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On the Recruitment of Company Developers for Security Studies: Results from a Qualitative Interview Study

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Abstract

To address the issue of participant recruitment for security developer studies, researchers proposed using freelance online platforms or recruiting computer science (CS) students as proxies. However, recent studies showed that company developers performed better than freelancers or CS students in security developer studies. Additionally, studies on factors influencing usable security and privacy in companies make recruiting professionals indispensable. Therefore, we investigated influential factors on the motivation of software developers regularly employed in companies to participate in security studies. We conducted 30 semi-structured interviews on their perceptions of study factors concerning study design, recruitment methods, and data collection. We found that the study duration, topic, monetary compensation, and trust are influential factors for participation in developer studies. However, participants were concerned about high effort and weak performance in security tasks. Based on our findings, we provide recruitment and study design recommendations for future security research with company developers.

1 Introduction

Recruiting professional software developers for usable security studies is an ongoing challenge. Due to the small population size, lack of time, spread out geographical locations, and high cost [2–4, 30, 32, 33, 53, 66], researchers are often struggling to recruit participants, especially for quantitative studies or studies involving software development tools [1, 20, 32, 44, 60]. Therefore, Kaur et al. [29] and Tahaei et

al. [60] compared different online recruitment platforms and samples (freelancers vs. CS students) for security developer studies concerning participants' programming skills and security knowledge. They proposed to either recruit freelancers, CS students or to use specific crowdsourcing platforms along with pre-screening surveys.

However, while the recruitment of CS students or freelancers might be useful for the investigation of different study design parameters (e.g., security prompting) or specific research questions (e.g., "Does a new system design improve the state of the art?") [42], past research also noticed significant differences in the preferences and performance of students and professionals in security developer studies [17, 42, 66]. In a password-storage study, Naiakshina et al. [42] found that professional software developers employed in companies submitted significantly more secure solutions and chose better security mechanisms than CS students or freelancers.

Research on factors influencing usable security and privacy in companies, such as the company context, organizational processes, security culture, or the communication between security and privacy experts and software developers, makes recruiting professional software developers from the industry indispensable [7, 8, 24, 34]. Further, understanding the challenges software developers face after the introduction of new regulations for security and privacy affecting companies (e.g., California Consumer Privacy Act (CCPA) or the General Data Protection Regulation (GDPR)) makes the recruitment of company developers necessary [5, 34, 58].

While different approaches exist to recruit professional software developers employed in companies [24, 42, 55], it is unclear yet how and where developers prefer to be contacted and recruited for security developer studies. Do they prefer to be contacted by researchers or sign up for a mailing list to receive study invitations? Does it matter whether researchers come from academia or industry? Which type of study would they be willing to participate in (online, lab, or field study)? Is the length and type of study (interview, survey, programming task) relevant? While in some security studies, developers

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participated for free [3, 14], in others, they received monetary compensation [31, 42]. No consensus among researchers exists on the type and the amount of compensation to receive higher participation rates yet.

To provide first insights into the study perceptions of company developers, we conducted 30 semi-structured interviews with professional software developers employed in companies and investigated the following research questions:

- **RQ1:** How do study factors affect the motivation of company developers to participate in security studies?
- **RQ2:** How and where do company developers prefer to be contacted for participant recruitment?
- **RQ3:** Which concerns do company developers have with study data collection?

To the best of our knowledge, this is the first qualitative study investigating influential factors on the motivation of professional software developers employed in companies to participate in empirical research studies. We recruited company developers from former studies and participants who indicated not having previously participated in studies. With this sample, we explored the motivations of company developers to participate in studies instead of deterrent reasons for refraining from study participation at all. Our study findings suggested that company developers prefer to be actively recruited for academic research studies with flexible time slots and receive monetary compensation linear to the study duration. However, security tasks were perceived as specifically challenging. Company developers were concerned that security tasks might be more complex than general programming tasks and thus less predictable in the effort. Additionally, if studies are conducted in accordance with their company, developers might feel the pressure of performance tests. Based on our findings, we provide recommendations for future security studies with company developers.

2 Related Work

In this section, we discuss existing guidelines and recommendations for participant recruitment in software engineering studies and work on factors affecting participant motivation.

2.1 Guidelines on Participant Recruitment

Existing work on conducting software engineering studies assists researchers by providing them with guidelines and case studies on how to set up specific study tasks, such as surveys [41], interviews [26], or experiments [57, 63]. The recruitment advice found in the literature often focuses on recruiting a reliable and representative sample [48] or providing testimonials on specific issues and pitfalls during participant recruitment [19]. While guidelines exist on how to recruit professionals for software engineering studies, they

focus on how to conduct studies methodologically [11], how to recruit the right participants [49], or how to establish cooperation between researchers and companies [52]. There exist also recruitment guidelines from different fields, such as health sciences [36], that discuss barriers to study participation. However, these are tied to a clinical context and might not be generalized to a software engineering context. While these recommendations are helpful for reliably collecting data from recruited participants, they provide little insight into how to motivate suitable individual software developers more efficiently and in significant numbers.

Thus, to conduct empirical studies with developers, researchers often relied on their industrial and personal contacts [24, 29, 42] or convenience samples such as CS students [9, 32, 44, 59, 60], crowdsourcing (e.g., Appen, Clickworker, MTurk or Prolific) and freelancer platforms (e.g., Upwork, Freelancer) for participant recruitment [16, 17, 23, 25, 29, 43]. These platforms come with challenges such as unreliable data [17, 47, 56], weak built-in tools [51], or contract limitations (e.g., participants can be compensated only via Upwork for the first two years) [23]. Therefore, Kaur et al. [29] and Tahaei et al. [60] compared different recruitment platforms and samples and provided recommendations on specific crowdsourcing and freelancer platforms for participant recruitment. However, it is unclear yet, how professional software developers employed in companies can be recruited sustainably. We investigated factors affecting company developers' willingness to participate in research studies specifically with a security focus and provide insights into viable recruitment strategies.

2.2 Studies on Participant Motivation

In [54], Smith et al. studied factors associated with recruiting professional developers for software engineering surveys. These factors were based on research of study design, persuasion, and the researchers' experience in conducting previous surveys. A post-hoc analysis of surveys from past research showed that scarcity cues (e.g., time limits or a maximum number of participants) and similarity cues (e.g., being part of the same company) increased the chance of a high survey response rate. Interestingly, besides monetary compensation, complimenting participants or using humor in the study invitation made survey invitations even more successful.

Based on their lessons learned from qualitative research with developers, Brandt et al. [13] provided recommendations on improving the recruitment process for security developer studies. First, they suggested motivating participants by convincing them that there is value beyond monetary compensation for participating in a study, such as learning about a new tool or security technique. Second, they proposed stating why an individual participant is valuable for the particular research study, e.g., competence in a specific domain. Third, they recommended reducing the effort for participants, e.g., by using a

calendar service for meetings or providing an online development environment instead of setting up an environment themselves. In addition, it might be beneficial to appeal to different types of motivation, such as fun, drive to produce knowledge, social connection, and self-improvement to increase study participation rates [6]. In the context of an end-user study, Hsieh et al. [27] investigated the influence of incentives on participation bias in surveys. They found that different incentives influenced the task outcome, i.e., different incentives attracted participants with different motivations. For example, charity rewards attracted participants who valued universalism and benevolence. Using diverse stimuli might increase the response rate and draw a more varied sample, as compensation is quite individual. Offering monetary compensation, however, was the most effective way to increase response rates. Compared to the previous studies, we conducted semi-structured interviews with professional software developers from companies. We explored their attitudes, expectations, and perceptions concerning recruitment strategies, challenges, and study factors such as the study type, security, and compensation.

