



UNIVERSITY OF GOTHENBURG

# **Change Resistance in Continuous Integration: An Exploratory Case Study**

*Bachelor of Science Thesis Software Engineering and Management*

ADELYN REGINE AQUINO  
EMILY LU

University of Gothenburg  
Chalmers University of Technology  
Department of Computer Science and Engineering  
Göteborg, Sweden, June 2016

The Author grants to Chalmers University of Technology and University of Gothenburg the non-exclusive right to publish the Work electronically and in a non-commercial purpose make it accessible on the Internet.

The Author warrants that he/she is the author to the Work, and warrants that the Work does not contain text, pictures or other material that violates copyright law.

The Author shall, when transferring the rights of the Work to a third party (for example a publisher or a company), acknowledge the third party about this agreement. If the Author has signed a copyright agreement with a third party regarding the Work, the Author warrants hereby that he/she has obtained any necessary permission from this third party to let Chalmers University of Technology and University of Gothenburg store the Work electronically and make it accessible on the Internet.

## **Change Resistance in Continuous Integration: An Exploratory Case Study**

ADELYN REGINE AQUINO  
EMILY LU

© ADELYN REGINE AQUINO, June 2016.

© EMILY LU, June 2016.

Examiner: ERIC KNAUSS

University of Gothenburg  
Chalmers University of Technology  
Department of Computer Science and Engineering  
SE-412 96 Göteborg  
Sweden  
Telephone + 46 (0)31-772 1000

Department of Computer Science and Engineering  
Göteborg, Sweden June 2016

# Change Resistance in Continuous Integration: An Exploratory Case Study

Adelyn Regine Aquino and Emily Lu

Department of Computer Science and Engineering, Software Engineering & Management Program,  
Gothenburg, Sweden  
{aquinoregine2, emilylu0708}@gmail.com

**Abstract.** With continuous integration (CI) becoming more and more widely adopted among software organizations, tackling the resistance during the change process becomes an important and inevitable step. This paper attempts to identify the change resistance in adopting continuous integration and its corresponding mitigation strategies. The research is conducted in order to answer two questions; 1) What are the factors that trigger resistance to adopting continuous integration? and 2) Which are the mitigation strategies for the identified reasons for resistance? To answer these questions, a case study was conducted at Ericsson AB where the CI drivers, line managers, change leaders and cross-functional team members (XFT) had been interviewed. The results found fall under 4 forms of resistance; *social, organizational, cultural and technical*. Most of the resistance factors covered by *social* and *organizational* are concluded to be general resistance to change and not specific to CI, while the factors in the *cultural* and *technical* are specific to the organization and the adoption of CI. Some of the mitigation strategies for resistance such as workshops, setting up small goals, involving more people were identified and proved to be effective but the remaining resistance factors are still to be eliminated.

**Keywords:** Continuous Integration, Agile Software Development, Change Resistance

## 1 Introduction

Continuous Integration (CI) was introduced by Kent Beck and Ron Jeffries as part of eXtreme Programming, an agile methodology practice that aims to improve the quality and process of software integration [1], [2], [3]. The practice of CI allows early and frequent integration, as well as immediate feedback for newly integrated code. The greatest benefit that CI offers is that it detects errors and reduces risks [4].

The work of Ståhl and Bosch [5] explores the benefits of CI in the software industry, such as that CI supports the agile testing practices of automated customer acceptance tests, improves the communication both within and between teams, increases developers' productivity and improves project predictability. Aside from the benefits, the study points out the negative effects of continuous integration as an important topic for future research. As more and more software organizations are practicing CI nowadays [6], the problem is that the challenges they encountered during the change process due to the negative effects could lead to change resistance; a phenomenon experienced by software organizations in change projects. Kurt Lewin defined the term change resistance as a force that is equally affecting managers and employees [7].

Current research professes that there is resistance to CI but gives no in-depth account of the triggers or the form of the resistance and the mitigation strategies [5], [8], [9]. Therefore, this paper aims to conduct a case study for the purpose of answering two research questions:

*RQ1: What are the factors that trigger resistance for adopting continuous integration?*

*RQ2: Which are the mitigation strategies for the identified reasons for resistance?*

In our exploratory case study, we found that there are four forms of resistance; social, organizational, cultural and technical. Each form consists of different factors that trigger the change resistance. Some of the change resistance found have already been eliminated by the mitigation strategies while the rest is still to be resolved. The findings will be useful for software organizations that would like to practice CI in the future.

Section 2 of this paper introduces the related work. Section 3 provides the research methodology. Section 4 states the results. The two research questions are discussed in-depth in section 5 before concluding the results in section 6. Finally, section 7 discusses the future work in relation to our contributions.

## **2 Related work**

Due to the limited amount of studies done on our research topic, this section begins with discussing the related work about general change resistance, then moving on to agile change resistance and mitigation strategies, finally the challenges in the process of CI. The approach is to discuss the topic from a broader perspective before narrowing down to the main issue.

### **2.1 General Change Resistance and Mitigation Strategies**

“Resistance to change is a natural defense mechanism.” [10] to the idea of change because change would often put people out of their comfort zone. In order to make the change work, the transition period must be accomplished. To do this, the first requirement is to let go of the old habits. The second requirement is called neutral zone where people feel uncomfortable so they are eager to get out of this zone. This is where the organization puts focus on how they can maintain the change they have initiated. Lastly, the organization moves forward and tries to maintain the new state [11]. Coch and French concluded that it is possible for the management to remove group resistance to change in work style by having group meetings where they bring up the need for change and allow group participation in change planning [12]. Boohene and Williams conducted a study investigating the factors that influence the organizational change. The study proposed 4 hypotheses to determine the factors and found out that less employee participation in decision making and lack of trust in management contributed highly to resistance. In addition to that is the lack of motivation, poor channels of communication and quality of information exchange triggered the resistance. The suggested strategies were that the managers need to encourage their employees to

participate in decision making, practice accepting constructive criticism and clearly communicate the need for change [13]. The study of Washington and Hacker examines the understanding of the managers with regards to the organizational change process. The aim of the paper was to find the role of knowledge in the success of a change process. To find out the relationship between the two, they conducted a survey among 296 senior level managers. They found that the managers who fully understood the change were less resistant to the change. Also, managers would less likely think that the change will fail and would never regret the implementation of change [14]. Vrhovc, Hovelja, Vavpotič and Krisper proposed a resistance checklist where lack of top management commitment is one of resistance factors identified. This factor was categorized as organizational issue when it comes to change resistance. According to the study lack of top management commitment results for the key users of the organization to feel that they are not part of the project [15]. Dent and Goldberg [7] reviewed five management textbooks about change resistance. The causes of resistance and the strategies to overcome it are shown in Fig. 1.

<b>Resistance to Change: Causes and Strategies</b>					
<i>Authors</i>	<i>Kreitmer (1992)</i>	<i>Griffin (1993)</i>	<i>Aldag &amp; Stearns (1991)</i>	<i>Schermerhorn (1989)</i>	<i>Dubrin &amp; Ireland (1993)</i>
<b>Causes of resistance</b>					
Surprise	X				
Inertia	X				
Misunderstanding	X	X	X	X	
Emotional side effects	X	X	X	X	
Lack of trust	X	X	X	X	
Fear of failure	X				X
Personality conflicts	X	X	X	X	
Poor training	X				
Threat to job status/security	X	X	X	X	X
Work group breakup	X	X	X	X	
Fear of poor outcome					X
Faults of change					X
Uncertainty		X	X	X	
<b>Strategies for overcoming</b>					
Education	X	X	X	X	
Participation	X	X	X	X	X
Facilitation	X	X	X	X	
Negotiation	X	X	X	X	X
Manipulation	X	X	X	X	X
Coercion	X	X	X	X	
Discussion					X
Financial benefits					X
Political support					X

**Fig. 1. Resistance to Change: Causes and Strategies**  
(Dent and Goldberg, 1999)

The theory of Kotter on change management introduces steps on how to transform the organization to reach the success of the change. The first step is to establish a sense of urgency. An organization needs to have a clear motivation of why the change is necessary. The second step is to form a powerful guiding coalition. Leaders of the organization should be committed to work as a team. The next step is about creating a vision and developing strategic initiatives in order to achieve it. The fifth step is to

empower others to act on the vision. Motivating people to act according to the set vision removes the obstacle to the change. Next, plan for and create short-term goals. When people do not see the benefit or the progress of the change, they will soon resist it. Consolidate improvements and producing more change. This is the step to continue and practice the process of the change improvements in the organization. The last step involves institutionalizing new approaches so that the members of the organization see change as part of the culture [16].

