trends that would indicate repetition of a possible fault process [4].

Which techniques can be used for the product to pass at first (FPY)?

The defect prevention mechanism should be evaluated when trying to improve the FPY. This mechanism is a framework and ongoing process of collecting defect data, doing root cause analysis, determining and implementing corrective actions and sharing the lessons learned to avoid future defects [2].

The root cause analysis of a defect is driven by three key principles: reduce defects and improve quality, apply local expertise, and target systematic errors. Root cause analysis is the process of finding and eliminating the cause, which would prevent the problem from recurring [2]-[6].

The Six Sigma program promotes being proactive rather than reactive. The actual methods most software developers used is the software development process (SDP), that consist of six steps: Planning, Requirement Analysis, Design, Coding, Testing and Maintenance. By integrating Six-Sigma to the SDP it is obtained the Design for Six Sigma (DFSS). The basic steps for DFSS are: Define, Measure, Analyze, Design, and Verify [3].

The cause and effect diagrams (also known as the Fishbone diagram) can also be used to validate the root causes determined during the process [1]. It consists in a graphical representation that allows the finding of the root causes of defects. It provides the ability to analyze the root causes of factors that occur in many different aspects of the process. This will facilitate the find of solutions and also provide a clear way to understand it.

ANALYSIS APPROACH

The Six-Sigma DMAIC methodology is the strategy approach used. This section present the application of DMAIC methodology, highlighting the five phases of the methodology and the key tools employed within the problem solving.

Define Phase

Currently, the department work inspection First Pass Yield (FPY) is 70%. As a result of having a lower FPY percent, it represents an increase of rework time which will result on an increment of delivery time and client cost. However, having a higher FPY will result in an inverse effect, which will benefit the company and also the client. The goal of this project is to improve the FPY from a 70% to an 80% or greater.

Measurement Phase

Historical data was captured from the Work Inspection Tool (WIT). The collected data is for products that went through the work inspection process in the 2014 and the first quarter of 2015. Figure 1 shows the behavior of the FPY percent for the collected data, which FPY average is 72.6%.

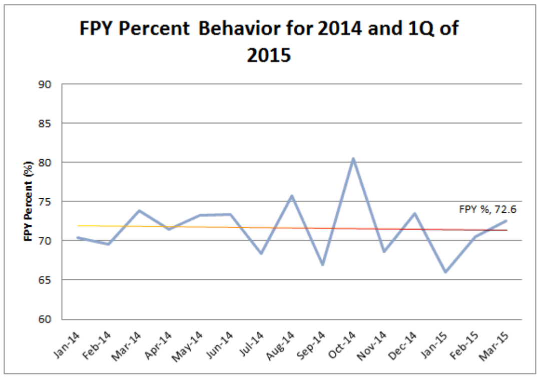

Figure 1
FPY Percent Behavior for 2014 and 1Q of 2015

Analysis Phase

A total 1942 products inspection were performed during 2014 and 1Q of 2015. There were a total of 539 products that didn't pass the inspection at first. As shown in Figure 2, the products defects represent a total of 28% of all performed inspections.

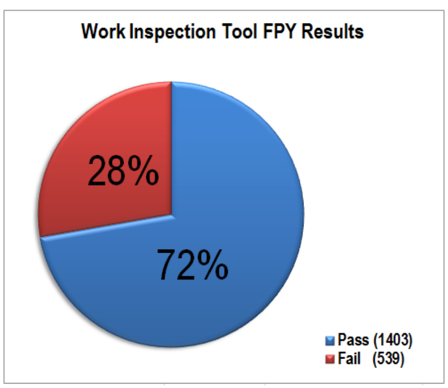

Figure 2
Work Inspection Tool FPY Results

The products that fail to pass inspection were classified in two major categories: defects that cannot be prevented, since depends on the designer knowledge and not in the process, and defects that can be prevented by an implementation of some type of tool or a change in the process.

As shown in Figure 3, the products containing defects that can be prevented represent a total of 68% of all products that fail inspection, while the product containing defect that cannot be prevented represent a total of 32% of defected inspections.

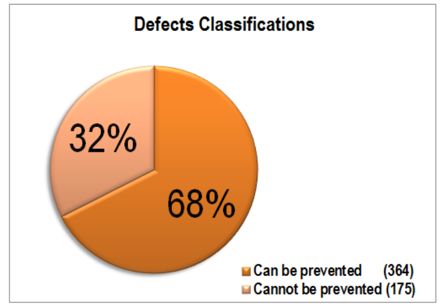

Figure 3
Defects Classifications

For purposes of this project, the defects that cannot be prevented won't be addressed, given the limitation of time. However, a recommendation to reduce this type of defects is to provide trainings with the purpose of increasing the designer's technical knowledge.

In the case of defects that can be prevented, a root cause analysis was performed. The cause and effect diagram tool was used for this analysis. Figure 4 shows the output of the cause and effect analysis. A summary of defect cause and the represented percent in the FPY is shown in Table 1.