3 Methodology

To investigate influential factors on company developers' willingness to participate in security studies, we conducted 30 semi-structured interviews with regularly employed professional software developers. All 30 interviews were conducted online by the same researcher using Zoom Video Communications [67]. While participants did not have to turn on their cameras mandatory, the audio was recorded using OBS Studio [46] and transcribed. At the end of the interviews, participants were asked to fill out a short survey on their demographics (Appendix B). In total, we collected 23.25 hours of interviews with a mean interview length of 46.5 minutes (min: 31, max: 64, median: 46).

3.1 Study Factors

We developed a list of relevant study factors based on related work and several meetings and discussions with one highly experienced (5 years of experience in conducting studies with end users and developers) and one senior researcher from the human-centric security research field (more than 20 years of experience). First, we were interested in developers' perceptions of different study design parameters. We asked participants whether the study topic might affect their decision to participate in a scientific study, especially focusing on security or involving security tasks. Additionally, we asked for reasons for their preferred study types: *Online, Lab, and Field Studies*, and study tasks: *Survey, Interview, and Practical Task*. Practical tasks might require writing programming code, a code review, or a protocol. We also asked participants how the study duration and compensation might influence their willingness

to participate in a study. For example, whether they would be interested in participating in a workshop or receiving licenses for software products they might use for their job or free-time. Second, we investigated how and where participants prefer to be recruited by researchers. We asked for different recruitment channels such as email, company research cooperation, conferences, workshops, social networking platforms (e.g., Xing [65], LinkedIn [35], Facebook/Meta [38], Twitter [62]) and whether participants would prefer to be recruited by an active or passive recruitment strategy. Participants might receive personal study invitations from researchers or mailing lists if being actively recruited. With passive recruitment, participants would be required to search for study invitations, e.g., on the Web. We also wondered whether researchers' backgrounds, such as computer scientists or psychologists, might affect participants' willingness to participate in a study. Third, we explored their trust in researchers' organizations, such as academia or the industry. Since different data can be collected from participants in a study, we also explored their privacy concerns with data collection, storage, and usage.

After participants reported their experience with previous research studies, they were presented with the different study factors relevant to the context of study design, recruitment process, and trust in research:

- **Study design:** Study topic, study type, study task, study length, compensation
- **Recruitment:** Active/passive recruitment, recruitment channels, researcher background
- **Data collection:** Trust in researchers' organization, data collection, storage and usage

To test our study setting and interview guideline, we conducted a pilot study with two CS students and one professional software developer. Both CS students worked halftime in a company and provided valuable feedback on the interview guideline. We adapted the guideline by adding additional follow-up questions based on the participants' feedback. The final interview guideline can be found in Appendix C.

3.2 Participants

For participant recruitment, we used our personal contacts and a database of professional software developers who have already participated in past empirical research studies and agreed to be contacted for future studies. Thus, we ensured a broad spectrum of experience with different recruitment channels, study parameters, and study tasks with a security focus. Nineteen interested participants signed up for the study. Additionally, participants shared our study invitation with their friends and colleagues. Thus, 64 additional interested participants signed up for the study. To ensure only professional software developers regularly employed in companies would participate in our study, we asked all participants to fill out

Table 1: Demographics of the 30 participants

Gender	Male: 26, Female: 4
Age	min = 22, max = 53, sd = 9.13, median = 33, mean = 35
General Development Experience [years]	min = 4, max = 30, sd = 8.22, median = 12, mean = 14.2
Working in Company [years]	min = 2, max = 30, sd = 7.02, median = 7, mean = 10
Weekly Work Hours	min = 20, max = 50, sd = 9.87, median = 40, mean = 37.3
No. of Employees in Company	1000+: 10, 500-999: 5, 250-499: 2, 10-249: 10, 1-9: 3
Company Type	Web Development: 12, Frameworks/Libraries: 4 Consulting: 4, Industry: 6, Other: 4
Company Security Focus	Yes: 18, No: 12
Experience with Security Tasks	Yes: 22, No: 8
Participated in Studies Before	Non-Security: 9, Security: 15, None: 5, NA: 1
No. of Studies Participated Before	min = 0, max = 10, sd = 2.34, median = 2, mean = 2.35, NA: 3

a pre-screening questionnaire (Appendix A). We excluded participants who indicated working less than part-time at a company or if software development was not part of their job. Out of 40 invited company developers, 30 participated in our study. We did not receive a response from the remaining ten participants concerning an interview appointment. Twenty-eight interviews were conducted in German and two in English. Participants received 100€ as compensation.

An overview of our participants' demographics can be found in Table 1. All participants were regularly employed as software developers in German companies. On average, participants were 35 years old. Twenty-six were male, and four were female. On average, participants worked for ten years in a software development company, with a mean of 37 hours per week. Our participants had an average of 14 years of experience with software development. Most participants worked in companies with 10-249 or at least 1000 employees. Twelve participants reported working in a company specialized in web development, while others were employed in consulting or industrial companies, as well as in companies specialized in the development of libraries, frameworks, or middleware. Eighteen participants indicated working for companies with a security focus. Twenty-two of the 30 participants were experienced with working on security-related tasks in their company. Twenty-four participants stated to have already participated in a scientific study in the past, of whom 15 have already participated in a study with a security focus.

3.3 Evaluation

We analyzed the transcribed interviews with the software MAXQDA [64] by using thematic analysis [12]. After two researchers (R1 and R2) coded the first three interviews individually, they agreed on one codebook through discussion. Based on this codebook, all the remaining interviews were analyzed by the first two researchers, R1 and R2, and a third researcher, R3. Researcher R1 coded all 30 interviews. R2 coded a random set of 15 and R3 the remaining 15 interviews. As suggested by McDonald et al. [37], we calculated

an inter-coder agreement to ensure the consistency of the code application. It was calculated using Cohen's kappa coefficient (κ) [15]. The inter-coder agreement between R1 and R2 measured 0.77, and R1 and R3 0.78. A value above 0.75 is considered to be a high level of coding agreement [21]. The codebook can be found in Appendix D. Reported quotes were translated using DeepL [18] and adapted by the researchers in necessary cases to convey the quotes' meaning properly.

3.4 Limitations

This study has several limitations that need to be considered when interpreting the results. First, we cannot claim the completeness of the presented list of different study factors relevant in the context of study design and participant recruitment. There may be other factors influencing the motivation of company developers to participate in empirical research studies that are not covered in this study. However, we provide preliminary findings on factors that might be worth to be further explored in future research. Second, since we asked about factors influencing developers' decision to participate in a research study, results may suffer from a social-desirability bias. In addition, since our participants were willing to participate in research studies, they might be favorable to research and thus might have other views than those who abstained from this or study participation at all. As such, we can only make claims of motivations and preferences of participants willing to participate in research studies. Third, we recruited professional software developers regularly employed in German companies. Our study findings might not apply to developers from other parts of the world. Further work is needed to make any generalizable statements.

