Satisfaction, Practices, and Influences in Agile Software Development

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ABSTRACT

The principles behind the Agile Manifesto begin with "Our highest priority is to satisfy the customer…". It also states that Agile projects should be build around motivated and self-organized teams, which might also lead to more satisfied developers. Several studies indeed report an increased job satisfaction by anecdotal evidence. In this paper we address the topic of satisfaction by in-depth analysis of the results of a nationwide survey about software development in Switzerland. We wanted to find out if satisfaction depends on the applied development method, and, more concrete, how satisfaction relates to other elements in the development process, including the use of various practices, and the influences on business, team and software issues. We found that higher satisfaction is reported more by those using Agile development than with plan-driven processes. We explored the different perspectives of developers and those with a management role and found a high consistency of satisfaction between Agile developers and Agile management, and big differences with using working plan-driven methods. We found that certain practices and influences have high correlations to satisfaction, and that collaborative processes are closely related to satisfaction, especially when combined with technical practices. Applying recursive partitioning, we found which elements were most important for satisfaction, and gained insight about how practices and influences work in combination. We also explored the relationship between satisfaction and personal experience with Agile development. Our results in this analysis are principally descriptive, but we think they can be a relevant contribution to understand the challenges for everyone involved in Agile development, and can help in the transformation to Agile.

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CCS CONCEPTS

• **Software and its engineering → Software creation and management**; **Software development process management**; **Agile software development**;

KEYWORDS

Agile Software Development; Satisfaction; Software Development Practices; Software Process

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1 INTRODUCTION

In the last decade Agile software development methods have been widely used in industry and have become mainstream, as recent studies show [8, 18]. The studies typically report "management of changing priorities", "faster time to market", "team morale", "team productivity" and "people development" as top benefits from performing Agile practices. While the very first principle of the Agile Manifesto begins with "Our highest priority is to satisfy the customer…" [1], studies also show that Agile team members themselves report stronger satisfaction compared with their experience with plan-driven approaches (e.g. [19]). However, not much is known about the most powerful reasons for the satisfaction. Hence we examine the following research questions:

RQ1 : How does the applied software development method influence satisfaction of the team?

We wanted to find out if Agile development leads to higher satisfaction than traditional plan-driven approaches. This question has also driven earlier research, as we discuss later, though such interest was more common when Agile methods were new. We also wanted to find out if the view on satisfaction of management is similar to that of individual professionals. We define the terms Agile and plan-driven according to Boehm and Turner in [3].

RQ2 : How does satisfaction correlate to the applied practices?

Most importantly, we wanted to find out which practices relate most strongly to satisfaction.

RQ3 : Does satisfaction depend on the influences achieved with the development method?

We also wanted to find out if and how satisfaction relates to the results achieved with Agility. For this we were asking how Agility influences certain business aspects (like time-to-market), team aspects (like team moral), and software aspects (e.g. software architecture). We use the term "influences" for these results or outcomes of Agility.

The goal of our analysis was to help getting a deeper understanding about the effect of Agile development and to get indicators about the human aspects of Agile software development.

To address our research questions we analyze the results of a nationwide study of Agile software development in Switzerland, conducted in 2016. In the study we asked company representatives (i.e. typically upper management), and individual professionals to complete two independent surveys.

In the next section, we review earlier work on satisfaction in software development, especially that with a focus on Agile processes. We then outline the nature of our survey, the source of our study data, and the main results concerning satisfaction. The results are then explored in more detail, investigating relationships in the data in order to better understand the potential reasons for satisfaction or dissatisfaction. In particular, we explore how development practices and various influences relate to satisfaction. We then discuss our results and present our conclusions.

2 RELATED WORK

The first empirical study on satisfaction in Agile development was conducted by Mannaro et al. in 2004 [11]. Their focus was on Extreme Programming (XP), where they surveyed 55 XP and 67 non-XP professionals using the Goal-Question-Metrics (GQM) approach [2]. They found that satisfaction was greater among XP professionals than others on a number of measures, not only in general, but also on a variety of specific issues, such as reduced stress, increased productivity, and better attitude.

In 2006, Melnik and Maurer presented results of a large (n=756) online survey [12], also based on the GQM approach; they also discussed a large survey that had recently been conducted by *Computerworld* magazine. They applied statistical inference and found evidence that Agile practitioners were more satisfied than others, and also that experience with Agile methods increased that effect. They also reported that the effect was found both for programmers and managers.

In 2007, Tessem and Maurer presented results of a case study of satisfaction in a large Agile team at an ICT company producing software for the petroleum industry [14]. The team used Scrum, but with some practices (such as pair-programming) from XP. The study was based on interviews with team members and consideration of the general Job Characteristics Model (JCM) of Hackman and Oldham [6]. This study also found strong support for satisfaction with Agile methods, and pointed to alignment with five elements of the JCM, including the positive effects of autonomy, of variety in work, of good communication with others, of significance of the work, and of addressing "complete" units of work (e.g. user stories).

Tripp and Riemenschneider have addressed the issue of satisfaction in Agile development looking for theoretical underpinnings [16, 17]. They explored satisfaction in Agile development with Hackman and Oldham's JCM, taking a quantitative approach to see how well results from an Agile development survey match the model. They first used regression and factor analysis [17]. They focused on Coding Standards, Daily stand-up, Refactoring, Pair programming, Unit testing, Iterative planning, and Automated builds. They did find evidence that the Agile practices relate to most elements of the JCM, though interestingly did not find evidence for the "autonomy" element. Their later analysis applied the more sophisticated approach of structural equation modeling (SEM) [16]. The approach distinguishes Agile project management (PM) practices and Agile software-development approach (SDA) practices, and suggests how each relates to the JCM. The PM practices included were Daily stand-up meeting, Iterative delivery, Retrospectives, and Burndown (charts). The SDA practices included were Automated (unit) testing, Automated builds, Continuous integration, Coding standards, Refactoring and Pair programming. The findings of the study suggest that PM practices directly influence satisfaction, whereas SDA practices do support some of the elements of the JCM, but do not directly support satisfaction. The authors highlight the interdependence of the practices, and also consider that the "autonomy" element of the JCM may not align well with the team emphasis in Agile development.