## **2.2 Agile Change Resistance**

Although there are very few studies on change resistance to CI, many studies have explored the change resistance for other agile practices. Vijayasathy and Turk conducted an anonymous online survey among 98 software professionals to find out the factors influencing their adoption decision and challenges of adopting agile methodology in early stages. The report claimed that the respondents have troubles accepting agile development due to organizational resistance and lack of interest from the management. Additionally, respondents recognized the lack of training, peer support, ignorance of agile, facilities for pair programming, individual resistance and the exclusive reliance on economic evaluation criteria as other barriers to the adoption of agile [17]. The case study by Paasivaara, Lassenius, Heikkila, Dikert and Engblom investigates the integration of lean and agile transformation in three global sites of Ericsson in Finland, Hungary and in US. The results suggest that the top challenges they experienced in integrating lean and agile transformation in the global sites were creating a shared understanding of the change; enabling end-to-end development; bridging cultural differences; and creating transparency between the sites. These challenges that were solved later became success factors. The mitigation strategies that were found include having an early and broad involvement of global sites at all organizational levels, constant communication, cross-site visits, and creation of joint infrastructure [18]. Misra, Kumar, U., Kumar, V., and Grant's paper explores the challenges involved when transitioning from traditional software development process to agile. The paper proposed a framework to understand the required changes and challenges. When introducing agile in an organization, changes in organizational culture, management style, knowledge of management strategies and development process will occur. In this sense, there are negative effects or challenges in consequence to the changes such as developer resistance, developer perceptions of freedom, upper management resistance, problems with incorporating agile in legacy systems, conformance with traditional process standards, problems with environments with legacy systems, etc. [19].

## **2.3 Challenges in adopting Continuous Integration**

Vafaie and Arvidsson's research on the impact of implementing continuous integration in an organization. Their case study found negative impacts of the way the organization implemented CI. They organized those impacts by 4 themes. Under the theme of work environment, they found increase of stress level, difficulty in isolating from the

previous work and complexity of work. The theme of code quality includes unsure build quality, build faults and unstable baseline. The theme responsibility mentioned that too many people can enter the baseline, and finally, development process theme suggested there is no clear guideline for working with CI. It is mentioned that if there would be a problem with CI, it is not directly against it but because of other reasons like technical problems such as increased overhead in maintenance, going through the product's legacy projects and having too many failed builds [20]. In Debbiche, Dienér and Svensson's study, they found that change resistance is one of the barriers in adopting CI. The results showed that the most frequently mentioned challenges were tools and infrastructure such as maturity, regression feedback time, and test automation; domain applicability as in product complexity; mindset such as changing old habits, skepticism and exposing work intention; and finally, the bottom-up approach [8].

In the recent study by Hukkanen on the challenges of adopting CI, the author produced a summary of challenges from some of the related work as shown in Fig 2.

Challenge	Nature	Papers								
		Miller [2008]	Dannan et al. [2007]	Claps et al. [2015]	Olsson et al. [2012]	Neely and Stolt [2013]	Leppänen et al. [2015]	Bellomo et al. [2014]	Debbiche et al. [2014]	Stahl and Boseb [2014a]
Communication	Social	X	X							X
Distributed development	Social	X			X				X	
Management support	Social			X	X	X	X	X	X	
Change resistance	Social						X	X	X	
Understanding of the CI/CD process	Technical / Social						X	X	X	
Sufficient hardware	Technical	X		X						
Test automation and testing technique	Technical			X	X	X	X		X	
Infrastructure maintenance	Technical						X			
Software architecture	Technical							X		
Tool issues	Technical				X				X	
Dependency management	Technical								X	
Requirement definition	Technical								X	
Size or complexity of product	Domain						X		X	
Domain applicability	Domain				X				X	

**Fig. 2. CI adoption challenges in literature.**  
(Hukkanen, 2015)

Their case study found that the challenges in adopting CI can be sorted by themes such as testing, infrastructure, dependency management, communication and CI practicalities. CI relies on stable automated testing in order to ensure good build results, which appears to be a technical factor. Support from the management is an important

social factor. Furthermore, the management's lengthy corporate decision making process resulted in a decrease in development efficiency which indicates the importance of communication effectiveness. The infrastructure or the overall CI practicalities also have impact on the effectiveness of the process [9].

### **3 Methodology**

This section contains an introduction of the case company, followed by a description of how the research was conducted; how we collected and analyzed the data as well as the validity procedures taken and threats.

#### **3.1 Research Context**

As one of the world's leading telecommunications companies, Ericsson began their Lean and Agile journey in 2008, and with the introduction of Scrum and cross-functional teams in the following years, they slowly transformed their mindset and ways of working. The change was mainly a top-down initiation, then CI was introduced along the agile journey as another step towards a more mature agile R&D organization.

The company already implemented CI as the development framework for most of their products and soon to be established as part of their culture. To further investigate the CI journey at the organization, we interviewed some people from two teams handling two different products that represented the overall organization of CI at Ericsson. Based on the individual knowledge and given their background and experience about CI, we found many factors that triggered resistance in adopting CI and the corresponding mitigation strategies for them. Also, we found that Continuous Deployment (CD), as the next step following CI, is highly anticipated by the organization in the future [28].

#### **3.2 Research Strategy**

This is an exploratory case study [21] that aims to find out the resistance triggers that presented at the case company Ericsson when adopting CI. Our research will be conducted through a qualitative approach using semi-structured interviews [22] to explore the various resistance factors.

The interview questions (see appendix A) were formed based on the two research questions. Our focus is on the change resistance and the mitigation strategies, other information such as the interviewee's background, past experience, experience with change management, prior experience with CI, current product, responsibilities and future suggestions are also obtained so that we could observe and discuss in relation to the answer to our research questions.

#### **3.3 Data Collection**

The interviewees are of four types of roles. CI drivers (CID), who are responsible for supporting the cross-functional teams and securing the product quality; change leaders (CL), whose responsibility is to support the line managers and drive the change. The line managers (LM) are the ones who drive the organization and the process of the products. The cross-functional teams (XFT) are involved in the process of developing,



designing and testing. The hierarchical relationship of the roles is CL, LM, CID, XFT, from top to down.

Initially, the case company offered us 8 CI stakeholders as interviewees, with 4 on each product unit. Due to the fact that one of the candidates was not available, we contacted other recommended interviewees and ended up with 9 candidates in total. The roles of the interviewees are mid-level management in the hierarchical organization, including 3 line managers, 2 change leaders and 2 CI drivers. In order to compare the difference in resistance between the management and developers, 1 designer and 1 tester from the cross-functional teams were also interviewed. They were chosen by the two line managers due to the availability of them working at the local site.

The length of the interviews varies from 25 minutes to 50 minutes. The questions we prepared were used as a guideline during the interviews to make sure the research questions were covered while asking follow up questions when the answers given by the interviewee were vague. The 9 interviews were recorded then transcribed using InqScribe<sup>1</sup>. Information was then extracted from the transcripts for analysis. The order of the interviews is displayed in table 1.