3.5 Ethics

Our institution does not have a formal Institutional Review Board (IRB) process for computer science studies, but the study protocol was cleared with the institutional data protection officer. Our participants were provided with a consent

form complying with the General Data Protection Regulations (GDPR). They were informed about the practices used to process and store their data and that they could withdraw their data during or after the study without any consequences. The audio recordings were deleted after transcription. We assured all participants they would be informed about the study results, and only anonymized data would be published.

4 Results

In this section, we present the motivational factors and barriers concerning study design, participant recruitment, and data collection we identified in the interviews. An overview of the factors can be found in Table 2. To report statements, we labeled participants P1-P30. While we note how many participants stated specific themes to indicate their frequency and distribution, we do not aim to generate quantitative results.

4.1 Study Design

In the following, we present relevant insights into the study design of security studies with software developers concerning the study topic, study type, task, length, and compensation.

4.1.1 Study Topic

Our participants frequently noted an interest in the study topic as motivation for their participation. They often perceived the topic as an opportunity to learn something useful or to work on something in line with their interest: “*Sure, the topic has to interest me somehow*” — [P19]. Six participants (e.g., P4, P7, P10, P12, P24) were willing to receive less compensation if they could work on a study topic that is in line with their motivation to participate: “*If it is a topic that interests me [...] I would also participate in studies, but that is not where I earn my money*” — [P4]. However, the opposite was also true. Participants claimed they would need a higher compensation to compensate for their disinterest in the study: “*So, if the topic does not interest me at all, then you could lure someone or me with money*” — [P2]. In addition, participants often mentioned they were less likely to participate if they were unsure about fulfilling the requirements for study participation. They worried they could negatively influence the study results and thus told to be hesitant to participate: “*The study topic, yes, I think it is essential that I [...] have to know, if I can say something about it or not*” — [P4].

We did not observe differences in the statements of participants who have already participated in security studies (15/30) and those who participated in software engineering studies (9/30) or did not participate in studies at all (5/30). However, participants often explicitly referred to IT security as a topic they would consider when participating in a scientific study: “*This is a topic that also interests me in a professional context*” — [P16]. One participant stated that,

especially in the context of IT security, they can “[...] *learn (something themselves)*” — [P10]. Participants felt that developer studies with a focus on security might be a good opportunity to update their knowledge concerning state-of-the-art security: “*If you’re programming something, anything security-related, and you realize that I haven’t updated my knowledge in the last ten years, that kind of added value*” — [P18]. Two participants also stated that they liked to be challenged: “*It has a playful component. You challenge yourself. I can see that I’m doing a good job*” — [P29]. The motivation to learn something new is also reflected in the non-monetary compensation our participants suggested. For instance, attending a workshop: “*[Offer] an information event on the IT security topic there, that would [...] make that more interesting again*” — [P16] or receiving a security certificate: “*So something like a security certification that you could maybe then obtain*” — [P10]. However, P11 stated that it is hard to estimate the difficulty of security-related tasks. Therefore, they would like to be informed about the extent of effort the task might need: “*Especially in the area of security, it is always good to know in advance at what level such a study will ultimately be conducted, how deep the whole thing goes technically. In the field of software development, it is always assumed that things will become technical very quickly*” — [P11].

4.1.2 Study Type

All but one participant stated online studies to be their preferred study type. As advantages, participants mentioned the flexibility and duration of an online study: “*Because the time required is less than for another study*” — [P1], comfort: “*You are at home in your comfort zone*” — [P28] and that they do not have to travel in the COVID-19 pandemic: “*I do not have to leave the house. [...] Right now also with all that Corona time. This is just more pleasant [...]*” — [P26]. Eighteen participants (e.g., P1, P5, P11, P17, P30) mentioned that they expected less compensation in an online study compared to a field or laboratory study.

All participants stated that participating in a lab study might be more challenging since they would need to travel. Twenty-one participants (e.g., P2, P5, P14, P21, P26) noted that they would expect additional compensation for traveling: “*If that is now somehow locally at the university, where I had to drive there, then the travel costs would have to be somehow considered, plus the time expenditure [...]*” — [P2]. P3 described that they would have taken a day off from work to participate in a laboratory setting: “*The planning, that simply my life gets affected more, that I have to organize more, maybe take a day off or something like that*” — [P3]. Our participants had different opinions on field studies. Twelve participants (e.g., P3, P6, P9, P22, P27) were open-minded toward field studies, provided their employer would previously approve the study participation. Others (e.g., P3, P11, P12, P26, P28) explained

Table 2: Motivational factors and barriers concerning study design, recruitment, and data collection

Study Factor	Factor Level	Motivation	Barrier
Study Topic	Software	In line with developer hobby or job	Unexciting topic
	Engineering	Self-improvement	Uncertainty about requirements
		Learning effect	Uncertainty about effort
Security	Update knowledge	Security performance test	
Study Type	Online	Flexibility	
		Working from home/while traveling	Traveling time and expenses
		Anonymity	Issues due to Covid-19
Laboratory	Social interaction	Requirement to take a day off work	
Field	Combining work with study		Concerns about data privacy of clients
			Conflict when working with clients
			Conflict when working from home
			Company reputation in case of weak security performance
Study Task	Survey	Short	
		Easy to do	
		Flexibility	Length
Interview	Variety to job	Social interaction	
		Flexibility	Length
		Learning effect	
Practical	Personal challenge		Uncertainty about task requirements
			Uncertainty about task effort
			Length
Study Length		Control of time scheduling	Length
		Time flexibility	Rigid date scheduling and loss of flexibility
		Continuous compensation in long-term studies	Long-term commitment
Compensation		Monetary compensation	Skepticism toward too high compensation
Recruitment	Strategy	Active recruitment	Passive recruitment
		Forwarded by friends and colleagues	Spam
	Company	Trust in approved study	Lack of time
Channels	Asynchronous nature of email		Performance test
		Unsolicited emailing with verifiable identity	Headhunting on networking platforms
		Study advertisement at workshop or conference	Unsolicited emailing without verifiable identity
Data Collection		Trust in academia	Distrust in industry
		GDPR compliance	Sharing sensitive data

that they have been in home office for a long time and thus did not believe conducting a field study would be a good idea: “*But when it comes to seeing myself in my natural environment, for example, I don’t know if the field study isn’t the best way to go, in quotes, because this home office situation isn’t necessarily what you prefer*” — [P6]. P11 would also like to avoid involving customers: “[...] *I am also visiting customers as a software developer, and I do not need someone there who conducts a study, who stands behind me, and who looks over my shoulder*” — [P11].