This interplay of "technical" and "collaborative" practices also features in studies of other aspects of Agile development. For example, following their field studies of collaboration in 6 Agile teams, Robinson and Sharp make the point that collaboration works as well as it does because the practices have a structure to address important technical issues [13]. Following the analysis of their quantitative study of performance in Agile teams, Wood et al. [20] make a similar point: it is not merely that teamwork leads to better performance, but rather that the teamwork works with the technical practices.

In [5] Dybå and Dingsøyr provide a literature review about empirical studies of Agile software development. They mention studies that report improved customer satisfaction when using Agile methodologies. They also report about satisfaction from the developer perspective, mentioning a higher satisfaction with the product and customer collaboration.

In [10] Lindsjørn et al analyze the effect of teamwork quality (TWQ) on various aspects and report a strong positive impact of teamwork quality on work satisfaction.

In our study we use a broader range of practices (more technical practices, collaboration practices and planning practices) and set the satisfaction in relation to the influences in business and team aspects and the applied practices. We take a descriptive approach, and explore various concrete issues.

3 STUDY SETUP

3.1 Study Purpose

Our study was a nationwide online survey conducted by us in Switzerland in 2016. The study is about the usage of development methods and practices in the IT industry, and about the influence of applying Agile methods on projects. More detail is available about the survey instrument and the general results in the study report [9].

Table 1: Distribution of the roles of the participating companies and sizes of the companies in the study.

Role	%
CEO	34%
CTO	17%
Development Manager	11%
Team Leader	10%
CIO	7%
Project Manager	6%
Designer / Architect	2%
Software Developer	2%
Product Manager	1%
Researcher	1%
Other	9%

Size	%
Micro enterprise (≤ 9)	25%
Small enterprise (10-49)	37%
Medium enterprise (50-249)	19%
Large enterprise ≥ 250)	19%

3.2 Study Approach

The study addresses both Agile and plan-driven companies as well as both Agile and plan-driven IT professionals, or any hybrids. The study is designed as two independent surveys: one for companies, one for IT professionals.

In the company survey we address representatives of the company or the development department of a company, i.e. typically upper management level. This allows us to compare the answers from management with those of the IT professionals, typically software developer (see more about participant demographics in section 3.3)

The survey questions are identical for both groups; however the professional has one additional question about issues that has changed personally since introducing Agile (called "MyAgile").

The study is executed as two independent online surveys. To ensure a company is represented only once in the company survey, we sent personalized links to one management representative of each company. The IT professional survey is an anonymous survey. We distributed the link to the anonymous survey via email and through professional social media like LinkedIn an XING.

The addresses of the companies and the professionals were collated from the supporting national IT associations, as well as from our own institutional databases.

3.3 Participant Demographics

We emailed 1399 companies directly with personal access code for the company representative, and about 5000[1] IT professionals in Switzerland. with an anonymous link to the the survey. 142 companies and 185 IT professionals filled out the complete survey. The addresses of the companies and the professionals were collated from the participating IT associations SwissICT[2] and SWEN[3], as well as from our own institutional databases. Table 2 shows the detailed survey statistics. The impression value of the anonymous IT professional survey indicates the number of people visiting the survey web site.

[1]We do not know the exact number, since these mailings were partially done by partner associations

[2]www.swissict.ch

[3]http://www.swen-network.ch

Table 2: Survey Statistics

	company survey	anonymous survey
Impressions (Gross2)	1399	529
Response rate	18.16%	62.00%
Completion rate	10.15%	31.19%

Table 1 shows the demographics of the roles of company representatives. It shows that 34% of the participants were Chief Executive Officers and 17% were Chief Technology Officers. "Other" includes roles like Business Analysts, Agile coach, founder, owner, and CFOs.

The responding IT professionals were typically Senior Software Developers (17%), Software Developers (12%), Project Managers (13%), Team Leader (10%), and Designer/Architects (10%). We had a high number of "Others" (17%), which include roles like Scrum Masters, Agile Coaches and Product Owners. The IT professionals were also working mostly in a company, but were participating and speaking for themselves.

Table 1 shows the distribution of the sizes of the participating companies following the official categories of the Swiss Statistical Office[4]. More than 60% are micro and small enterprises. Among the large enterprises there were four with more than 10,000 employees.

From the 182 participating professionals 102 participants provided the company name. The professional participants come from 59 different companies. Table 3 shows the distribution of participants per company. The first row shows that there were 44 companies with one participant; 29 participants are coming from only 4 companies (two of these companies are in the financial domain). For 80 participants we don't know form which company they are. We must therefore be cautious about the potenial lack of representativeness in our results.

Table 3: Distribution of Participants per Company

Number of Companies	Participants per Company
44	1
6	2
3	3
2	4
1	5
1	7
1	8
1	9
N/A	80

The main branches of the companies are IT Services/IT Consulting (30%), Software Industry/Development (28%). Public Service and Finance/Insurance companies make 8% each. Next comes Telecommunication with 7%. The rest are 4% and below. The participation is a reasonable reflection of the character of software development in Switzerland according to the official governmental statistical office.

