Mapping the Pain: How Modelers Experience and Respond to Common Domain Modeling Frustrations

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Abstract. Despite the widespread use of domain models, the modeling process remains underexplored, particularly regarding the interactions among agents, products, and activities. Building on prior work that identified 16 recurrent moments of dissatisfaction ("pain points") experienced by modelers during these interactions, this study offers a deeper analysis to clarify the significance of these pain points and support improvements in modeling practice. Through an online survey of 49 modelers, the study provides empirical evidence on the frequency of these moments, the reasons behind the frustrations they cause, and the strategies modelers use to address them. The descriptive analysis offers valuable insights into these aspects, revealing interesting patterns among modelers. These findings have implications for practice and academia, offering a foundation to enhance the modeling experience and improve the value of domain modeling efforts.

Keywords: Pain Points · Domain Modeling · Conceptual Modeling · Modeling Experience

1 Introduction

Although domain models are widely used in organizational and academic settings, the domain modeling process itself is not yet fully understood. While it is well established that this process involves multiple agents (e.g., modelers, domain experts, sponsors), products (e.g., models, languages, tools), and activities (e.g., requirements elicitation, concept negotiation), their interplay and influences on the modeling experience remain under-explored.

Our previous study [26] took an initial step toward addressing this gap by identifying 16 of the most prevalent and impactful pain points of domain modeling. They reflect moments of dissatisfaction that modelers experience throughout

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the modeling process. For instance, such a moment arises when modelers and domain experts struggle to reach a shared understanding of a concept. Dissatisfaction may also occur when modelers feel overwhelmed by the manual effort involved in model verification or layout due to a tool's lack of features.

This study provides a deeper analysis of these pain points to further substantiate their relevance to the field. It investigates their practical occurrence, focusing on their frequency, reasons for frustrations, and the reactions they provoke. By understanding these pain points and their implications for modelers and the modeling process, this research aims to enhance modelers' experiences and improve the modeling practice. Additionally, it provides insights into the interactions among agents, products, and activities, helping practitioners anticipate and address potential challenges. Consequently, it equips the modeling community with knowledge to better plan initiatives, assess costs, identify solutions, refine methods, improve languages and tools, and guide novice modelers.

Our study was guided by the following research questions:

RQ1: *How often do modelers experience the pain points of domain modeling?*
RQ2: *Why do modelers feel frustrated by these pain points?*
RQ3: *How do modelers react when facing these pain points?*

To address these research questions, we conducted an online survey targeting modelers with experience in domain modeling. We got 49 responses from a diverse sample in terms of years of experience, activities performed, and application context. The study focuses on descriptive analysis over statistical inference.

The findings of the study show that all analyzed pain points are prevalent among the participants, with frequencies ranging from sometimes to usually. These frustrations were predominantly associated with *lost time*, *financial losses*, and *difficulties in achieving goals*, rather than concerns about e.g. self-esteem. While some pain points were viewed as unavoidable or even necessary challenges inherent to modeling, modelers continued to value modeling as a problem-solving tool. They also identified training as an effective strategy for addressing most pain points and seemed unwilling to change the modeling language they use.

In [26], we analyzed the pain points related to a specific type of domain modeling, referred to as structural conceptual modeling. These models aim to identify, analyze, and describe key structural regularities–such as types (classes), attributes, relationships, and constraints–within a specific universe of discourse [9]. Examples include models specified using Entity-Relationship diagrams (ER) [4], UML Class Diagrams [14], and OntoUML [9]. This paper also focuses on this type of modeling. Thus, we henceforth use the terms models, modelers, and modeling to refer to structural conceptual models and their associated concepts.

The remainder of the paper unfolds as follows. Section 2 presents the state of the art. Section 3 introduces the pain points of domain modeling. Section 4 details the survey research process employed. Section 5 presents the findings derived from the survey data analysis and provides a discussion of the results. Section 6 addresses potential threats to validity. Finally, Sect. 7 offers concluding remarks and outlines directions for future research.

2 State of the Art

Several studies have focused on identifying pain points, challenges, and pitfalls in modeling-related contexts. In [7], a survey of 304 practitioners identified barriers to conceptual model use, such as the variety of modeling methods, tool cost, investment risk, and tool complexity. While our study also highlights practical challenges, it focuses more on frustrations experienced during the modeling process, rather than on adoption barriers.

A meta-review in [27] analyzed publications on the practical use of modeling languages and the benefits and challenges perceived by practitioners in model-driven engineering (MDE). The main issues identified included limited tool functionalities, organizational resistance, immature methods, and high learning effort. Our study resonates with these findings but provides first-hand accounts of how such challenges are experienced across roles and phases of modeling.

Studies on modeling education [13,16,21,22] have focused on the difficulties novice modelers face when using UML. They identified recurring issues related to understanding domain constraints, mastering language constructs, dealing with abstraction, navigating modeling tools, and accessing support materials. Although these studies primarily address students and early modeling stages, they echo technical frustrations also reported by professionals in our study.