4.1.3 Study Task

We asked participants about taking part in a study involving a practical task. Some indicated they would appreciate taking part in practical experiments and would prefer it over an inter-

view or survey: “*Yeah, because in practical tasks, [...] you will have the opportunity to learn something*” — [P21]. Others (11 participants, e.g., P4, P16, P18, P22, P25) mentioned uncertainty about practical tasks, as they do not know what to expect, how long they will need, and whether they might fit the task requirements: “[...] *but then the framework conditions would have to be a bit clearer in advance, and basically I would also have to know what kind of tasks I would be facing. So the uncertainty would then rather strengthen the aversion*” — [P16]. Further, P6 described that in programming tasks, they had to engage deeper with the topic: “*I associate a practical task with the fact that I have to get involved with the subject. That means that in my mind, it’s always associated with more effort*” — [P6]. Almost all participants perceived a practical task as more difficult in general. When asked if the study task influences the compensation they expect, half of

the participants wanted to receive higher compensation for a practical task compared to a survey or an interview: “*I would [...] expect a higher compensation for the practical work, definitely*” — [P24]. Further, P16 compared the work on a practical task with an “*examination situation*” — [P16].

Participants often preferred surveys and interviews over practical tasks, as they perceived them as a variety of their working tasks: “*I am coding, doing it the entire day. And then an interview is a welcome diversion*” — [P2]. Social interactions were frequently referred to as a positive factor associated with interviews: “*Because then I would rather interact, instead of standing alone, in front of some piece of paper, or sitting and having the feeling, oh, I still have to fill out this piece of paper*” — [P6]. Further, participants valued the flexibility surveys offer besides lower attention required: “*And because I do not have to expend so much effort and because I don’t have to think much, you can do that on the side*” — [P7]. Thus, participants accepted less compensation for surveys: “*So, with such a click survey, I would not necessarily expect such an amount as a reward for the interview here. Because you can do it in between, while you are doing something else, or you can interrupt it*” — [P16]. However, participants disliked long surveys due to boredom and mental fatigue: “*But whenever I am filling out a survey, especially if it is longer, I get to the point where I drift in thought and simply start clicking through, to finish*” — [P8].

4.1.4 Study Length

Many participants considered a long duration as a barrier to taking part in a scientific study, which can not be broken through other forms of motivation: “*One can then simply not participate. [...] But I think that [this] is not a factor now for better hourly payment*” — [P17]. Fifteen participants stated that their time is limited, e.g., because of family responsibilities: “*I have a job and a family, so it is always difficult to find the time slot [...]*” — [P16], or the need for recreation: “*Although I am employed full time, [...] I should also relieve my head a bit sometimes*” — [P17]. Participants were also asked about their willingness to participate in long-term studies spanning months or even years.

Some participants stated that while they might be interested in participating, they would not like to agree on fixed dates, weeks, or even months ahead: “*I couldn’t say, okay, I can set this exact block for myself every two weeks or every month*” — [P18]. P19 stated that it would be beneficial if you can “*[...] determine the time frame accordingly, [so] that you can also do something [...] on the weekend or [...] in the evening after work*” — [P19]. Another participant liked the idea of a long-term study: “*It would be super cool if such a study is a long-term study and you get money again and again*” — [P5]. However, 15 participants (e.g., P4, P7, P17, P22, P29) preferred a study length of one to four hours.

Ten participants (e.g., P4, P17, P19, P25, P28) equated time

to money and compared the study compensation with their salary: “*[...] Either I sit for two hours or more in a study or I just work longer, then I think most people start to wonder whether it’s worth it*” — [P18]. However, 18 participants (e.g., P2, P8, P11, P16, P28) did not expect a higher hourly wage for more extended studies. Instead, they expected linear payment: “*So basically that you have some kind of hourly rate that you have for an interview, if you say one hour one hundred euros, if it’s two hours it’s two hundred euros*” — [P16]. If taking a vacation day for a study with a long time frame would be necessary, six participants (e.g., P5, P11, P19, P24, P25) expected to be compensated for the loss of a working day: “*So then it would have to be much better paid than the day off costs me [...]*” — [P24]. In a multi-day time frame, 15 participants (e.g., P5, P9, P11, P19, P27) stated to “*[...] rather not participate if [it would require a] day or something, then the will is not so high*” — [P16]. Overall, many participants stated that flexibility is essential. Having control over the time frame might increase the willingness to participate even in a long-time framed study: “*So the more flexible you are in choosing the time slot, the longer you can manage the hours for a study*” — [P2].

4.1.5 Compensation

Almost all participants (28/30) preferred receiving monetary compensation: “*Are there serious compensation suggestions other than money?*” — [P15]. Nine Participants perceived compensation methods such as Amazon vouchers as appropriate as well: “*Amazon is like cash to me actually*” — [P2]. Fourteen (e.g., P5, P10, P16, P21, P26) opted for participation in a workshop as compensation. Still, restrictions were mentioned for workshops: “*[...] especially for such an on-site study, if it is somehow integrated into a workshop, where I then take something away for myself, it would be interesting for me*” — [P16]. As a further barrier to workshop participation, participants stated that “*with training offers [...] it’s [...] again associated with having to sort of balance out when, how, where*” — [P6]. They would need to coordinate with their employer first to get some time off: “*So if, for example, some conference is to take place now, [then] I would have to ask my employer [...] and they would have to spend the money accordingly. And that’s exactly what you could save at that point*” — [P26]. Further, participants mentioned that they were concerned a workshop might force them to take part at a specific date, which might limit their flexibility: “*[...] Then I probably lack the time flexibility again*” — [P5].

Eighteen participants were willing to accept a software license as compensation for study participation if it fitted their requirements: “*[...] only [...] if it is something I am working on right now*” — [P5]. One participant explained that even if they would be interested in getting a license, they would still compare this to the actual monetary value of the product: “*[...] nevertheless, I would weigh afterward again*

[...] , what is the financially equivalent value of it [...]” — [P1].

Most participants (24/30) stated that a higher compensation would increase their willingness to participate in a study, and thus they might ignore the challenges they perceive. P3 specifically said that they would also do “[...] unpleasant things” — [P3] if the amount of compensation would be appropriate. Many participants reported that there exists a hard limit for study participation. For example, some stated they must fulfill their family and work responsibilities. Therefore, taking part in studies that last more than some hours might not be possible - regardless of the compensation amount: “[...] because I have a family and two children. So I have to find a place to fit it all in. That’s why the time factor is also important in any case” — [P6]. Five participants also mentioned that they might be skeptical if the compensation would be too high: “I would be more concerned if a private company paid me too much” — [P3]. Interestingly, 100 euros for an interview study with software developers was perceived as too high by P14: “So I definitely think it’s way too much in this study” — [P14].

4.1.6 Other Factors

Beyond monetary compensation, other factors were mentioned developers perceived as a motivation to participate in scientific research. Some participants wanted to contribute to society and maintain “[...] the dialogue, between the generations, between old and young, experienced and inexperienced” — [P4] because it might be valuable for “the community” — [P13]. Thirteen participants (e.g., P3, P8, P10, P19, P26) stated that they were motivated to help since they were curious “what will happen afterward (with the results)” — [P4]. Others were motivated by recognizing their own mistakes and receiving feedback on their work: “if they will give me some feedback” — [P23]. Some liked the idea of receiving “an appreciation letter or basically certificate” — [P21] as recognition for their efforts, and others felt appreciated “[...] to be asked as an expert about something” — [P5]. Twenty participants (e.g., P6, P9, P12, P19, P26) also reported that their work activity is in line with their preferences in their free-time, and thus they might consider participating in a scientific study: “My profession is also my hobby” — [P7].

