Improvement to the quality of software products delivered to the client: Code and documentation

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ABSTRACT

Elimination of product defects is critical in order to provide quality products to the client. A peer review process and preventive actions were implemented in a software development department; with the objective to reduce the defects by at least 20% in the products delivered (code and documentation). Historical data about defects was collected. The defects were analyzed, classified; their root causes were identified and preventive actions were implemented. It was found that the implementation of the peer review process alone, reduced the quantity of defects in about 23%, and the implementation of preventive actions combined with the peer review, reduced the defects occurrence in about 40%. It can be concluded that the implementation of a peer review process and the effective identification and implementation of preventive actions can reduce the quantity of defects significantly.

INTRODUCTION

One of the main objectives of a software engineering (aerospace) company is to provide quality products that fully comply with the requirements of the client. To accomplish this, the company needs to deliver software code and documentation free of defects to the different clients (internal or external). The department, in which the project will be implemented, lacks of an internal peer review process and some important defects preventive procedures (see Figure 1).

OBJECTIVE

The objective of the project is to reduce the quantity of defects (from previous months) in products delivered to the client, for at least 20%, in a specific department of the company. This is expected to be achieved by implementing a peer review process and using tools from the six sigma methodology to identify preventive actions that can be applied to the process (see Figure 1).
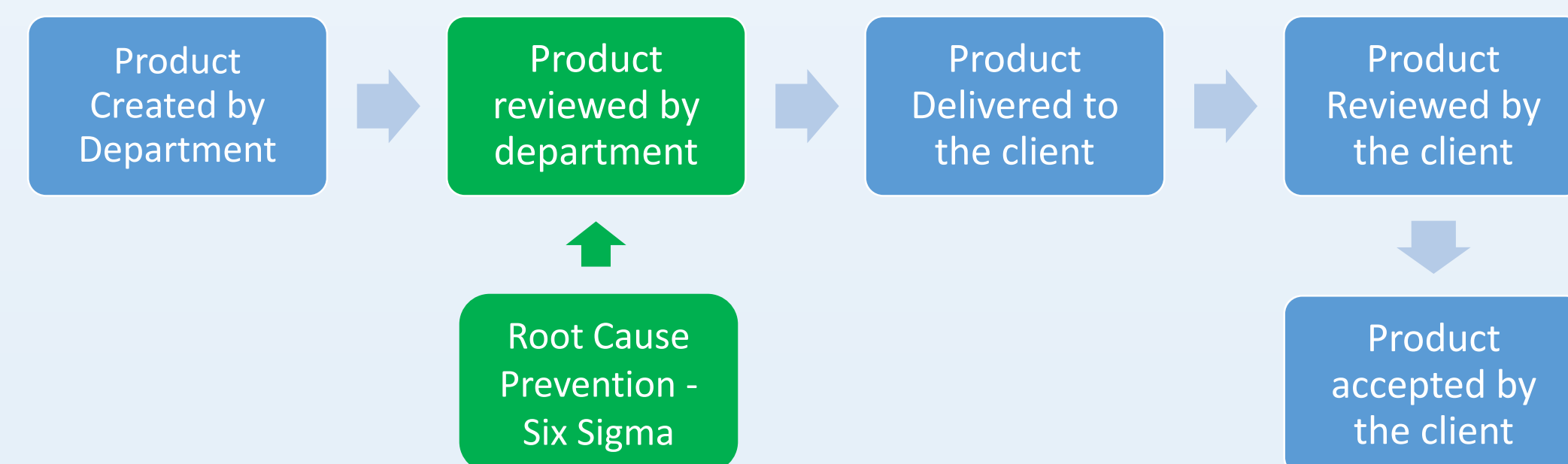

Figure 1
Current Process (blue squares) and New Implemented Process (green squares)

ACTIVITIES

Peer Review Process Implementation
During the second week of March 2015, the department implemented an internal peer review process. This was done because the department is relatively new (less than one year) and it lacks of some processes that can contribute positively to the quality of the products delivered to the client.

Historical Data Collection
Defects data from the months of November 2014 to February 2015 was collected (see Table 1). A P-Chart, created from that data, is shown in Figure 2. As noticed in the P-Chart, the average proportion of defects, for those four months, was calculated to be about 0.2879, which means that about 28.79% of the artifacts (lines of code and pages of documentation) delivered to the client contain defects.

