



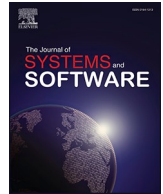
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Job satisfaction at risk: Measuring the role of process debt in agile software development

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ABSTRACT

Process debt (PD) in agile software development represents inefficiencies that undermine team performance and job satisfaction. This study investigates the quantitative impact of PD on job satisfaction within agile teams, surveying 191 participants from two software development organizations. Our research examines five PD types: Process Unsuitability, Roles Debt, Synchronization Debt, Documentation Debt, and Infrastructure Debt. Using multiple regression analysis, our model explains approximately 33.8 % of the variance in job satisfaction. Among the five PD types, Process Unsuitability and Roles Debt emerged as statistically significant predictors of reduced job satisfaction. These findings indicate that certain forms of PD have a measurable negative impact on developers' perceptions of their work environment. By identifying which PD types most strongly influence job satisfaction, this research offers empirically grounded insights that can inform targeted interventions. Understanding and addressing the most impactful PD categories may help organizations refine agile processes, thereby mitigating the detrimental effects of process inefficiencies on job satisfaction.

1. Introduction

While much attention has been afforded to understanding and mitigating Technical Debt (TD) (Holvitie et al., 2018), a parallel yet distinct phenomenon known as Process Debt (PD) has begun to gain recognition for its influence on software development organizations (Ahmad and Gustavsson, 2023, 2024; Gomes et al., 2023; Martini et al., 2019, 2020, 2023; Melo et al., 2021; Saeeda et al., 2023, 2024). Alves et al. (2014) extended the metaphor of debt to include a wider range of TD types, including thirteen categories where one of which was PD. In software development, there is a widely held belief that the quality of the development process is directly linked to the quality of the software produced (e.g., Cugola and Ghezzi, 1998; Kitchenham and Pfleeger, 1996; Unterkalmsteiner et al., 2011). Consequently, initiatives aimed at improving software processes seek not only to enhance product quality but also to decrease time-to-market and reduce production costs (Unterkalmsteiner et al., 2011). Process efficiency, therefore, plays a crucial role not only in the success of the final product but also in the well-being of the teams involved (Vidgen and Madsen, 2003). PD describes suboptimal or outdated processes within ASD teams that, although perhaps initially intended to streamline development, often

lead to significant operational inefficiencies and decreased personnel satisfaction (Martini et al., 2023).

Martini et al. (2019) differentiate the impacts of PD from those of TD, indicating unique impacts that necessitate distinct management strategies. While TD typically focuses on code-level and architectural compromises made for short-term gain (Codabux et al., 2017; Holvitie et al., 2018), PD extends this notion into the procedural domain (Martini et al., 2020). Both forms of debt involve deferred improvements and future liabilities, but they differ in their primary point of impact. TD largely affects the software's maintainability and long-term quality (Kruchten et al., 2012), whereas PD shapes the human and organizational environment in which software is developed, influencing developer satisfaction, communication, and workflow efficiency (Ahmad and Gustavsson, 2024; Martini et al., 2019). In essence, PD complements the TD concept by recognizing that process-level inefficiencies can accumulate over time, just as code-level shortcuts do, ultimately creating organizational overheads and long-term costs that cannot be mitigated through technical fixes alone.

Furthermore, the initial consequences of PD identified by Martini et al. (2023) include developers' overhead, mistakes, and lowered morale due to tedious work conditions, intensified by uncertainty about

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and loss of trust in established processes. PD represents a specific subset of process inefficiencies that align with the debt metaphor. It involves situations where processes, either through deliberate trade-offs or unintended accumulation, introduce inefficiencies that have compounding negative effects over time. Not all process inefficiencies constitute PD, only those that lead to future issues requiring additional effort to rectify. Among these, the most impactful consequences are deemed to be the uncertainty and mistrust in processes, which directly influence developers' perceptions of their roles and the effectiveness of their contributions (Martini et al., 2023). Such conditions are not only harmful to the quality of the software products but also affect the developers involved, signaling a critical area for empirical investigation and the development of new management practices (Martini et al., 2023). By clearly distinguishing PD from general process inefficiencies, we focus on those issues that embody the debt metaphor, emphasizing the importance of proactive management to prevent long-term negative outcomes.

Being unsatisfied in your work situation has an impact on development productivity (Graziotin et al., 2018), and therefore, the interplay between job satisfaction and productivity is another crucial dimension that frames this discussion. Judge et al. (2001) and Storey et al. (2019) articulate a bidirectional relationship between overall job satisfaction and productivity, suggesting that any factor that adversely affects one is likely to impact the other. In the context of PD, this relationship implies that not only can decreasing job satisfaction from process inefficiencies lead to lower productivity, but the resulting decline in productivity can further diminish job satisfaction (Sinval and Marôco, 2020).

Despite the growing academic discourse surrounding PD, there remains a notable gap concerning its quantification and its measurable impacts on job satisfaction. To date, analogues to studies on TD, research exploring PD has predominantly been qualitative in nature. These qualitative studies (e.g. Ahmad and Gustavsson, 2024; Martini et al., 2019, 2020, 2023; Saeeda et al., 2024) have provided valuable insights into the characteristics, implications, and experiential aspects of PD. However, they fall short of offering a systematic, quantifiable approach to assessing its impact, particularly in terms of job satisfaction among software developers.

The absence of quantitative measures not only limits the depth of understanding of PD but also constrains the ability of organizations to address and mitigate its impacts strategically. While qualitative research has successfully highlighted the existence and nature of PD, the field lacks empirical data that could verify the scale of its impact and the effectiveness of potential interventions. This is particularly critical in understanding how PD influences job satisfaction which is a key driver of employee performance and organizational success (Storey et al., 2019).

Job satisfaction in software development is influenced by several factors, ranging from personal fulfillment and career growth opportunities to the more immediate work environment and process efficiency (Judge et al., 2001). The intricacies of how PD affects these dimensions have yet to be explored through quantitative studies. As such, there is a need for empirical research that employs quantitative measures to establish a clear link between PD and job satisfaction.

This study aims to bridge this gap by introducing quantitative research to develop and validate instruments that can measure the extent of PD and assess its direct and indirect effects on the satisfaction and well-being of software developers. It offers not only a deeper understanding of the impact of PD but also provides a foundation for developing metrics that can guide organizational strategies for process improvement. Such measures are crucial for moving beyond anecdotal evidence and towards a robust framework that can effectively diagnose, quantify, and address the repercussions of PD on job satisfaction in ASD environments.

The remainder of this paper is organized as follows: Section 2 provides a background, first by defining and explaining the concept of PD, and then by examining the dimensions of job satisfaction to

contextualize its significance in studies of PD within ASD. Section 3 describes the research approach, including the operationalization of job satisfaction and PD types, the formulation of research hypotheses, and the data collection methodology in the organizational contexts. Section 4 presents the data analysis used to explore the relationships between PD types and job satisfaction and presents the findings. Section 5 discusses these findings in the broader context of existing literature, highlighting their implications for theory and practice in software development. Finally, Section 6 concludes the paper by summarizing the key insights, discussing the current study's limitations, and suggesting directions for future research.

2. Background

In this section, we provide the study background by first defining and explaining the concept of PD. Next, we examine job satisfaction as a concept to provide context and justification for its importance in studies on PD in ASD environments.

2.1. Defining process debt

In software development, debt metaphors have become increasingly useful for conceptualizing and communicating the long-term impacts of suboptimal decisions and practices. Alves et al. (2014) extend the metaphor of debt to include a wider range of TD types in their proposed ontology, which includes thirteen categories such as architecture, build, code, and notably, PD. This comprehensive view underscores the interconnectedness of various debt types and highlights the broad spectrum of challenges that can accumulate as debt within software development. While both PD and TD describe debts incurred through suboptimal practices, they impact organizations in distinct ways. TD primarily concerns the quality and maintainability of the codebase and has direct implications for the technical aspects of a product (Holvitie et al., 2018). In contrast, PD affects the workflows and procedures that guide software development, thus having a broader impact on organizational efficiency and employee satisfaction (Ahmad and Gustavsson, 2024; Martini et al., 2019).