4.2 Recruitment

When asked what should be included in the study invitation, 23 participants (e.g., P1, P9, P10, P16, P24) stated that “the theme must fit me in any case [...]” — [P26]. Another participant stated that they would want to be personally addressed because “it’s just much more personal, and then you also have a good feeling that you’re helping (with) something” — [P5]. For short studies, some participants preferred to start with the task after receiving the study invitation immediately: “If

one [...] would have to sign the consent form or make an appointment or something similar, then rather not” — [P2].

4.2.1 Active & Passive Recruitment

Twenty-five participants (e.g., P2, P4, P12, P17, P25) favored active over passive recruitment. One of the disadvantages of passive recruitment most participants faced was “not knowing where to find it” — [P28]. Seventeen participants (e.g., P1, P3, P12, P22, P29) considered not having to look for a study themselves as an advantage of active recruitment, as summarized by one of the participants: “For me, this is just right. I am a lazy person” — [P25]. Overall, many participants considered being personally addressed in active recruitment as beneficial since “that just comes much more personal” — [P5] and they knew “that I was not simply addressed randomly” — [P4], but rather for the skill they possess. Not all attitudes towards active recruitment were positive. Seven participants (e.g., P9, P15, P22, P27, P29) worried that active recruitment could result in spam: “If twenty emails per week are coming in now, I guess it’s time for me to activate the spam folder” — [P29]. Most participants (21/30) favored asynchronous communication, especially for first contact, which applies to both types of recruitment: “I like all forms of first contact where I don’t have to react spontaneously, whether it’s an email or an ad” — [P3]. Nine participants also had positive attitudes towards study invitations being forwarded by friends or colleagues since they have “[...] a few bonus points of trust on top” — [P9], especially if they already received their study compensation.

4.2.2 Researcher Background

Researchers’ background was often linked to the study topic. For instance, 14 participants (e.g., P2, P8, P10, P12, P30) stated their decision to participate in a study would not be affected by involving researchers from fields other than computer science: “This would not be so important to me” — [P19]. However, P2 noted that they would be more willing to help researchers if they shared the same background: “When I see that is also a computer scientist, then I still tend to be more helpful” — [P2]. Three participants (P15, P16, P17) considered a researcher’s background as essential for their decision to participate in a research study: “I think you have to have a background there” — [P16]. Nine participants (e.g., P1, P3, P13, P14, P21) stated that “it really depends on the topic, if it is supposed to be more interactive, the IT person will probably have more understanding of the terms” — [P9]. P3 stated that “Experience would be more critical” — [P3].

4.2.3 Company

Ten participants (e.g., P3, P12, P25, P26, P29) believed their employer would be willing to share a study invitation among their employees. However, “when there is a lack of time in

the company, [the employer would] say: "Ah, we'd better not pass that on" — [P1] even though they promised researchers otherwise. Other concerns had been that "in the worst case, the employer is in cahoots with the researcher and uses the situation to test my performance somehow" — [P29] or that they might be forced to participate by their employer: "That would be fine, too, if the employer didn't push me to do it" — [P17]. Four participants (P2, P9, P11, P25) complained about disguised headhunters: "You wouldn't get through to me at all, very quickly put a stop to it and say, yes, that's actually just a hidden inquiry. In reality, you are a recruiter" — [P11]. Still, study invitations approved by an employer were trusted more: "I mean, if the employer has already run this, certain checks have already been run in advance, which means that I can really assume that it is a serious study" — [P20].

4.2.4 Recruitment Channels

Almost all participants preferred email as their primary recruitment channel: "So as a computer scientist, I have to be honest, I'm most comfortable with the email form" — [P17], due to its asynchronous nature: "Because of the asynchronous and because it is then just a bit personal" — [P6]. Unsolicited emailing, participants accepted under certain conditions: "I would like to know where they got my email address from" — [P30] and who the sender is, since "if it was in my inbox from someone I didn't know, I would be skeptical. That's when the alarm bells go on" — [P29]. Most participants indicated using social networking sites such as LinkedIn or Xing for their professional contacts. Some participants agreed on receiving invitations through these channels: "I think, so something like Xing or LinkedIn or something like that, I think you would expect it anyway" — [P18]. Others (eight participants, e.g., P6, P14, P26, P28, P30) refused to be contacted through such channels: "[...] because I personally perceive it less as a place for news" — [P6]. Some participants (P9, P10, P24, P28) stated that they were exhausted by the mass of recruiters contacting them. Thus, they might end up skipping legitimate study invitations: "I usually blindly reject all requests with this automatic no-thank-you answer. A request like that could certainly be overseen" — [P24].

Participants had mixed feelings about being recruited at a conference or a workshop. One participant stated that since they are already at the venue, they might participate in the study: "I was at a conference where this was asked, where I participated in a small survey, especially if you are on site anyway, the hurdle is of course very low if you can just do it spontaneously" — [P3]. Some might be more willing to participate if a speaker shares a study invitation with the audience while keeping it asynchronous. One participant stated: "I'm generally not the one who likes to be addressed by booths or something, but if it's a conference and the speaker says, well, pass on the information, or it's also advertised somewhere, whatever" — [P10].

Most participants indicated rarely using social networking platforms such as Facebook or Twitter. One participant questioned how serious study invitations, shared via these channels, are: "I don't really think it's serious either. Honestly, I wouldn't believe it's anything real either" — [P18]. Still, one participant stated that the channel is not essential, but rather who is recruiting and how participants were addressed: "So basically, I wouldn't say if you brought it to my attention [...] via Twitter, I wouldn't do that because that came via Twitter" — [P6].

4.3 Data Collection

Participants preferred data collection to be fast and easy: "So, if you work with modern tools, for example, GitHub, where you can upload and download the code, that would have been more comfortable. In that case, I have, I think, sent it via email. I am not entirely sure, but it was a bit of back and forth" — [P2]. Some participants were irritated by the collection of the same data multiple times: "But questions which were already asked, then discussed afterward again, I found a bit odd" — [P11].

4.3.1 Researcher Organization

Participants had different attitudes toward the type of organization conducting the study. Many participants mentioned they had a high level of trust toward public institutions like universities. They thus were more comfortable with data sharing compared to private corporations: "Because I am more prepared to participate in public studies and use my personal resources, and my data is part of that, compared to private studies" — [P12]. In addition, some participants believed that universities had a lower budget compared to corporate entities and thus expected a lower compensation from studies done by universities: "To be honest, I thought that the university pays worse. [...] I think [companies] also have more money" — [P18]. Further, some participants raised concerns regarding illegal data collection by companies during studies, something they assumed was less likely to occur with public institutions: "So, there are some things, like market research institutes, where you can install some kind of client, [...] which then collects all kind of data in the depth of windows and sends to them, where you have no control in the first place" — [P10]. Some participants assumed German companies were more likely to collect their data in compliance with GDPR.

4.3.2 Privacy Concerns

Some participants felt that a high compensation for their data would raise suspicion about the usage of their data: "If the compensation for things like that is higher, I (would) have concerns about whether [...] (it is) too high and why" — [P3].

