Kaizen Cookbook: The Success Recipe for Continuous Learning and Improvements

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Abstract

In recent years, there has been significant attention paid to the application of Lean thinking to software-centric organizations. However, there is noticeable challenges accompanying the use of it. Even when applied properly, sustaining the realized benefits becomes challenging. There is a need to have a sustainable and continuous improvement method that is embedded into the daily operations of the development process. We provide a summary of our experience on how Kaizen has helped in improving a software development team's productivity by more than 20%, enhanced the responsiveness of the team by more than 62%, increased the overall customer satisfaction by more than 17%, and is still improving!

1. Introduction

Maintaining a competitive advantage in an increasingly ruthless software development business environment requires more than just acquiring the latest technologies, advanced development tools, and competent engineers. For decades now, software development organizations have been exploring ways to advance quality, productivity, and predictability of their development and maintenance efforts.

Software development teams need to have the capability to periodically conduct self-analysis and explore ways to continuously learn how to improve their development processes [12]. A case study is presented to demonstrate the validity and value of the application of Kaizen as an overarching model for continuous learning and improvements.

This research study resulted from the need of the organization under study to sustain the benefits that it has realized from implementing the fundamental Lean principle, “Eliminating Waste”. The organization needed a simple, yet a powerful approach to realize continuous improvements.

In order to introduce Kaizen successfully to software-centric organizations, Kaizen should not be executed as a series of short events with start and end dates. In fact, Kaizen should be integrated into the organization culture and becomes a habit embedded within the daily operations for software development teams.

Over more than 18 months of using the proposed Kaizen model, the research partner organization has achieved noticeable and steady improvements. The results have shown statistically significant correlations between organization learning and both, team productivity and customer satisfaction. The major contributions of this report can be summarized as follows:

• This study attempts to offer a first step to define the Kaizen philosophy in software development organizations;
• It empirically provides a narrative of "how" different tools and techniques can be used to design and measure a working Kaizen model;
• To the best of our knowledge, it is the first study that discusses the application strategy of Kaizen through double-loop learning, reflective practices, 5 Whys, and self-determined standards to sustain continuous learning and the benefits of Lean initiatives.

This paper is organized as follows. Section 2 discusses the problem statement and the subsequent research questions. Section 3 describes Kaizen as a comprehensive model as well as its elements (methods, techniques, and tools). Section 4 is the case study, it provides a description of the research study, context, scope, and methodology; it also provides an insight into how the model was designed and measured. In addition, it discusses the discovered results. Section 5 describes the related work on Kaizen in different industries. Section 6 provides an insight into validity threats, while Section 7 provides conclusions and recommendations from this study.
2. Problem Statement

The House of Lean [11], the visual representation of the Lean principles, practices, concepts, and tools, illustrates the required foundation for Lean to be successfully implemented. Figure 1 represents the very basic form of the Lean house, it is obvious that to realize the ultimate goal of Lean, delivering “value to customers”, the two main pillars of Lean: Just-in-time (JIT) and Jidoka must be built on top of a strong foundation, stability and standardization, which can be better achieved through involving and developing the manpower within an organization.

Figure 1. The Lean House

Lean related principles and practices to software development, however, are relatively new and their applications to software-centric organizations are yet to be established [1][27][29]. The focus of this research is on the core principles of the foundational base of the Lean house, Kaizen and standards.

Kaizen and standards are important; however, like the other Lean principles, no pure definitions are available in the literature [1][24]. Albeit the majority of the Lean proponents agree on the importance and criticality of Kaizen, there is a major ignorance to the term in the influential books and publications that are concerned with the application of Lean to software development; for example, Poppendieck and Poppendieck [22] and Shah and Ward [24].

The available literature on the application of Lean to knowledge-based industries, in general, has not gone beyond defining Kaizen as Lean’s terminology for continuous improvement, evidence can be found in Wang et al. [29]. Hence, the research investigators started reviewing the original Lean essence from the manufacturing perspective to have an in-depth understanding of the Kaizen principles. One major risk associated with reviewing Lean principles from a manufacturing perspective is:

“...when imitating proven techniques from other disciplines to software development, the problems most likely arose because of imitating the practices (context-specific) rather than the principles” [1, pp. 2022]

Transferring Kaizen from the manufacturing industry to the software-centric organizations is not a straightforward process; it is complex and requires the reinvention and the reinterpretation of practices in the new context. Hence, the primary research questions have been formulated as:
1. What does Kaizen mean to software organizations?
2. What are the main Kaizen principles and concepts?
3. What are the workable practices to realize these principles and concepts in the software development context?