[4]http://www.bfs.admin.ch/bfs/portal/en/index/themen/06/02/blank/key/01/groesse.html

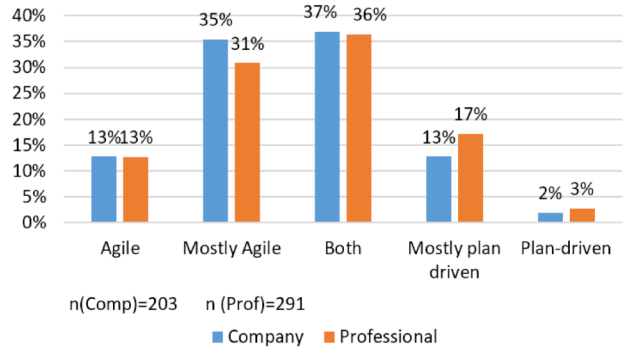

Figure 1: Percentage of companies and individual professionals doing agile on a scale from pure agile to pure plan-driven.

3.4 Study Questions and Analysis

We used an input-output model to address project aspects: We were asking about the application of common development practices, especially in Agile software development. We were also asking for influences of Agile software development, especially about business influences, team influences and the influence on software quality. We also added questions about experience, self-ratings and the personal situation and company background. The main basis for our questions were the earlier Swiss Agile Study [8], the study by Version 1 [18], and our own experience with industry, that teams use different processes depending on the the projects or external factors. The survey instrument questions and general results are availble in the report [8]. The questions and our analysis is principally based on Likert scales, and is therefore a quantitative approach based on self-reported experience and perception. Qualitative analysis was minimal, and limited to write-in answers to some questions where our categories could not be exhaustive.

4 BASIC FINDINGS

In this section we present results about the distribution of applied methodologies and satisfaction.

Figure 1 shows the results of the company representatives and individual professionals to the question: *1.1 Is your company currently practicing plan-driven or agile software development?*. The participants could choose on a scale from (pure) Agile, mostly Agile, both, mostly plan-driven, and (pure) plan-driven. Aggregated, 85% of the companies and 80% of the professionals answered to apply Agile development, at least to some extent; however, only 13% for both, companies and professional, responded to apply only Agile development.

The survey question concerning satisfaction asked *1.3 How satisfied are you with your current methodology?*. Possible answers were on a scale from 1 (unsatisfied) to 4 (very satisfied). We have chosen a 4-point Likert scale to force a choice and avoid equivocation. Figure 2 shows the satisfaction results of all participating companies and all individual professionals. In the survey of companies, most representatives responding indicated satisfaction. In the survey of professionals, however, the results were balanced between unsatisfied and satisfied. We speculate that the difference between company representatives and individual professionals may stem from the representatives wanting to present a more positive view of their organization, or may indicate some detachment from the actual experience of software development.

We were especially interested to explore whether Agile development leads to more satisfaction. Figure 3 shows the analysis of the above question divided into three participation categories. We aggregated the "pure Agile" and "mostly Agile" companies into one "Agile" group, the "pure plan-driven" and "mostly plan-driven" into a "plan-driven (PD)" group and kept the "both" group standalone.

Figure 3 shows a very high satisfaction rate, for both the Agile companies and the individual professionals, with very similar values. In the "Both" category the companies still report high satisfaction, while the professionals are not quite as satisfied. However, in the "plan-driven" category companies, i.e. management, still report a high level of satisfaction with the methodology (71%), while only 16% of the professionals report to be satisfied or very satisfied. But 40% of the plan-driven developers report to be unsatisfied with the methodology.

To begin our analysis, we can compare the level of satisfaction (1–4) reported with the level of agility (from 1: plan-driven to 5: Agile). This is shown in Figure 4, on the left, where each level of Agility is shown on the horizontal axis, and the distribution of satisfaction responses for each is shown by a boxplot.[5] The self-reported level of Agility may not be accurate, so we also show (on the right of the figure) how the level of Agility compares to the mean level reported for a number of Agile technical practices. As we can see, this demonstrates a strong relationship, suggesting a link from the practices, to perception of Agility, to satisfaction.

The company data was provided by representatives who were mostly managers, often senior managers. However, a number of the individual professionals responding were also managers. We therefore explored the levels of satisfaction by such managers compared

[5] Although the Likert data is ordinal, we use boxplots to show distribution in a compact manner. The thick line indicates the median, the coloured box indicates the inner quartiles, the whiskers indicates the outer quartiles, and circles show outliers. Diamond markers show the mean.

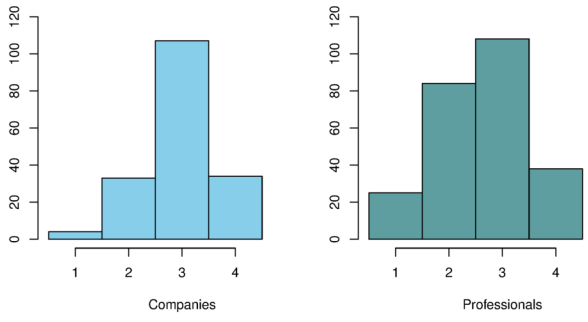

Figure 2: Results from survey: company representatives (left) and individual professionals (right). Distribution of reported satisfaction, on a scale from 1 (unsatisfied) to 4 (very satisfied).

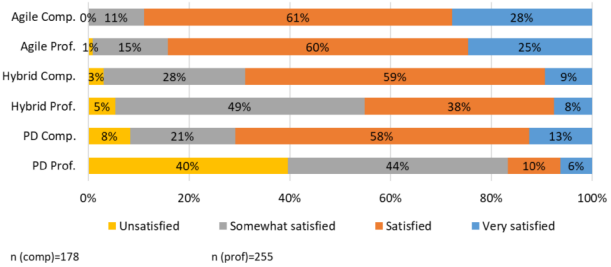

Figure 3: Satisfaction with the methodology aggregated to agile (pure agile and mostly agile), both, plan-driven (mostly plan-driven, pure plan-driven) for companies and professionals (Agile Comp, Agile Prof, Both Comp, Both Prof, PD Comp, PD Prof).