PD refers to the accumulation of inefficiencies within the processes that govern software development activities (Martini et al., 2019). Martini et al. (2019, p. 114) present the following definition of PD: "a sub-optimal activity or process that might have short-term benefits but generates a negative impact in the medium-long term." Alves et al. (2014) describe PD as the residue of organizational practices that, while perhaps once effective, have become misaligned with the organization's current operational or strategic demands. This misalignment typically results from processes designed under assumptions or for no longer relevant purposes, thereby imposing unnecessary burdens or constraints on the software development team (Martini et al., 2019). We acknowledge that the concept of PD is contested within the technical debt community. Some scholars argue that extending the technical debt metaphor beyond its original scope of code-related issues may dilute its effectiveness and lead to confusion (Kruchten et al., 2012; Rios et al., 2018; Tom et al., 2013). These critics emphasize that the metaphor traditionally involves a conscious trade-off between short-term benefits and long-term costs, rather than emerging debt due to unintended consequences of evolving processes and practices. However, we argue that PD can also result from conscious decisions that prioritize immediate gains over long-term process health. For example, a development team might deliberately skip sprint retrospectives or code reviews to deliver a feature more quickly. This conscious decision provides short-term benefits in meeting delivery schedules but incurs PD by forgoing essential process activities that support continuous improvement and quality assurance. This perspective aligns with the broader understanding of debt in software development, where intentional shortcuts lead to future liabilities. Despite these concerns, we adopt the term PD in alignment with previous research by Rios et al. (2018) and

Martini et al. (2019, 2020, 2023), who have extended the technical debt metaphor to include process inefficiencies within ASD teams. We believe that framing process inefficiencies as a form of debt is valuable because it highlights the cumulative negative impacts, whether arising from conscious decisions or emerging problems, that such inefficiencies can have on development teams.

Codabux and Williams (2013) further explore the scope of PD by identifying its various manifestations within software development practices. They note that PD can arise in several forms and suggest three PD areas (or types). One is named Infrastructure Debt, where inadequate tools or platforms hinder effective development practices and include issues related to both the digital and physical tools required for optimal process execution (Li et al., 2015; Martini et al., 2020, 2023). Technology and tools are important in supporting the processes and automating and facilitating process steps (Ramač et al., 2022). Problems arise when these tools are outdated, poorly integrated, or unfit for contemporary processes, leading to errors and inefficiencies. Infrastructure issues could end up delaying development activities or hindering the progression of the software (Çağlayan and Özcan-Top, 2024). Inadequate physical workspace arrangements that fail to meet the functional needs of teams also contribute to this type of debt (Codabux and Williams, 2013; Li et al., 2015).

Besides Infrastructure Debt, Codabux and Williams (2013) also present Documentation Debt, characterized by outdated or unclear documentation that fails to meet current needs. It also involves challenges related to the adequacy and accessibility of process documentation (Li et al., 2015; Martini et al., 2020, 2023). Teams may struggle with either a lack of necessary information, which leaves critical procedures unclear, or overly detailed documentation that buries important details under an avalanche of irrelevant data (Li et al., 2015; Codabux and Williams, 2013). A lack of documentation could also render false or inadequate information about the system's creation, deployment, and use (Çağlayan and Özcan-Top, 2024). Also, a lack of documented decision rationales, i.e., why decisions were made and their expected impacts, could cause confusion and harm to the software development process (Liebel et al., 2018).

A third process debt type is mismatching roles and responsibilities, or Roles Debt, which relates to ambiguities in roles and responsibilities leading to inefficiencies and frustration among team members (Codabux and Williams, 2013). Roles debt occurs when there is a discrepancy between the responsibilities outlined in a process and the actual roles within the organizational structure (Codabux and Williams, 2013). Such discrepancies often lead to confusion and inefficiency, notably in cases where roles such as Product Owner are not clearly defined or aligned with organizational expectations (Martini et al., 2023).

Martini et al. (2020, 2023) further investigate the different forms of PD and develop a comprehensive framework through empirical studies to classify six distinct types of PD, thereby extending the three types suggested by Codabux and Williams (2013). Each type reflects specific operational inefficiencies that cumulatively impact the overall effectiveness.

The fourth PD type presented in the framework by Martini et al. (2020, 2023) is Process Unsuitability, which emerges when existing operational procedures do not align with the organization's or its specific units' current needs (Martini et al., 2020, 2023). One cause of process unsuitability is that there are too many conflicting processes. This misalignment is particularly detrimental in agile contexts if teams are forced to follow outdated waterfall-like methodologies, resulting in significant overhead and operational delays (Martini et al., 2020, 2023). Teams might also be forced to follow unsuitable processes due to the need to follow standards, especially in highly regulated software domains. However, the reverse situation could be equally problematic such as when teams lack important development processes, including regular code reviews (Yli-Huuma et al., 2014). Lacking proper quality processes could sometimes result from business decisions which could pressure software teams to deliver faster (Yli-Huuma et al., 2014).

A fifth PD type, *Synchronization Debt*, is highlighted in scenarios where multiple processes operate in parallel without effective synchronization. This lack of integration leads to skipped steps, workflow confusion, and frequent disruptions, especially impacting developers who rely on streamlined workflows to maintain productivity and meet project deadlines (Martini et al., 2020, 2023). In larger organizations, where several teams are dependent on each other, inter-team coordination is necessary when documentation and tools are used across teams (Martini et al., 2019).

Finally, the *Activity-specific Debt* type relates to inefficiencies linked directly to specific tasks within a process, such as prioritization or certification (Martini et al., 2020, 2023). Due to its highly contextual nature, this type of debt varies across different environments and is challenging to generalize or operationalize for statistical measurement. This specificity requires tailored approaches for analysis and intervention, reflecting the unique contexts in which this debt occurs. Therefore, we decided not to include this PD type in our construct development.

2.2. Job satisfaction and work processes

Job satisfaction, often regarded as a critical indicator of workplace well-being and performance, reflects the emotional and cognitive evaluation of one's job experiences (Spector, 1997; Storey et al., 2019). Job satisfaction could be defined as "an internal state that is expressed by effectively and/or cognitively evaluating an experienced job with some degree of favor or disfavor" (Wright and Copanzano, 2000, p. 85). This definition emphasizes the subjective nature of job satisfaction, underscoring it as a personal internal state shaped by individual experiences and perceptions. Job satisfaction is a widely studied construct in organizational psychology and management and several theories have been proposed to explain job satisfaction. For example, Herzberg's Two-Factor Theory distinguishes between hygiene factors and motivators as the primary drivers of job satisfaction and dissatisfaction (Herzberg et al., 1959). Hygiene factors, such as company policies, salary, and working conditions, do not necessarily motivate employees but can cause dissatisfaction if inadequate. The theory suggests that addressing hygiene factors prevents dissatisfaction, while enhancing motivators promotes satisfaction (Herzberg et al., 1959). Over the past twenty years, there has been a notable increase in interest in employees' job satisfaction, happiness, and related positive states (Bhatia and Mohsin, 2020; García-Buades et al., 2020; Graziotin et al., 2018). Happiness in the workplace aligns with the absence of negative states, such as stress and burnout, while representing the presence of positive states marked by emotional (positive affect) and cognitive (satisfaction) components (Salas-Vallina et al., 2018). This heightened attention coincides with a shift in organizational structures from traditional machine bureaucracies to more fluid, ad hoc arrangements (Lee and Edmondson 2017; Mintzberg, 1984).