In many cases, participants preferred to share as little data as possible. However, 16 participants (e.g., P6, P11, P15, P21, P30) argued they would be willing to share their data if the usage was in line with the research topic: “*Eye movement, well, I really do not know, [. . .] I would have to be sure how it is processed*” — [P15]. Questions concerning sensitive data raised the issue of anonymity for many participants: “*Well, to be honest, there really was [that] moment in a survey after a study. [. . .] I would say that not everyone honestly answers such sensitive questions because, in the end, you are still not sure how anonymous everything is. So there is a certain amount of trust, but still*” — [P17]. This was linked to the study type, as participants frequently mentioned the increased anonymity of online studies as a positive factor: “*This is the most significant advantage for me. Maybe also that it is a little anonymous*” — [P7]. By contrast, many participants were skeptical about field studies, as data collected at their workplace might be critical: “*And then this person asked me about security-relevant features, about knowledge, that you have to have for it and finds out, I do not know, how to solve this problem best. And you could use that against the company where I work*” — [P5].

5 Discussion

In this section, we discuss our research questions. We provide insights into recruitment obstacles specifically related to the company context. Past research with students showed that they were often available for laboratory studies [10, 32, 61], flexible in time [40], and did not worry about the consequences of their study performance [43]. Besides logistical issues, our participants reported being less flexible in time and worried about their and their company’s reputation, unpredictable effort, and potentially bad performance communicated to their company. Since most of our participants were already experienced in study participation, preferences on the indicated factors for specific types of studies we identified might only apply to participants willing to participate in research studies. While we cannot make any claims about those who opted not to participate in this study or studies in general, our results indicated preferences for different types of studies on recurring participants. As such, our results can help researchers retain interested participants for various types of studies.

RQ1: Influence of study factors on study participation. Our participants indicated monetary compensation as the most influential factor motivating them to participate in research studies. Participants felt that high rewards could compensate for working on research topics they might not be highly interested in or participating in long-time framed studies. They also expected higher rewards if working on practical security tasks or required to take a day off from their regular work (e.g., traveling for a lab study). However, they were willing

to work on study tasks in their free time as long as they did not conflict with their family responsibilities. Thus, flexibility and schedule control was essential for accepting study invitations, which were not considered to be compensated by higher monetary compensation.

Our participants generally did not expect a higher payment for long-time framed studies but rather a linear hourly rate. Still, they were skeptical about high payment if they could not relate it to the expected effort. Thus, participants expected less payment for online studies, short surveys, or studies conducted by academic researchers in a university context. While participants perceived vouchers (e.g., Amazon) as another form of monetary compensation, workshop participation or software licenses might be less promising forms of compensation due to highly individual demands. Besides compensation, participants were often motivated by idealism to contribute to society, self-improvement, or receive feedback on their work.

With the continuous threat of security vulnerabilities attackers might exploit, it seems participants felt that developer studies focusing on security might be an excellent opportunity to evolve and update their security skills and knowledge concerning recent security topics. They indicated that security tasks would have a positive learning effect. Participants would also appreciate receiving a security certificate after study participation. Especially, practical tasks might be an excellent way to improve their security skills, and thus participants would be willing to participate in security developer studies. However, participants were concerned that security tasks might require more effort than expected. They were also often unsure whether they fulfilled the requirements. Therefore, they would like to have clear information on the task requirements. Additionally, they worried about weak performance in security tasks, which might be linked to their company (e.g., in a field study).

RQ2: Recruitment. With active recruitment by researchers, developers were not required to search for study invitations, which might save time and effort. Additionally, participants indicated being unsure where to look for study advertisements. They favored email as a recruitment channel since it allows asynchronous communication. Further, they appreciated the personal contact and assurance they were recruited based on their competence in the studied field. However, participants were concerned about unsolicited emailing or the uncertainty about where their contact information was gathered from. Therefore, study invitations forwarded by friends and colleagues - especially if they had already received their study compensation - were trusted the most and thus might increase the likelihood of positive responses. Participants trusted study invitations distributed over their company since they felt their employer had already approved them. However, they worried about performance tests and the pressure of being forced to participate in the study. While social networking platforms were considered suitable for participant recruit-

ment in a professional context (e.g., LinkedIn, Xing), some participants were unsure how serious invitations were from social networking platforms in a more personal context (e.g., Facebook/Meta, Twitter). However, study advertisements at workshops or conferences were perceived as a suitable way to recruit participants.

RQ3: Data collection. Compared to the industry, research institutions like universities enjoy great trust among company developers, which is why most developers indicated being more willing to share their data. Participants preferred to share as little data as possible unless they were informed about data usage. They also indicated that the data collected should be in line with the research topic and comprehensible. However, security studies involving very high compensation raised concerns about data usage. Surveys and online studies were considered more anonymous than other study types and tasks. Thus, participants may be more willing to share personal data. Still, participants had no concerns about sharing source code as long as they were assured that it would not be used for commercial purposes. Data collection becomes even more vital when conducting field studies in a company because developers are worried about client information leakage or weak performance in security studies damaging their company's reputation. Overall, concerns about data collection might be mitigated by adequately informing participants about the data collection process and measures taken to ensure anonymity.

6 Recommendations

In this section, we provide recommendations for future usable security and privacy research studies based on our findings.

6.1 Study Design

In the following, we present our recommendations concerning study design.

Study Topic. For security studies with company developers, specific requirements and the expected effort should be made clear since uncertainty about tasks or topics might discourage developers from participating. Our participants were often unsure about the target group of study invitations or assumed other participants might be more suitable for the study topic. This is especially true for IT security since tasks in this domain are expected to be more challenging. If a study includes researcher-participant interaction, it might be beneficial to state a researcher's experience with the study topic.

Study Type. Online studies might be the preferred form for study participation for all study types (interview, survey, practical task) if high numbers of participants are required. If a laboratory setting has to be chosen, a virtual study environment, as proposed by Huaman et al. [28], might be a good

option. Otherwise, explicitly compensating participants' time and travel expenses might be required.

Study Task. Many developers felt pressure on the performance of their practical tasks. High dropout rates due to potential task difficulty were also observed in past research, such as 42% in a study conducted by Acar et al. [1]. Thus, in usable security developer studies, participants might be made aware that the usability of a system but not their performance is tested. Concerns regarding task difficulty can also be alleviated by clearly stating the study requirements. Including an example task, as done in previous studies, can provide reassurance to participants [50, 51]. For surveys, developers preferred to start immediately after receiving the study invitation. Thus, including the survey link in the study invitation might be beneficial. This could be combined with checking for inclusion criteria and screening questions to ensure data quality. Due to the COVID-19 pandemic, participants reported having fewer social interactions. An interview can be a welcomed variety to company developers' daily jobs. For interviews, developers preferred minimal organizational effort. Using an easy scheduling service can reduce developers' effort and increase flexibility.

Study Length. Time flexibility is an essential factor for developers. Naiakshina et al. [42] reported that "developers dropped out because of a lack of time and [not managing] to solve the task in a functional way." Thus, long-time framed studies need also to be flexible in terms of time schedule, which might include offering dates on the weekends or outside office hours. It might also be beneficial to highlight the compensation, if available, associated with long-time framed studies.