Table 1
Collected Data November 2014 to February 2015

Date	# Artifacts	Defects	Proportion	Date	# Artifacts	Defects	Proportion
Nov 1st	551	177	0.32	Jan 1st	508	135	0.27
Nov 2nd	507	140	0.28	Jan 2nd	389	92	0.24
Dec 1st	302	108	0.36	Feb 1st	558	149	0.27
Dec 2nd	318	98	0.31	Feb 2nd	493	145	0.29

Defects Classification and Analysis
The collected defects from the previous four months were analyzed and classified. Based on the literature review and with the feedback of the leads and managers from the department, the defects classification from Table 2 was used.

Using the classification of Table 2, a Pareto chart was developed in order to determine the major offender (defects that occurs more), see Figure 3.

Table 2
Data collected (March and 1ˢᵗ two weeks of April)

Functional	Cosmetic	Escape
Incomplete	Misplaced	
Incorrect	Duplicated	
Inconsistent	Typo	Defects from other phase
Ambiguous	Not Relevant	

As can be noticed in the Pareto chart, the quantity of the functional defects is 585 (56%), meaning that the functional defects are the major offender.
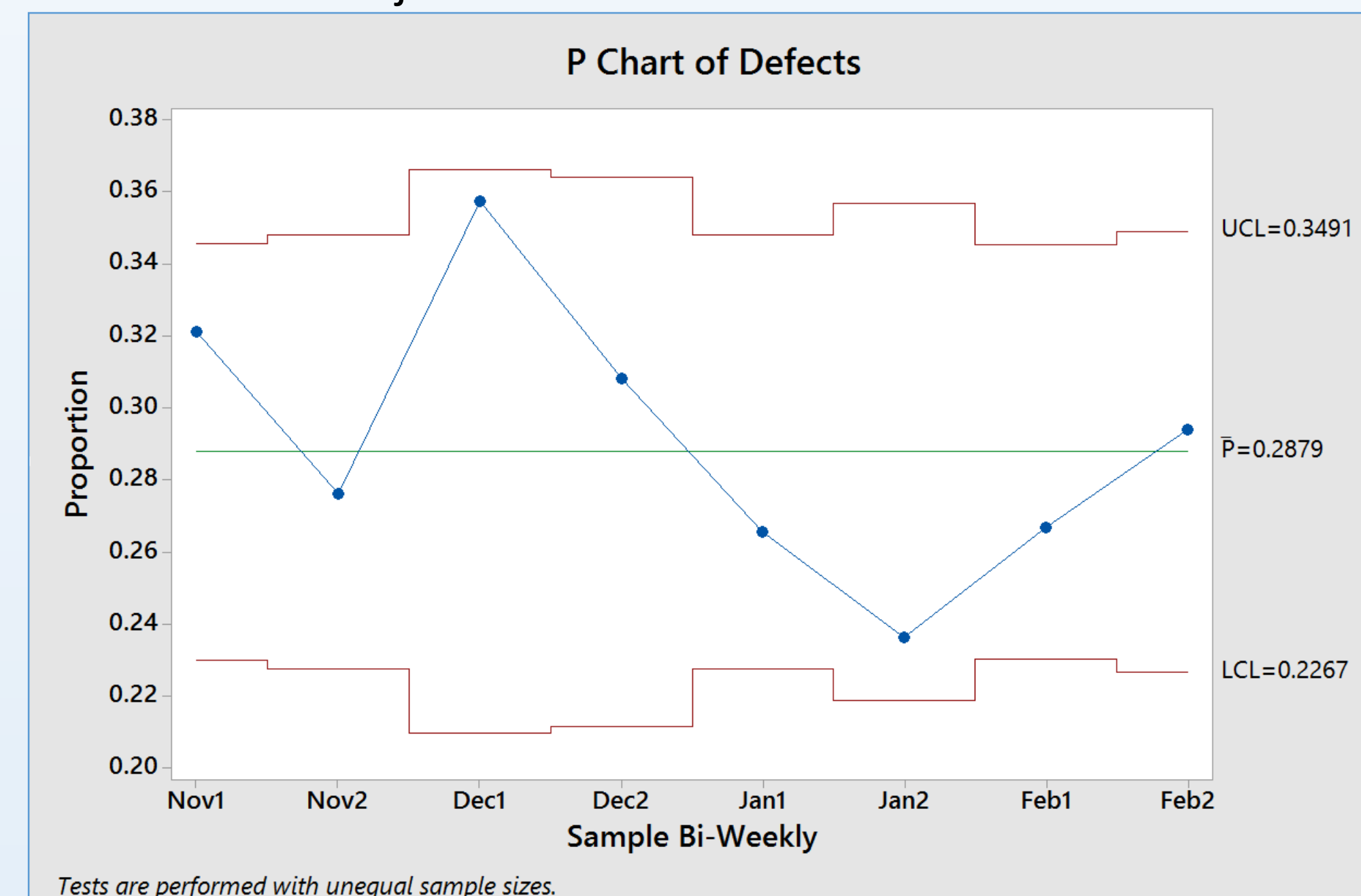