In various industries, organizational processes significantly impact job satisfaction. For example, studies have shown that well-designed processes reduce workload stress, prevent burnout, and improve overall job satisfaction among nurses and physicians in the healthcare sector (Aiken et al., 2002). Conversely, inefficient processes can lead to increased errors, stress, and dissatisfaction among healthcare professionals (McGlynn et al., 2003). In the manufacturing industry, the implementation of Lean Manufacturing processes has been associated with increased job satisfaction due to improved workflows, employee involvement, and reduction of wasteful activities (Conti et al., 2006). However, if Lean processes are implemented without considering employee well-being, they can increase job strain and reduce satisfaction (Hasle et al., 2012). Administrative processes and organizational support influence teachers' job satisfaction in the education sector (Collie et al., 2012). Efficient processes that minimize bureaucratic tasks allow teachers to focus on instructional activities, enhancing job satisfaction (Collie et al., 2012). These examples illustrate that processes are critical in job satisfaction across various domains.

2.3. Job satisfaction in software development

The relationship between job satisfaction and productivity in software development is complex and multifaceted. Research has often sought to measure productivity through various metrics such as project velocity and software quality (e.g. MacCormack et al., 2003). However, Storey et al. (2019) highlight that productivity remains a perceptually based measure, influenced significantly by developers' self-assessments of their performance. This perception-based approach aligns with the findings of Valaei and Jiroudi (2016), which show that job satisfaction beneficially affects job performance, suggesting that a satisfied employee is more likely to be a productive employee. Also, in a meta-analysis of over 250 studies, Judge et al. (2001) identified a bi-directional relationship between satisfaction and performance. Sinval and Marôco (2020) also link job satisfaction to broader well-being constructs, suggesting that satisfaction influences and is influenced by employees' general health and efficiency.

In software development, the complexity of the work also plays a crucial role. Research indicates that job complexity significantly influences the relationship between job satisfaction and job performance in general office settings (Judge et al., 2001) and more specifically in software development environments (Storey et al., 2019). This relationship implies that in complex work environments, where cognitive and problem-solving skills are important, job satisfaction seems to have a significant positive correlation with productivity. (Judge et al., 2001; Storey et al., 2019). Therefore, in professions characterized by high complexity, such as software development, job satisfaction would, to a higher degree, predict high productivity (Judge et al., 2001; Storey et al., 2019).

Expanding on the dynamics of job satisfaction, Koziol and Koziol (2020) introduce a trichotomy that categorizes factors affecting job satisfaction into three groups: motivators, hygiene factors, and demotivators. Motivators are elements that, when present, inherently enhance job satisfaction, such as achievement and recognition (Koziol and Koziol, 2020). As previously discussed, hygiene factors, originally introduced by Herzberg et al. (1959), refer to the baseline conditions that employees expect, such as job security and adequate working conditions. According to Koziol and Koziol (2020), while these factors may not actively motivate employees when present, their absence can lead to dissatisfaction and erode job satisfaction. Demotivators, interestingly, actively contribute to dissatisfaction when present, such as unfair treatment or lack of autonomy. This framework suggests that job satisfaction is not merely the presence of positive factors but also the absence of negative influences (Koziol and Koziol, 2020). Therefore, process inefficiencies, role ambiguities, and other types of PD may act as demotivators or negatively impact hygiene factors, thus lowering job satisfaction. Conversely, the reduction or management of PD could serve as a motivator, enhancing satisfaction and, by extension, perceived productivity.

3. Research method

In the following three subsections, we explain our research method. Section 3.1 describes the metrics used to measure job satisfaction and PD, focusing on the development and validation of the survey instrument. The next Section (3.2) presents the study's hypotheses based on the theoretical framework, specifying expected relationships between PD types and job satisfaction. The last Section (3.3) outlines the data collection methods, study design, and sample characteristics, emphasizing the diversity and scope of the participant base to enhance external validity.

3.1. Operationalizations of job satisfaction and process debt types

Despite that there are many different psychometric instruments to measure the job satisfaction construct, criticism has been made about

the way this construct has been measured (Wanous et al., 1997) since few of those instruments have actually shown satisfactory validity evidence (van Saane et al., 2003). In the review conducted by Van Saane et al. (2003) the authors concluded that only seven of 29 reviewed measures fulfilled the minimum criteria of an adequate instrument (i.e. internal consistency and validity evidence). One of the most widespread measure instruments is the "Index of Job Satisfaction" originally containing 18 items (Brayfield and Rothe, 1951), which also has a short version containing only five items called the "Short Index of Job Satisfaction" (SIJS) (Judge et al., 2000). For each item, subjects are asked to respond to each item by checking a five-point scale (1 – "Strongly Disagree", 2 – "Disagree", 3 – "Undecided", 4 – "Agree", 5 – "Strongly Agree"). Regarding the validity evidence based on the internal structure in terms of reliability, this shorter five items version presents a good internal consistency evidence, for example an α value of 0.89 in the study by Judge et al. (2000).

The SIJS has advantages over other measures as it is freely available, has shown good psychometric properties and has been used in different cultures (Ang and Woodside, 2017; Jawahar and Liu, 2017; Sinval and Marôco, 2020). Therefore, the SIJS instrument was used in this study to measure the level of job satisfaction in ASD teams.

To measure PD, we developed a survey instrument based on both previous research and collected empirical data. The survey development process is presented in Fig. 1. In our steps to identify and operationalize the PD constructs, we were guided by the rigorous guidelines prescribed by MacKenzie et al. (2011) and Recker and Roseman (2010). These methodological steps were important to ensure reliability and validity. First, we investigated the existing previous qualitative studies on PD but also organizational studies of a quantitative nature to investigate survey instruments that might be close to our area of study. This phase established a solid theoretical foundation for our constructs and inspired us to develop proper survey items. In the next phase, we conducted interviews with experts in the field, which facilitated the generation of a comprehensive list of potential items capable of measuring the PD constructs. With a preliminary item pool, we discussed the list with domain experts to assess each item's relevance and accuracy. This involved a systematic evaluation process, where experts were asked to rank the items based on their significance and applicability. After this expert evaluation, we engaged in a collaborative refinement process with both scholars and practitioners to enhance the precision and clarity of the items.

Several items used in the survey were based on existing items from other survey instruments developed for other contexts, i.e. not used in ASD organizations. For example, Doolen et al. (2003) operationalized team processes in a study of a production team, and Thomas et al. (2018) operationalized task coordination and synchronization in a healthcare management context. We adapted these original items so that they fit our conceptual definition and unit of analysis (i.e., PD in ASD teams). As an example, we changed the original item "For any given situation, the sequence of actions required to achieve desired outcomes is clear to our team" (Thomas et al., 2018) by replacing the words "sequence of actions" with "work processes" to better fit with our investigated PD constructs. Table 1 shows an overview of the five constructs and the studies where we used adapted items for our purpose.

In Table 1, the expression "+ self-created items" means that items were constructed and formulated based on the practitioner interview transcripts. The practitioners discussed and ranked these, and from the list of highest-ranked items, we ended up with a pool of eight to ten items per construct.

We formulated an initial version of the survey instrument, which was then subjected to a pre-testing phase involving experts. The objective of this phase was to solicit feedback on the survey's overall clarity and to make necessary adjustments before wider distribution. To do this, we asked four researchers who had experience in ASD and project management theory to evaluate the content validity of our items. The researchers received a questionnaire in which they were provided with the conceptual definition of each construct and the related item pool. They

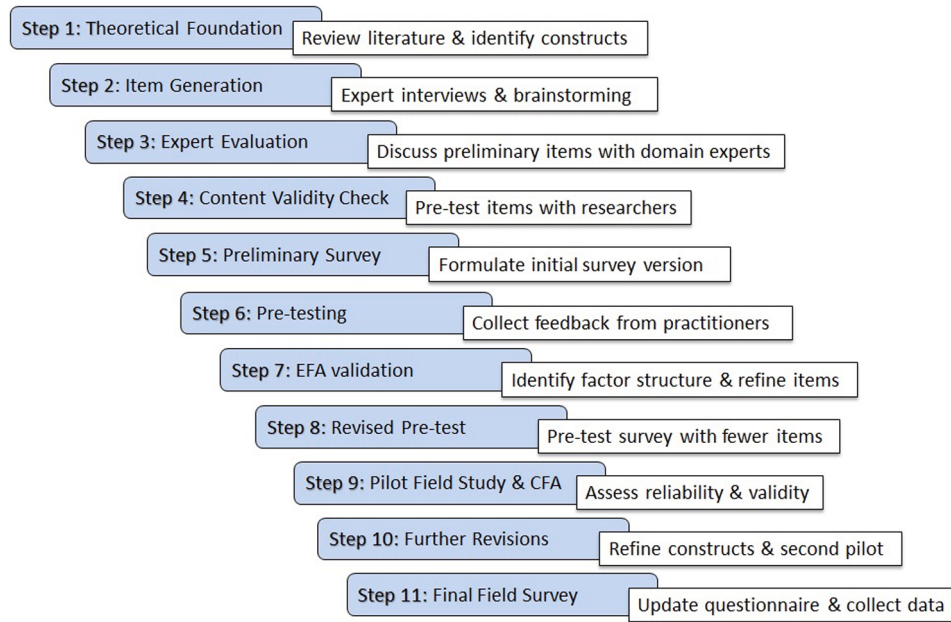


Fig. 1. Survey development process. An overview of the steps to develop the survey instrument.