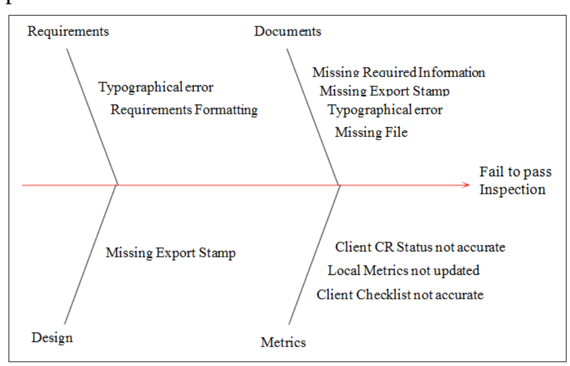

Figure 4
Cause and effect diagram

Table 1
Defects Root Cause

Root Cause for Design	*Defect freq.*	*FPY %*

Missing Export Stamp	19	0.98%
Root Cause for Requirements	***Defect freq.***	***FPY %***
Requirements Formatting	67	3.45%
Typographical error	44	2.27%
Root Cause for Metrics	***Defect freq.***	***FPY %***
Client CR Status not accurate	35	1.80%
Local Metrics not updated	48	2.47%
Client Checklist	27	1.39%
Root Cause for Documentation	***Defect freq.***	***FPY %***
Missing Export Stamp	37	1.91%
Typographical error	13	0.67%
Missing required information	13	0.67%
Missing File	61	3.14%

Improve Phase

In order to improve the work inspection First Pass Yield, a prevention plan was identified for each of the root cause defect identified in the analysis phase. Table 2 presents the list of the root cause defect and their prevention plan.

Table 2
Defects Prevention

Root Cause for Design	***Defect Prevention***
Missing Export Stamp	Run pre-inspection software to validate designs documents export stamp
Root Cause for Requirements	***Defect Prevention***
Requirements Formatting	Create Requirements Templates (Standardize Requirement)
Typographical error	Integrate spelling checker to requirement software.
Root Cause for Metrics	***Defect Prevention***
Client CR Status not accurate	Run pre-inspection software to validate CR Status
Local Metrics not updated	Run pre-inspection software to validate local metric
Client Checklist	Run pre-inspection software to validate client checklist
Root Cause for Documentation	***Defect Prevention***
Missing Export Stamp	Run pre-inspection to validate Export Stamp.
Typographical error	Integrate spelling checker.
Missing required information	Run pre-inspection software to validate required fields.
Missing File	Run pre-inspection to validate required files

As part of the strategy to improve FPY, this project has implemented three (3) preventive plans. These plans are as follow:

- **Pre-inspection software** – This software shall prevent an agglomeration of minor's defects, by validating that defects are not present in the product. The sum of these defects represents a total of 12.36% of the FPY.
- **Requirements Formatting Templates –** requirements templates were created in order to standardize the formatting and prevent this type of defects. The requirements defect is the major offender which represents 3.45% of the FPY.
- **Typographical Validation –** spelling checkers were activate/added in tools. This type of defects represents a total of 3.45%.

Training about the improved methods was provided to the team staff working with the process.

Compilation of Results

Control Phase

After the implementation of corrective actions, the metric of FPY for the first two weeks of May 2015 was obtained from the works inspection tool. A total of 178 products were inspected in which 14 fail to pass the inspection.

Root cause analysis on the products containing defects shows that these defects are categorized as defects that cannot be prevented, since depends on the designer knowledge and not in the process. However, defects addressed on the prevention plans were not found on products inspected, which can be observed the efficiency of the process improvement.

Discussion

This project was implemented with the objective of improving the First Pass Yield (FPY) of work inspections from 70% to 80% or greater. In order to achieve this objective, the Six-Sigma DMAIC methodology was followed and corrective actions were identified.

After the implementation of corrective actions, the data of the work inspection tool was obtained for a period of two weeks. The FPY percentage obtained from the inspection tools shows an improvement of the FPY from a 70% to 92%. The obtained FPY achieved the project objective.

CONCLUSION

The First Pass Yield (FPY) is a useful metric in which indicate the behavior of products that pass through a process without defects. Having a lower FPY can be translate in an increase of rework time which will result on an increment of delivery time and client cost.

This project was implemented for an aerospace company, dedicated on providing services in software and system, with the aim of improving the First Pass Yield (FPY) of work inspections from 70% to 80% or greater.

Six-Sigma DMAIC methodology was followed in order to analyze and improve FPY. It was found that some defects can be controlled with corrective actions. After the implementation of these corrective actions data was obtained from the work inspection tool showing an improvement of the FPY to a 92%. The obtained results demonstrate the efficiency of the process improvement, which succeeded the project objective.

It is recommended the continue monitoring of the process, since it can be identified new opportunities of improvements.

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