Towards Understanding Emotional Responses to Requirements Changes in Agile Teams

Kashumi Madampe
kashumi.m@ieee.org
University of Auckland
Auckland, New Zealand

Rashina Hoda
rashina.hoda@monash.edu
Monash University
Melbourne, Australia

Paramvir Singh
p.singh@auckland.ac.nz
University of Auckland
Auckland, New Zealand

ABSTRACT

Agile software development welcomes requirements changes even late in the process. However, it is unclear how agile teams respond to these changes. Therefore, as the starting point of a planned extensive study on handling requirements changes in agile projects, we examined the emotional responses to requirements changes by agile teams. In this paper, we (i) introduce a novel combined approach of using Grounded Theory and Sentiment Analysis (through SentiStrength and Job Emotion Scale), (ii) present three distinct phases of emotional responses, a summary of emotions, and variation in emotions and sentiment polarity (positivity, negativity, and neutrality) at each stage, and (iii) emphasize the necessity of taking emotional responses of agile teams into consideration when applying agile principles and practices to deal with changes.

CCS CONCEPTS

• **Software and its engineering → Agile software development**.

KEYWORDS

Agile Software Development, Emotions, Requirements Changes, Sentiments

1 INTRODUCTION

"When dealing with people, remember you are not dealing with creatures of logic, but with creatures of emotion" – Dale Carnegie

The Agile manifesto [2] declares *"responding to change over following a plan"* as one of the four core values and *"welcoming changing requirements, even late in development"* as one of its twelve principles. However, we argue that responding to and welcoming change not only involves handling strategic issues but also emotional aspects, which is easier said than done. While agile practices may provide a framework for dealing with changes, the human aspects of responding to change is not understood. In particular, the emotional response of agile teams to requirements changes needs to be understood if we wish to apply fully and benefit from agile principles and practices.

Emotions are defined as *"sequence of interrelated, synchronized changes in the states of all of the five organismic subsystems (information processing, support, executive, action, and monitoring) in response to the evaluation of an external or internal stimulus event as relevant to central concerns of the organism"* [21].

Emotions act as behavioral motivators [3] and have a linkage on cognition [3], productivity [7, 9, 15], and decision making [14]. Studies on emotions are increasingly gaining focus in software engineering [4, 7–10, 13–20, 23, 24] (summarized in Section 2). However, to the best of our knowledge, emotions of agile teams in response to requirements changes has not been studied, leading to the question, *"how do agile teams emotionally respond to requirements changes (RCs)?"* In this paper, we report a pilot study exploring this research question.

We experimented with a novel approach of combining Grounded Theory and Sentiment Analysis (described in Section 3) and identified three stages where agile teams report emotional responses when *receiving*, *implementing*, and *delivering* requirements changes. Some fluctuations in positive and neutral responses were found in all stages, whereas a noticeable decrease in negative emotional responses was observed as teams progressed from receiving → implementing → delivering. Ultimately, our vision is to highlight the importance of considering emotional aspects when applying agile principles and practices especially with respect to responding to requirements changes.

2 RELATED WORK

Studies on the emotions of software developers have focused on *software development practices* such as code reviews [1, 19], code refactoring [23], testing [14], and debugging [13]. Emotions involved in the *software development process* [16, 24], software developers' *performance* [7, 8], progress [15], productivity [4, 9], and improving emotional awareness in software development teams [10] have also been investigated. Other studies focused on the role of emotions in supporting *software development tools* such as Stack Overflow [17] and JIRA [18].

Research on emotions in the requirement engineering activities of software development is relatively scarce. Ramos and Berry [20] note that emotional issues are not considered in requirement engineering as long as emotions of all stakeholders stay positive. Ortu et al.[18] states being aware of the team's emotional state supports the manager in creating an environment capable of coping with the team's negative emotions. Overall, research on emotions in software development is steadily gaining momentum; however, to the best of our knowledge, emotional responses to requirements changes in agile teams has not been studied.

3 RESEARCH METHOD

Extracting emotions of software developers can be done directly and indirectly with the use of software development artifacts such as commit messages and through self-assessment immediately after the performance of software development tasks, respectively [23]. Studies have used approaches such as surveys [24], monitoring physiological changes with biometric sensors [15, 24], psychological approaches [4, 7], and software development artifacts followed by sentiment analysis [10, 18, 23] for this.