In the context of business process modeling (BPM), a literature review in [1] highlighted difficulties in engaging stakeholders and translating business goals into technical objectives. Similarly, a Delphi study conducted in [12] involving academics, practitioners, and tool vendors revealed concerns around standardization, unclear value, and execution challenges. In [17,18], the authors conducted interviews and focus groups with analysts and managers, identifying issues such as limited stakeholder synergy, insufficient modeling expertise, and the burden of model maintenance. These findings closely align with the pain points reported in our study. In particular, the uncertainty surrounding the purpose and long-term value of process models mirrors the doubts expressed by our participants about the usefulness and longevity of the models they produce.

Beyond identifying pain points, some studies have used them to inform artifact development. For example, the framework for Model-based Software Engineering (MBSE) and the curated set of best practices proposed in [15] were grounded in modeling-related pain points identified by the study. Similarly, the taxonomic theory of modeling difficulties presented in [19] was derived from investigations into modelers' experiences throughout the data modeling process [19,20]. Therefore, while our study does not present a prescriptive solution, it similarly provides an empirical foundation for future artifact design.

Unlike these previous studies that primarily focus on identifying modeling pain points, our research delves into how modelers experience and respond to them in practice. By examining the frequency, reasons for frustrations, and reactions to these pain points, our research provides a better understanding of their effects on the modeling process. This deeper exploration offers insights that can inform future efforts in improving modeling tools, methods, and training.

3 The Pain Points of Domain Modeling

"Pain point" is a term from Marketing describing customers' psychological dissatisfaction when their expectations are unmet during interactions with a product or service [28]. Pain point analysis is used by organizations to identify moments of customer dissatisfaction as experienced during a consumption journey, enabling targeted efforts to improve their experience. Empirical studies have employed pain point analysis across various fields. For example, scientific software development [30], computational notebooks [3], and requirements engineering [6].

In [26], we applied this strategy to modeling, investigating the pain points experienced by modelers. We framed modeling as a dynamic interaction involving various products, activities, and agents to identify instances of dissatisfaction when modelers, acting as service consumers, interact with modeling languages, tools, methods, and related resources. To this end, we conducted a five-phase empirical study employing a multi-method approach [5] to identify 16 of the most prevalent and consequential pain points in the modeling experience. Below, we present these pain points and illustrate situations in which they may arise.

- *Improper Requirements:* I could not properly define the model requirements. E.g., when stakeholders were unsure of their needs or the domain was unfamiliar to me.
- *Resistance to Modeling:* My stakeholders resisted adopting modeling, a modeling language, or a tool. E.g., when they perceived modeling as unnecessary or I failed to demonstrate the value of the model I wanted to create.
- *Expensive Requirements:* It was costly to define the model requirements. E.g., when many requirements had to be defined and agreed among many stakeholders.
- *Effortful Negotiation:* It was costly to negotiate a common definition among experts about a concept of the project's domain of interest. E.g., when I lacked negotiation skills or even my domain experts could not agree among themselves.
- *Effortful Verbalization:* It was costly to verbalize my model in a way that was suitable for the different audiences that should be able to use it. E.g., when the tool I used lacked such a feature or too many different verbalizations were required.
- *Inadequate Explanation:* It was hard to explain my model to my stakeholders. E.g., because they do not know how to model or I am not good at explaining my model.
- *Unclear Conceptualization:* Writing definitions for the elements in my model was hard and boring. E.g., when domain experts were not available or I was unsure how to structure a definition.
- *Complexity Issues:* The model has become too complex and too costly to maintain. E.g., because the tool I chose did not support documentation or the model contained too many elements.
- *Laborious Reuse:* I wanted to reuse an existing model, but I had to redraw it from scratch. E.g., when it was only available as an image or in a different language/tool.
- *Tool Restrictions:* I could not choose the modeling tool I wanted. E.g., due to constraints related to cost, expertise, culture, or bureaucracy.
- *Effortful Diagramming:* It was costly to manually split the model into visually appealing and understandable views (diagrams). E.g., when I was unfamiliar with aesthetic guidelines or the tool did not support diagram creation.
- *Overlooked Documentation:* My colleagues did not consider it important to document the model and did not understand my efforts to do so. E.g., when they lacked modeling knowledge or I failed to show the model's value for maintenance or reuse.

- *Limited Verification:* The tool I chose did not support model verification. My model was large and complex and verifying it by myself was not trivial. E.g., when I had to use a suboptimal tool due to organizational constraints or lacked experience.
- *Unclear Approach:* It was costly to define the model-driven approach. E.g., when my company lacked a modeling culture or I struggled to identify the best method.
- *Disinterest in Use:* I was the only one on the team interested in using and reusing the model. E.g., when I was the sole person who understood it or my colleagues did not know how to leverage its benefits.
- *Unclear Documentation:* I was not sure how to document my model. E.g., when I was uncertain about what to include or how much effort to invest.

4 Research Method

The study employed an online survey, as it offers a cost-effective and efficient means of systematically collecting data, enabling access to a geographically dispersed sample while preserving anonymity. Following the survey research process outlined in [23], we consolidated the 13 steps proposed into the three phases detailed below. Study findings and supplementary materials are available in [24].