3. Kaizen Philosophy

Kaizen has been defined by the majority of researchers as “change for better”, the literal translation of the Japanese term (Kai: change, and zen: better). However, Kaizen from the manufacturing perspective goes far beyond the literal translation. Kaizen, as a comprehensive thinking philosophy, is a binding agent for many other techniques, methods, and tools that empower employees and encourage them to continuously re-think the way they do their jobs in a more efficient and effective manner [20].

3.1 Literature Review: What is Kaizen?

A review of the most cited literature on Kaizen has unveiled that, yet after more than three decades of existence and continuous development, Kaizen in the manufacturing industry itself has not been well established, and it lacks a clear definition of what it means and what it entails. The review of the literature, however, revealed three of the most frequently cited research studies [6][20][25]. The latter is a literature review on Kaizen philosophy.

Berger [6], based upon the book of Imai [20], attempted to define Kaizen and all that pertains to it as a holistic approach. Berger [6] also attempted to outline the reasons behind why the adoption of Kaizen in North America and Europe has not been as successful as it has been in Japan. The investigators have extracted and synthesised the characteristics of Kaizen from Imai [20] and Berger [6]. The list below summarizes the key findings on Kaizen’s main characteristics:

• Kaizen offers an incremental approach, for small improvements;
• Kaizen is process and people oriented rather than results-oriented;
• Kaizen suggests to solve problems as they arise;
• Kaizen improves not only the process or work standards, but also the organization as a whole;
• Kaizen is characterized as a self-discipline approach;
• Kaizen promotes learning by doing, organization learning, and shared mental knowledge;
• Kaizen needs standards to serve as baselines and targets to measure the realized improvements;
• Kaizen activities can be implemented on either the individual level, or the organizational level;
• Kaizen promotes questioning the work procedures;
• Kaizen is developed on a suggestion-based approach;
• Kaizen should be embedded as a work habit.

Recognizing Kaizen as an embedded habit within the organization’s culture rather than a small project with start and end dates can develop a very dynamic and changing environment. Based upon this theory, the research investigators attempted to establish a comprehensive Kaizen model that consists of methods and techniques to support realizing each of the abovementioned characteristics. Based upon feedback, from the research participants, the proposed Kaizen model went through several iterations of development and refinement.

The proposed model, as depicted in Figure 2, is composed of four elements: 1) Reflective practice, which represents the method to learn from previous experiences to improve the current and the future course of actions; 2) double-loop learning as an approach to challenge and ultimately change the underlying organizational culture; 3) The analysis technique, which is used to identify the root-causes of the problems; and 4) Policies and Standards, which are intended to serve as the baseline to measure future improvements and to promote self-discipline.

In order for Kaizen to be successful, software development teams need to have the capability to periodically conduct self-analysis and explore ways to continuously learn how to improve their development processes [12]. This results in promoting learning and ultimately leads to establishing a learning organization. Dybå as cited in Dingsoyr [12, pp. 294] defines a learning organization and suggests that an organization has to “promote improved actions through better knowledge and understanding”.

3.2 Double-loop Learning

Schon and Argyris [2] recognize single-loop and double-loop learnings as mechanisms to provide the capacity to change and question the primary beliefs and values of action. Single-loop, on one hand, the most basic form of learning, results in changes in the behaviors and actions that an individual carries out within a system. On the other hand, double-loop learning is referred to as reframing [26], which is recognized for questioning the function and purpose of the type of work that is carried out in an organization [3].

Double-loop learning proposes that people should be reflective on whether certain rules need to be altered after applying the appropriate correction action to a detected deviation [4]. Double-loop learning requires an individual to deeply consider the reason why a problem exists [18]; it demands an individual to not only identifies the problem, but also finds the underlying reason for occurrence. When a problem is detected, the primitive reaction is to solve the problem by finding an action strategy that would work within the governing values and beliefs. Double-loop learning occurs when the action is observed and the underlying assumptions of the values and beliefs are questioned [3][4].