Figure 2
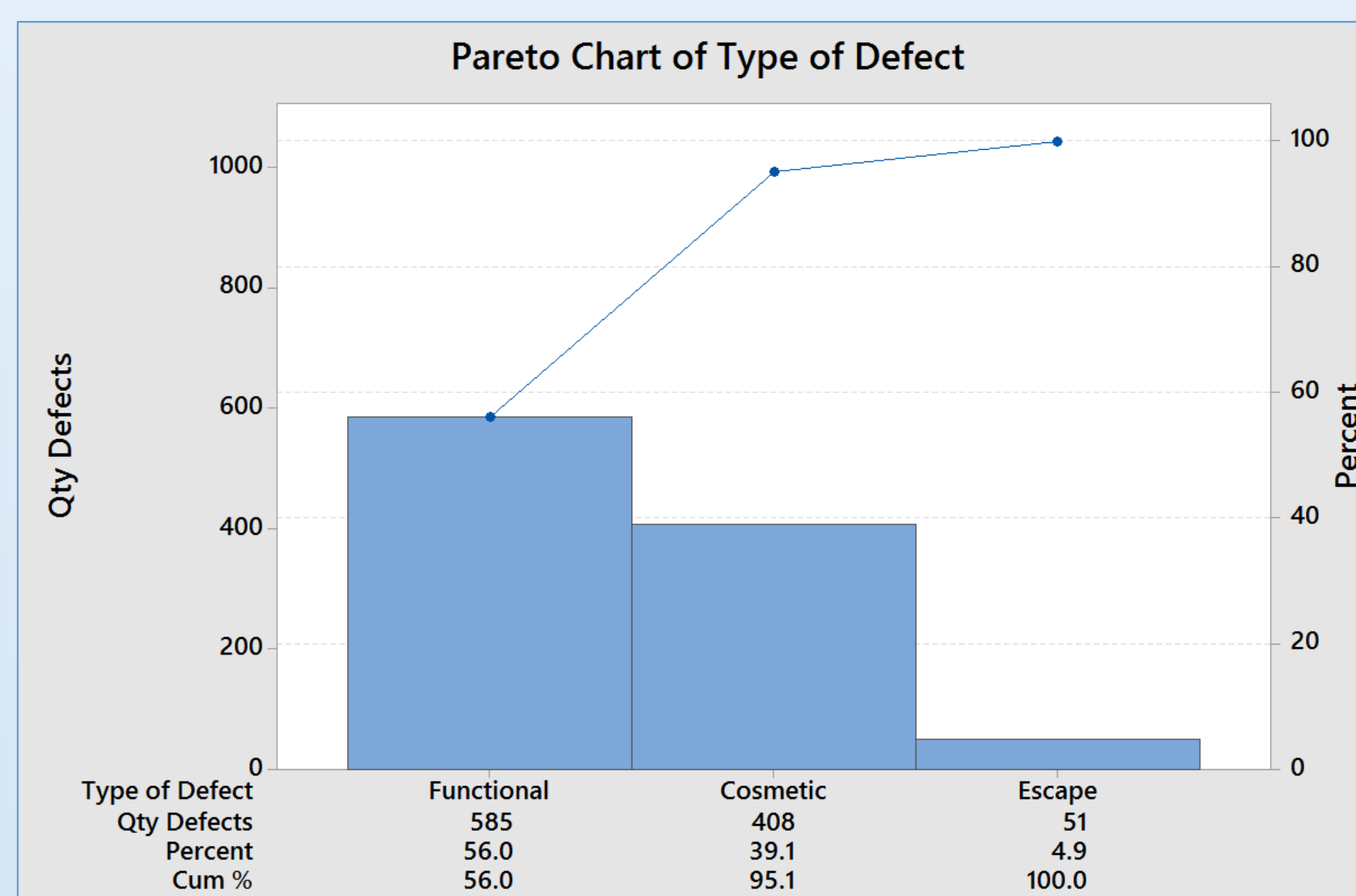**P-Chart of defects (Pre project implementation)**

Figure 3
Pareto Chart of Types of Defects

Root Causes Determination
The major offender, found the previous activity, was analyzed using the six sigma tool of cause and effect, and the "5 why's" technique, in order to find the root cause(s) of it. A summary of that analysis can be found in the first and second column of the Table 3.