Table 1
Construct definitions and sources of initial items.

Construct	Construct definition	Initial Items adapted from:
Process Unsuitability	The degree to which a process is not aligned with the needs of the organization.	Doolen et al. (2003) Thomas et al. (2018) + self-created items
Synchronization Debt	The degree to which synchronization impacts productivity and disrupts individual stakeholders' workflows.	Thomas et al. (2018) + self-created items
Roles Debt	The degree to which there is a discrepancy between the roles and responsibilities outlined in the organizational structure.	Gray-Stanley & Muramatsu (2011) Rizzo et al. (1970) Thomas et al. (2018) + self-created items
Documentation Debt	The degree to which documentation does not fit the actual work processes.	Daft & MacIntosh (1981) Van de Ven & Delbecq (1974) + self-created items
Infrastructure Debt	The degree to which the tools are poorly integrated, outdated, or unfit for the work processes.	Torkzadeh & Doll (1999) + self-created items

rated how well each item represents the intended construct on a seven-point Likert Scale. In addition, the researchers could write comments or questions that helped us select appropriate items and further improve them. To mitigate the risk of survey fatigue (Galesic and Bosnjak, 2009) among respondents, fewer items were included, limiting each construct to a maximum of seven items in the pilot study. For each construct, we selected the seven best items based on the highest mean (M) and median (Med). All items showed a very good content validity ($4.0 < M < 7$; $4 < Med < 5$).

Based on the selected items, we developed the first version of the survey that we pre-tested to twenty practitioners from one of our university's industry partners. Besides a link to the online survey questionnaire, we e-mailed instructions to the practitioners that they should, for each item, make notes on thoughts or questions they might have. Eighteen e-mail answers were collected containing comments and ideas for improvement from the participants. This gave us additional

information on how the survey could be improved. We revised the wording of the questionnaire items. The revised questionnaire was sent out to another software development organization that is an industry partner with our university. Overall, 63 participants replied and filled out the survey. We then conducted an explorative factor analysis to examine the reliability and validity of the overall instrument. We employed principal component analysis with varimax rotation to identify the underlying factor structure of the survey items. Factors were retained based on eigenvalues greater than one, and items with factor loadings exceeding 0.40 were considered significant contributors (Howard, 2016) to their respective factors, ensuring construct validity. An open-ended question where practitioners were asked to provide comments further improved the wording of the items. A few items showing somewhat low factor loadings were removed, which resulted in a final version of the pre-test questionnaire that contained four items for each construct.

A pilot field study was conducted to gather data, which was then analyzed using statistical techniques to assess the reliability and validity of our instrument. This stage was critical for verifying the instrument's ability to measure the constructs accurately and consistently. Data was collected through an online survey within two software development companies using ASD methods. This was the first test to understand process debt types and variances, so we intended to avoid getting noisier data by looking at more than two organizations. The sample size was in total 184 respondents from the two organizations. The pilot field study data was tested through confirmatory factor analysis (CFA) in the statistical software tool R. All constructs showed sufficient reliability with a Cronbach's alpha > 0.7 and Composite Reliability > 0.5 (Gustavsson et al., 2024). Also, construct Composite Reliability exceeded 0.8 for all constructs. Third, the Average Variance Extracted (AVE) was higher than 0.5. The analysis demonstrated our developed measurement instrument's reliability and validity but raised concerns about model fit. Although the Goodness of Fit Index (GFI = 0.98) indicated a good fit and the Comparative Fit Index (CFI = 0.92) suggested a reasonable fit, the elevated Root Mean Square Error of Approximation (RMSEA = 0.108) raised concerns. This discrepancy implies that while the model effectively captures certain aspects of the data, it may fail to account for inherent nuances or complexities within the dataset. The pilot field study was presented at the ISD conference in 2024 (Gustavsson et al., 2024).

Based on the concerns of the goodness of fit statistics, we discussed how to improve the survey instrument further. Since the pilot field study only contained four items per construct, we discussed some of the items previously removed with experts and practitioners. Based on these discussions, we revised the wording on some of them and constructed a new version of the questionnaire, with each construct having seven or eight items. Once again, we talked to the first industry partner organization and were able to conduct a new pilot field study where 74 participants replied and filled out the survey. A few items showing somewhat low factor loadings were removed, which meant that the final version of the questionnaire contained four to six items for each construct (presented in [Appendix A](#)).

Based on this new version of our questionnaire, we conducted a field survey within two large-scale ASD organizations to measure PD empirically (which is the study presented in this paper). Both organizations used similar agile processes and ceremonies, such as sprint planning, scrum of scrums, and a hierarchy of product owners coordinating with product management. By looking at only two similar organizations, we were able to control for other context factors, such as different kinds of large-scale agile frameworks. Instead, we focused on understanding process debt within only these two organizations, thereby increasing internal validity. The six scales (five PD types and job satisfaction) were replied to on a Likert scale from 1 (Strongly disagree) to 7 (Strongly agree).

The measurements from the field survey showed that the scales had Cronbach α s ranging from 0.74 (acceptable) to 0.91 (excellent). The highest Cronbach α (0.91) was measured for Job Satisfaction using SJIS (five items). Documentation Debt (0.82), Infrastructure Debt (0.81) and Sync Debt (0.8) were good. Process Unsuitability Debt (0.75) and Roles Debt (0.74) were acceptable. According to [Streiner \(2003\)](#), a Cronbach α that is <0.5 is unacceptable, between 0.5 and 0.6 is poor and between 0.6 and 0.7 is questionable. As presented, none of the scales had Cronbach α s below 0.7.

3.2. Research hypotheses

Since we, at this point, can not be sure about the relationship between dependent and independent variables, we first chose to conduct a bivariate correlation analysis. We do not imply that the five PD types cover the full concept of PD by any means, but this study is a first step toward understanding these connections, and we only argue that the types suggested by [Martini et al. \(2023\)](#) at least cover most aspects of PD. Hence, we set up the research hypothesis that any of the five PD types as defined and operationalized by [Martini et al. \(2023\)](#) (Process Unsuitability, Roles Debt, Sync Debt, Documentation Debt, Infrastructure Debt) are correlated to job satisfaction as operationalized by [Sinval and Maróco \(2020\)](#) in the Short Index of Job Satisfaction (SIJS).

The null and the six alternative hypotheses for PD as a whole and each PD type are as follows:

The null hypothesis (H0) in all cases is that the correlation coefficient is zero, i.e., that there is no significant correlation between Job Satisfaction (js) and the other variables.