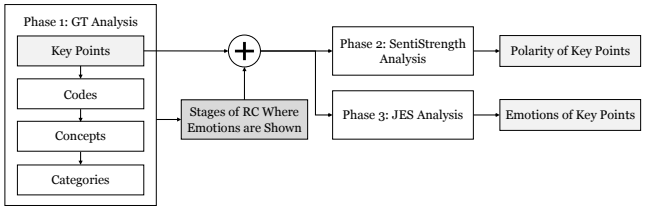

Figure 1: Combined data analysis process

3.1 Our Research Approach

We used an approach that combined Grounded Theory and Sentiment Analyses in our pilot study, performed as a preliminary part of a more extensive study on this topic. The proven richness of GT analysis in understanding human aspects of software engineering [11, 22] and the established strength of Sentiment Analysis in extracting emotional indicators [10, 23] led us to experiment with a combined approach.

Invitations for participation were posted on professional social media channels such as LinkedIn, Meetups, Twitter, and Facebook. From 16 initial responses, 10 participants were selected for the pilot study (n=8 NZ, n=2 Australia) considering their accessibility. The agile experience of the participants ranged from 1-18 years and their overall work experience in the software development industry in a range of 2-56 years. Participants included heads of projects, managers, business analysts, scrum masters, and testers.

3.2 Data Collection

Participants were requested to fill a pre-interview questionnaire to collect the demographic data, project, and team information. The pre-interview questionnaire was designed by following Shastri et al.'s study [24]. It took approximately 10 minutes to fill and helped us save time to focus on discussing emotions during the interview. Then face-to-face (n=7) and online (n=3) interviews were conducted. Each interview lasted 50-60 minutes on an average. We found that getting people to express/reflect on their emotions directly is challenging. Therefore, we switched to capturing emotional responses in conversations about handling RCs in agile projects through the open-ended questions such as: *"Thinking of a recent agile project you were part of, how did a requirements change travel through the project?"*. Here participants shared key milestones of RCs. We followed up by asking questions such as *"What happens when the requirements change is at <milestones provided by the participant>"* and *"How does that make your team feel?"*. This indirect approach yielded more information about emotions. The recorded interviews were then transcribed manually in preparation for analysis.

3.3 Data Analysis

A mixed approach was taken for the analysis of the qualitative data collected through three phases (Fig 1). Firstly, data were analyzed using GT's open coding and constant comparison procedures [6], resulting in *key points, codes*, and the overarching concept of the existence of three stages of RCs where the teams exhibit emotional responses when *receiving, implementing*, and *delivering RCs*.

In the second phase, the key points from the GT analysis were categorized into the three stages identified and then processed using *SentiStrength*, which is widely used in sentiment analysis research [10, 23], to identify the emotional polarity (positivity, negativity, and neutrality). SentiStrength scores each word for *positivity* in the range of 1 (e.g., *outgoing*) to 5 (e.g., *overjoyed*), *negativity* in the range of -1 (e.g., *lost*) to -5 (e.g., *devastated*), and for *neutrality* as 0 (e.g. *no feeling*) and provides an overall score. However, SentiStrength only provides the polarity of emotions. Therefore, as the third phase of the data analysis process, in order to identify the corresponding emotions of the key points (e.g. *enthusiastic, frustrated, worried*), we used D. Fisher's *Job Emotions Scale (JES)* [5] as it targets *emotions* at work and was also used in a previous software engineering study [24].

4 RESULTS AND DISCUSSION

4.1 Grounded Theory Analysis

As mentioned above, we analyzed the interview data using GT's open coding and identified that the majority of emotions are shown by the agile teams during the three stages of RCs: *receiving, implementing*, and *delivering* requirements changes. Fig 2 shows part of the emergence of the stage *receiving an RC* from the underlying key points and codes. These stages were the times where teams emotionally responded to RCs during the software development process.

4.2 SentiStrength Analysis

As we processed the key points using SentiStrength, we found that the emotional responses of agile teams range from -3 to 3 when *receiving RCs*. When *implementing RCs*, the teams' emotional responses fell in the range of -2 to 3, whereas it ranged from -2 to 2 when *delivering RCs*.

As shown in Fig 3, the positive emotions of the teams fluctuate in a way that it is higher when *receiving an RC* (n=8), drops when *implementing* (n=4), and grows again (n=10) when *delivering*. The neutral response is high (n=12) when *receiving* and stays at the same level (n=2) when *implementing* and *delivering*. In contrast, the negative emotional responses decrease drastically from the stage of receiving (n=16) and lowers as it goes through *implementation* (n=4) to *delivery* (n=2).