RESULTS AND ANALYSIS

Collected Data (After Implementation of Project Activities)
Data was collected for the last two weeks of March 2015 and the first two weeks of April 2015. During those dates the implementation of the peer review process was in place, but not the implementation of the identified preventive actions. Also data for the first two weeks of March 2015 was collected (that data doesn't include the peer review process). All this data is contained in the Table 3.

Table 3
Data collected (March and 1ˢᵗ two weeks of April)

Date	Artifacts Qty.	Defects Qty.	Proportion	Functional Defects	Cosmetic Defects	Escape Defects
March 1ˢᵗ – 2ⁿᵈ Wk.	575	155	0.27	80 (52%)	65 (42%)	10 (6%)
March 3ʳᵈ – 4ᵗʰ Wk.	512	101	0.20	60 (59%)	23 (23%)	18 (18%)
April 1ˢᵗ – 2ⁿᵈ Wk.	468	107	0.23	76 (71%)	26 (24%)	5 (5%)

The collected data, for the last two weeks of March and the first two weeks of April, shows that the proportion of defects was reduced, from 0.28 (see Figure 2), to an average of 0.22. Also it can be noticed that there is a significant reduction in the quantity of cosmetic defects from 39.1% (see Figure 3) to about 24%.

Also data was collected for the last two weeks of April 2015 and for the first week of May 2015. During those dates the implementation of the peer review process and the implementation of the identified preventive actions were in place. This collected data is shown in the Table 4.

Table 4
Data collected (3ʳᵈ and 4ᵗʰ wk. of April and 1ˢᵗ wk. of May)

Date	Artifacts Qty.	Defects Qty.	Proportion	Functional Defects	Cosmetic Defects	Escape Defects
April 3ʳᵈ – 4ᵗʰ Wk.	497	85	0.17	59 (69%)	22 (26%)	4 (5%)
May 1ˢᵗ Wk.	230	40	0.17	28 (70%)	10 (25%)	2 (5%)

Table 3
Root Causes and Preventive Actions for Functional Defects

Sub Type	Root Cause		Preventive Actions	
Incomplete	• Requirements not available • Requirement from client ambiguous • Incorrect use of development tools	• Lack of time • Lack of experience • Document outdated	• Periodic meetings with the client • Training to the developers • Use of version tracking system • Identify experienced reviewers	
Inconsistent	• Wrong source of data • Requirement ambiguous	• Different developers • Lack of experience	• Training to the developers • Resource utilization planning	• Create templates
Incorrect	• No standardization of requirements • Not enough information from client	• Requirement ambiguous • Lack of system knowledge • Developer without experience	• Create templates for requirements. • Training to the developers • Periodic meetings with the client • Identify experienced reviewers	
Ambiguous or Unclear	• No standardization • Different developers	• Lack of experience	• Create templates • Training to the developers	• Resource utilization planning

As can be seen in Table 4 the proportion of defects was reduced even more (to 0.17). It can be noticed that the quantity of cosmetic defects remain nearly the same as in the Table 3, meaning that the reduction of defects was due mostly because of the reduction of functional defects.