![Figure 2. The Proposed Kaizen Model](image-url)
3.3 Reflective Practice

Double-loop learning can be realized through accessing the organization memory, which was defined by Croasdell et al. [9, pp. 3] as:

The means by which knowledge from the past is brought to bear on present activities resulting in higher or lower levels of organizational effectiveness.

Reflecting on past experiences can be achieved by employing reflective practices [5]; these practices are divided into two main methods:

I) Reflection-in-action is applied to facilitate immediate improvements to the current course of action as it is happening; it is done instinctively, while drawing on previous experiences;

II) Reflection-on-action is used to facilitate the achievement of future learning and improvement objectives by reflecting on previous experiences to avoid pitfalls and to incorporate successes in the future course of actions.

3.4 The Analysis Technique - 5 Whys

In order for the improvements to be achieved by preventing problems from reoccurring again, the root cause of the problem should be identified. The 5 Whys is a root-cause analysis technique [7] that was devised by Toyota during the evolution of the Lean production system. It is commonly used in lean enterprises, as it provides a factual-based approach to identify the causal link between the problems and their root causes [21]. It also gives the ability to question the course of action while it is being implemented, which realizes the objectives of reflection-in-action.

The following is a real-life example that was used to identify the main reasons behind not following the standards in the organization under study:

1) Why the standards were not followed? Because the standards were not documented.
2) Why were the standards not documented? Because of the resistance to document them.
3) Why there was resistance? Because the engineers were not aware of the standards importance.
4) Why were not the engineers aware of the importance of standards? Because there was a lack of communicating the benefits of standards.
5) Why was there a lack of communicating the importance and benefits of standards? Because it was assumed that developers were aware of these benefits!

This example revealed two root-causes, the first was a lack of communication, and the second was an invalid assumption that there was adequate awareness of the importance of standards to the organization.

3.5 Polices & Standards

Standards are more than just documented procedures on how to get the work done. Standards represent the best way an organization knows how the work should be accomplished at any given point of time [19]. Hence, the standards should be flexible enough to be altered once a better way is identified [30]. The main goal of work standards is to reduce variances and defects, which ultimately leads to a higher quality product or service [19].

Higher quality, however, cannot be achieved if the engineers were enforced to follow the standards without understanding the work itself, its nature, and objectives [19]. Therefore, work standards should consist of the goal of work, policies, pre and post conditions, and constraints on performing the work. However, the actual procedural level and steps on the “how-to” should be self-determined by the engineers themselves [10].

The self-determined standard serves as a base-line for future improvements [28]. For example, consider there is an agreed upon self-determined timeframe for task handling, once an engineer finds a better approach for task handling and documents it to be a new self-determined standard, the time difference between the old approach and the new one is the realized improvements. In addition, self-determined standards, when documented properly, contribute to the organizational memory, and hence enable learning as part of the reflective practices.

4. Model Evolution and Evaluation

The evolution and evaluation of the proposed model have been carried out through a real-life case study. This case study seeks to demonstrate how the model has evolved and how its value was validated in a medium-sized IT organization. This research was inspired by the need of the IT organization to sustain the benefits that have been realized from applying the Lean’s fundamental principle “Eliminating Waste”; for more details, see Al-Baik and Miller [1].

The organization under study and the research group agreed to keep the identity of the organization anonymous. Hence, for the remainder of the paper, we will refer to the organization by the arbitrary name ORGUS. ORGUS is an internal medium-sized IT department that serves more than 35,000 end users. At the time of writing this report, ORGUS has over 300 staff, distributed over 24 teams, and an estimated annual budget of approximation $37 million. The full description of the 24 teams and the services offered by ORGUS was given in Al-Baik and Miller [1].
4.1 Research Scope

Despite the fact that the Kaizen model has been implemented and used by the vast majority of the groups in ORGUS, the scope of this study is limited to a software development group. The research project employed a core project team and a supporting team. The core team had eleven team members including the investigators. The supporting team was composed of ninety-three resources engaged throughout the project and participated in refining the Kaizen model. As the reported results of this study is limited to the software development group, the supporting team is considered to be composed of those twenty-five participants who were only involved when the Kaizen model was first devised and applied by the software development group.