4.3 JES Analysis

Job Emotion Scale (JES) consists of a list of 16 emotions where eight are positive (e.g., *happy, enthusiastic*), and eight are negative (e.g. *angry, disappointed*). We mapped the key points identified through

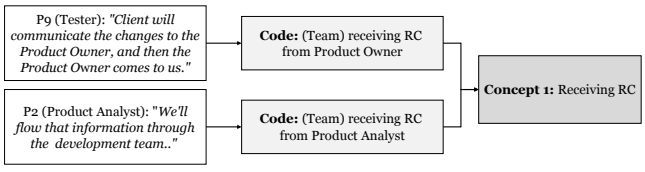

Figure 2: Emergence of the stage *Receiving a requirements change*

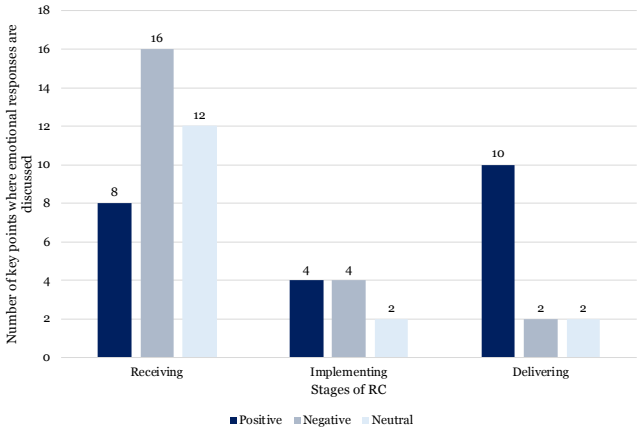

Figure 3: Emotional polarity at different stages of RC using SentiStrength

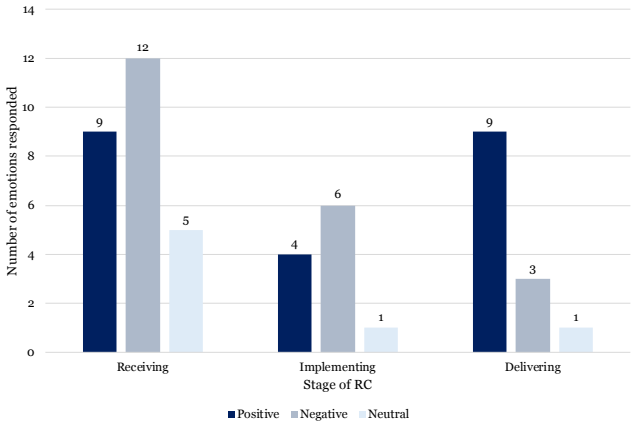

Figure 4: Emotional polarity at different stages of RC using JES

GT to the emotions in JES. When a participant mentioned a unique emotion multiple times at a certain stage, we considered it as a single instance. Table 1 shows the highest mentioned emotions by the participants at each stage.

Fig 4 shows the total number of emotions reported at different stages of RC. A majority of participants reported that their teams responded negatively when *receiving* an RC. When *implementing* an RC, the positive and negative emotions were balanced, whereas while when delivering an RC, teams responded with predominantly positive emotions.

4.4 Differences in Polarity Results

Surprisingly, further analysis at key point level shows contradictory results across the SentiStrength and JES approaches. Out of the 60 key points we processed using SentiStrength and JES, 14 key points in SentiStrength are in contradiction with the JES results. Table 2 below shows examples of such key points, polarity values derived from SentiStrength, JES polarity values, and JES value.

Manual analysis of these key points shows 23% (14 out of 60 key points) of the SentiStrength polarity results are inaccurate. For example, RRC2, IRC1, DRC1, and DRC2 have a neutral polarity in SentiStrength, respectively, while JES clearly performs better for these. In case of RRC1 and RRC3, SentiStrength analysis was more sensitive, while JES analyzes these as neutral. Finally, DRC3 shows a case of clear contradiction. In this case, we carefully re- examined the instance DRC3 and discovered that manual analysis through JES was more accurate. SentiStrength requires improvement in scoring the words in sentences. For example, "why[0] didn[0] t[0] you[0] kind[1] of[0] give[0] me[0] the[0] heads[0] up[0]", SentiStrength scores "kind of" as two separate words even though it is considered as a single phrase in natural use. Therefore, SentiStrength needs to be complemented by manual analyzing at a finer level using JES and further GT analysis as needed.