Compensation. Monetary compensation is the most influential factor in increasing participant rates. However, participants also appreciated security certificates when participating in security developer studies. Thus, offering workshops after study participation, where participants can receive security certificates, might be a promising approach. In long-time framed studies, we suggest considering the hourly wages of company developers since they tend to compare the time invested in a study with their working time. Letting participants choose between different types of compensation besides intrinsic motivation (e.g., learning something new, updating knowledge) might improve response rates as well as sample quality as proposed by Hsieh et al. [27] in an end-user context. Interestingly, our participants considered the compensation of 100€ for a one-hour interview study rather high. While this can be the first indication for interview study payment, more research is needed on the payment levels for different study types, tasks, and lengths.

6.2 Recruitment

In the following, we present our recommendations concerning participant recruitment.

Recruitment Strategy. The study invitation should reflect and appreciate participants' competencies. It might be essential to explicitly state why their participation is vital for the study by acknowledging their skills and study topic requirements. In addition, participants might be informed how their participation can benefit themselves, the community, or society. For example, the conducted research might be helpful for the following generation, personal improvement, or specifically in the IT-security context, resolving security misconceptions and reducing security vulnerabilities. Previous work indicated that similarity cues improved response rates in surveys [54]. Thus, highlighting a shared professional or academic background might make a study invitation more appealing. Interestingly, all participants provided their consent to be contacted for future studies. They preferred this recruitment strategy due to the low effort. Therefore, we recommend asking participants for their consent to receive future study invitations after study participation. However, it would be helpful to avoid sending unsuitable study invitations and instead address the required target group of the study. For future work, it might be beneficial if a central database of interested software developers might be available to the research community. Alternatively, a central web page collecting advertisements for different research studies comparable to job openings might be a good form of informing interested participants.

Recruitment Channel. Email is the most preferred channel of communication as well as first contact because of its asynchronous nature and having everything in one place. Despite the common usage of social media and online forums for participant recruitment in security studies [7, 39, 45], most of our participants were unwilling to be recruited through these channels. Thus, we recommend using additional channels, as done in other security studies [29], alongside email. Research conducted by institutions like a university, research cooperation with companies, and study recommendations by friends and colleagues might increase trust in the study and thus participation rates. For unsolicited emailing, researchers might include where and how they extracted the contact information and explain how to remove the participant's contact information from this source. In addition, researchers might provide a verifiable way to check their identity or institution.

6.3 Data Collection

In the following, we present our recommendations concerning study data collection.

Data Collection, Storage and Usage. Explaining the purpose of re-iterating questions in surveys and interviews for data validity reasons might avoid irritating participants when the same information is gathered multiple times. In addition, data collection should be easy and relate to the study domain. Using internet hosting services such as GitHub for programming code submissions might be beneficial since developers

indicated familiarity with them. If it is necessary to collect sensitive data from participants, it might be explained why this information is required. Participants mentioned fear of repercussions from the deanonymization of study data, a concern which was raised in past research as well [22]. Addressing and explaining the precautions taken may alleviate concerns.

Consent Form. Some participants were concerned with data collection, storage, and usage. Thus, we recommend presenting the consent form separately from the study invitation text to avoid overwhelming participants. Since our participants often referred to GDPR, researchers might inform participants whether data collection is in line with GDPR or CCPA, including third-party services used for data collection, storage, and analysis, e.g., transcription and hosting surveys.

7 Conclusion

Researchers often struggled to recruit developers for security studies. While using online freelancer platforms or inviting students can often be a good choice for participant recruitment, past research showed that the behavior of developers, freelancers, and CS students might differ in security studies. Additionally, usable security and privacy research in the company context requires recruiting professional software developers from the industry. Therefore, we conducted 30 semi-structured interviews with company developers to investigate influential factors on their willingness to participate in security developer studies. We found that participants mostly preferred to participate in short studies conducted online and in line with their interests. Developer studies with a security focus were perceived as specifically attractive since participants felt they might update their security knowledge and test their skills by receiving feedback on their performance. However, participants were concerned by the effort and weak performance effects security tasks might entail. Still, most barriers concerning study design, participant recruitment, and data collection might be countered by monetary compensation. Overall, company developers preferred to participate in studies with low effort but were willing to accept long-time frames if flexibility was ensured.

While offering first insights into influential factors on company developers' motivation to participate in security studies, further research is required with company developers from other parts of the world. Further, our findings suggested a strong influence of monetary compensation. Since no consensus between researchers exists, more research is needed in the context of different payment levels. Future studies might mitigate potential selection bias by conducting, e.g., large-scale and anonymous surveys to solicit participants without prior study experience. Since most of our participants stated, they are rarely invited to studies, utilizing different recruitment strategies might reach more first-time participants. However, more research is required to investigate barriers to study participation.

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A Pre-Survey

A.1 Consent

I agree to take part in this survey

I agree / I do not agree

A.2 Questions

Q1: How old are you?

Q2: What best describes your current primary occupation?

Employee / Freelancer / Researcher / Apprentice / Bachelor student / Master student / Other (please specify:)

Q3: Are you employed by a company and work more than 19 hours a week? (Yes / No)

Q4: In which area do you currently work?

Consulting / Software Development / Testing / Other (please specify:)

Q5: Is software development part of your job?

Yes / No / Other (please specify:)

Q5: Which email address may we use to contact you regarding your participation in our study?

B Post-Survey

B.1 Consent

I agree to take part in this survey

I agree / I do not agree

B.2 Questions

Q1: Please enter your pseudonym:

Q2: How old are you?

Q3: What is your gender?

Male / Female / Diverse / I prefer not to answer / I prefer to describe myself:

Q4: What is your nationality?

Q5: How long in total have you been employed as a software developer in a German company or organization? (In years)

Q6: How many hours per week do you spent developing software?

Q7: What is your job title?

Q8: What kind of software are you developing? (Multiple selections possible)

Web applications / Mobile applications / Desktop applications / Embedded software development / Enterprise applications / Other (please specify:)

Q9: How many years of experience with software development do you have in general?

Q10: How many employees has your company in total?

1-9 / 10-249 / 250-499 / 500-999 / 1000 or more

Q11: Which business sector does your company belong to?

Game development / Building network and communication / Web development / Development of middleware, system components, libraries and frameworks / Other (please specify:)

Q12: Has your company a focus on security? (Yes / No)

Q13: Are you taking on security-related tasks in your field of work? (Yes / No)

Q14: Do you want to be contacted by our research group to be informed about the study results? (Yes / No)

Q15: Do you want to be invited by our research group for further studies? (Yes / No)

Q16: If you would like to be contacted by our research group, please provide a valid e-mail address. This e-mail address will be stored separately from the study data.

C Interview Guideline

Introduction

- Have you participated in a scientific study in the past?
 - *If yes:* Was this a developer study?
- In how many studies have you taken part in the past?
- In what kind of studies have you taken part in the past?
 - *Researcher note: Explicitly ask for programming tasks*
- Have you ever had a negative experience?

Influence - Study Topic

- Is the study topic something you take into account when deciding whether to participate in a study? Is the topic of the study important to you?
 - *If yes:* What topics are you interested in?
 - *Computer Science/Software Development/IT Security/private interests as a study topic*
- Would you also participate in studies on topics that are not interesting to you?
 - *If No:* Could you be convinced to participate in a study on a topic not interesting to you? *If Yes:* How?
 - *If job-related studies are not attractive:* How could you be motivated for this kind of study?