**Table 1. Interviewees**

<b>ID</b>	<b>Role</b>	<b>Experience with CI</b>	<b>Has prior experience with CI</b>
01	LM	1 year	Yes
02	CL	6 years	Yes
03	LM	3 years	No
04	XFT	5 years	No
05	CID	4 years	Yes
06	CID	4 years	Yes
07	LM	4 years	No
08	CL	3 years	No
09	XFT	3 years	Yes

Semi-structured interviewing is said to be suitable in the case when there is only one chance to conduct the interview while allowing the interviewers to follow a set of guidelines and develop better understanding of the topic by adding relevant questions spontaneously [23]. Additionally, the “member checks” technique was applied to

---

<sup>1</sup> <https://www.inqscribe.com/>

establish validity [23]. The process involved an interviewer taking notes of important information and later on asking the interviewee to confirm the information, adding or modifying anything missing or incorrectly stated. Hence, it allowed us to confirm the information for more reliable results. Information gathered from earlier interviews was formulated as additional questions and hypothesis asked to later interviewees, which adds more to the validity. Reflecting on previous interviews also helped us to fine-tune the interview questions and collect more useful data. For the sake of consistency, the changes we made to the interview questions were limited, such as changing the phrasing and order of the questions.

### 3.4 Data Analysis

The collected data were analyzed using a general inductive approach as a process of theory building [24]. The procedure involved identifying new concepts, evidence from raw data; then forming themes based on the findings [25]. By cross checking with previous findings in other case studies, going from within-case analysis to cross-case analysis, allowed us to expand and discuss the findings from a broader context. The extracted data were analyzed using a thematic approach following these steps [25]:

**1. Extraction:** This step we examined the transcripts and found text segments related to the research objectives while highlighting and labeling them. These texts were rephrased if the sentences were too long or redundant and put into the spreadsheet under the corresponding property category depending on the type of information. The order of extraction followed the rule that interviews of the candidates with the same role will be extracted first before moving on to the next role. The properties extracted include the following:

- Current role
- Experience at Ericsson
- Responsibilities
- Current product
- Views of CI
- Introduction to CI
- Experience with CI
- Views on product suitability
- Experience with change management
- Triggers of the resistance
- Events
- Forms of resistance
- Mitigation strategies
- Outcomes
- Existing problems
- Suggestion for improvements

Using a quote by one of the interviewees as an example to demonstrate the analysis process: *“The problem was management. When it comes to line managers, because we have an organization where line managers historically are responsible for our ways of*

*working, our processes. And then what they saw was that I was doing a process change without them being involved.*” Here, we highlighted “*management*”, “*line managers*” and “*doing a process change without them being involved*”.

**2. Coding:** The resistance factors directly or indirectly mentioned were identified and coded using more concise words or phrase. Other information such as the interviewee’s view of CI, experience with CI, mitigation strategies used, problems encountered and suggestions were also extracted.

In the quote given above, we found two resistance factors, both caused by miscommunication. The first one is that the interviewee did not involve the line managers because he assumed that it is unnecessary, we concluded that it is due to “*incorrect assumption of responsibilities*”. The second problem is that the line managers resisted it because they were not involved in decision making, the resistance is caused by “*key stakeholders not being involved*”.

**3. Forming themes:** The resistance factors were then sorted into themes that represent the forms of resistance, the themes were chosen based on the source of the identified triggers.

The two factors found above are categorized under the *social* label, because fundamentally, it is a communication issue between individuals, and one of them overstepping the other’s responsibilities.

**4. Checking:** The process involved checking the findings against the notes that were taken during the member checking process; unmatched information in the spreadsheet was corrected. The resistance factors were then re-examined to see if they support the themes accurately.

Here we re-categorize the factors if they do not fit the theme. “*incorrect assumption of responsibilities*” and “*key stakeholders not being involved*” are still considered to be *social* problems, not *organizational*. The reason is that these could be solved by communication, do not require a change in organizational structure or communication channel.

**5. Refining:** After making sure the factors were listed under the correct form of resistance, they were shortened into concise words, phrases, or sentences for clarity.

The final step we rename the factors into more concise phrases. “*Incorrect assumption of responsibilities*” is renamed to “*misjudgment of responsibilities*”, and “*key stakeholders not being involved*” is renamed to “*absence of key stakeholders in decision making*”.

### **3.5 Validity Procedures and Threats**

The research used convenience sampling [26] as we had limited access when selecting the interviewees. All candidates were selected by our contact at Ericsson, or contacted through some of the candidates due to their experience with CI and availability. The possibility of bias exists since the interviewees were not selected by us, we have no knowledge about their attitude towards CI and how closely they work with it, also their identities were not anonymous to our contact, so the validity could be affected by these

reasons. Furthermore, due to convenience sampling, product owners has been discarded which could add another point of view about CI.

Before the interviews, the interviewees were informed of the research topic but no details were given, this ensures that the interviewees had an idea of the topic. They were also notified that the interviews will be recorded and their identities will remain anonymous, hence they are more likely to speak freely and provide us more information.

The interviews were conducted in a mixed order in terms of the interviewee's role since it is difficult to follow a specific order considering their schedule. The schedule for the interview allowed us to execute the plan-act-reflect cycle in an action research inspired manner [27]; giving us the opportunity to reflect after an interview and fine-tune the questions to improve interview quality for the next interviewee. As shown in table 1, candidates with the same role were not interviewed immediately after the previous one, with the exception of the two CI drivers, which means we would be able to improve interview quality for the second interviewee of the same role. Hence, the overall validity would not be affected by the interview order as the quality of the interviews were balanced.

When analyzing data, we paid extra attention to the specific parts of the interviews when resistance factors and mitigation strategies were mentioned to avoid mishearing as much as possible, and made sure they were transcribed correctly. Aside from that, the member checking technique also helped to avoid mishearing.

The scope of our study covers change resistance, but in order to avoid bias, we let the interviewees decide what they considered to be resistance. The validity threat would be that some of the resistance factors mentioned were not strictly resistance in previous studies within the change management area.

## **4 Results**

This section contains the findings from our study. The results include a brief overview of the CI journey at Ericsson, the interviewees' views of CI, the resistance factors, mitigation strategies, existing problems and suggestions for improvements.

Based on the information given by the interviewees, the organization began their Lean & Agile journey in 2008, introduced XFT in 2009, until then it was all top-down approach. The adoption of CI started around 2010, it was a bottom-up initiation from the employees such as the developers, engineers and a few CI experts. Later on, a group of people who were committed to CI including some of the project managers and associate leaders formed a team and continued to involve people bottom-up. Eventually, the initiative reached the management.

The interviewees were working on two types of products; product A has version A1 and A2, A1 contains large legacies and is being developed in different global sites while A2 is comparatively newer. Product B is also being developed at different sites globally, but it is the earliest product to start CI.

#### 4.1 View of CI

When asked about their definition and view of CI, the interviewees' responses were very positive. The change leaders said that CI means faster and smaller integrations, and a way to secure quality by having automated tests. And one of the change leaders who had lots of experience being a developer stated that CI makes it easier to make changes as a developer without worrying about how much it will affect the system due to having a CI machinery doing the checking.

*“Since I'm a developer also from the beginning, basically it means that as a developer you don't have to think as much of how your change affect the system, you can make a change and you can run the CI machinery and you can see that after that you know if your change works [...].”*

The CI drivers saw it as a solution to version conflicts by having one common branch, and a step towards continuous deployment — a state where the software functionalities are deployed continuously at a customer site [28]. They were very content with CI because it has simplified their work, meaning that they do not have to do detailed integration planning anymore.

*“I was very positive about it, because I thought this would simplify my work. I mean, most probably make me redundant, meaning that I wouldn't be needed any longer. [...] Because if I'm coming to a position where everyone else do my work, then I can do something else.”*

Nonetheless, the CI drivers mentioned that the increasing individual responsibility of the XFT requires the team to be self-disciplined and reflect on the problems actively and spontaneously.

The line managers agreed that CI should have been brought in much earlier and it has improved the efficiency a lot. And a good CI machinery is necessary for a sustainable software company, as well as allowing the developers to focus on building the functionalities.

*“CI means that my engineers, developers can focus on the product development as such on the real stuff; on building functionalities on the program. And since we started to evolve our CI, all the frustration and the irritation around engineers went away.”*

For the XFT members, CI has made their job a more enjoyable experience and it is inseparable from other Agile discipline. They confirmed that CI allows them to get to know the product as a whole, improved their understanding of the problems and purpose.