4.2 Research Methodology

The Action research methodology was espoused during this study. In an attempt to increase the scientific rigor of this research, the investigators imposed the Cooperative Method Development approach by Dittrichet et al. [13]. The primary investigator has been working in ORGUS for more than 3 years; hence, he was considered a normal participant rather than an observing participant [15][23]. In order to better understand the staff behavior in ORGUS, ethnographic methods were employed during the different phases of the research cycle. As recommended by Dittrichet et al. [13], Action Research was implemented in three phases: 1) Understanding Practice (see 4.3), 2) Deliberate Improvements (see 4.4), and 3) Implement and Observe Improvements (see 4.5).

The Focus groups [7] approach was adopted to facilitate a number of workshops. The investigators were involved in more than 100 workshops, which varied from one to three hours. As the scope of this study is limited to the software development group, the number of workshops is considered to be the eight workshops that were conducted with the software development group. For each of these workshops, the goals and scope were communicated clearly and revised based upon input and feedback from the participants. The findings from the workshops were then shared with the participants for review and validation.

Each workshop started with an icebreaker event. For example, the first brainstorming workshop aimed at identifying the challenges that the group had in ORGUS, it started with an opposite question: “If you were given a chance to make your colleague’s life miserable at work, what kind of limitation would you impose on him?” then, a question was asked to find out what the limitations that the team actually had: “Which of these limitations do really exist in ORGUS?”

4.3 Analyse Practices to Discover Problems

The analysis of the current practices was conducted during the Understanding Practice phase. The investigators reviewed ORGUS’ policy booklet and other related documentation to gain a better understanding of ORGUS’ culture, assets, environment, employees’ actions and practices, and the context within which ORGUS operates.

ORGUS has paid close attention to the behavioral tendencies of its engineers, whom must undergo personal assessments that produce detailed behavior pattern analyses (sample report is available upon request) designed to improve productivity, teamwork, and communication.

Four three-hours brainstorming workshops were conducted with the software development group to analyse the current practices and procedures concerned with software development processes, including management processes. Based upon the analysis of ORGUS’ policies and the behavioral pattern analyses, it has been concluded that ORGUS had a set of defensive routines that inhibited both, learning and improvements. Defensive routines disempower the employees and encourage a defensive reasoning environment. A defensive routine is defined as:

any policy, practice, or action that prevents embarrassment or threat, but does so in ways that prevent discovery of the cause of the embarrassment or threat. An example is organizational mixed messages. ‘Mary, you are in charge, but check with Charles.’ 'Bill, be creative, but be careful.' [5, pp. 9]

ORGUS, for example, had a policy that prohibited direct communication between software development teams and external customers. Other policies imposed unnecessary approval steps. In addition, the pattern analysis reports revealed that about 70% of ORGUS’ engineers in the software development group have defensive reasoning characteristics [5, 23].

4.4 Kaizen Design and Measurements

The empirically-discovered practices were then encoded into a simple model to facilitate dissemination of the findings across the organization, leading to phase II: deliberate improvements. The model and focus groups [7] were then used to drive the design of: 1) the Kaizen model, and 2) measurements of the model effectiveness.
4.4.1 Designing Kaizen. The design approach itself followed the Kaizen principles (see 3.1). Specifically, the focus groups, through involving the employees, sought to achieve three objectives: 1) A first step towards empowering the employees by involving them in the decision making process. 2) Increase the sense of ownership and self-discipline, as employees are likely to buy-in to a model that they have established themselves (self-determined); and 3) Designing a working model that solves real-life problems by incorporating the inputs (suggestion-based) from the participants who have been actually implementing the procedures and were affected by the existing policies.

Likewise the brainstorming, the focus groups were facilitated through four three-hours workshops. The goals were to focus on discussing alternative solutions to one or more major problems that had been identified during phase I.

In order to be considered appropriate for use as an element of the proposed Kaizen model, each alternative (a technique, a method, or a tool) needed basically to satisfy the three following conditions: 1) Help realizing as many as possible of the previously specified Kaizen principles and concepts (see 3.1). 2) Easy to use by assessing the perceived appropriateness and quality of use by the team. 3) Fits-in and supports other elements of Kaizen.

It is worth mentioning that a higher weight was given to the tools and methods that ORGUS has invested-in and the employees were familiar with.

4.4.2 Measuring Kaizen Effectiveness. Despite the popularity of Kaizen, likewise its definition, there have been no clear criteria for measuring its effectiveness [17]. The proposed Kaizen model is composed of several elements, measuring each element of Kaizen by itself will result in focusing on a micro level of Kaizen, while the hypothesis is that measuring Kaizen effectiveness should in fact be at a macro level.