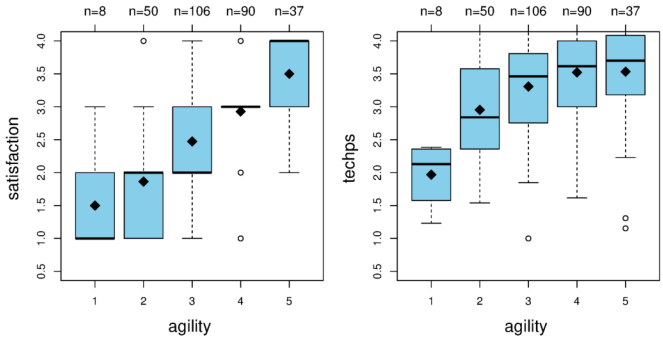

Figure 4: Satisfaction levels by level of agility claimed (left) 1–4, and mean level of technical practices by level of agility (right) 1–5 claimed. Together these show that satisfaction is related to level of agility, and that the claimed level is indeed based on the level af actual technical practices used.

with developers. We had asked for individual professional's job titles, and counted as managers anyone with "manager" or "coach" in their title, 62 in all; we counted as developers anyone with "developer" or similar in their title, 64 in all. The results are shown in Figure 5, and show similar patterns: more agility is associated with greater satisfaction. We also explored the manager/developer distinction in many other aspects of the data for individual professionals, and found few differences.

5 POTENTIAL REASONS FOR SATISFACTION

In this section, we explore the potential *reasons* for satisfaction, using the data from answers to other questions in the survey. In particular, we use the answers from the survey of professionals, because they were answering for themselves alone. We omit the answers from the companies, i.e. management, here, because they might tend to claim more positive satisfaction than individuals, as Figure 3 indicates.

In a survey of this nature, we actually cannot detect reasons, or causes, for satisfaction, but merely answers that exhibit a close

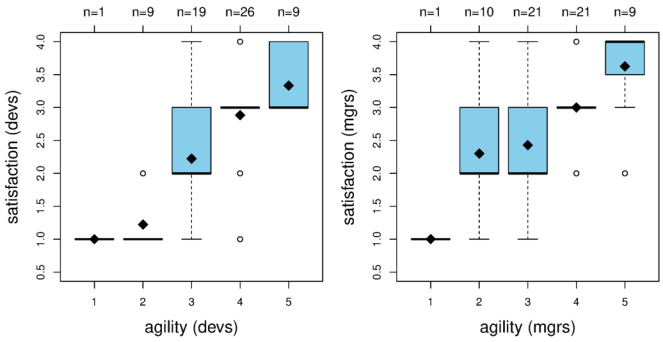

Figure 5: Satisfaction levels by level of agility, for developers (left), and managers (right), showing the relationship between satisfaction and agility is true for both.

relationship. The survey questions follow a consistent Likert scale format (1–5), and so allow detection of similar patterns mathematically. We identify the similarities we find, and discuss *how* these relationships might arise.

The survey question about satisfaction came very early in the survey, and asked a simple direct question: "How satisfied are you with your current methodology?" As the survey progressed, professionals were asked about a range of their experiences in their software development environment. There were several sets of questions about *practices*: first technical practices, then collaboration practices, and lastly planning practices (Table 4). Each of these sets comprised several questions. Later, there were question sets about *influences* of Agile, first business influences, then team influences, and then software influences (Table 4). We acknowledge that in some cases these categorizations are more distinct than ideal: some measures could well feature in several categories. The list of practices reflects common practices in software development and especially in Agile software development. With the list of influences we wanted to find out the impact on business, team and software level. We use the term *practices* for things that teams do, while we use the term *influences* for the resulting effects. Hence we regard practices as "inputs", and influences as "outputs".

To examine the relationship between satisfaction and other issues, we compared the answers for satisfaction and for other issues on a person-by-person basis, where each person responded to the same questions. We computed correlation statistics, comparing satisfaction answers with the matching answers for other questions. A correlation shows that when one figure is low, so is the other, and similarly for high. To compute the correlation, we use Spearman's non-parametric "rho" (ρ) method, rather than Pearson's r, because our Likert scale data is ordinal, and this approach supports more conservative results. A rho approaching 1 is an extremely close match, a rho approaching -1 is extremely close but opposite, and a rho approaching 0 is a very poor match. We also calculated significance, the probability that such a result might occur by chance, and dismissed results beyond an alpha level of 0.05.

Table 5 shows the top 10 correlations of satisfaction with various answers about software development practices, on the left.

Table 4: *Agile Practices*: technical, collaborative, and planning. *Agile Influences*: business, team, and software. Each practice and influence was ranked on a Likert scale of 1–5.