*“I think it's a good way to work and it's also more enjoying for developers and testers to actually get to know the product completely, like every feature, and you make smaller incremental steps and I think it's better [...].”*

Most of the interviewees had prior knowledge about CI, but without any formal introduction, they were mostly influenced by a couple of key individuals who were CI expertise during the Lean and Agile transformation and by the request of the developers, only few were driven by curiosity and personal interest.

## 4.2 Resistance Factors and Mitigation Strategies

Our analysis resulted in four broad themes, where each theme captures resistance factors mentioned by different interviewees, as well as the mitigation strategies. The themes are not orthogonal due to the fact that CI is complex with multiple dependencies within Ericsson.

Social factors include psychological factors such as fear and worries that are natural human responses, and individual mistakes such that lead to inefficient communication (see table 2). Organizational factors were those caused by management decisions, a lack of proper channels or problems caused by the company infrastructure such as costs during the process (see table 3). Cultural factors, on the other hand, were case-specific due to the product being developed in different global sites. But these resistances are caused by cultural gap and diversity in personal value rather than geographical reasons (see table 4). Lastly, technical factors represent the technical issues and difficulties related to the CI environment and technical requirements such as test coverage and product maturity (see table 5). Not all resistance factors have a corresponding mitigation strategy, but most of them have been resolved at this stage.

### 4.2.1 Social Factors

When asked about whether the change resistance was specific to CI, some interviewees responded that the resistance was not specifically due to CI, but rather the change itself, and the fact that people are afraid of change in general. This could be seen as the fear of outcome due to uncertainties. By involving each team in workshops and having a group of people driving the change have resolved this issue.

*“I think that it’s more like we are afraid of changes. And also it’s very difficult to do change. If you don’t follow it up and so on you will go back to your old habits again, [...] I think that we need to follow up and see how it goes and so on. So it’s more the change that we are afraid of instead of CI.”*

Due to the misjudgment of responsibility by one of the interviewees, the resistance emerged when the line managers who were responsible for the process were not involved in the decision making process, nonetheless the problem was eliminated once the communication was established and the line managers saw the proof points.

*“The problem was management. When it comes to line managers, because we have an organization where line managers historically are responsible for our ways of working, our processes. And then what they saw was that I was doing a process change without them being involved.”*

Overall, there was nearly no resistance seen from the developers, some of the experienced employees did not see the reason to change because they felt comfortable with the old way. Although it took time to show the benefits, getting a few minor breakthroughs and motivating the developers with the benefits of CI helped the organization to strengthen their belief.

*“I think getting a few minor breakthroughs earlier where we get proof points that this change is working really made a difference.”*

Other than that, one of the XFT members reported that they were told to be involved in the change but the instructions were not clear enough. The difficulty was not to adopt CI but to transition from waterfall to CI. The other developer with no previous experience with other development framework stated that going CI was not a problem. This shows a lack of precise instructions and the difficulties in transitioning mindset.

*“[...] so it's been a change from waterfall to CI but it was not mentioned that 'now we are changing from waterfall to CI'. I don't think people knew what we are going to do, or they maybe didn't say it, but what people thought was 'being involved in the transformation'.”*

**Table 2. Social Factors**

Form of resistance	Resistance Factors	Role	Mitigation Strategies
Social	Fear of outcome	CL CID	Had workshops with each team
			Started working in the new way
			Took small steps and set up small goals
			Had a group of drivers being transparent about the change
			Involved more people
	Absence of key stakeholders in decision making	CID	Involved and communicated with the stakeholders
	Misjudgment of responsibilities	CID	-
Developers' lack of motivation	LM	Got a few minor breakthroughs	
		Motivated the change with benefits	
Lack of precise instructions	XFT	-	
Difficulties in transitioning from the Waterfall mindset	CL CID XFT	-	

#### 4.2.2 Organizational Factors

One interviewee stated that what made the change of CI so special comparing to other change projects at Ericsson was that it was not the management's initiation, it was the will of the employees, and thus the resistance mainly comes from the top management. In contrast, there was no reported resistance among the developers, what is worth mentioning is that, while not all developers have knowledge about CI, one of the interviewees suggested that the developers did not have any idea of their own, they heard about the change and just went with it. The underlying message also raised some interesting questions. Does the lack of knowledge from some of the developer's result in the absence of resistance because they have no choice? And why does it have an opposite effect on the management?

*“And I also started to understand the organizational view. Okay, we need everyone to be on board. I was looking very much on the developers, because they're the one doing integrations. But the resistance I saw, and I realized, was in upper management.”*

One of the interviewees pointed out that the process was very internally oriented, they could have done some research about success examples of CI at other companies so that people would believe in it.

*“I think that the resistance and the barriers was maybe not the people resisted because they didn't want this, but was more like didn't know or didn't see and understand how much it actually gives us in the later state [...] and then it was more lack of knowledge or lack of going and see how others have done.”*

Many interviewees responded that the management was not committed to CI in terms of investments and hiring experienced people. Especially due to the fact that having good automated testing is important for CI, one of the change leaders emphasized that if the management had brought in people who have done plenty of testing before, they would know how important automated tests are.

*“I think the main resistance was the top management at that time. They didn't understand how important it was. They thought that we could do a little investment in test automation and we could eventually get there, and I think that was the main struggle [...].”*

The lack of knowledge and priorities of the management resulted in a prolonged change process before the change became effective. However, once the management saw the proof points that CI was working, they immediately showed commitment and support. The entire process took about 3 years, which was unnecessarily long, according to one of the interviewee.

*“Commitment from management, no we did not have that, but we didn't ask for permission either. [...] then we needed more hardware investments. Then we got the commitment, because they saw that this is working.”*



On the other hand, our interviewees stated that it was also understandable due to the management not seeing direct benefits, while for the developers the benefit was obvious. Hence, the resistance from the management is mainly caused by indirect benefit.

*“But it's obvious for many developers, designer and so on, those who do the real work. But for management, they did not see the benefits, because the benefits are more indirect for them. It's not affecting their everyday. But it was affecting the everyday of every single developer.”*

It was mentioned that the company was struggling with tough competition around the time when CI was getting popular, it was a bad time to implement such change; therefore, although the organization was aware of CI since 2010, the initiative was only brought up very recently. Aside from that, one of the interviewees noticed that due to the product was developed at other sites, delay in information spreading seemed to be a problem.

*“[...] I think it takes more time when it's from different place, it's a communication problem.”*

**Table 3. Organizational Factors**

Form of resistance	Resistance Factors	Role	Mitigation Strategies
<i>Organizational</i>	Management's lack of knowledge and research	CL CID LM	-
	Lack of clear priorities	CL	Realized the importance of CI and prioritized it
	Lack of investment in automated testing	CL	Shown proof points that CI is working
			Brought skilled and experienced people to drive CI
	Bad timing	CL	-
	Management's lack of commitment due to indirect benefit	CID	Shown proof points that CI is working
	Budget limit and costly machinery	LM	-
	Lack of proper communication channel with with non co-located cooperators causing information delay	XFT	-

### 4.2.3 Cultural Factors

The cultural aspect was brought up by one of the line managers working with development teams in different sites. Due to the specific product being developed in Hungary, the development teams wanted to be a bit protective of their own product and their own way of working, and did not want to be compared with other sites.

*“One of the things is also (the product) is not invented here, in this case in Budapest, it's not invented in Sweden [...] I'm thinking of also it's a bit of cultural aspect as well, given the Hungarian culture that you want to be a bit protective, site protective. [...] We will continue with involving people bottom-up. And I'm not sure if that is the right way, given that we have a cultural difference.”*

Also, it was mentioned that the Hungarian teams expected their leaders to be more direct and give clear instructions, but CI is more about self-discipline than detailed planning and requirements from the leaders. The team leaders tried to discuss with the group and come up with solutions, but the cultural gap and communication barrier were difficult to overcome.