Measuring the effectiveness of Kaizen was more difficult than expected, this difficulty lies in the heart of Kaizen, as its main principle suggests, “Kaizen offers an incremental approach, for small improvements”; hence, each improvement by itself is likely to be unobtrusive.

The incremental improvements can, however, be accumulated over-time and seen as a dramatic change. This hypothesis, however, cannot be validated before running Kaizen for several months. The limitation was that the management in ORGUS needed assurance of the proposed model effectiveness prior the approval to proceed with using it. In response to these circumstances, the research investigators utilized two instruments to measure the model effectiveness:

1) Short-term measures, based upon the review of the available literature on Kaizen, the investigators found research studies [14][16][17] discussing a systematic, empirical-based constructed scale that has been adequately tested and validated in industrial settings to evaluate the effectiveness of Kaizen events. Kaizen events are defined as short-term improvement activities that target both, the business performance and the human resources knowledge, skills, and attitudes [16].

The brainstorming and focus group workshops in this research study have been deemed to fit under this definition. Hence, they were considered Kaizen events, and thus appropriate for being measured by the effectiveness model. If the results were significantly positive, they should provide the assurance required by the senior management in ORGUS.

2) Long-term measures, based around combining the previously stated two hypotheses, Kaizen as a holistic system can over-time introduce dramatic changes that continuously improve learning and team performance. The criteria to measure the Kaizen effectiveness have been formulated around these specific objectives: development cycle time, defect removal efficiency, statistical analysis of accumulated organization knowledge and learning, and finally the most important measure, customer satisfaction.

4.5 Kaizen Results and Perceived Benefits

In order to assess if improvements have been achieved from designing and using the proposed Kaizen model, the investigators collected data during both phases, phase II to provide an insight to the short-term results, and phase III to collect data on the overall long-term performance of the proposed Kaizen model.

The implementation of the Kaizen model has been incremental and gradual. In order to be sustainable, the model required to be part of the organization culture. The research investigators worked with the software development team to design and rollout a model that is embedded within the daily operations of ORGUS.

The workshops served as forums where the proposed Kaizen model has been gradually injected into the organization culture. The knowledge of ORGUS’ policies and work practices has helped in utilising them to derive a workable model.

For example, the daily operations of ORGUS are heavily dependent on its ticketing system. In order for a task to begin, a work-order must be created in the ticketing system and assigned to only one engineer at any given time. Once the task is completed, the work-order should be linked to a Knowledge Base Article (KBA) that describes how the task was fulfilled.
Figure 3 illustrates a process flowchart that starts when a problem is encountered and ends when a resolution is implemented and documented. KBAs can materialize the self-determined standards on how the work was accomplished. KBAs have also been used as a measurement factor of the model, where the newly created KBAs indicate accumulated organization knowledge, and updates to existing KBA s indicate the process of both, learning and improving existing standards.

Figure 3 also shows how the proposed practices support realizing the different characteristics, principles, and concepts of Kaizen (see 3.1). These practices were designed and agreed to be appropriate for use during the focus group workshops. These workshops also served as a platform to collect and analyse performance data that provided early assurance on the Kaizen events effectiveness.

Farris in [17] concluded that surveys are appropriate for studying Kaizen event effectiveness. Following Farris’ [16] model, on a six-point Likert-type scale, a Kick-Off survey was conducted at the beginning of the workshop, and a Report-Out survey was conducted at the end of the workshop. The scale is encoded as, 1 for “Strongly Disagree” and 6 for “Strongly Agree”. The surveys are intended to measure the following factors:

1) The group’s buy-in to the goal of the workshop by measuring the Goal Clarity (GCL), Goal Difficulty (GDF), and Affective Commitment to Change (ACC).
2) The appropriateness of the elements of the Kaizen model, which were measured by the perceived Appropriateness of Tool (APT), and Quality of Use (QOU).
3) The perceived benefits of the workshops in terms of facilitating the gains of Understanding of Continuous Improvement (UCI), Skills (SKL), Attitude (ATT), Impact on Work (IMW), and Overall Success (OAS).

The results are shown in Table 1. The groups’ buy-in factor was extracted from the Kick-Off survey, while the other two factors were extracted from the Report-Out survey. Responses 5 for “Agree” and 6 for “Strongly Agree” were grouped and aggregated to represent positive responses towards the related attribute. In order to be consistent, the scale for Goal Difficulty was reverse scored.