Table 1: Highest emotions mentioned at each stage ((+): Positive, (0): Neutral, (-): Negative, En: Enthusiastic, Dep: Depressed, Fru: Frustrated, Hap: Happiness, Lk: Likeness, Wor: Worried, NF: No Feeling)

	Receiving	*Implementing*	*Delivering*
+	En (n=3)	En (n=1) Lk (n=1) Hap (n=1)	En (n=4)
0	NF (n=5)	NF (n=1)	NF (n=1)
-	Fru (n=5)	Fru (n=3) Dep (n=3)	Fru (n=1) Wor (n=1)

5 CONCLUSION

With the use of a novel combined approach of Grounded Theory and Sentiment Analyses (using SentiStrength and Job Emotion Scale), we identified three stages of requirements changes (RC), where participants reported agile teams responding emotionally: *receiving*, *implementing*, and delivering an RC. Positive and neutral emotional responses of agile teams fluctuated in a high → low → high manner as teams go through the three RC stages. In contrast, negative emotional responses are high when receiving an RC and move towards positive as teams move to *implementing* and *delivering*, implying that agile teams become emotionally positive as they deliver an RC.

Also, the use of SentiStrength resulted in inaccurate values for approximately 1/4 of the results, which supports our use of JES for correction and finer analysis.

The outcomes of this pilot study show that even though agile focuses on embracing change, agile teams undergo emotional ups and downs in responding to requirements changes. Therefore, considering emotional aspects is imperative to understanding and improving how agile teams respond to changes in practice.

In the future, using GT's theoretical sampling, we will approach developers as participants in our study using the same combined approach. In addition, we plan to retrieve direct sources of emotional responses by studying the comments and commit messages from code repositories to gain more insights. Thus far, we found SentiStrength was suitable in analyzing our data since we processed only the specific key points on emotions, which did not contain any specific terms used in software engineering. However, in future

Table 2: Differences in polarity results at each stage- SentiStrength vs JES (RRC: Receiving RC, IRC: Implementing RC, DRC: Delivering RC, SP: SentiStrength Polarity, JP: JES Polarity, JV: JES Value, (+): Positive, (-): Negative, (0): Neutral, NF: No Feeling, Dep: Depressed, En: Enthusiastic, UnH: Unhappy, Wor: Worried)

Key Point (from interview data)	SP	JP	JV
RRC1: *And just let's acknowledge that some things are out of our control, unfortunately*	-	0	NF
RRC2: *it would freak me out*	0	-	Dep
RRC3: *I don't get stressed*	+	0	NF
IRC1: *You are basically drained*	0	-	Dep
DRC1: *feel motivated*	0	+	En
DRC2: *demotivation*	0	-	UnH
DRC3: *why didn't you kind of give me the heads up?*	+	-	Wor

we can consider SentiStrength-SE [12] if we find emotion indicators embedded in technical language. Overall, we recommend a multi-faceted combined approach to studying complex emotion indicators in agile software teams as they respond to requirements changes and aim to build a comprehensive theory that explains its various facets.

REFERENCES

[1] Ikram El Asri, Noureddine Kerzazi, Gias Uddin, Foutse Khomh, and M. A. Janati Idrissi. 2019. An empirical study of sentiments in code reviews. *Information and Software Technology* (2019). https://doi.org/10.1016/j.infsof.2019.06.005

[2] K Beck, M Beedle, A Van Bennekum, A Cockburn, Ward Cunningham, Martin Fowler, James Grenning, Jim Highsmith, Andrew Hunt, Ron Jeffries, Jon Kern, Brian Marick, Robert C Martin, Steve Mellor, Ken Schwaber, Jeff Sutherland, and Dave Thomas. 2001. Manifesto for Agile Software Development. https://agilemanifesto.org/

[3] Ricardo Colomo-Palacios, Adrián Hernández-López, Ángel García-Crespo, and Pedro Soto-Acosta. 2010. A study of emotions in requirements engineering. In *Communications in Computer and Information Science*. https://doi.org/10.1007/978-3-642-16324-1{_}1

[4] Broderick Crawford, Ricardo Soto, Claudio León de la Barra, Kathleen Crawford, and Eduardo Olguín. 2014. The Influence of Emotions on Productivity in Software Engineering. In *Communications in Computer and Information Science*. https://doi.org/10.1007/978-3-319-07857-1{_}54

[5] Cynthia D Fisher. 1997. *Emotions at work: What do people feel and how should we measure it? Part of the Human Resources Management Commons.* Technical Report. http://epublications.bond.edu.au/business_pubs/1

[6] Barney Glaser and Anslem Strauss. 1967. *Grounded Theory: The Discovery of Grounded Theory.*

[7] Daniel Graziotin, Xiaofeng Wang, and Pekka Abrahamsson. 2014. Happy software developers solve problems better: Psychological measurements in empirical software engineering. *PeerJ* (2014). https://doi.org/10.7717/peerj.289