**Table 4. Cultural Factors**

Form of resistance	Resistance Factors	Role	Mitigation Strategies
Cultural	Site perspective due to product being developed in several global sites	LM	-
	Different expectations of leaders due to cultural gap	LM	Talked with the group and come up with strategies

### 4.2.4 Technical Factors

The change leaders and CI drivers mentioned the technical issues that they encountered. CI allows the teams to continuously integrate to one common branch which is the master branch that will be delivered to the customer. The problem was that the frequent integrations and testing caused the master branch to break much more often, but due to the lack of traceability, some people used it as an opportunity to just deliver and not take responsibility for it.

*“I think we don't have the framework to go CI all the way [...]”*

Later on, they created a tool that allowed the developers to follow their commit after each delivery so that they were responsible for fixing it once it was broken.

*“[...] we have that 'follow the commit' that they started to look into. So when you do integration and something went wrong you can follow and see where it comes from [...]”*

One of the line managers also expressed that the people working on the hardware production saw that the master branch was breaking much more often and thought it was caused by CI and assumed the quality was degraded, but the reality was that CI allowed them to run more tests more frequently, which led to finding more faults, so in fact, it was the quality becoming more visible rather than getting degraded.

It was mentioned by one of the CI drivers who is experienced in automated testing that the instabilities in the environment have really been a struggle when it comes to securing the quality and trusting the test results, it was hard to find out whether the faults were in the build or caused by the environment. The only way to tackle it was to solve them one by one, unfortunately there were no better ways.

*“Because if you have instabilities in the product or in the test cases or environment, CI is very difficult.”*

Product A1 is old and was developed in a waterfall fashion before it was ramped up 2 years ago. The legacy made it difficult to adopt CI because it inherited so many problems. CI follows a “fail fast, fix fast” principle which was cumbersome to execute for an old product with so many known issues.

*“And due to the fact that it's an old product, much legacy, many experienced people, it's kind of cumbersome to start changing the ways of working, changing the methodology, and also we can understand that from a business case perspective.”*

Test coverage and feedback loop were also affecting the quality of builds. They believed that it is critical to the CI framework that if the test coverage is not good enough and the feedback is not fast enough, frequent delivery itself will not solve any problems.

*“If we're gonna go with CI, it's crucial that you have good regression test otherwise it would not work; and we didn't have that, so the quality degraded a lot.”*

Many interviewees emphasized the importance of quality when it comes to CI, since it has been a concern since the beginning that the automated tests were not good enough. The candidates also expressed that there are still plenty of things to improve but at least now people have finally realized the importance of it.

*“We introduced new quality strategies where we said that all errors of high severity should have highest priority always before anything else. And that was also a way to keep our latest system version really under control [...]”*

When it comes to products, 5 out of 9 interviewees thought that CI is suitable for any large scale software development while the rest pointed out that for a product with a long history and many known issues it is difficult to implement CI, especially when the architecture is not really evolved with the feature, which is considered a technical

debt<sup>2</sup>. And it was mentioned by one of the interviewees that there is still resistance where people cannot build using the CI machinery because of specific conditions. People think that developing test coverage for old architecture would be too costly.

*“I think there is resistance still around many places where people are like ‘Oh no we can't build the CI machinery for our product because it has this and this specific conditions. It has an architecture of that kind or it's very old we don't want to we cannot develop test coverage to that because it will cost too much’.”*

**Table 5. Technical Factors**

Form of resistance	Resistance Factors	Role	Mitigation Strategies
<i>Technical</i>	Incomplete framework	CL	Introduced "follow my commit"
	Instabilities in the environment	CID	Tackled the instabilities one by one
	Legacy	CID LM	-
	Quality concerns due to poor test coverage and feedback loop	LM CL CID	Put more effort into automated tests Perseverance Prioritized high severity errors

#### 4.2.5 Summary of Resistance Forms by Role and Product

For a summary of the findings sorted according to the role of the interviewees, see table 6. The initials stand for S - social, O - organizational, T -technical, C - cultural respectively. The interviewee background gives an overview of their previous roles or experience, and their involvement with the XFT. Due to the fact that the change was a bottom up initiation, we decided to see if the direct or indirect involvement of the change leaders, CI drivers and line managers with the XFT members would result in them seeing different forms of resistance. The maturity of the product and their previous experience could also have an impact on what kind of resistance they perceived.

---

<sup>2</sup> Technical debt is commonly associated with extreme programming; usually refers to unexpected rework cost caused by taking shortcuts to delivering feature.  
[http://www.sei.cmu.edu/architecture/research/arch\\_tech\\_debt/](http://www.sei.cmu.edu/architecture/research/arch_tech_debt/)

Here we define *directly involved with XFT* as monitoring, supporting, and directly affecting the everyday work of the XFT members. Indirect involvement means supporting other roles who support the XFT, product and CI machinery.

**Table 6. Resistance forms by Interviewee’s role and Product Unit**

ID	Role	Form(s) of Resistance Observed	Product Unit	Interviewee Background
08	CL	S, T	B	Lean & Agile coach; Indirectly involved with XFT
02	CL	S, O	A	Former developer, team leader, project manager; Directly involved with XFT
06	CID	S, O, T	A2	Former integration leader, production technician, EPL leader; Indirectly involved with XFT
05	CID	S, O, T	B	Former integration leader, project manager, product manager; Indirectly involved with XFT
01	LM	S, O, C, T	A1	Former developer, project manager; Directly involved with XFT
07	LM	S, T	A2	Former designer, scrum master, team leader and product owner; Directly involved with XFT
03	LM	O, T	A	Department manager; Directly involved with XFT
09	XFT	S, O	A1	Experienced with waterfall; Tester
04	XFT	-	A	No prior experience with other frameworks; Designer

Change leader (08) and line manager (07) both perceived the social and technical resistance. Interestingly, they do not work in the same product unit; one is not directly involved with the XFT members while the other one is. But one of the responsibilities of change leader (08) is to “*support the line managers*”, and since both of them have lots of experience as leaders, which might explain why they share the same perspective. They were also the two interviewees who did not mention any organizational resistance from the management, the general impression of the interviews was that both seemed to think the technical and social resistance were stronger than management problems.

Change leader (02) and XFT (09) happened to point out the same types of resistance. Change leader B described his main responsibility as “*to drive, monitor and support*

*the teams*” while change leader (02) was more leaning towards an agile coach. Direct communication and frequent follow up would also explain why change leader B was the only interviewee who did not mention any technical resistance, agreeing with the XFT members.

The two CI drivers both identified from the social, organizational and technical aspects, given their similar experience as former integration leader and technical background.

Both XFT members reported no resistance from themselves, but XFT (09) observed the social and organizational issues. The result shows an unexpected contradiction that the people working with the technical side of CI have not noticed any technical resistance at all, but the middle managers did. One of the reasons could be that this is a bottom-up change, but we cannot conclude that this is the only reason, since leaders often need to look at the process from a broader view, as the CI drivers mentioned they need to “*nurse the quality of the master branch*”, hence they may notice more technical problems. Moreover, XFT (09) mentioned that difficulties in transitioning to CI due to being used to the waterfall mindset, but XFT (04) responded with a positive tone and claimed that it was hard to compare CI with waterfall due to having no experience with the latter.

Line manager (01) was the only interviewee who mentioned the cultural aspect due to working with sites in foreign countries. With least experience with the current role and CI among all interviewees, line manager (01), with more than 15 years of experience at manager position, perceived resistance in all forms. The legacy issue was also brought up as a major struggle for going CI during the interview because of the old architecture and inherited issues of A1.

### **4.3 Existing Challenges and Suggestions**

The interviewees reported that currently there are some known problems including the test results that cannot be fully trusted due to instabilities in the environment, long delivery time for corrections, issues with reflecting and finding faults since XFT members need to take on the responsibility themselves, test coverage is not high enough, feedback loops are not fast enough, difficulties in verifying the software due to the hardware not being developed up to speed, and overly simplified test requirements making it difficult to set up scenarios.