H0. $\rho_{js,pd} = \rho_{js,pu} = \rho_{js,rd} = \rho_{js,sd} = \rho_{js,dd} = \rho_{js,id} = 0$

H1. There is a significant correlation between Job Satisfaction and Process Debt (pd): $\rho_{js,pd} \neq 0$

H2. There is a significant correlation between Job Satisfaction and Process Unsuitability (pu): $\rho_{js,pu} \neq 0$

H3. There is a significant correlation between Job Satisfaction and Roles Debt (rd): $\rho_{js,rd} \neq 0$

H4. There is a significant correlation between Job Satisfaction and Synchronization Debt (sd): $\rho_{js,sd} \neq 0$

H5. There is a significant correlation between Job Satisfaction and Documentation Debt (dd): $\rho_{js,dd} \neq 0$

H6. There is a significant correlation between Job Satisfaction and Infrastructure Debt (id): $\rho_{js,id} \neq 0$

where ρ = correlation coefficient.

3.3. Data collection

This study was carried out at two organizations (see [Table 2](#) for an overview). The companies were found through our research network. The first author did all the data collection from the participating organizations. The data collection took place between November 2023 and January 2024 using the software Survey&Report provided by our university. Each potential respondent received a unique survey link via a secure email distribution list, ensuring that no individual could submit multiple responses. Respondents were assured of anonymity, as the survey did not collect names, email addresses, or other personally identifiable information. We collected 203 responses of which 191 responses could be used for analysis. Because our analysis required a complete dataset, we removed all cases containing one or more missing values using listwise deletion. This procedure reduced the sample from 203 to 191, representing a decrease of $<6\%$. Given that the missing values were randomly distributed and did not affect any particular variable disproportionately, this minor reduction should not be a concern ([Hair et al., 2014](#)). The software development department investigated at Company 1 had a total number of 112 members who received the surveys via their managers. The response rate was 63.4 % for Company 1. The second department, at Company 2, had a total number of 182 members and also received the surveys via their managers. The response rate was 67.6 % for Company 1. In total, the survey was distributed to 294 team members in ASD teams and 191 responded, hence an overall response rate of 65.0 %. We believe that the high participation rate from the two organizations was primarily due to timing. The first author attended several department planning meetings at both organizations as an observer, and the survey was distributed during one of these planning days. Employees were encouraged by their managers to complete the questionnaire during breaks, and many did so. Also, to motivate participation, we offered insights into the results and also sent a reminder two weeks after the initial contact. We believe that this contributed to the high response rate.

The practitioners who participated in our study were from two Swedish organizations. Company 1 is a consultancy firm serving clients in the telecommunications sector. The studied department maintains and develops a software product that has been continuously improved for more than twenty years. The organization adopted ASD methods in 2009 and employs large-scale agile practices to coordinate the fourteen teams working on the product. Company 2 is a Fintech company that develops systems in the insurance sector. The studied department is responsible for integrating various systems within the organization. ASD methods were introduced in 2010, and the company utilizes the same types of large-scale agile practices as Company 1, including multi-team planning workshops, cross-team coordination meetings, and multi-team review meetings. Regarding work experience, there was a relatively even distribution among the participants, as 14.1 % had >30 years of experience, 26.2 % had >20 years, 20.4 % had >10 years, and 39.2 % had <10 years of work experience. Most participants were team members, i.e., designers, developers, and testers working in the teams (60.9 %); the others were Scrum masters (13.0 %), product owners (8.2 %), managers (8.2 %), and stakeholders (people in other roles interested in the results) in the organization (10.8 %). The key demographics of our survey respondents are summarized in [Table 3](#).

Since we wanted to examine experiences on a personal level, we did

Table 2
Participant information.

Organization	Business	Number of Employees	Participants
Company 1	Telecommunications	4 900	71
Company 2	Fintech	2 200	123
Total:			191

Table 3
Survey respondent demographics.

Aspect	Value	N	Percentage
Work experience	0 – 10 years	75	39.2 %
	11 – 20 years	39	20.4 %
	21 – 30 years	50	26.2 %
	31 + years	27	14.1 %
Position/Role	Team member (developer, tester, designer etc.)	120	62.8 %
	Scrum master	22	11.5 %
	Product owner	16	8.4 %
	Manager	12	6.3 %
Gender	Stakeholder/Other	21	11.0 %
	Female	67	35.1 %
	Male	111	58.1 %
	Non-binary	2	1.0 %
	No answer	11	5.8 %

not differentiate between different types of teams or roles in the organizations. We also did not examine where they were placed in the organization or the content of their software development tasks. However, having data from two different companies strengthens the external validity.

4. Results and analysis

In the following sections, the findings from the research are outlined. [Section 4.1](#) offers a descriptive overview, and [Section 4.2](#) examines the relationships between variables through multiple regression analysis.

4.1. Descriptive analysis

[Table 4](#) presents the aggregated statistical measures for the scales and background variables applied to the 191 respondents. These measures include the mean of all computed mean sums, the minimum and maximum values observed, and the associated standard deviations. A key aspect to note from the data is the interpretation of the numerical values relative to PD levels. Specifically, higher numerical values indicate a lower presence of PD as experienced by the respondents. Thus, these values should be interpreted positively; the greater the numerical value, the lesser the PD perceived within the organization by the respondent. This inverse relationship between the numerical scores and the level of PD is important for the correct analysis and understanding of our survey results.

We conducted several tests to evaluate if the data was normally distributed. Q-Q plots, tests of skewness and kurtosis, and Shapiro-Wilk tests were conducted to investigate the normality of the distribution for the constructs. A skewness value ≤ 2 or a kurtosis ≤ 4 may be used as reference values for determining considerable normality ([West et al., 1995](#)). All the variables are within the acceptable range of normality (see [Table 4](#)). However, we also tested normality using the Shapiro-Wilk

Table 4
Descriptive statistics.

Variable	Mean	SD	Min value	Max value	Skewness	Kurtosis
Job Satisfaction	5.72	1.02	1	7	-1.360	2.503
Process Unsuitability	4.70	1.02	1	7	-0.254	0.045
Roles Debt	4.91	1.03	1	7	-0.422	0.440
Sync Debt	4.23	1.22	1	7	0.094	-0.393
Documentation Debt	4.24	1.08	1	7	-0.143	0.236
Infrastructure Debt	4.48	1.16	1	7	-0.441	0.137
Work experience	16.50	12.77	0	45	0.224	-1.238
Team size	7.29	3.90	2	16	-0.336	-0.199

test which is often recommended as the best choice for testing the normality of data. It has been reported that the Shapiro-Wilk test provides better power, (power is related to a test's ability to detect whether a sample comes from a non-normal distribution). Setting the significance level to 0.01 ($\alpha = 0.01$) ([Vishnubhotla et al., 2020](#)), the Shapiro-Wilk test showed that all process debt types, but not the job satisfaction construct, presented scores that complied with a normal distribution. The following scores were identified for Process Unsuitability ($p = 0.212$), Roles Debt ($p = 0.016$), Sync Debt ($p = 0.098$), Documentation Debt ($p = 0.109$), and Infrastructure Debt ($p = 0.017$).

In order to analyze the connections between the PD types and job satisfaction, we ran bivariate correlation analyses on all five PD types and job satisfaction, using the mean of all the items for each scale. The Pearson product-moment correlation coefficient was used to measure correlations between the mean values of the dependent variable and the independent variables (see [Table 5](#)).

Since we did not know the direction of the correlations, we opted to use two-tailed tests. The size of the effects was compared with the effect size guidelines as suggested by [Cohen \(1992\)](#), also known as Cohen's rules. According to Cohen's rules, an effect size is deemed small if the correlation coefficient value is close to 0.10, medium if the correlation coefficient is about 0.30, and large if the correlation coefficient is about 0.50. A large effect size indicates that the associations found in the study are very likely to be seen in similar research, while a medium effect size suggests that the associations are somewhat likely to be observed in other studies ([Cohen, 1992](#)). We set the significance level (α) at 0.05 to minimize false positives and defined the effect size as medium.

As can be seen in [Table 5](#), Process Unsuitability has a large effect (above 0.5) and a significant relation to job satisfaction. Roles Debt, Sync Debt, Documentation Debt, and Infrastructure Debt have a medium correlation/effect (above 0.5) and significant relation to job satisfaction. Therefore, we reject the null hypothesis in favor of H1, H2, H3, H4 and H5. This means that lower PD is connected to higher job satisfaction for all PD debt types. However, since a bivariate correlation analysis was conducted, we do not know the direction of the effect, and higher job satisfaction might instead lead to lower levels of PD, although this is not plausible. Theoretically, it does not seem likely that an increase in job satisfaction will lead to decreasing process debt in the organization.