Questionnaire Design. The questionnaire was subjected to five iterative revisions by four researchers before approval. The final version was composed of three sections: introduction, user profiling, and pain point report.

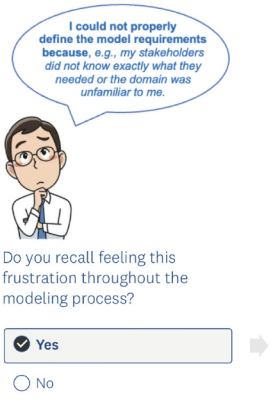
The introductory section included a consent form, a brief explanation of structural conceptual models, and a question regarding the respondent's experience with this type of model. Respondents without experience were directed to conclude their participation.

The user profiling section comprised ten mandatory personal questions (PQs) aimed at assessing respondents' background in modeling. These questions were presented in multiple-choice and single-choice formats, structured as follows: PQ1.1 and PQ1.2 addressed respondents' experience and preferences regarding modeling languages; PQ2.1 and PQ2.2 focused on their experience and preferences related to modeling tools; PQ3 inquired about years of modeling experience; PQ4 identified the modeling activities they had engaged in; PQ5 required a self-evaluation of their modeling expertise; PQ6 examined the context in which they applied modeling; PQ7 explored how they learned about modeling; and PQ8 asked about their education level.

The pain point report section was organized into sixteen subsections, each corresponding to a specific pain point. Each subsection featured fifteen standardized questions addressing our research questions. They were organized as follows: a dichotomous question (yes/no) to confirm the respondent's experience with the pain point (RQ1.1), followed by fourteen Likert scale questions (five points) assessing its frequency (RQ1.2), reasons for the frustrations it caused (RQ2.1–2.5), and possible reactions it elicited (RQ3.1–3.8). Respondents answered the Likert scale questions only if they confirmed experience with a pain point. For pain points that required additional context for clarity, we included examples

in the description to aid comprehension. Questions RQ2.1–2.4 examine four key potential reasons for frustration: *wasted time*, *financial losses*, *unmet goals*, and *diminished self-esteem*. Questions RQ3.1–3.7 explore seven possible reactions to the pain points: abandoning modeling, taking no action, implementing workarounds, pursuing training, or changing the modeling language, tool, or method. The analyzed reasons and reactions were defined based on insights from interviews and brainstorming sessions conducted in the authors' previous research [25,26].

SurveyMonkey was selected as the platform to host the online survey. Before its launch, five modelers tested it asynchronously. Based on their feedback, rephrasing and spelling adjustments were made, while the structure and design remained unchanged. The final version of the survey is available in [24]. An example of questions for the pain point *Improper Requirements* is shown in Fig. 1.



Objective	Assessment Questions
Frequency	RQ1.2: How often do you recall experiencing this frustration?
Reasons	RQ2.1: I felt frustrated because I wasted time or made others waste their time.
	RQ2.2: I felt frustrated because it generated more costs than expected.
	RQ2.3: I felt frustrated because I could not achieve my goals.
	RQ2.4: I felt frustrated because I had negative feelings about myself (e.g. incompetence, unappreciated).
	RQ2.5: Other reason (please specify)
Reactions	RQ3.1: Although I felt frustrated, I kept modeling without changing anything.
	RQ3.2: This frustration contributed to my decision to change the modeling language.
	RQ3.3: This frustration contributed to my decision to increase my and/or my team's skills in conceptual modeling.
	RQ3.4: This frustration contributed to my decision to change the modeling tool.
	RQ3.5: This frustration contributed to my decision to change the modeling method.
	RQ3.6: This frustration contributed to my decision to implement a workaround within the model-based approach.
	RQ3.7: This situation made me frustrated enough to give up on solving the problem using model(s).
	RQ3.8: Other action (please specify)

Fig. 1. Subsection related to the pain point *Improper Requirements*

Data Collection. The survey was launched on October 30, 2023, during the EDOC 2023 conference, using a banner and a LinkedIn post on the conference page for promotion. The same strategy was applied at the ER 2023 conference the following week. Afterward, posts were shared in relevant LinkedIn groups and on the authors' pages. Direct invitation emails were also sent to the authors' professional contacts and researchers from the conceptual modeling field identified via Google Scholar. The survey closed on December 13, 2023, after receiving 50 complete responses. However, one participant, who reported no frustrations across all 16 questions, was deemed an outlier and excluded from the analysis.

We acknowledge that our sample size is not statistically representative. However, as an exploratory study, the priority was on recruiting knowledgeable participants over randomly sampling a population [23]. Accordingly, we focused on reaching modelers with diverse experiences rather than maximizing sample size.

Data Analysis. As the survey relied primarily on Likert-scale questions and involved a small sample, descriptive statistics were employed for data analysis [11]. The data were first organized into tables displaying the number of responses for each category within the variables. These tables were then used to visualize data distribution through graphs and charts. When appropriate, measures of central tendency such as mean, median, and mode were included. For open questions (RQ2.5 and RQ3.8), we conducted a thematic analysis using inductive coding [2]. This process uncovered additional reasons for, and reactions to, participants' frustration during the modeling process. The resulting themes and findings are presented in detail in [24].