Agile Practices	Agile Influences
Technical Practices	**Business Influences**
Unit testing	Time to market
Coding standards	Manage changing priorities
Automated builds	Alignment between IT
Refactoring	& business objectives
Continuous integration	Project visibility
Software Craftsmanship	Handling of project risk
DevOps	Development process
Clean Code	Management of distributed teams
Behavior Driven Development	Requirements management
Acceptance Test Driven Development	Delivery predictability
Test Driven Development	
Automated acceptance testing	
Continuous delivery	
Collaborative Practices	**Team Influences**
Dedicated product owner	Team productivity
On-site customer	People development
Daily stand-up	Effectiveness of meetings
Retrospective	Impediment management
Open work area	Engagement of product owner
Team-based estimation	Team morale / motivation
Collective code ownership	Stress at work
Pair programming	Working overtime
Single team	
Self-organizing team	
Planning Practices	**Software Influences**
Release planning	Product / software innovation
Iteration planning	Software quality
User stories	Software maintainability
Taskboard	Engineering discipline
Burndown charts	Software architecture
Story mapping	Defect rate
Prioritized backlogs	
Short Iterations	

Table 5: Satisfaction correlations for Agile practices and influences. Technical practices are prefixed TP, collaborative practices with CP, and planning practices with PP; business influences with BI, software influences with SI, team influences with TI

#	Practices Questions	rho	p.value
1	CP Self organizing team	0.446	<.001
2	CP Collective code ownership	0.375	<.001
3	PP Story mapping	0.306	<.001
4	PP Short Iterations	0.299	<.001
5	CP Single team integrated development and testing	0.293	<.001
6	TP Software Craftsmanship	0.275	0.001
7	PP Prioritized backlogs	0.258	<.001
8	CP Team based estimation	0.247	<.001
9	TP Refactoring	0.245	<.001
10	TP Acceptance Test Driven Development ATDD	0.235	0.001
#	**Influences Questions**	rho	p.value
1	BI Time to market	0.333	<.001
2	BI Management of distributed teams	0.289	0.001
3	BI Handling of project risk	0.261	0.001
4	BI Development process	0.249	0.002
5	SI Software architecture	0.239	0.003
6	TI Stress at work	0.224	0.007
7	BI Ability to manage changing priorities	0.218	0.006
8	BI Delivery predictability	0.216	0.008
9	TI People development	0.213	0.009
10	BI Project visibility	0.193	0.019

We sorted the results in decreasing order of rho, so more highly correlated answers are shown first. (More precisely, in order to detect any reverse correlations, we sort by absolute value of rho, but report the true value). In the table, we can see that the highest correlation for satisfaction with practices comes from the collaborative practice of a self-organizing team, followed by that of collective code ownership and Story mapping, and these are the only practices with rho>0.3. Figure 6 presents boxplots for these two issues, showing how they relate to satisfaction. Moreover, the top 5 are all either collaborative practices or planning practices. Although 3 technical practices are in the top 10, the pattern seems clear: it is collaboration and planning practices that most closely match satisfaction.

Moving from practices to influences, we use the same technique, with the results shown on the right of Figure 5. Here the most high correlated answer is about time to market. This could be an indication that fast time to market might generate higher satisfaction. Interestingly, the second most highly correlated answer is about management of distributed teams. This might seem odd, because Agile methods are often regarded as poor on this aspect, but the finding simply means that when management of distributed teams is done well, satisfaction is high. The relationships for these are shown in the boxplots in Figure 7. Note also row 5 on the right of Table 5, Software architecture, the highest and only "Software Influence" measure in the top 10. Row 6 is Stress at work: we reverse-coded this aspect, so a high result means lower stress: it makes sense that this is related with high satisfaction. Overall, it is interesting that 7 of the top 10 are business influences. This suggests that success with business aspects might have a strong impact on, or necessary for, software professionals' satisfaction, reflecting the first principle of the Agile Manifesto: "Our highest priority is to satisfy the customer…" [1].

Considering the practices and the influences together, it is tempting to see a general picture: satisfaction is highly correlated with collaborative and planning practices, together with success in business aspects. However, this is not the whole story. Referring again to Table 5, we can see that even the highest correlations are only in the range of .3 or .4, and so nowhere near the 1 indicating a perfect correlation. This is not surprising, because software development is complex, and we should not expect any one practice or influence to lead to perfect satisfaction. Rather, it makes more sense that several aspects would be necessary for high satisfaction. Moreover, consideration of only correlation is quite limited, and will miss some

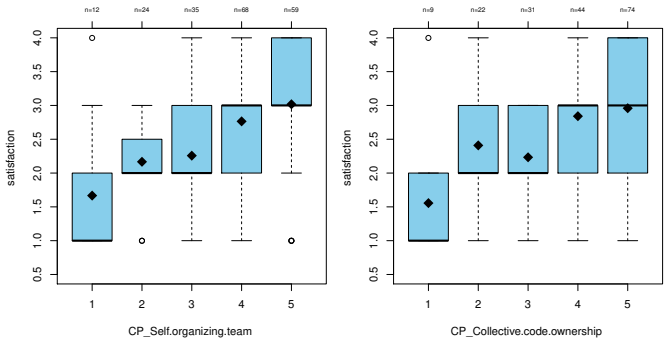

Figure 6: Satisfaction levels by Self-organizing team and Collective code ownership.

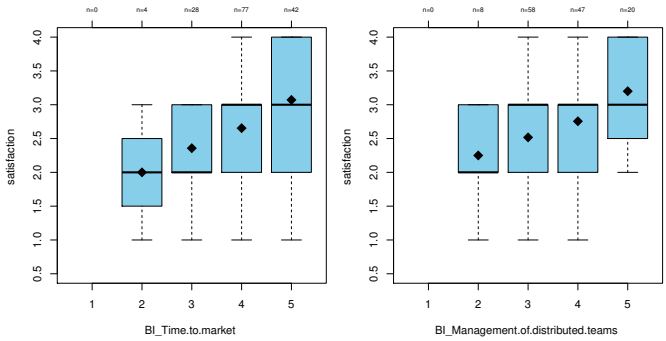

Figure 7: Satisfaction levels by Time to Market and Management of Distributed Teams.

important patterns, such as close matches for part of a distribution, but divergence elsewhere.