As shown in Table 1, the grouped frequency distribution (GFD) along with the frequency ratio were provided for each attribute as they have been deemed more appropriate to analyse Likert-type data.

<table>
<thead>
<tr>
<th>Table 1. Kaizen Events Effectiveness</th>
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<tr>
<td><strong>Factor</strong></td>
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<tr>
<td>Buy-in</td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Tool Appropriateness</td>
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<tr>
<td>Perceived Benefits</td>
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<td></td>
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<td>Overall</td>
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Research participants have been very committed to the change events with more than 90% perceptual positive responses to the “buy-in” factors. The participants have reached a perfect consensus of 100% on that new skills were acquired during the Kaizen.
events. The tools, methods, and techniques that compose the Kaizen model, have been deemed appropriate by more than 95% of the respondents.

Overall, the respondents’ perceptions with regard to the success of the Kaizen events have exceeded 95%. The reported results have been accepted as an adequate assurance of the Kaizen model effectiveness, and were deemed sufficient by senior management to warrant proceeding with using the proposed Kaizen model.

After using the model for over 18 months, the results have been showing steady improvements. Data have been collected and triangulated [15] from different sources using various techniques, including surveys for customer satisfaction and auto-generated reports produced by business intelligent software that is connected to the ORGUS’ ticketing system.

The auto-generated reports provided data with regard to the performance of the software development group based around established quality attributes as described below:
1) Development Cycle Time (DCT), the time elapsed from start to end to produce a feature or to fix a defect.
2) Defects Removal Efficiency (DRE), the ratio of the detected and fixed defects to the total defects during a specific project phase.
3) Percent Delinquent Fixes (PDF), the ratio of defects that exceeded the targeted response times to the total number of fixed defects during a specific timeframe.

Table 2 provides a summary of the reported results, over 18 months, from October 2013 to March 2015, inclusive. The data is aggregated to show the results per quarter. Table 2 shows the total number of New KBAs (NK) and the total number of Updated KBAs (UK) in each quarter, it also shows the averages of DCT in days, DRE, and PDF. Customer satisfaction (CS) has been gauged at the end of each quarter through a customer satisfaction survey with regard to their experiences with the software development group.

<table>
<thead>
<tr>
<th>Quarter</th>
<th>NK</th>
<th>UK</th>
<th>DCT</th>
<th>DRE</th>
<th>PDF</th>
<th>CS</th>
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<tr>
<td>Q4/13</td>
<td>170</td>
<td>2</td>
<td>14.33</td>
<td>68.33</td>
<td>23.00</td>
<td>76</td>
</tr>
<tr>
<td>Q1/14</td>
<td>520</td>
<td>120</td>
<td>12.00</td>
<td>70.00</td>
<td>21.67</td>
<td>81</td>
</tr>
<tr>
<td>Q2/14</td>
<td>844</td>
<td>437</td>
<td>16.33</td>
<td>67.67</td>
<td>25.00</td>
<td>79</td>
</tr>
<tr>
<td>Q3/14</td>
<td>764</td>
<td>947</td>
<td>8.33</td>
<td>74.00</td>
<td>20.00</td>
<td>84</td>
</tr>
<tr>
<td>Q4/14</td>
<td>564</td>
<td>1479</td>
<td>5.33</td>
<td>80.00</td>
<td>13.33</td>
<td>87</td>
</tr>
<tr>
<td>Q1/15</td>
<td>469</td>
<td>1749</td>
<td>5.33</td>
<td>82.33</td>
<td>10.67</td>
<td>89</td>
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As can be seen in Table 2, the creation of new KBAs has dropped over time, while the number of updated KBAs has amplified. This indicates a successful adoption of double-loop learning, which has changed the employees’ behavior to update existing KBAs rather than creating a new one for every new task.

Over the 18 months, the DCT and PDF have dropped on average by 62.8% and 53.6%, respectively, which indicates an improved response time. CS and DRE have increased on average by 17.1% and 20.4%, respectively, which indicates a boost to productivity and better customer satisfaction.

In order to validate the results, the quality attributes have been examined for dependency correlations with organization knowledge and learning, which are represented by newly accumulated knowledge, and by the learning process through reviewing and contributing to the existing knowledge.