5 Results and Discussion

The analysis in this section is based on 49 survey responses. Some analyses use these responses as data points, while others treat the 321 pain point reports as individual data points. Throughout the text, the most significant findings are highlighted and labeled with an "F".

5.1 Study Population

All 49 respondents reported having experience in structural conceptual modeling. In a self-assessment of their expertise (PQ5), 2% identified as novice, 6% as beginner, 24% as intermediate, 31% as advanced, and 37% as expert. Regarding years of experience (PQ3), 2% had less than one year, 29% had between one and three years, and 69% had more than three years. Among those with over three years of experience, the reported range spanned from 5 to 40 years, with a mode of 20 years, a mean of 18, and a standard deviation of 8.9.

Throughout their years of experience, respondents have engaged in various modeling tasks (PQ4). The data indicates that 94% have participated in creating conceptual models, while 73% have contributed by reviewing and providing feedback on models created by others. Additionally, 53% have undertaken tasks related to documenting or implementing conceptual models, and 47% have been involved in modifying models initially developed by others. In summary, 82% have participated in multiple modeling activities over their careers, underscoring the diverse skill sets of the survey participants.

The respondents reported engaging in the aforementioned modeling activities across diverse contexts (PQ6), with research (73%), education (65%), and industry (49%) being the most common. Moreover, 78% indicated involvement in modeling across multiple contexts. Among those operating within a single context, the majority (12%) were exclusively involved in industry, while no respondents reported working solely in education.

Regarding respondents' experience with modeling languages (PQ1.1), UML [14] emerged as the most widely used, with 96% reporting familiarity. This was followed by ER/EER [4] (71%), OntoUML [9] (43%), and ORM [10] (22%). Moreover, 84% indicated experience with multiple modeling languages. Among

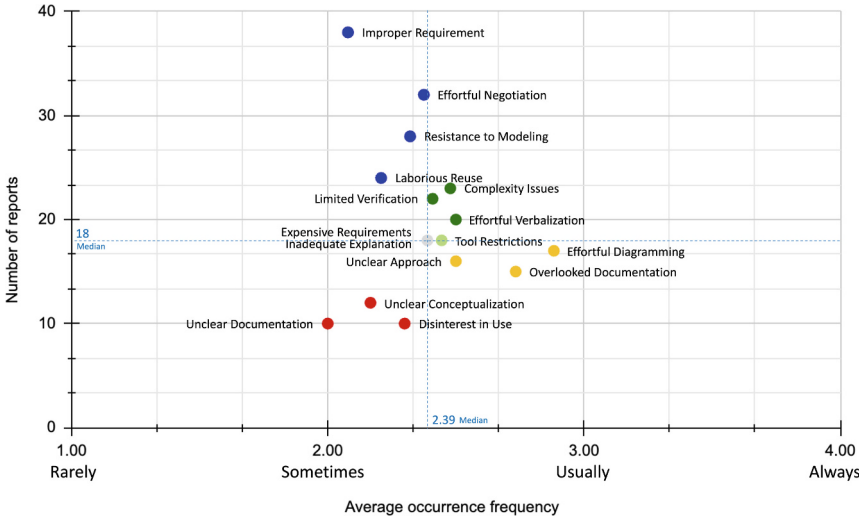


Fig. 2. The frequency with which the pain points are experienced.

those familiar with only one language, UML was the most prevalent, reported by 12%. Regarding their experience with modeling tools (PQ2.1), Draw.io was the most commonly used, with 47% reporting experience, followed by Visual Paradigm (45%), Enterprise Architect (31%), and Lucidchart (27%). Additionally, 63% indicated familiarity with multiple tools, while only two respondents reported no experience with any tool.

Because some pain points are related to language and/or tool issues, respondents were asked to select a specific modeling language and tool as a reference for completing the questionnaire. For modeling languages (PQ1.2), 53% chose UML, 24% chose OntoUML, and 18% chose ER/EER, while the remaining 4% selected other languages. For modeling tools (PQ2.2), 33% chose Visual Paradigm, 24% chose Draw.io, and the rest selected other tools, which did not provide a sufficiently representative sample for analysis.

The study population profile reflects a diverse and experienced sample, aligning with our focus on prioritizing expertise over random sampling [23]. We consider this sample appropriate for supporting our exploratory analysis.