To explore this, we considered several approaches. For example, in studies of complex processes, the approach indicated might be multiple regression, where satisfaction is the dependent variable (DV), and the practices and influences are the independent variable (IVs), and a formula relating them is sought. We feel, however, that this is more suitable for underlying continuous physical processes. Accordingly, we took an approach that looks for critical points in the data that affect satisfaction. To do this, we used Recursive Partitioning to create a Regression Tree [4, 15]. In this approach, the analysis begins with the whole data set, and determines which IV, and at what point, best divides distinctly the DV. Thus we obtain two sets, one with lower satisfaction, and one with higher. The process is then applied recursively.

We applied this approach first to the practices, and obtained the trees shown in Figure 9 on the left tree. As we might expect from the earlier correlation analysis, the primary factor is the collaborative practice of a self-organizing team. The tree is split between results for that question on a rating of 3.5 (on the Likert scale of 1–5), with the lower to the left, and the higher to the right. On the right, we next see, again as we might expect from the correlations, the factor of collective code ownership. Where it is at or above 3.5, the next

#	My Agile
1	I pay more attention to technical excellence
2	My work life balance has improved
3	Release is not a nightmare anymore
4	We have developed a culture of mutual respect
5	I feel much more committed/dedicated to the team and to the work
6	I have more fun at work
7	I think my work is more valued
8	We have a team environment which is honest and trusting
9	Team members take the initiative to accomplish tasks more often
10	The team has been empowered to make decisions about how to do their work and execute on those decisions without outside interference
11	We have a culture of servant leadership
12	We have a team environment which allows for mistakes
13	The team is encouraged to be creative and to experiment with new ideas

Table 6: "My Agile" questions, each question was ranked on a Likert scale of 1–5.

#	My Agile	practice	rho	p.value
1	The team has been empowered to make decisions about how to do their work…	CP Self organizing team	0.378	<.001
2	I feel much more committed dedicated to the team and to the work	CP Pair programming	0.371	<.001
3	The team is encouraged to be creative and to experiment with new ideas	CP Self organizing team	0.362	<.001
4	Team members take the initiative to accomplish tasks more often	CP Self organizing team	0.355	<.001
5	We have a culture of servant leadership	CP Self organizing team	0.321	<.001
6	We have a team environment which allows for mistakes	CP Self organizing team	0.317	<.001
7	I think my work is more valued	TP Software Craftsmanship	0.309	0.001
8	I think my work is more valued	PP Story mapping	0.300	<.001
9	We have a team environment which allows for mistakes	CP Pair programming	0.299	<.001
10	We have developed a culture of mutual respect	CP Self organizing team	0.298	<.001

Table 7: Correlations between "My Agile" questions and practices (top 10 significant).

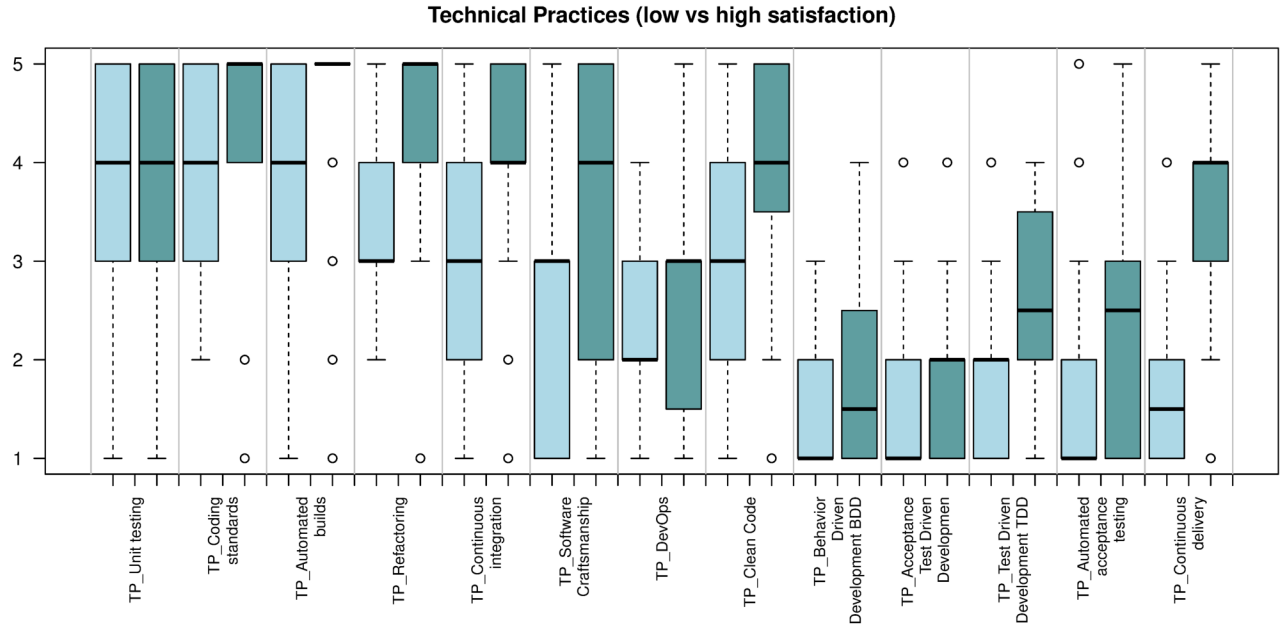

Figure 8: Results for questions about Technical Practices, showing those in low (lighter colour) vs. high (darker colour) satisfaction cases.