For now, their focus is on stabilizing the environment, improving regression tests and faster feedback loop as these were seen as extremely important for securing the quality. As for the future, 6 interviewees agreed that “*CI is a stepping stone towards continuous deployment*”. One of the interviewees stated that perhaps there was a lack of transparency when it comes to communication between the developers and management, and suggested that they need to flatten out the organization structure a bit so that the information spreading between each level would be faster, more direct, and less information loss.

## 5 Discussion

This section answers the research questions in-depth by discussing our results in a broader context in relation to the previous studies in related work. Although there are very few studies on the negative impact of CI, and no known works about the change resistance specific to CI, there are some general change resistance factors that have been discovered in related work, with the closest case being the adoption of agile, since CI is part of the Agile practices. Here, we intend to discuss whether the factors were general or specific to this case. Furthermore, by looking into the factors that are case-specific, we would be able to find out whether the resistance was caused by the nature of change or CI from a technical aspect. Finally, to re-visit the context, we will bring out a discussion about what our findings could mean to the future of CI at the organization, such as Continuous Deployment (CD).

### 5.1 RQ1: What are the factors that trigger resistance for adopting continuous integration?

There are four forms of change resistance identified during the forming of themes based on the types of resistance. As observed, the social factors are caused by communication and psychological reasons such as fear, doubt and worries, as well as the uncertainties regarding roles and responsibilities, to the product and to the people involved in the change. Cultural factors are separated from social because the cultural gap cannot simply be fixed by means of communication. The gap was caused by different perceptions and attitudes towards the change. The organizational form was based on the management problems considering the bottom-up situation of the change. Technological form of resistance represents the issues formed using the technology in this case the process of CI.

#### 5.1.1 Social Factors

*Fear of the outcome.* People were unsure of the change due to not knowing what to expect, and afraid that the change will fail. In the paper of Dent and Goldberg [7], the study mentioned the work of Dublin and Ireland (1993) where they tackled people's fear of poor outcome, e.g. they might earn less money, might feel inconvenient or might be required to do more work, as a resistance factor. Our results agreed with the previous work, the uncertainties brought by the change process was what people were afraid of, not the idea of CI, especially knowing that the change will benefit them in terms of productivity, product quality and simplicity, if it is done properly. This suggest that fear of outcome is a general change resistance and not specifically due to CI.

*Absence of key stakeholders in decision making.* The decision of not involving line managers in the decision making cause them to resist the change. Coch and French [12] discussed that group participation is a factor that helps eliminate group resistance to change. In addition to that is the paper of Boohene and William [13] which proved that less participation from employees contributes to resistance. These serve as an evidence

that the organization made a mistake of not involving more people to the decision making of the change.

*Misjudgment of responsibilities.* A misunderstanding in responsibilities resulted in a gap between the two stakeholders which made the line managers reluctant to the change, as they saw that the process that they have been responsible for was being changed by someone else without involving their experience. However, there is no evidence that the involvement of line managers during the decision making would guarantee less resistance. Line managers considered the change to be unnecessary when the old way is still working. This suggests the underlying problem of different perceptions from the employees when it comes to necessity and consequences of the change [7]. After realizing the mistake in both parties, and as the change slowly progressing, the line managers saw the benefit of CI. Misunderstanding has been the issue that triggers change resistance from the line managers, this factor can also be found in other studies. Four out of five manager's textbooks mentioned that misunderstanding is one of the causes of change resistance [7]. This factor is one of the general resistance and not case-specific.

*Developer's lack of motivation.* The lack of motivation as a contributor to change resistance was mentioned in the study by Boohene and William [13]. In our case study, one of the interviewees suggested that developers who had no knowledge about CI did not see the reason to change. The lack of motivation could be caused by several reasons; being persistent about the old ways, lack of knowledge, fear of poor performance [7]. A related study suggested that management should be open to constructive criticism and be clear about the need, benefits and motivation behind the change [13]. In our case, it is the responsibility of the change initiator to be transparent about the reason behind the change, as one of the interviewee suggested, the transformational way of change management is the only way to bring out a successful change project. The importance of communication in bottom-up approach discussed that individuals should be able to share their concerns and needs without worrying about retribution [13]. However, our results indicate that there is a lack of transparency and information loss from both sides, the top management and the change initiators. It was unsure if the information was not delivered due to the communication channel, or the sender and receiver. The result found extended the reasons behind the lack of motivation from the developer's' point of view.

*Lack of precise instructions.* This again pointed out the lack of communication in terms of the employee's needs. A study claimed that if the change concerns the tasks of individuals, then communication throughout the change and the information being delivered to the change stakeholders are vital [13]. The study also suggested that most change projects fail because of the lack of energy spent on helping those affected by the change to better understand it. In the case of Ericsson, besides the lack of acknowledgment from the top management due to communication issue, one of XFT members who participated the CI workshops still stated that no one knew exactly what to do, which indicates the concerns or confusion of the developers were not delivered in a good way within the group of people who were driving the change, although the



purpose of the workshop was to clear the concerns of the developers and listen to their needs. The same kind of issue was also found in another research, where the results state that the organization lacks clear guidelines for working with CI [20]. This strengthens the idea that effective communication results in development efficiency [9].

*Difficulties in transition from the waterfall mindset.* In one of the studies, it was mentioned that during the early stage of adoption of CI, developers experienced three stages in order to overcome the transition period [11]. The first stage is letting go of the old habits, in our case the old habit is the waterfall mindset. The author also mentioned about the difficulty of change in this stage as people resist it as they were comfortable to what they used to do. The second stage is to motivate the people to accept the change step by step and secure them about the benefit it will bring in the future. In this case, this step was successfully performed and the developers showed no resistance. The last step is to move on and maintain the change, which is what they are striving to achieve at the current stage where CI has become a solid part of their development framework. The outcome suggested that the developers experienced a general change resistance and not specific to the adoption of CI.

### **5.1.2 Organizational Factors**

*Management's lack of knowledge and research.* A previous study claimed that lack of knowledge lead to more resistance [14]. Especially when it comes to leadership, the authors found that the better a leader is, the more they know about the change and will be less resistant to the change. The relation between the two factors is confirmed by our study, the managers were resisting due to their lack of knowledge about CI. One of the challenges mentioned in Hukkanen's paper is the understanding of CI/CD process [9] which falls under the technical or social nature of change, the categorization disagrees with ours which is specific to the management. The result serves as an additional factor to consider when it comes to a bottom-up approach where the management's knowledge has direct impact on decision making.

*Lack of commitment due to indirect benefit.* Lack of commitment from top management was seen as a low probability but high effect risk factor while the lack of perceived value was considered high probability and low effect [15]. The study suggests the stakeholders will resist change if they do not see the benefit or the benefit is relatively low. In our case, *management's lack of knowledge and research* could be one of the reasons why they could not see the benefit in the long run, hence they were not committed to it. Combining our results with the previous study, the evidence suggests that the lack of commitment from management not only exists in top-down approach but also from a bottom-up point of view.

*Lack of priorities, lack of investment in automated testing, bad timing, budget limit and costly machinery and lack of proper communication channel with non co-located cooperators causing information delay.* These factors are considered case-specific. These could be seen as the challenges caused by the bottom-up approach [8]. *Lack of priorities* and *bad timing* were the results of the company going through tough

competition at that time, the management had to focus on the products, therefore neglecting the change due to its complexity. The benefits being indirect to the top management could be another reason that they hesitated *to invest* and could not acknowledge the importance of *test automation*. However, when they started to show progress and good results, the management decided that CI is the way to go. *Lack of proper communication channel with non co-located cooperators causing information delay* still exists, while not a human factor that is threatening the CI process but definitely making it much harder, such issue could be solved if the organization could focus on it.

### 5.1.3 Cultural Factors

*Site perspective due to product being developed in several global sites and different expectations of leaders due to cultural gap.* Since the development sites are globally distributed, cooperation between sites is often a multi-cultural collaboration. In another case study performed at Ericsson, one of the top challenges they experienced in integrating lean and agile is bridging the cultural differences [18]. This situation remains to be a problem in the organization as it cannot be solved immediately by means of only communication.