4.2. Multiple regression analysis

A multiple regression analysis was conducted using a confirmatory estimation approach to assess the extent to which PD variables explain job satisfaction ([Hair et al., 2014](#)). The confirmatory approach means that all independent variables are included in the regression model ([Hair et al., 2014](#)). This analysis, therefore, incorporated all five independent variables: Process Unsuitability, Roles Debt, Synchronization Debt, Documentation Debt, and Infrastructure Debt, with job satisfaction as the dependent variable. Certain assumptions need to be met to validate the appropriateness of multiple regression analysis. Tests were conducted for the assumptions of linearity, independence of error, normality, multicollinearity, and homoscedasticity.

For a good fit of the model, linearity is assumed between the independent variables and the dependent variable. The linear relationship between variables was tested by visual inspection of scatter plots, which showed that the assumption of linearity was met.

The Durbin-Watson statistic was used to test the assumption of the independence of errors (no self-correlation between errors) of independent and dependent variable scores. An acceptable range of the Durbin-Watson statistic is 1.50 - 2.50, and the computed value of 2.306 fell within this range; hence, the assumption of the independence of the errors was met.

We also plotted frequency histograms for the confirmatory multiple linear regression model to test for normality. The residuals (errors) of the regression line should be approximately normally distributed, and this was tested by examining the histogram. The mean is expected to be

Table 5

Pearson correlations of variables (N = 191 respondents).

Measure	1	2	3	4	5	6
1. Job satisfaction	1					
2. Process Unsuitability	0.566***	1				
3. Roles Debt	0.487***	0.565***	1			
2. Sync Debt	0.384***	0.604***	0.590***	1		
3. Documentation Debt	0.367***	0.568***	0.455***	0.506***	1	
4. Infrastructure Debt	0.313***	0.562***	0.345***	0.433***	0.496***	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

close to zero, and the standard deviation to be close to one. Additionally, the Normal Q-Q plot was used to determine if the points were approximately aligned with the diagonal. Visual inspection shows that the assumption of normality was met.

It is also important to check for multicollinearity, a condition where independent variables in the model are highly correlated (Mills and Prasad, 1992). Multicollinearity can lead to unstable estimates of the regression coefficients, which can affect the interpretation and accuracy of the model. A commonly applied guideline for detecting multicollinearity involves reviewing the correlation coefficients between pairs of variables (Young, 2017). If the correlation coefficient between any two variables exceeds 0.8 (Young, 2017), this indicates multicollinearity. As shown in Table 5 above, none of the correlation coefficients for the independent variables were equal to or higher than 0.8. Further tests were conducted using the tolerance value, and the variance inflation factor (VIF) of the coefficients. The extent of variance in the independent variable that the other independent variables fail to explain is the tolerance (Belsley, 1991). According to Belsley (1991), tolerance greater than 0.10 and VIF not >10 is acceptable. Computed values of tolerance for the independent variable were all greater than 0.10 and that of the VIFs were <10 (see Table 7 below). This test confirms that no multicollinearity exists in the dataset for the independent variables.

The result of the confirmatory multiple regression model test is presented in Table 6.

The multiple regression analysis revealed that the model explains approximately 33.8 % of the variance in job satisfaction (Adjusted $R^2 = 0.338$). The mean square for regression (14.175) is much higher than for the residual (0.696), indicating that the model explains a significant amount of variability in job satisfaction. The F value (20.375) with a significance level of $p < 0.001$, indicates that the regression model is statistically significant and that the PD types variables collectively contribute to predicting job satisfaction.

Among the independent variables, Process Unsuitability ($B = 0.437$, $p < 0.001$) and Roles Debt ($B = 0.254$, $p = 0.001$) were found to be significant predictors of job satisfaction. The positive coefficients for these variables suggest that higher levels of Process Unsuitability and Roles Debt are associated with lower job satisfaction. The beta values indicate that Process Unsuitability ($\beta = 0.434$) has the strongest impact on job satisfaction, followed by Roles Debt ($\beta = 0.255$).

In contrast, Synchronization Debt ($B = -0.034$, $p = 0.623$), Documentation Debt ($B = 0.028$, $p = 0.705$), and Infrastructure Debt ($B = -0.017$, $p = 0.796$) were not significant predictors of job satisfaction in

this model.

5. Discussion

While most studies on the debt metaphor in software engineering have focused on TD, there is a growing recognition of the importance of PD (Blokhina, 2024; Martini et al., 2020, 2023; Saeeda et al., 2024). Studies on TD highlight its detrimental effects on code quality and system maintainability (Codabux and Williams, 2013; Codabux et al., 2017). However, the implications of PD are broader, affecting organizational workflows and team dynamics (Ahmad and Gustavsson, 2024; Codabux and Williams, 2013; Martini et al., 2023).

Alves et al. (2014) expanded the debt metaphor to include various types of debt, underscoring the interconnectedness of these challenges. The results of this study demonstrate significant correlations between various types of PD and job satisfaction, emphasizing the critical role that process efficiency plays in the well-being and productivity of ASD teams. The trichotomy of workplace motivation proposed by Koziol and Koziol (2020) categorizes factors affecting job satisfaction into motivators, hygiene factors, and demotivators. The negative impacts of PD on job satisfaction suggest that these inefficiencies undermine the basic hygiene factors necessary for a positive work environment. PD can, therefore, be seen as a significant demotivator, actively contributing to dissatisfaction by introducing inefficiencies and ambiguities into developers' workflows.

The Pearson correlations analysis in our study showed significant correlations between job satisfaction and all five PD types. The effect size of Process Unsuitability was large ($r = 0.566$) and the four other types: Roles Debt ($r = 0.487$), Sync Debt ($r = 0.384$), Documentation Debt ($r = 0.367$), and Infrastructure Debt ($r = 0.313$), showed a medium effect. The next step was to perform a confirmatory multiple regression test. The results provided the basis for testing the hypotheses presented in this paper. The statistical significance of each type of PD was evaluated to determine whether the null hypotheses could be rejected in favor of the alternative hypotheses. The strong positive correlation ($B = 0.437$) and the highly significant p-value ($p < 0.001$) indicate a significant relationship between Process Unsuitability and job satisfaction. Thus, H2 is supported, and the null hypothesis (H0) is rejected. The positive correlation ($B = 0.254$) and significant p-value ($p = 0.001$) also suggest a significant relationship between Roles Debt and job satisfaction. Therefore, H3 is supported. However, the negative but non-significant correlation ($B = -0.034$) and high p-value ($p = 0.623$) indicate no significant relationship between Synchronization Debt and job satisfaction. Thus, H4 is not supported. The positive but non-significant correlation ($B = 0.028$) and high p-value ($p = 0.705$) indicate no significant relationship between Documentation Debt and job satisfaction. Therefore, H5 is not supported. The negative but non-significant correlation ($B = -0.017$) and high p-value ($p = 0.796$) indicate no significant relationship between Infrastructure Debt and job satisfaction. Thus, H6 is also not supported.

The significant results for Process Unsuitability and Roles Debt suggest that certain PD types both correlate with and predict job satisfaction. However, because not all types of PD showed significant correlations in our multiple regression analysis model, the overall hypothesis H1 can only be partially supported. The combined effect of

Table 6

Confirmatory specification and analysis of variance with all five independent variables.

Multiple R	0.596				
Coefficient of determination (R^2)	0.355				
Adjusted R^2	0.338				
RMSE	0.834				
	Sum of Squares	df	Mean Square	F	Sig.
Regression	70.826	5	14.175	20.375	< 0.001
Residual	128.706	185	0.696		
Total	199.582	190			

Table 7
Variables entered into the Regression Model.