5.2 The Frequency of the Pain Points of Modeling

To assess the frequency of the pain points, we analyzed how many respondents have experienced each pain, and how often. To examine the occurrence of a pain point among modelers, we analyze responses to questions RQ1.1 (Fig. 1) for all 16 pain points. As illustrated in Fig. 2, **each pain point was reported by at least ten participants, providing evidence of its prevalence (F1)**. The most frequently reported ones were *Improper Requirements* (38), *Effortful*

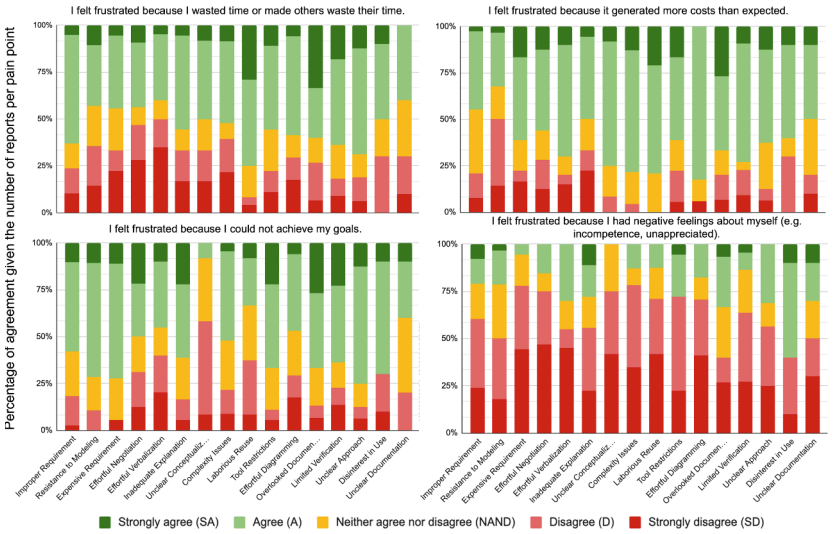


Fig. 3. Reasons for the frustrations behind the analyzed pain points.

Negotiation (32), *Resistance to Modeling* (28), *Laborious Reuse* (24), *Complexity Issues* (23), *Limited Verification* (22) and *Effortful Verbalization* (20).

To examine the recurrence with which modelers experience a pain point, we analyze responses to question RQ1.2 (Fig. 1) for all 16 pain points. As illustrated in Fig. 2, **all pain points were experienced by participants with a frequency ranging from sometimes to usually (F2).** The most frequently experienced ones were *Effortful Verbalization* (2.50), *Complexity Issues* (2.48), and *Limited Verification* (2.41). Conversely, the least frequently experienced pain points are *Disinterest in Use* (2.30), *Unclear Conceptualization* (2.17), and *Unclear Documentation* (2.00). While many respondents reported encountering *Improper Requirements*, *Effortful Negotiation*, *Resistance to Modeling*, and *Laborious Reuse* at some point in their careers, these were not experienced frequently.

5.3 The Frustration Behind the Pain Points of Modeling

To understand why modelers felt frustrated when encountering the pain points and explore the reasons for these frustrations, we analyzed responses to questions RQ2.1–RQ2.5 (Fig. 1) for all 16 pain points. Figure 3 presents the analysis for each source of frustration. As shown, *NAND* (see the legend of Fig. 3 for an explanation of the abbreviations) responses are relatively low across most pain points, suggesting that respondents generally have clear opinions on whether these factors contribute to their frustrations. Among the 321 reported pain points, 55% of respondents *SA* or *A* that they felt frustrated due to wasted time, 61% due to financial losses, 56% due to unmet goals, and 21% due to diminished self-esteem. These findings suggest that **frustrations throughout the modeling process**

are more commonly driven by financial loss, unmet goals, and wasted time than by self-esteem-related issues (F3).

Figure 3 highlights that *Laborious Reuse* and *Overlooked Documentation* are the pain points more frequently associated with wasted time, as evidenced by the highest percentages of *SA* responses, at 29% and 33%, respectively. These findings align with those in [26], reinforcing two key observations. First, most modelers prefer creating new models over reusing existing ones to avoid wasting time. Second, stakeholders' resistance to model documentation impacts the modeling process, resulting in delays. In contrast, *Effortful Negotiation* and *Effortful Verbalization* are the pain points least associated with wasted time, with 47% and 50% of respondents indicating *SD* or *D*, respectively. This suggests that **participants view the additional time required for certain modeling tasks, such as negotiating concept definitions and generating verbalizations, as necessary rather than wasteful (F4).**

Regarding additional costs, *Resistance to Modeling* stands out for its minimal impact on financial resources, with 50% of respondents either *SD* or *D* with its contribution to financial waste. In contrast, *Unclear Conceptualization*, *Complexity Issues*, *Laborious Reuse*, and *Effortful Diagramming* exhibit high levels of agreement, with 75% or more of respondents *SA* or *A* with their association with frustrations related to increased expenses. These four pain points are linked to model documentation in various ways. Textual concept definitions and visually appealing diagrams are key components of documentation, while tasks such as model maintenance and reuse depend on documentation quality. Therefore, **model documentation can help mitigate frustrations arising from wasted financial resources throughout the modeling process (F5).**

Regarding frustration related to goal attainment, *Unclear Conceptualization* stands out, with 58% of respondents *SD* or *D* that difficulties in writing concept definitions affect goal achievement. One possible explanation is that most modelers create models for personal use [25], where they already understand the model's conceptualizations, making written concept definitions unnecessary. However, when modelers' goals depend on others understanding the model, difficulties in formalizing definitions become more relevant.