### 5.1.4 Technical Factors

*Quality concerns due to poor test coverage and feedback loop.* Test automation, tool issues and software architecture were found as technical challenges in a recent study [9]. Our results agreed with their findings, problems with *test coverage and feedback loop* was mentioned to be the most frequently challenge in adopting CI [8]. Our result strengthens the importance of having good test coverage and fast feedback loop. Tool issues was solved as Ericsson introduced a tool for merging and tracking integrations.

*Legacy.* Software architecture belongs to one of the obstacles with *legacy*, as it has been found in previous work that dealing with legacy systems is a challenge in agile [19], [20]. With smaller and faster integration being the signature of CI, legacy with so many known problems poses a threat to the quality, since it requires the team to fix all the previous faults in order to continue with new builds, while the product does not allow them to roll back to a previous point; plus, developing test coverage for an old architecture (technical debt), whether going CI is worth the cost is definitely questionable.

*Incomplete framework, instabilities in the environment.* When it comes to product, a change in framework in the middle of the development process is certainly challenging and can be a trigger to resistance as well, as one of the previous studies suggested that the technical factors found were said to be difficulties and not directly against CI, but they could still trigger resistance [20].

## **5.2 RQ2: Which are the mitigation strategies for the identified reasons for resistance?**

Based on the Satir Change model [29] currently the change process of CI at Ericsson is going from the integration and practice stage to a new status quo. The management could eliminate all forms of group resistance [12] and this is what Ericsson's management has been doing. At this stage, the social and organizational change resistance have already been resolved but there is still existing resistance caused by cultural and technical factors.

The strategies that they have used to eliminate the social and organizational form of resistance is found to be general strategies used to counter any kind of resistance. Workshops, setting up small goals, involving more people including the stakeholders, pointing out the benefits of the change, motivating the changes, getting minor breakthrough and starting working in the new way are also found to be feasible strategies [7], [12], [13]. Some steps from Kotter's theory of management are identified in how Ericsson brought in CI. For instance, communicating the vision in Kotter's theory — in this case the company decided to make CI a priority and started with workshops. Initiating proof points and bringing skilled and experienced people were the actions to empower others to act on the vision, based on step 5 of Kotter's theory [16]. Furthermore, there are no related work found about how to resolve the change resistance caused by bottom-up approach with concrete examples.

In terms of the cultural change resistance, the problems are not yet solved through communication, but it was mentioned that teams working with CI were experienced people who were used to their own way of working, which suggested that bringing in people with new perspective could be a potential solution. As for different expectation for leadership, this requires better understanding of the foreign organizational culture and teamwork dynamic. The solution being raised to mitigate the differences between foreign teams was to communicate within the group and come up with strategies, this was seen as an effective way based on the results in one of the studies where they suggested that this type of change resistance will be successfully mitigated when the organization maintains a constant communication follow up with cross-site visits [18].

There are no further studies found on how to mitigate the technological change resistance both in general and agile resistance and directly to CI. On the other hand, the mitigation strategies found in our study for technical issues are rather case-specific. The tool "follow my commit" was an effective solution to keep track of broken builds and fix them as soon as possible. Tackling the instabilities one by one was the only solution they had due to technical complications, and it has been an issue for producing reliable test results. The solutions they came up with to secure quality in CI was to put more effort into automated test, develop higher test coverage, to persevere and to prioritize high severity faults.

## **5.3 From Continuous Integration to Continuous Deployment**

Our findings suggest a list of potential problems that future organizations may encounter when they aim to adopt CI so that they could take necessary precautions. On the other hand, for organizations that have moved past CI, going towards CD, these

resistances or existing problems have a prospective meaning. In this section, we will discuss the most representative factors and what can be learned beyond.

Communication plays an important role in the success of CI transformation. In the future, when adopting CD, similar social factors might appear as problems. Communication obstacles usually involve people's behavior and their different perspectives, and the resistance might differ depends on how individuals view the introduction of CD. Therefore, miscommunication could still be an issue given the fact that different stakeholders will be involved while the organizational hierarchy is unlikely to change. Our findings show that social resistance could be mitigated by traditional change management strategies, such as workshops and motivate people with the benefits. The same strategies could still be used when continuing with CD.

The factors that we found under the organizational resistance can be seen as three core problems: the bottom-up approach of the change, management's preparation and cost estimation. These factors are unlikely to be hindering the adoption of CD in the future if the organization has learned from them by applying effective mitigation strategies found when adopting CI. If CD will be introduced using a bottom-up approach, the organization probably will not have a hard time accepting the change since they have learnt what is to be expected in the similar scenario of CI. If the change will be a top-down approach, in this case the organization have already experienced when introducing agile, they will know how to handle. In terms of lack of preparation, the organization have learned the importance of establishing communication channels and hiring experienced people, therefore, when the organization is ready for CD, these will not be major issues.

For all the benefits CI has to offer for large-scale software development: one common branch, constant access to the latest software version, easier merging; cross-site communication becomes something vital in terms of product quality, synchronization, productivity and resource allocation. This is where the social and organizational aspects of communication meet; not only does it require stable, effective communication channels, the product and people management are extremely the key. Dealing with cultural gap and information transparency is not only up to the management, but the developers themselves as well. If it is not solved when adopting CI, it definitely will remain as a problem for CD, as it requires a much more mature constant pipeline, and constant cross-site synchronization.

Dealing with legacy systems is reported to be the trickiest and most time and resource consuming. CI is great for brand-new products, but it is impossible to have a clear cut between the traditional development framework and CI. The framework transitioning is what needs the most attention, especially when it is inevitable for products with long history. With no available strategies to deal with these old products, the rate of integration is greatly decreased since most of the time is spent on fixing inherited problems and outdated codes, which will become an even more serious problem for CD, since the product simply cannot be deployed at a constant cycle, let alone deployment automation. The organization is currently working on developing test coverage and test automation as they have realized the importance of them, since reliable test results and good quality control are the signature of CI. At the same time, they are also tackling the instabilities in the environment, and with time, increasing the test coverage to a decent level is totally achievable, hence making it easier to move towards CD, where a good test coverage is elementary.

To conclude, we could view the step from traditional development to agile as more of a transition in mindset, the step from CI to CD a transition in technical framework. While similar social and organizational problems are likely to occur unless everyone actively learn from their mistakes, these issues are unpredictable but easier to resolve as people gain experience; the technical and social factors are more or less predictable when experienced people are involved, but could be harder to resolve as they tend to differ from case to case. What is to be noted is that, the social and organizational problems could remain unnoticed but affecting the change process in the long run, the technical and social problems are more acute, and if not solved immediately for CI, they will only become harder to solve for CD.

## **6 Conclusion**

As an exploratory case study, the purpose of this paper was to identify the triggers to change resistance in the adoption of CI and the mitigation strategies applied. The research took place at Ericsson, one of world's leading telecommunications companies. 9 semi-structured interviews were carried out in order to answer the two research questions about the triggers of change resistance in adopting CI and the mitigation strategies. The 9 respondents participated in the interviews include CI drivers, line managers, change leaders and XFT members. The interviews were 25 to 50 minutes long and the "member checking" technique was used to establish validity to our results.

Discussions were made based on the research findings and compared to related work. To conclude the resistance factors, we discovered four forms of them. The social and most of the organizational resistance were not specific to the case but to change process in general. The cultural and technical factors found were specific to the change of CI. Most mitigation strategies found were proved to be effective in eliminating the change resistance but there is still more resistance to be resolved. Although there are plenty of change resistance and challenges during the change process, the respondents were positive about CI and would not go back to the old ways due to the benefits it provides such as securing the quality, faster integration, trustworthy results, simplifying their work and overall better quality. However, the respondents stated that there is always room for improvements and suggested CI as a step closer to continuous deployment. The discovery of the challenges that lead to resistance to CI and its applied mitigation strategies serve as a guideline for organizations who wish to adopt CI in the future.