Variables Entered	Regression Coefficients			Statistical Significance		Correlations		Collinearity Statistics	
	B	Std Error	Beta	t	Sig.	Partial	Part	Tolerance	VIF
Process Unsuitability	0.437	0.088	0.434	4.939	< 0.001	0.341	0.292	0.451	2.218
Roles Debt	0.254	0.078	0.255	3.267	0.001	0.234	0.193	0.574	1.741
Synchronization Debt	−0.034	0.069	−0.040	−0.492	0.623	−0.036	−0.029	0.520	1.924
Documentation Debt	0.028	0.073	0.029	0.379	0.705	0.028	0.022	0.592	1.690
Infrastructure Debt	−0.017	0.066	−0.019	−0.259	0.796	−0.019	−0.015	0.633	1.581

the significant types (Process Unsuitability and Roles Debt) suggests that aspects of PD significantly impact job satisfaction. These findings imply that while certain aspects of PD significantly affect job satisfaction, others do not. This partial support for the overall hypothesis H1 underscores the complexity of PD and its varied impacts on job satisfaction.

The significant correlation between Process Unsuitability and job satisfaction highlights how rigid or outdated processes can hinder developers’ efficiency and morale. For example, developers might be required to follow cumbersome procedures when deploying code (Gomes et al., 2023) that delay progress or adhere to principles that do not suit the project’s agile nature (Santos et al., 2022). Such misalignments force developers to spend additional time navigating processes rather than focusing on coding and problem-solving, leading to frustration and decreased job satisfaction. Similarly, Roles Debt manifests when there is ambiguity in role definitions either within the team (Hoda et al., 2012) or with roles interacting with the team in the organization (Jovanović et al., 2017). Challenges related to introducing new roles and redefining existing responsibilities when adopting agile methods are well-documented (Jovanović et al., 2017). Developers may find themselves taking on responsibilities outside their expertise (Saeeda et al., 2024) or experiencing overlap with other team members (Martini et al., 2020), causing confusion and inefficiency.

The findings of this study partially support the statements by Martini et al. (2019) regarding the negative effects of PD on team dynamics and individual satisfaction. According to Martini et al. (2019) PD directly impacts daily operations by embedding inefficiencies into developers’ workflows, leading to increased errors, developer overload, and diminished morale. Our study provides nuanced support for these observations, as significant correlations were found between specific PD types (Process Unsuitability and Roles Debt) and job satisfaction, indicating that these inefficiencies are indeed potentially harmful to developers’ job satisfaction. Notably, the adjusted R² value of 0.338 indicates that approximately 33.8 % of the variance in job satisfaction can be explained by the five types of PD included in the model. In social settings where many factors influence human behavior, an adjusted R² of this magnitude is considered substantial. This significant proportion of explained variance underscores the importance of addressing Process Unsuitability and Roles Debt to improve job satisfaction.

The significant positive correlations between job satisfaction and Process Unsuitability and Roles Debt align with the findings of Storey et al. (2019), who articulated a bidirectional relationship between job satisfaction and productivity suggesting that any factor adversely affecting job satisfaction will likely impact productivity (Storey et al., 2019). Our study’s results support this, showing that some types of PD reduce job satisfaction which could potentially lower productivity. The findings suggest that targeted interventions to reduce these forms of debt could lead to significant improvements in job satisfaction within ASD teams. While previous research has linked technical factors (e.g., code quality) to developer happiness, this focus on PD emphasizes that structural and procedural inefficiencies are equally important contributors to developer well-being and performance. This perspective resonates with broader research on developer happiness and organizational resilience, where nurturing positive psychological states can foster long-term stability (Borg and Graziotin, 2024; Graziotin et al., 2018).

By mitigating process-related inefficiencies and clarifying roles,

organizations can create conditions that support developers’ emotional well-being, thereby reducing the risk of stress and burnout and improving long-term performance. Sinval and Marôco (2020) linked job satisfaction to broader constructs of well-being, suggesting that job satisfaction influences and is influenced by the general health and efficiency of employees. Our findings support this perspective, demonstrating that PD, by reducing job satisfaction, could negatively affect overall employee well-being. This underscores the need for organizations to address PD not merely as a technical issue, but as a critical factor in maintaining a healthy and productive work environment. Moreover, aligning with broader organizational research (Orlikowski and Barley, 2001), the interplay between process design and worker well-being reflects a socio-technical balance. Inefficient processes not only hinder straightforward productivity metrics but also influence the psychological climate of the team, reinforcing the idea that organizational resilience and agile maturity depend on continuously refining both technical and social facets of development processes.

Although our study was conducted within ASD teams, we acknowledge that the underlying principles may not be limited to this context. The flexibility and adaptability of ASD environments (Dybå and Dingsøyr, 2008) might mitigate some of the negative effects of process-related issues. In more plan-driven or traditionally structured teams, where processes can be rigid and less open to iterative improvement (Petersen and Wohlin, 2010), such inefficiencies may indeed lead to equal or greater dissatisfaction. While we are cautious in generalizing beyond ASD without additional empirical support, future research could examine the extent to which these findings hold in different organizational settings.

However, the study also revealed that not all types of PD significantly impact job satisfaction. Specifically, Synchronization Debt, Documentation Debt, and Infrastructure Debt did not correlate significantly with job satisfaction. This divergence suggests that while some process inefficiencies are critical in affecting job satisfaction, others may be perceived as less critical. One possibility is that Synchronization Debt, although causing occasional coordination delays, may be seen as a predictable aspect of large-scale development that teams learn to navigate by adjusting and improving communication patterns (Gustavsson, 2019; Scheerer et al., 2014). Documentation Debt might similarly be regarded as a mild inconvenience rather than a fundamental blocker. In ASD organizations, clarification of work processes often relies on regular face-to-face meetings to compensate for gaps in process documentation (Pikkarainen et al., 2008), thereby reducing its direct impact on overall job satisfaction. Infrastructure Debt, such as outdated systems or restrictive platforms, may be viewed as a more distant, structural issue rather than a personal burden on developers’ work processes. Teams might regard infrastructure-related challenges as given conditions to work around, anticipating eventual organizational investments or scheduled upgrades (Meyer et al., 2014). This sense of detachment may lead developers to accept such limitations as industry norms, focusing dissatisfaction instead on more controllable factors, such as role clarity or suitable processes. Taken together, these findings underscore the complexity of PD and highlight the importance of a more targeted approach to its management. Understanding which PD types developers can tolerate and adapt to will enable more nuanced interventions that prioritize addressing the most impactful forms of PD first.

5.1. Theoretical implications

Despite the growing academic discourse on PD (Ahmad and Gustavsson, 2023, 2024; Gomes et al., 2023; Martini et al., 2019, 2020, 2023; Melo et al., 2021; Saeeda et al., 2023, 2024), significant gaps remain in quantifying its impact and developing effective management strategies. While qualitative studies have provided valuable insights, there is a pressing need for empirical research that employs quantitative measures to establish a clear link between PD and job satisfaction. This study contributes to bridging this gap by providing quantitative evidence of the significant correlations between PD types and job satisfaction.

The results of this study substantiate the hypothesis that various forms of PD are significantly correlated with job satisfaction among software developers. Specifically, the significant correlations between job satisfaction and the five types of PD (Process Unsuitability, Roles Debt, Sync Debt, Documentation Debt, and Infrastructure Debt) highlight the pervasive influence of process inefficiencies on developers' well-being. These findings align with the conceptual framework proposed by Martini et al. (2023), reinforcing the notion that PD is a critical factor impacting not only individual satisfaction but possibly well-being as well as productivity (Storey et al., 2019).