[8] Daniel Graziotin, Xiaofeng Wang, and Pekka Abrahamsson. 2014. Software developers, moods, emotions, and performance. *IEEE Software* (2014). https://doi.org/10.1109/MS.2014.94

[9] Daniel Graziotin, Xiaofeng Wang, and Pekka Abrahamsson. 2015. Do feelings matter? On the correlation of affects and the self-assessed productivity in software engineering. *Journal of Software: Evolution and Process* (2015). https://doi.org/10.1002/smr.1673

[10] Emitza Guzman and Bernd Bruegge. 2013. Towards emotional awareness in software development teams. In *2013 9th Joint Meeting of the European Software Engineering Conference and the ACM SIGSOFT Symposium on the Foundations of Software Engineering, ESEC/FSE 2013 - Proceedings*. https://doi.org/10.1145/2491411.2494578

[11] Rashina Hoda, James Noble, and Stuart Marshall. 2012. Developing a grounded theory to explain the practices of self-organizing Agile teams. *Empirical Software Engineering* (2012). https://doi.org/10.1007/s10664-011-9161-0

[12] Md Rakibul Islam and Minhaz F. Zibran. 2018. SentiStrength-SE: Exploiting domain specificity for improved sentiment analysis in software engineering text. *Journal of Systems and Software* (2018). https://doi.org/10.1016/j.jss.2018.08.030

[13] Iftikhar Ahmed Khan, Willem Paul Brinkman, and Robert M. Hierons. 2011. Do moods affect programmers' debug performance? *Cognition, Technology and Work* (2011). https://doi.org/10.1007/s10111-010-0164-1

[14] Agata Kolakowska, Agnieszka Landowska, Mariusz Szwoch, Wioleta Szwoch, and Michal R. Wrobel. 2013. Emotion recognition and its application in software engineering. In *2013 6th International Conference on Human System Interactions, HSI 2013*. https://doi.org/10.1109/HSI.2013.6577877

[15] Sebastian C. Müller and Thomas Fritz. 2015. Stuck and frustrated or in flow and happy: Sensing developers' emotions and progress. In *Proceedings - International Conference on Software Engineering*. https://doi.org/10.1109/ICSE.2015.334

[16] Alessandro Murgia, Parastou Tourani, Bram Adams, and Marco Ortu. 2014. Do developers feel emotions? An exploratory analysis of emotions in software artifacts. In *11th Working Conference on Mining Software Repositories, MSR 2014 - Proceedings*. https://doi.org/10.1145/2597073.2597086

[17] Nicole Novielli, Fabio Calefato, and Filippo Lanubile. 2014. Towards discovering the role of emotions in stack overflow. In *6th International Workshop on Social Software Engineering, SSE 2014 - Proceedings*. https://doi.org/10.1145/2661685.2661689

[18] Marco Ortu, Alessandro Murgia, Giuseppe Destefanis, Parastou Tourani, Roberto Tonelli, Michele Marchesi, and Bram Adams. 2016. The emotional side of software developers in JIRA. In *Proceedings - 13th Working Conference on Mining Software Repositories, MSR 2016*. https://doi.org/10.1145/2901739.2903505

[19] Rajshakhar Paul, Amiangshu Bosu, and Kazi Zakia Sultana. 2019. Expressions of Sentiments during Code Reviews: Male vs. Female. In *SANER 2019 - Proceedings of the 2019 IEEE 26th International Conference on Software Analysis, Evolution, and Reengineering*. https://doi.org/10.1109/SANER.2019.8667987

[20] Isabel Ramos and Daniel M. Berry. 2005. Is emotion relevant to requirements engineering? https://doi.org/10.1007/s00766-005-0014-5

[21] K R Scherer. 1987. Toward a dynamic theory of emotion. *Geneva Studies in Emotion* (1987).

[22] Yogeshwar Shastri, Rashina Hoda, and Robert Amor. 2017. Understanding the roles of the manager in agile project management. In *ACM International Conference Proceeding Series*. Association for Computing Machinery, 45–55. https://doi.org/10.1145/3021460.3021465

[23] Navdeep Singh and Paramvir Singh. 2018. How Do Code Refactoring Activities Impact Software Developers' Sentiments? - An Empirical Investigation into GitHub Commits. In *Proceedings - Asia-Pacific Software Engineering Conference, APSEC*. https://doi.org/10.1109/APSEC.2017.79

[24] Michal R. Wrobel. 2013. Emotions in the software development process. In *2013 6th International Conference on Human System Interactions, HSI 2013*. https://doi.org/10.1109/HSI.2013.6577875