## **7 Future Work**

The research has raised some new possible topics for future studies to explore. The change resistance factors found in our research were mostly coming from the management due to the approach of the change initiative. However, we cannot conclude if these resistances are typical for a bottom-up change due to the lack of evidence and theories. The same goes for the mitigation strategies, the finding suggests that there seems to be a phenomenon that the existing feasible tactics for resolving bottom-up resistance are far less than top-down. A bottom-up change might not be typical, but it

would be helpful to find other strategies to mitigate management resistance besides “*showing them the proof points*”.

Looking for the difference between forms of resistance in hierarchical and flat organizational structure would shed light on strategies for removing change resistance more effectively and efficiently in different types of organization.

The problems emerged when transitioning to CI on legacy system also seems to be worth investigating. Finding out better ways to deal with inherited problems on larger and older systems would mean reducing difficulty for development teams; allowing them to practice CI regardless of the product suitability or integrity.

**Acknowledgment.** We would like to express our gratitude to Anna Sandberg and all interviewees who made this research possible. Besides the participants at Ericsson, we would also like to thank our supervisor Håkan Burden for his support and guidance.

## References

1. Beck, K. (1999). Embracing change with extreme programming. *Computer*, 32(10), 70-77.
2. Hamdan, S., & Alramouni, S. (2015). A Quality Framework for Software Continuous Integration. *Procedia Manufacturing*, 3, 2019-2025.
3. Huo, M., Verner, J., Zhu, L., & Babar, M. A. (2004, September). Software quality and agile methods. In *Computer Software and Applications Conference, 2004. COMPSAC 2004. Proceedings of the 28th Annual International* (pp. 520-525). IEEE.
4. Fowler, M., & Foemmel, M. (2006). Continuous integration. *Thought-Works* <http://www.thoughtworks.com/ContinuousIntegration.pdf>, 122.
5. Ståhl, D., & Bosch, J. (2013). Experienced benefits of continuous integration in industry software product development: A case study. In *The 12th IASTED International Conference on Software Engineering, (Innsbruck, Austria, 2013)*(pp. 736-743).
6. West, D., Grant, T., Gerush, M., & D'silva, D. (2010). Agile development: Mainstream adoption has changed agility. *Forrester Research*, 2, 41.
7. Dent, E. B., & Goldberg, S. G. (1999). Challenging "resistance to change". *The Journal of Applied Behavioral Science*, 35(1), 25-41.
8. Debbiche, A., Dienér, M., & Svensson, R. B. (2014). Challenges when adopting continuous integration: A case study. In *Product-Focused*
9. Hukkanen, L. (2015). Adopting Continuous Integration-A Case Study: Master's Thesis, Aalto University School of Science
10. Haslam, S., & Pennington, R. (2010). Reducing resistance to change and conflict: A key to successful leadership. *Resource International*, 1, 3-11
11. Bridges, W., & Mitchell, S. (2000). Leading transition: A new model for change. *Leader to leader*, 16(3), 30-6.
12. Coch, L., & French Jr, J. R. (1948). Overcoming resistance to change. *Human relations*.
13. Boohene, R., & Williams, A. A. (2012). Resistance to organisational change: A case study of Oti Yeboah Complex Limited. *International Business and Management*, 4(1), 135-145.
14. Washington, M., & Hacker, M. (2005). Why change fails: knowledge counts. *Leadership & Organization Development Journal*, 26(5), 400-411.
15. Vrhovc, S. L., Hovelja, T., Vavpotič, D., & Krisper, M. (2015). Diagnosing organizational risks in software projects: Stakeholder resistance. *International Journal of Project Management*, 33(6), 1262-1273.
16. Kotter, J. P. (1997). Leading change: why transformation efforts fail. *IEEE Engineering Management Review*, 25(1), 34-40.
17. Vijayarathy, L., & Turk, D. (2012). Drivers of agile software development use: Dialectic interplay between benefits and hindrances. *Information and Software Technology*, 54(2), 137-148.
18. Paasivaara, M., Lassenius, C., Heikkila, V. T., Dikert, K., & Engblom, C. (2013, August). Integrating global sites into the lean and agile transformation at ericsson. In *Global Software Engineering (ICGSE), 2013 IEEE 8th International Conference on* (pp. 134-143). IEEE.
19. Misra, S. C., Kumar, U., Kumar, V., & Grant, G. (2006, December). The organizational changes required and the challenges involved in adopting agile methodologies in traditional software development organizations. In *Digital Information Management, 2006 1st International Conference on* (pp. 25-28). IEEE.

20. Vafaie, N., & Arvidsson, M. (2015). Metrics to measure the impact of continuous integration-An empirical study. *Software Process Improvement* (pp. 17-32). Springer International Publishing.
21. Runeson, P., Host, M., Rainer, A., & Regnell, B. (2012). *Case study research in software engineering: Guidelines and examples*. John Wiley & Sons.
22. Cohen, D., & Crabtree, B. (2006). Qualitative research guidelines project.
23. Rowlands, B. H. (2005). Grounded in practice: Using interpretive research to build theory. *The Electronic Journal of Business Research Methodology*, 3(1), 81-92.
24. Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American journal of evaluation*, 27(2), 237-246.
25. Cruzes, D. S., Dybå, T., Runeson, P., & Höst, M. (2015). Case studies synthesis: a thematic, cross-case, and narrative synthesis worked example. *Empirical Software Engineering*, 20(6), 1634-1665.
26. Marshall, M. N. (1996). Sampling for qualitative research. *Family practice*, 13(6), 522-52
27. O'Brien, R. (1998). An overview of the methodological approach of action research. *Faculty of Information Studies, University of Toronto*.
28. Olsson, H. H., & Bosch, J. (2014). Climbing the "Stairway to Heaven": Evolving From Agile Development to Continuous Deployment of Software. In *Continuous Software Engineering* (pp. 15-27). Springer International Publishing.
29. Weinberg, G. M. (1993). *Quality software management*. New York.



## Appendix A: Interview Questions

First of all, would you please introduce yourself a bit?

- Experience
  - How long have you been working at Ericsson?
  - How familiar are you with change management? What are some of the changes that you've been through?
  - How long have you been working with CI? Do you have any previous experience with CI?
- Product
  - Could you briefly describe the current product that you're working on?
  - How well do you think CI suits your current product?
- Role
  - What is your responsibility in your product unit? Could you tell us a bit about your routine?
- CI
  - What does CI mean to you?
  - What was your expectations of CI before you actually started? Did it meet your expectations?
  - How was CI introduced to you?
    - What was your initial reaction when you were introduced to CI?
    - Did you have any alternative ways of introducing CI at your company?
    - How did you prepare for it?
  - What was your impression of CI? If you could summarize the experience what would you say?
- Cross-functional/Agile

So we are aware that you're going through lots of changes, including CI, agile and cross functional teams. And the introduction of CI is a change regarding both organizational and technical aspects of software engineering.

- How do you think that the introduction of CI has affected your way of perceiving your role and competence?
- How do you perceive the introduction of agile and cross functional team?
- If you could make a comparison between the introduction to agile/XFT and CI, in which way do they affect your perspective differently? What does it bring you?
- Resistance
  - Have you encountered any resistance or barriers when it comes to adopting CI? What are they?
    - If yes.

- What do you think could have triggered the resistance?
    - How did you overcome it?
  - If no.
    - Is there anything that makes process of CI difficult or requires extra attention in order to get it done?
    - Do you think these resistance or barriers exist because it's CI or just change in general?
- Mitigation strategies
  - What have you done in order to mitigate the resistance?
    - Is it a common strategy for any kind of resistance, or is it especially used for CI?
    - Did it work?
      - If no.
        - What do you suggest instead in order to mitigate the resistance?
- Next step
  - Would you like to continue practicing CI in the future?
  - Do you think that CI is mature and reliable enough to be a part of the culture here at Ericsson?
  - What would you suggest for improvements?