With the collected data of Table 3 and 4, a new P-Chart (see Figure 3) was generated which also takes in account the previous data (without the implemented project actions). The phases in the P-Chart are denoted as Pre, which contains the data before the implementation of the project, Post (PR Only), which includes the data with the implementation of the peer review process only, and Post (PR and PA), which includes the data with the peer review process and the preventive actions implemented.
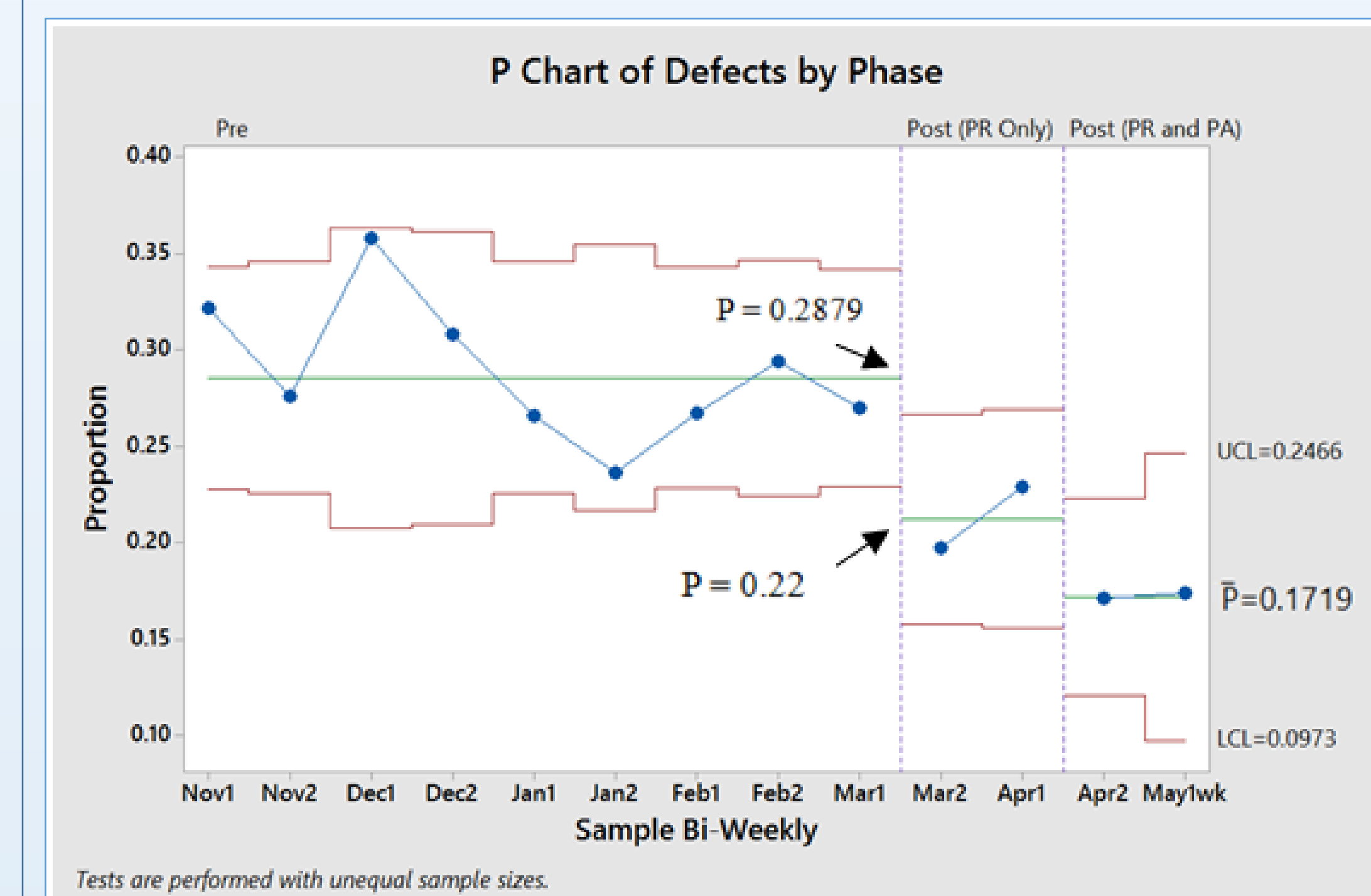

Figure 4
P-Chart of defects (All phases)

It can be seen that in each of the different phases of the project, a reduction in the proportion of defects was obtained. In the pre-project phase the proportion of defects was about 0.2879, then in the next phase, Post (PR Only), it was reduced to about 0.22 and the final phase, Post (PR and PA), the proportion was reduced to about 0.1719.

CONCLUSION

A reduction of about 23% (0.2879 vs. 0.22) in the quantity of defects, in the products delivered to the client after the implementation of the peer review process in the department, was achieved. This result is due mostly because the significant reduction of cosmetic defects. Also, an overall reduction of about 40% (0.2879 vs. 0.1719) in the quantity of defects was achieved. This result is mostly because of a significant reduction of functional defects with the implementation of the preventive actions. It can be concluded that the objectives of the project, of implementing an internal peer review and to reduce the quantity of defects in at least 20%, were achieved.

A variety of root causes were discovered during the project, which can be cataloged as an essential information that can be used for the continuous improvement of the quality of the products in the department.

FUTURE WORK

The other root causes, for which no preventive actions were established, needs to be analyzed in the near future by the department in order to continue with the reduction of defects that are delivered to the clients.