For most respondents, damaged self-esteem was the least frequent source of frustration when encountering these pain points. However, *Disinterest in Use* emerged as the pain point that affects modelers' self-esteem, with 60% of respondents indicating *SA* and *A*. This pain point reflects modelers' frustration when others involved in a project fail to recognize the benefits of the model. Although modelers typically develop models for their personal use [25], the lack of recognition of the model's utility by others can be discouraging, leading them to perceive their work as undervalued or unappreciated.

An open question (RQ2.5) invited participants to share additional reasons for their frustrations. Their responses highlight challenges related to stakeholders (e.g. "I felt frustrated because my clients consistently showed ignorance about the value of modeling." – *Improper Requirements*), tools (e.g. "It would have been better to do the modeling using a tool more suited to the needs." – *Tool*

Restrictions), autonomy (e.g. "I felt frustrated because I was given responsibility without authority to change things." – *Unclear Approach*), and the nature of the work (e.g. "Because it's a lot of work, sometimes repetitive work." – *Effortful Verbalization*). Additionally, they clarified that, **although frustrating, some pain points are inherent challenges of the modeling process that should be addressed (F6)**, such as *Expensive Requirements*, *Effortful Negotiation*, *Effortful Verbalization*, *Inadequate Explanation*, and *Limited Verification*.

5.4 The Reactions to the Pain Points of Modeling

To understand modelers' reactions to each pain point, we examined the responses to questions RQ3.1–RQ3.8 (Fig. 1) for all 16 of these. Figure 4 and 5 present the analysis for each analyzed reaction. As shown, *NAND* responses are minimal across most pain points, indicating that participants generally have clear opinions on how to address them. Moreover, among the 321 reported pain points, respondents *SA* or *A* that they reacted to the pain points by abandoning modeling (18%), taking no action (43%), implement workarounds (40%), pursue training (49%), or change the modeling language (16%), tool (29%), or method (43%).

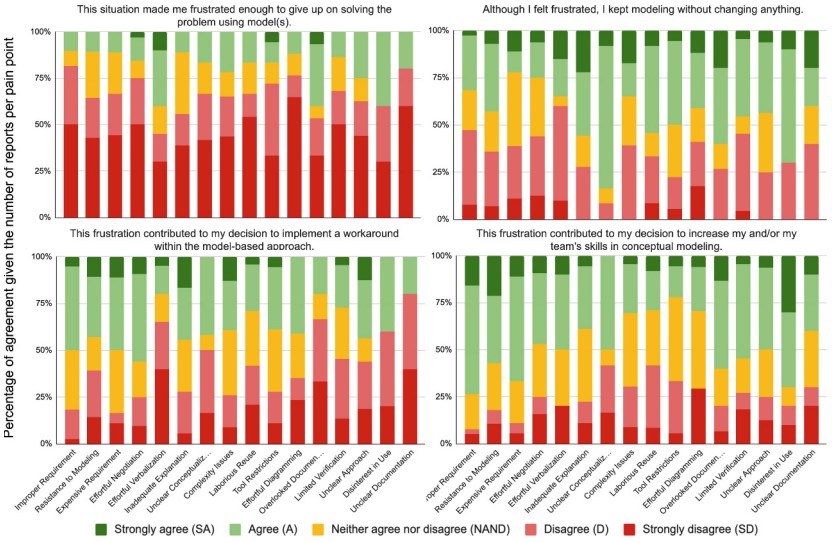


Fig. 4. Reactions to the analyzed pain points (Part 1).

As shown in Fig. 4, the percentage of *SD* responses is notably higher for abandoning modeling as a reaction. This suggests that **study participants are committed to using modeling as a problem-solving tool, even when the process is challenging (F7).** This finding aligns with that in [25] which states that modelers "always choose to solve problems through models, even if they do

not rationally know whether modeling is the best option for a given situation". Although participants are unwilling to give up modeling, *Effortful Verbalization*, *Overlooked Documentation*, and *Disinterest in Use* are the pain points that are most likely to prompt this reaction, with 40% of them indicating *SA* or *A*. One possible explanation is that modeling tools still offer limited support for verbalization and documentation, and conveying the value of modeling remains inherently difficult [26]. These challenges create barriers to understanding and using models, making it difficult to persuade others to adopt modeling.

The analysis suggests that respondents may overlook certain pain points, such as *Unclear Conceptualization* and *Disinterest in Use*. Specifically, 83% and 70% of them, respectively, *SA* or *A* to continuing modeling without making any adjustments in reaction to these pain points. This result can also be attributed to the fact that most modelers create models for personal use [25], which reduces the impact of challenges such as difficulties in defining concepts and limited interest among team members in using and reusing the model. In contrast, *Effortful Verbalization* is perceived as the pain point most requiring intervention, with 60% of respondents *SD* or *D* with taking no action. Given that verbalizing the model to enhance its accessibility and comprehensibility for diverse audiences can produce positive outcomes [26], it is reasonable for modelers to address issues related to this task promptly. Further analysis reveals that the most preferred reactions among respondents to this pain point involve increasing modeling skills and changing the modeling approach, with 46% and 50% of respondents selecting *SA* or *A* for these reactions, respectively.