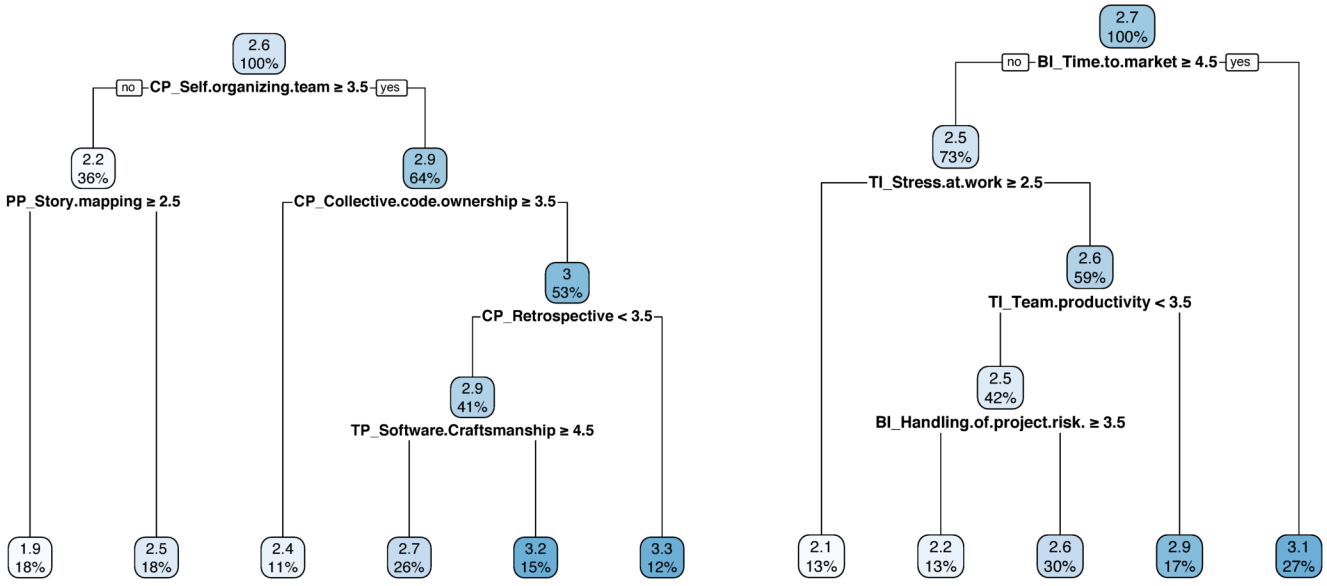

Figure 9: Satisfaction factors in practices (left) and influences (right). Nodes show implied satisfaction level and % of data, leaves limited to 10%. Tone density of nodes indicates levels of satisfaction: darker means higher.

factor is the collaborative practice of retrospectives, and that gives the highest result for satisfaction: a mean result of 4.1. We can explore the other branches for the tree, to see the effects of other factors. On the left side of the tree we can see the factors related to low satisfaction: the lack of user stories and story mapping appears strongly related to low satisfaction. Overall, the impression is similar to what we expected from the correlations, collaborative practices are paramount, though technical practices also play a role, and we now have more detail to identify which combinations lead to the best results. There is one important caveat. In the tree, note that the right-hand branch indicating higher satisfaction comes from *lower* emphasis on retrospectives. The tree on the right shows

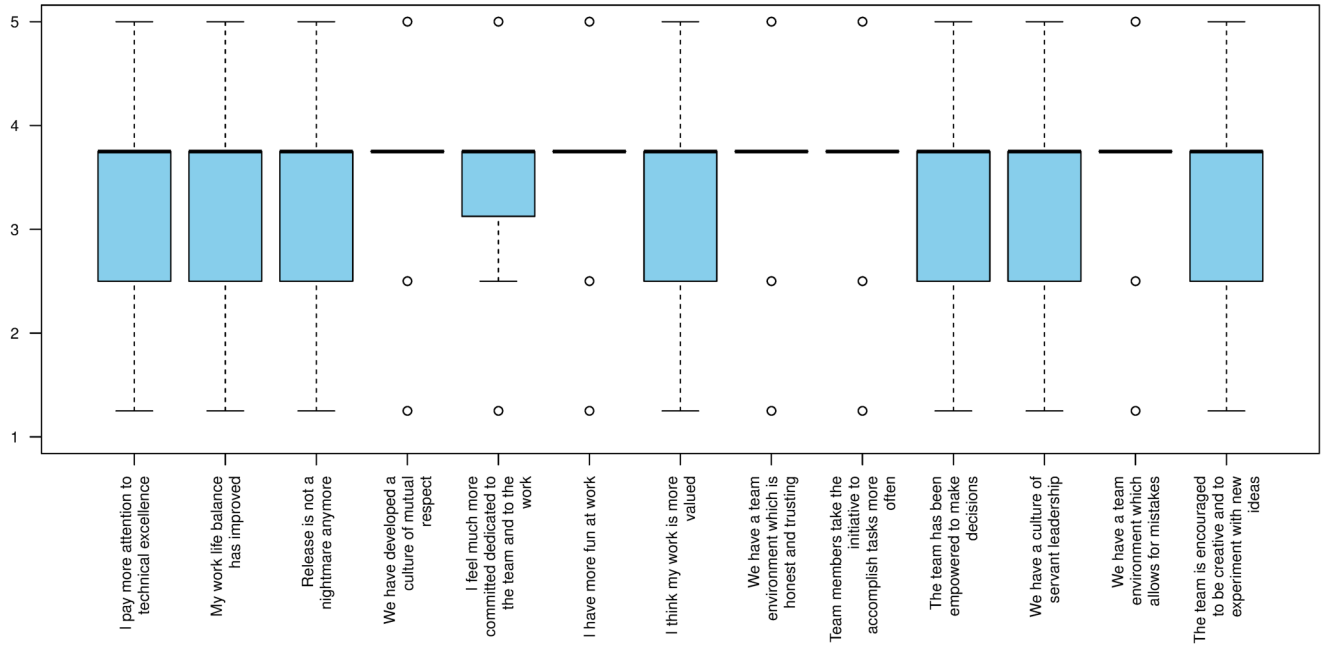

Figure 10: Results for "My Agile" questions 1–13 from Table 6.

the pattern for influences. Here we see that the primary factor is time to market, and for lesser levels the important issues are stress, productivity, and risk management. To illustrate the reality of low and high satisfaction, we offer Figure 8. The figure shows the results for the questions about technical practices for the leftmost (18%) and rightmost (12%) branches of the satisfaction tree about practices: the least and most satisfied professionals.