Influence - Trust

- During a study, information about your person is collected. The researchers conducting the study must adhere to rules (e.g., the anonymity of participants). Participants are informed about this in a consent form.

- To what extent do you trust a university to comply with informed consent?
 - *Researcher note, Address the following aspects and ask how important they are:* Respect for privacy and data protection, fair compensation, competence
- Does your opinion change if the conducting organization is from a private sector? (*Researcher note: Address the factors mentioned above again*)
- What do you think about organizations such as the Fraunhofer-Gesellschaft?
 - *Researcher note, alternatives to Fraunhofer: Max Planck Gesellschaft, German Research Foundation (DFG)*
- Does the type of organization impact the compensation you expect?
 - *If yes:* To what extent does the type of organization influence your expectation?

Influence - Researcher Background

- What influence does the background of the conducting researchers have on your willingness to participate in a study?
 - *Researcher note, examples: Computer scientist, psychologist, social scientist*
- Does the background have to match the topic?
- Would you prefer/avoid one of the mentioned backgrounds?
 - *If yes:* Why?

Influence - Lab, Field and Online Studies

- (*Researcher note: Shortly explain the difference between lab, field, and online studies.*) Do you understand what I mean by this?
- What do you (not) like about online studies?
- What do you (not) like about lab studies?
- What do you (not) like about field studies?
- Would this form of study be conceivable in your company?
- Which type of study do you prefer?
 - Why do you prefer this type of study?
 - What are the arguments against the other types of studies?

- Does the type of study influence the compensation you expect?
 - *Researcher note: Type of study in terms of the difference between lab, field, and online studies*
 - *If yes:* To what extent does the type of study influence your expectation?

Influence - Study Task

- During a developer study, there are usually three possible types of tasks. A survey, an interview, and practical tasks such as coding, writing a code review, or a protocol. Does the type of task in a study influence your willingness to participate in a study?
- Which tasks do you like to work on the most? Why?
- Are there tasks you avoid? Why?
- *If not already addressed:* How do you perceive the difficulty of these types of tasks?
 - What makes a task difficult for you?
 - What makes a task easy for you?
- Does the type of study task influence the compensation you expect for the same duration? *If yes:* To what extent does the type of study task influence your expectation, given the same duration?

Influence - Duration

- The duration of a study can vary depending on the research question. Some studies consist of a short questionnaire, and other studies can take several days.
- Does the duration of a study influence your willingness to participate? Here we assume you receive the same hourly compensation regardless of the study duration.
 - Is duration a criterion by which you exclude a study?
 - *Researcher note: If not mentioned, address the following aspects:* Conflict with working time, conflict with free-time, fatigue
- Is there a maximum duration beyond which you would no longer be willing to participate in a study?
 - Do other study factors influence this maximum duration? Why?
- Under what conditions would you be more likely to participate in long studies?

- *Researcher note, for example:* better compensation, less organizational effort, provision of catering, payment for travel.
- Would you be willing to participate in studies lasting several days, provided that your maximum duration is not exceeded on a individual days?
 - *If no:* Why?
- Is there a maximum number of days or a maximum time period?
- Does the duration of a study influence the compensation you expect?
 - *If yes:* To what extent does the duration of a study influence your expectation? Why?

Influence - Data Collection

- During a study, information about you is collected, such as your voice or image. Depending on the study, written code or biometric characteristics may also be recorded.
- Are you concerned about the data mentioned if it is collected from you?
 - *If yes:* Which specific data are you concerned about?
- Does the way it is recorded have an impact on your willingness to participate?
 - *If yes:* Is there any data, if recorded, that would stop you from participating in a study?
- Would you avoid studies that record data you are concerned about?
- Do you expect better compensation if the study records data you are concerned about?

Influence - Compensation

- How would you like to be compensated for the participation in developer studies?
 - *Researcher Note, for example:* Workshop participation, software license, conference tickets
- How do you feel about non-monetary compensation?
- Would you accept less compensation if the study would meet your preferences for study factors?
- Would you also be prepared to forego compensation completely?
 - *If yes:* Which study factors are particularly important to you in this regard?

Recruitment

- There are two methods for recruiting study participants. In active recruitment, potential participants are contacted directly by the researcher. In passive recruitment, the study is advertised in various ways, and a potential participant contacts the researcher independently.
 - What advantages (disadvantages) do you expect from active recruitment?
 - What advantages (disadvantages) do you expect from passive recruitment?
 - In which way would you prefer to be recruited?
- Where would you prefer to be recruited? Why?
 - *Researcher note, for example:* At work, on-site events, online events, by email, online communities such as Facebook group/Reddit/Xing/LinkedIn, flyers (by post/by hand), posters, employer
 - How should the first contact be made?
 - *Scenario:* An unknown university sends an email to you. How do you feel about that? How do you react?
 - Would an explanation on how the contact information was collected defuse the situation?
- Would you be willing to register to a website for future study invitations?
- Who should manage this platform?

Motivation

- What is the main reason that motivates you to participate in a developer study?
 - *Researcher note:* Ask for other reasons besides the main reason
 - *Researcher note:* Address this and previous studies: What were the reasons for participating in these/this studies?
- Are there any study factors that influence your willingness to participate that have not been mentioned yet?
 - *Researcher note:* If the participant has already participated in several studies, ask what researchers could do better

D Codebook

Table 3: Codebook used during the analysis of the transcribed interviews using thematic analysis

Theme	Code	Definition
Recruitment	Channel	Channel: All statements made regarding recruitment channel (where participants want to be recruited) and their influence on a participant’s willingness to participate
	Active	Active: All statements made about active recruitment and its influence on a participant’s willingness to participate
	Passive	Passive: All statements made about passive recruitment and its influence on a participant’s willingness to participate
Compensation	Compensation	All statements about compensation as the reward for participation, which is promised before participation. Includes non-monetary compensation such as software, hardware, vouchers, vacation trips or education offers
Length	Length	Direct and indirect statements about the influence of the study duration on a participant’s willingness to participate and the compensation they expect. This includes statements about time flexibility
Study Task	Study Task	All statements about the study task (survey, interview, practical tasks) and their influence on a participant’s willingness to participate and the compensation they expect
Study Type	Study Type	All statements about the study type (online, lab, field) and their influence on a participant’s willingness to participate and the compensation they expect
Trust in Organization	Trust in Organization	Trust in Organization: All statements about the conducting organization (university, company, hybrid institutions) and their influence on a participant’s willingness to participate and the compensation they expect. This includes trust in the intention of the conducting organization as well as trust in the competence of the conducting organization
	Data Collection	Data Collection: Opinions, fears, apprehensions, problems and wishes in the context of data collection. All statements on the influence of data collection on a participant’s willingness to participate and the compensation they expect
Motivation for Participation	Motivation for Participation	All statements made explicitly about the influence on a participant’s willingness to participate in a study that uses the keywords <i>participate</i> or <i>participation</i>
Influence Study Topic	Influence Study Topic	Influence Study Topic: All statements made about specific study topics, such as computer science, IT-security or subtopics of these and their influence on a participant’s willingness to participate and the compensation they expect
	Researcher Background	Researcher Background: All statements about a researcher’s background and their influence on a participant’s willingness to participate and the compensation they expect. This includes trust in the competence of the individual researcher background