While participants demonstrate a strong commitment to modeling, they adjust the modeling process according to the pain point encountered. For example, *Improper Requirements*, *Expensive Requirements*, and *Effortful Negotiation* are the pain points for which 50% or more of respondents *SA* or *A* that they react to them with workarounds. There are diverse methods for requirement elicitation and negotiation, which afford modelers the ability to explore strategies for identifying better solutions tailored to the context at hand. In contrast, there are limited guidelines for model documentation and verbalization [26], making it challenging for modelers to implement workarounds. Furthermore, these artifacts must be tailored to specific stakeholders, requiring more personalized solutions. This explains why *Unclear Documentation*, *Overlooked Documentation*, *Effortful Verbalization* are the pain points for which over 60% of respondents *SD* or *D* that they react to them with workarounds.

Figure 4 also reveals that respondents broadly view all pain points as opportunities to improve their own or their team's skills in conceptual modeling. This means that **study participants agree that training is a good strategy for addressing most pain points (F8)**. Four of them explicitly mentioned this in their responses to the open question (RQ3.8), citing training as a reaction to *Unclear Approach* (e.g. "Education. Also tried to point out examples of incoherent classification in existing company data structures."), *Improper Requirements* (e.g. "This frustration made me think about investing in the training of non-technical users."), *Resistance to Modeling* (e.g. "Aim to educate stakeholders on

what CM is really for.") and *Effortful Verbalization* (e.g. "This situation brought me to invest more in teaching non-technical users."). Although pursuing training had the highest proportion of *NAND* responses, *Improper Requirements* and *Disinterest in Use* emerged as a significant driver of skill development, with 73% and 70% of respondents selecting *SA* or *A*, respectively. Since defining model requirements and encouraging model adoption are complex tasks that rely on modeling expertise, fostering a shared understanding within the team can play a crucial role in addressing these challenges.

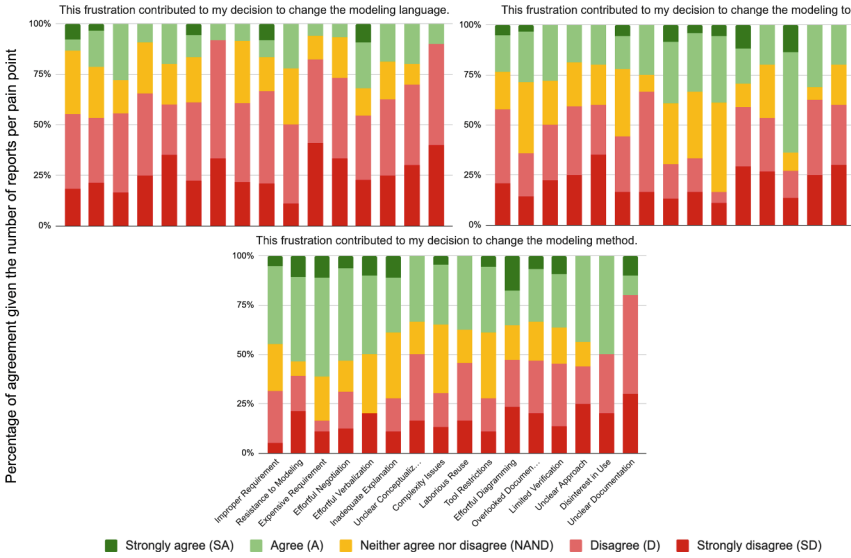


Fig. 5. Reactions to the analyzed pain points (Part 2).

As depicted in Fig. 5, **while participants exhibit some attachment to modeling tools and methods, they are generally more open to modifying these aspects than the modeling language (F9).** In most cases, at least 50% of respondents selected *SD* or *D* when asked about changing the modeling language in reaction to any pain point. The learning curve associated with a modeling language can be long and costly, which may explain modelers' reluctance to switch languages despite existing challenges.

Among the pain points analyzed, *Limited Verification* stands out as a driver of tool-related changes, with 64% of respondents selecting *SA* or *A*. Since this pain point directly stems from tool limitations, modifying the tool appears to be the most effective way to address it. Similarly, *Expensive Requirements* emerges as the pain point that leads to changes in the modeling method, with 61% of respondents in agreement. While the requirements elicitation method plays a role in defining model requirements, the extent to which the modeling method itself influences this process remains unclear.

Conversely, *Unclear Documentation* stands out as the pain point that is unlikely to trigger changes in the modeling language, tool, or method, with over 80% of respondents selecting *SD* or *D*. This suggests that such uncertainties stem more from modelers' experience, domain characteristics, and project scope than from the specific modeling tool, language, or method used. Likewise, writing definitions for model elements is not directly influenced by the modeling language, which explains why respondents show strong resistance to change the language in reaction to *Unclear Conceptualization*, with 92% selecting *SD* or *D*.