5.2. Practical implications

Our study adds to this body of knowledge by providing empirical evidence that PD significantly impacts job satisfaction. This is particularly important as the negative effects of PD on developers' morale and productivity are less understood than those of TD. By identifying significant correlations between PD types and job satisfaction, our research highlights the need for more comprehensive management strategies that address both TD and PD to improve overall project outcomes and developer well-being. By demonstrating these relationships, our research lays the groundwork for future studies to develop and validate instruments that can measure the extent of PD and assess its direct and indirect effects on the satisfaction and well-being of software developers. These findings suggest that organizations should prioritize regularly evaluating and adapting their processes. It shows the importance of continuous improvement practices, such as sprint retrospectives, which can help teams promptly identify and address process inefficiencies. Engaging developers in process design and decision-making ensures that processes are tailored to the team's needs, increasing effectiveness and job satisfaction. For addressing Roles Debt, clear communication and documentation of roles and responsibilities are essential. Organizations might consider role clarification sessions or workshops to ensure that each team member understands their duties and how they contribute to the team's objectives. By fostering an environment where roles are well-defined yet flexible enough to adapt to changing demands, teams can reduce confusion and enhance collaboration (Hoda et al., 2012; Edmondson, 2003).

For software development organizations, our survey instrument could be used to conduct regular audits, similar to how Google measures technical debt through periodic engineering satisfaction surveys (Jaspan and Green, 2023). By systematically administering the survey at set intervals, whether quarterly or at key delivery milestones, organizations could monitor trends in PD over time, much like how Google tracks the types of technical debt that hinder developer productivity (Jaspan and Green, 2023). This proactive approach would help identify and rectify inefficiencies before they accumulate. It would also enable the involvement of developers in the redesign of processes based on the feedback collected, ensuring that changes address their primary pain points. Such a feedback loop can enhance buy-in, reduce resistance to process change (Lavallée and Robillard, 2012), and ultimately serve as a continuous improvement mechanism for managing PD.

5.3. Research limitations

While this study provides valuable insights into the relationship between PD and job satisfaction, it is not without limitations. The reliance on self-reported data for job satisfaction and experienced PD may introduce subjective biases (Hair et al., 2014). Additionally, the study's cross-sectional design limits the ability to draw causal inferences about the directionality of the observed relationships (Hair et al., 2014). Future research should consider longitudinal designs to explore how changes in PD over time affect job satisfaction and productivity.

Moreover, the study was conducted within a specific cultural (both organizations residing in Sweden), which may limit the generalizability of the findings. Replicating this research across diverse organizational settings and cultural contexts would enhance the robustness and applicability of the results.

By utilizing the Short Index of Job Satisfaction (SIJS) as a measure, our study aligns with previous research (Sinval and Marôco, 2020), ensuring the reliability and validity of our findings. The SIJS is a psychometric instrument that measures job satisfaction through five items. The SIJS is useful due to its small number of items, producing data with good psychometric properties (Sinval and Marôco, 2020). However, the reliance on self-reported data introduces potential biases, as individuals' perceptions of job satisfaction may vary. This limitation is acknowledged in the literature (Storey et al., 2019), where perceptual measures of productivity are often influenced by subjective factors. Future research could benefit from triangulating self-reported data with objective performance metrics to provide a more comprehensive assessment of the impact of PD.

5.4. Future research directions

Given that the multiple regression analysis showed some PD types having significant correlations with job satisfaction, and some that did not, future research should further investigate these dynamics, focusing on the significant types of PD to develop targeted interventions that can enhance job satisfaction in ASD environments. To build on this study's findings, future research should also involve longitudinal studies to examine how interventions aimed at reducing PD influence job satisfaction and productivity over time. These studies could provide deeper insights into the causal relationships and long-term effects of PD management strategies.

Based on our result that PD explained 33,8 percent ($\text{Adjusted } R^2 = 0.338$) variance of job satisfaction, future studies should investigate the role of broader organizational and environmental factors, such as company culture, leadership styles, and market conditions, in moderating the relationship between PD and job satisfaction. Understanding these contextual influences could inform more tailored and effective interventions. Furthermore, examining experiences based on roles and teams presents an interesting avenue for future research. Different roles within software development teams, such as designers, developers, and testers, may perceive and be affected by PD differently. Investigating whether people in different roles have different perspectives on specific PD types and their impact on job satisfaction could provide more nuanced insights. Additionally, exploring variability between individual teams might reveal how team dynamics and communication patterns influence the relationship between PD and job satisfaction. Such studies could inform the development of role-specific or team-specific strategies for managing PD effectively.

Another future research direction would be to explore the interplay between PD and TD. Given the interconnected nature of these debt types, integrated research could yield comprehensive strategies for managing debt in ASD environments.

6. Conclusion

This study has advanced the understanding of Process Debt (PD)

within Agile Software Development (ASD) teams by exploring its impact on job satisfaction which is an important factor in overall team productivity and well-being. The research findings reveal that certain types of PD, specifically Process Unsuitability and Roles Debt, significantly correlate with and predict job satisfaction, indicating that these forms of debt have a tangible negative effect on developers' satisfaction levels. In contrast, other types of PD, such as Synchronization Debt, Documentation Debt, and Infrastructure Debt, do not significantly influence job satisfaction. These results partially support the hypothesis that PD negatively impacts job satisfaction but also highlight that not all PD types are equally detrimental.

The significant correlations identified between Process Unsuitability and Roles Debt with job satisfaction highlight the critical role these PD types play in affecting developers' work experience. These types of debt can be viewed as significant demotivators that undermine the hygiene factors necessary for a positive work environment, as proposed by [Koziol and Koziol \(2020\)](#). The findings suggest that addressing these specific forms of PD could lead to meaningful improvements in job satisfaction and, by extension, team productivity and overall well-being. By quantifying the effects of PD on job satisfaction, this study provides a starting point for more integrative research that examines how PD and TD together shape organizational resilience.

Overall, this study contributes to the growing body of literature on PD by providing empirical evidence of its varied impacts on job satisfaction. Future research should continue to explore the nuanced relationships between different types of PD and other organizational outcomes, such as productivity and employee well-being, to develop more effective strategies for managing PD in ASD teams.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used Grammarly to address grammar issues and improve the language, and ChatGPT 4o to enhance the manuscript's readability. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

CRedit authorship contribution statement

Tomas Gustavsson: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Muhammad Ovais Ahmad:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Funding acquisition, Conceptualization. **Hina Saeeda:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Conceptualization.

Declaration of competing interest

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Appendix A. Measurement instrument items

(R = Reversed item)

Job satisfaction (from the Short Index of Job Satisfaction ([Judge et al., 2000](#)))

I feel fairly satisfied with my present job
Most days I am enthusiastic about my work

Each day at work seems like it will never end (R)

I find real enjoyment in my work

I consider my job to be rather unpleasant (R)

Items for the Process Debt Types:

Process Unsuitability

People are often unsure about which process to follow for specific tasks. (R)

Our work processes are updated and well-suited for our current way of working.

In our team, we often discuss and improve our work processes.

I often have to wait for decisions to be made which stops me from finishing my tasks. (R)

The processes we must follow often result in duplicated work. (R)

Our work processes align with the business needs of the organization.

Roles Debt

My assigned tasks align with my official role in the organization.

I know what my responsibilities are.

There is ambiguity about who is responsible for specific activities in our processes. (R)

I feel certain about how much authority I have. (R)

People often perform tasks outside their designated roles due to unclear responsibilities. (R)

Synchronization Debt

Multiple work processes overlap in a way that creates additional administrative overhead. (R)

Our work processes often conflict with each other, leading to inefficiencies. (R)

Lack of proper coordination disrupts my individual workflow. (R)

Poor coordination have led to errors that could have been avoided. (R)

Documentation Debt

Our work processes are well documented and easy to understand.

The level of detail in our process documentation is well-balanced.

Our process documentation is frequently updated to be relevant.

Our process documentation often lack information about key steps or stakeholders. (R)

The process documentation is often too rigid to allow for creative problem-solving. (R)

The terminology used in our process documentation often leads to misunderstandings. (R)

Infrastructure Debt

We have suitable tools in place that increase the efficiency of our processes.

Our organization invests in updating or acquiring new tools to help make our processes work better

We have an effective tool integration which minimizes task-switching and streamlines operations.

Tools are often misused due to a lack of better alternatives. (R)

Data availability

The authors do not have permission to share data.

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