In the survey, professionals were also asked questions about their personal perspective on Agile processes, "My Agile": see Table 6. The question we asked was: *7.1 To what extent do you agree with the following statements?*. The participants could choose on a scale from "completely agree", "agree", "disagree" and "completely disagree". The general results for each question are shown in the boxplots in Figure 10. One thing we can immediately see is that the results are fairly consistent, with every scale showing the same median, although some distributions are very tight (e.g. "more fun at work".) We explored the relationship with satisfaction using the recursive partition approach, obtaining the tree shown in Figure 11. As we can see here, two factors stand out. The dominant finding is a relationship between satisfaction and the factor "I pay more attention to technical excellence": showing the importance to people of the quality of their work. Below, the issue of avoiding stress is shown to be important.

We were interested in the relationship between the results for these questions and those for the practices, so we calculated pairwise correlations for each of the "My Agile" questions with each of the practices questions. We used the same technique described above, and report the top 10 significant correlations in Table 7. As can be seen, we see several of the same factors we have highlighted before. In particular, having a self-organizing team is the practice most strongly linked to high scores in the "My Agile" questions, though some technical practices also appear in the top 10.

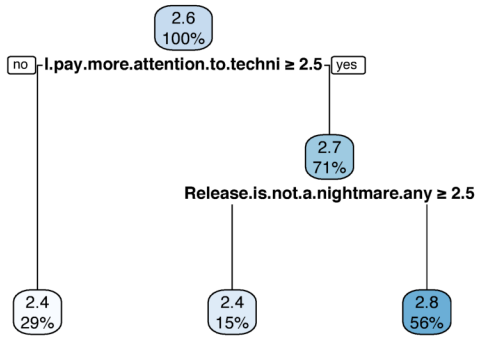

Figure 11: Satisfaction factors in answers to "My Agile" questions.

6 DISCUSSION AND CONCLUSIONS

In our findings described in the sections above, we first noticed confirmation that, for individual professionals, Agile development is associated with greater satisfaction than plan-driven development. Our question then was why this happened? What practices were most closely related to this trend, and what influences?

When we looked at practices, we considered three kinds: technical, collaborative, and planning practices. What we found was that the strongest relationship with satisfaction came from collaborative practices: self-organizing teams, and collective code ownership. The technical practices, such as software craftsmanship and story mapping, do have an effect, but at lesser levels. Overall, this suggests that self-organizing teams and collective code ownership need to be taken very seriously, otherwise satisfaction might suffer.

For influences, we enquired about business influences, team influences, and software influences. The dominant factor we found was a business factor: time to market. It seems that teams take pleasure in delivering fast. At lesser levels, team influences such as avoiding stress and maintaining productivity were seen to be important. Although our survey of professionals had mostly developers and low-level managers, it is interesting to see that business influences are seen as so important: this appears to show the kind of positive relationship between software development and business goals that Agile methods emphasize.

The survey also included the "My Agile" section, which sought to find out the personal feelings about the process. When we looked at the factors linked to satisfaction, the dominant one that emerged was a concern for technical quality. We found this interesting, because technical topics did not appear so important in our analysis of practices or influences.

Overall, we can describe the picture that emerges as follows. Agile development seems to lead to greater satisfaction primarily because of collaborative practices and business influences. Technical practices and team influences are important, but at lesser levels. On a personal basis, however, an ability to focus more on technical quality is seen as critical.

This picture suggests some lessons and some challenges. Perhaps the most important lesson relates to collaborative practices: if we expect Agile methods to lead to satisfaction, they cannot be ignored, and must be supported. In particular, the role of self-organization seems critical, and so studies of this are important: such as the work of Hoda et. al [7].

Our study has several limitations we acknowledge. One is the coverage of the survey. We found that the company types and job roles reflected our software industry well, but more careful coverage would be beneficial, especially to attempt representative balance across organizations and domains. Similarly, we must be cautious because the data is self-reported, and indeed self-selected. For example, it is possible that professionals might be more likely to self-select if they were interested in, or even advocates of, Agile methods. In future would we might be better to include questions to detect such bias to improve the validity of our results. Our emphasis on Agile methods might also dissuade proponents of more planned approaches from participating, so we should be especially hesitant about any negative findings about planned approaches. Finally, and of particular importance to the topic of this paper, is that we cannot assume correlation reflects causality. However, we are now able to identify potential causes to explore more specifically in later studies.

There are a variety of specific challenges. One arises from the anomalous finding about retrospectives discussed in the previous section: at some point too much emphasis is related to *reduced* satisfaction. So we cannot regard collaborative practices as always beneficial — or perhaps that in some cases practices like retrospectives need to be conducted with more care.

More broadly, there is a research challenge identified by the dichotomy of practices and influences with little emphasis on technical issues, but personal feeling is linked to ability to focus more on technical issues. One possibility is simply that professionals feel they know how to address technical quality, but identify collaborative practices are the key way to ensure time for such concerns. This needs more research.

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