An open question (RQ3.8) invited participants to share additional reactions to the pain points. Their responses highlight complementary strategies, such as adjusting modeling time (e.g. "I postponed modeling until later in the project." – *Improper Requirements*) and contributing to advancements in the conceptual modeling field (e.g. "Identified what the needed tool would be like but it hasn't been built. Helped develop [x] to partly address [the issues]." – *Tool Restrictions*). Respondents also provided examples of workarounds they implement within the model-based approach, such as: enhancing communication techniques through revising terminologies (e.g. "We change the terminology, dig up an authoritative source, and so on." – *Effortful Negotiation*) and adopting an example-based approach (e.g. "Also tried to point out examples of incoherent classification in existing company data structures." – *Unclear Approach*), refining agreement negotiation and requirement elicitation strategies (e.g. "After detailing questions that must be answered in term of the model and ones that do not, we continue the modeling process." – *Expensive Requirements*), and making collaborative tasks more interactive (e.g. "Follow the process and iteratively create a verbalization that everyone agrees with." – *Effortful Verbalization*). They highlighted how the pain points contributed to improvements in their modeling strategies (e.g. "This frustration contributed to better study the domain, ask more information to the stakeholders, and postpone the model results." – *Improper Requirements*), persuasive skills (e.g. "This frustration contributed to better explain the benefits of the model." – *Resistance to Modeling*), time management abilities (e.g. "I planned extra time for negotiation meetings in my next projects." – *Effortful Negotiation*), and project selection criteria (e.g. "This situation made me actively search for a new project in a team where there was a modeling culture." – *Unclear Approach*). Finally, three respondents expressed dissatisfaction with how current tools support verbalization, model explanation, and maintenance. For instance, one noted, "Would change to a tool that better conveys meanings if one existed." – *Effortful Verbalization*.

6 Threats to Validity

One concern pertains to the representativeness of the sample in relation to the broader population, affecting the ability to generalize findings [8]. While we acknowledge that our respondents' answers may not universally represent all contexts, there are notable similarities in the settings of our respondents and others engaged in domain modeling. For example, in process modeling, modelers often interact with stakeholders who lack modeling expertise, use models

for training and problem-solving, and navigate tool and language constraints. Similarly, researchers in the modeling domain often share overlapping teaching objectives and research interests. Given these parallels, it is reasonable to assume that similar responses could be obtained from other modelers in comparable contexts. Therefore, our sample offers a representative foundation for examining domain modelers' pain points, consistent with the partial generalization criteria proposed in [29]. However, we recognize that the sample size is insufficient to support statistical analysis, and we encourage future research to explore these pain points with a larger sample.

Another concern relates to whether the questions and corresponding answers accurately capture the characteristics under investigation [8]. While we cannot guarantee that all respondents answered the survey questions in a way that fully reflects their true opinions, emotions, or behaviors, we believe the questions effectively capture the intended meaning of the variables under investigation. This is because we followed an established survey development method [23] and conducted five rounds of testing to ensure clarity and minimize misunderstandings. However, due to tool limitations, we could not randomize the research questions, and we observed that the last two pain points were reported as the least experienced. This lack of randomization may have influenced the responses, an issue that should be addressed in future study replications.

7 Conclusion

Despite the widespread use of domain models, the modeling process remains underexplored, particularly regarding the interactions among agents, products, and services. A recent study [26] took an initial step toward addressing this gap by identifying 16 of the most prevalent and impactful pain points that arise as modelers engage with the elements of the modeling process. Building on this work, the present study investigates these pain points in practice by surveying 49 modelers to assess their frequency (RQ1), explore the reasons for the frustrations they evoke (RQ2), and examine how modelers react to them (RQ3).

The findings indicate that the analyzed pain points are prevalent among study participants, with at least ten reporting prior experience with each (F1). Moreover, all pain points were encountered with a frequency ranging from sometimes to usually (F2). Frustrations were more often linked to lost time, financial losses, and difficulties in achieving goals rather than concerns about self-esteem (F3). Although participants found the additional time required for modeling tasks frustrating, they viewed it as necessary rather than wasteful (F4). While some frustrations related to financial losses can be mitigated through model documentation (F5), others are perceived as unavoidable challenges inherent to the modeling process (F6). Despite the difficulties, modelers remained committed to using modeling as a problem-solving tool (F7), recognized training as an effective strategy to mitigate most pain points (F8), and exhibited resistance to changing the modeling language (F9).

This study has practical and academic implications for the domain modeling community. Practically, the insights can help practitioners refine modeling practices and better plan modeling initiatives, while also assisting developers in enhancing tools and languages. Academically, the research advances the field by extending existing studies and providing empirical evidence that can inform improvements in modeling methodologies and training strategies. Additionally, our findings highlight opportunities for future research. For example, future research could further validate and analyze the pain points, examine their relationship with specific modeling goals, explore strategies to mitigate them, and assess their impact on modeling costs. By bridging empirical findings with practical applications, this study equips researchers, developers, and practitioners with a foundation for enhancing the modeling experience and improving the overall value of domain modeling efforts.

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