The Correlation Coefficient and the Significance for each of the quality attributes are presented in Table 3. The statistically significant negative correlations have been marked with a single asterisk (*), while the positive correlations have been marked with double asterisks (**).

It is obvious from Table 3 that there are significant correlations between the three quality attributes and the organization learning and knowledge, specifically, UK. There is a positive linear correlation with DRE, which indicates the correlations between learning and the team’s efficiency in fixing defects.

Negative correlations exist between UK and both, DCT and PDF. The negative correlations here produce positive results, as the reduction in both, DCT and PDF is favourable. Furthermore, positive correlation exists between the UK and customer satisfaction.

There is no statistical evidence of correlations between any of the quality attributes and NK. There is also no statistical evidence of a correlation between the customer satisfaction and NK by just accumulating knowledge through adding new KBAs.

5. Related Work

Kaizen started to attract research attention since 1986, when Masaaki Imai published his book “KAIZEN – The Key to Japan’s Competitive Success”. Imai [20] tried to portray Kaizen as a comprehensive continuous improvement system by describing it as a strategy to involve both, employees and management to develop a customer-centric culture. This, however, targeted the manufacturing industry, where the majority of methods, techniques, and practices are not applicable to a software-centric organization.

Singh and Singh [25] reported 20 case studies on the application of Kaizen between 1995 and 2008 in different industries, including manufacturing, agriculture, aircraft manufacturing, and aerospace amongst others. Reviewing these case studies on the application of Kaizen has been the primary approach to analysis the related work on the topic.
The majority of the case studies report the use of Kaizen events to realize continuous improvements, mainly brainstorming workshops to discuss how the production process could be improved. One case study [8] that was conducted at an electronic manufacturing organization, however, emphasized the importance of mapping corporate values onto the employees’ values to improve both, the attitude towards change, and the management approach of the change process itself.

The available literature has not discussed organization learning, reflective practices, or the critical role of standards and policies in improving the organization. There has also no evidence of integrating Kaizen into the organization’s daily operations. The application of Kaizen was only reported through short events, lasting for weeks that aimed at improving one area of the work.

6. Threats to Validity

The improvements and results reported in section 4.5 must be interpreted cautiously. We cannot claim that the improvements resulted solely from implementing the proposed Kaizen model and practices. Nor can the impact of confounding variables or local factors be discounted; such as the successful implementation of other improvement initiatives. These factors could have significant impacts on the presented results, which compromises a threat to the Internal Validity.

The External Validity threat to our study is that our observations on this organization may not generalize to other settings, as this study summarizes over 2 years of work in one organization and is specific to its culture, practices, polices, and employees (study participants), the context of each organization per se might dramatically impact the improvement results.

In an attempt to reduce the Construct Validity threat, various data collection techniques were used during the three phases of the action research cycle. In order to limit data misinterpretation and to validate the findings [13][15], the investigators produced a report outlining their observations, and asked the research participants to validate them.

7. Conclusions

Organizations in the software engineering field must continuously seek improvements to sustain their competitive advantages and survive in rapidly changing market conditions. One way of achieving continuous improvements is through the application of Kaizen. Implementing Kaizen, however, is not an overnight process. Based on our experience during the journey to implement Kaizen, which spanned over 2 years, we summarize our recommendations as follows:

Challenge 1: Kaizen lacks a clear definition; there was no clear principles or concepts useful for software-centric organizations. Our recommendation for practitioners is to start with what we have established in this research. Imitating Kaizen from other industries is not a straightforward process. It requires innovation and creativity in crafting practices that can change the fundamental values and beliefs of individuals.

As for researchers, we believe that more research is needed to establish enough knowledge to develop a Kaizen framework for software-centric organizations.

Challenge 2: In order to implement Kaizen successfully, it needs to be embedded within the organization habit and be integrated into its culture. Our recommendation for practitioners is to understand the organization’s assets and capabilities to utilize them in developing practices that contribute to realizing the Kaizen principles and concepts. This
should start with empowering and involving the employees. Organizations should encourage creativity and inquiry in the working environment to trigger the learning process that helps in realizing and sustaining the benefits and advantages of Kaizen.

As for researchers, we suggest conducting more empirical studies to either validate or refute the analysis of the results that Kaizen promotes organization learning, which in turn, facilitates improving the overall performance of the organization; it can improve team productivity and increase the customer satisfaction.

8. References