

# Reporting Consent, Anonymity and Confidentiality Procedures Adopted in Empirical Studies Using Human Participants

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## Abstract

**Background:** Empirical studies involving human participants need to follow procedures to avoid causing harm to the subjects. However, it is not always clear how researchers should report these procedures.

**Aim:** This study investigates how researchers report ethical issues in the software engineering journal publications, particularly informed consent, confidentiality, and anonymity.

**Method:** We conducted a literature review to understand the reporting of ethical issues in software engineering journals. In addition, in a workshop, we discussed the importance of reporting the different ethical issues.

**Results:** The results indicate that 49 out of 95 studies reported some ethical issues. Only six studies discussed all three ethical issues. The subjects were mainly informed about the study purpose and procedure. There are limited discussions on how the subjects were informed about the risks involved in the study. Studies reported on how authors ensured confidentiality have also discussed anonymity in most cases. The results of the workshop discussion indicate that reporting ethical issues is important to improve the reliability of the research results. We propose a checklist based on the literature review, which we validated through a workshop.

**Conclusion:** The checklist proposed in this paper is a step towards enhancing ethical reporting in software engineering research.

**Keywords:** research ethics, informed consent, confidentiality, anonymity

## 1. Introduction

Human subjects are often involved in studies in software engineering research, mainly students and practitioners who are considered vulnerable participants [1, 2]. The research results may cause significant psychological, social and economic damage to subjects who are employees [2]. Similarly, there is a possibility that students who are subordinates could be coerced into participating in research studies [2], which may affect the validity of the results. Therefore, it is important to evaluate potential risks and vulnerabilities to participants before employing them in a research study. The researchers should take the necessary steps

to minimize or prevent risks [2], as well as to adequately inform the subjects about the study and its risks. Additionally, researchers should obtain informed consent explaining the purpose and procedure of the research, the potential conflict of interest, risks and benefits. The subjects are more likely to provide a reliable and honest response when they are ensured confidentiality and anonymity [3].

Given the importance of ethical issues, some journals provide guidelines on crediting authors (authorship), handling conflict of interest and reproducibility of the data and analysis software. In addition, journals provide specific guidelines on how to involve human subjects in the research and require that researchers report how they obtained informed consent. For example, Springer instructs the authors to report the ethical issues as follows – “*For all research involving human subjects, freely-given, informed consent to participate in the study must be obtained from participants and a statement to this effect should appear in the manuscript... if any of the sections are not relevant to your manuscript, please include the heading and write ‘Not applicable’ for that section*”<sup>1</sup>. We believe that it is not only important to state that authors obtained consent; however, the authors should also report the procedure of obtaining consent to improve accountability and trust.

Badampudi [4] reviewed how authors report ethical issues in the latest issues of the empirical software engineering journal. It concluded that there is limited reporting of ethical issues [4]. However, the review study only considered five issues from one journal. Our study has considered multiple volumes and issues of four different journals (more details in Section 2.2).

The contributions of our study are as follows:

- We reviewed how researchers reported consent, anonymity and confidentiality in 95 journal papers.
- In addition, we aggregated the different details reported in the primary studies and proposed a checklist that will help the authors to:
  1. Identify the consent, anonymity and confidentiality issues that are important for their study.
  2. Plan for addressing the consent, anonymity and confidentiality issues.
  3. Report the procedure to obtain consent, anonymity and confidentiality to increase accountability and trust.
- The checklist contributes to a better understanding of consent, anonymity and confidentiality by clarifying the difference between them and elaborating on what is meant by each ethical issue.
- We also conducted a workshop to discuss the checklist for consent, anonymity and confidentiality and get initial feedback.

It is important to keep in mind that both the review and the checklist we present in this paper cover only consent, anonymity and confidentiality issues related to software engineering empirical studies that use human participants directly. Ethical concerns not associated with that sphere are – the use of data from social networks, code repositories, or organization-related data, are out of scope. The review is also limited to a sample of publications in four journals.

The remainder of this paper is structured as follows: Section 2 presents background on ethical issues applicable to software engineering and the relevant related work to this study. Section 3 describes the design of our research, which is followed by Section 4, where we describe the literature review results. We present our and workshop results and checklist

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<sup>1</sup><https://www.springer.com/gp/editorial-policies/informed-consent>

for reporting ethical issues in Section 5.2. Section 6 presents the discussions and finally Section 7 concludes our study.

## 2. Background and related work

In this section we provide information on the ethical issues considered in our study, and elaborate the related work.

### 2.1. Ethical issues

Singer and Norman [1] identify four ethical issues that are relevant to software engineering empirical studies: informed consent, confidentiality, beneficence, and scientific value. Singer and Norman have discussed anonymity as part of confidentiality [1]. Whereas Coffelt [5] discussed the difference between the concepts. Anonymity is the state when the researchers can not identify the identity of individual subjects. While confidentiality refers to the state that the researchers know the subjects but take actions to protect their identity and data from being revealed [5]. We describe the ethical issues below.

- **Informed consent** can be obtained by disclosing the following information: the purpose of the study, research approach, who will access the raw data and for what purpose, risks to the subjects, anticipated benefits for the subjects, the importance of voluntariness and statement offering to answer subject's questions.
- **Anonymity** involves not collecting data that can identify or trace an individual or an organization.
- **Confidentiality** refers to protecting of the raw data and only publishing the aggregated results that cannot be traced to an individual or an organization.
- **Scientific value** relates to the study validity and, research topic importance [1]. If researchers do not ethically conduct research, it could lead to incorrect interpretation of the data and have implications on human participation such as waste of time and effort [6]. Examples of ethical issues in scientific value are: assigning participants to a disadvantaged control situation, incorrect results due to publication bias (not publishing statistically non-significant results)[7], researcher bias (flexible analyses that lead initially statistically non-significant results to become significant) [7] and experimenter expectancy bias (unintentional experimenter behavior that increases the likelihood of the hypothesis to be confirmed) [8].
- **Beneficence** has two components: human beneficence, which is maximizing benefits and minimizing harm (risk-benefit ratio), and organization beneficence which is minimizing the harm to an organization when uncovering issues and challenges in a company.

Our study, focuses on: informed consent (including the description of benefits and risks), confidentiality and anonymity. Since our goal is only on those ethical issues directly related to human participation, we did not focus on ethical issues related to scientific value in our study. Moreover, each of the ethical issues related to scientific value requires a deeper investigation. For example, a crossover study design is considered good to ensure that all participants are assigned to each control situation in the experiment. However, it is argued that crossover design may make the study more unethical in oncology clinical trials due to confounding by crossover [9]. Furthermore, if crossover design as not designed or analysed properly, it may results in invalid results [10], which affects the scientific value.

For investigating the reporting of beneficence in publications, the benefits and risks should be sufficiently discussed to investigate the beneficence. However, in our pilot study [4] we identified few studies that discussed risks explicitly; therefore, it would be difficult to investigate the beneficence unless explicitly discussed in the publication. We did not focus on beneficence reporting. However, we extracted information on risks and benefits, which will allow us to investigate beneficence.

## 2.2. Journals guidance to authors regarding reporting ethical issues

In this study, we analyze ethical issues as reported in a sample of papers from four leading software engineering journals: Springer – Empirical Software Engineering (EMSE), Elsevier – Information and Software Technology (IST), IEEE – Transactions on Software Engineering (TSE), and ACM – Transactions on Software Engineering and Methodology (TOSEM). These journals provide different guidance to authors regarding how to report ethical issues.

- **EMSE** recommends that an informed consent statement should appear in the paper manuscript for all research involving human subjects. The journal also touches on anonymity and confidentiality issues, although it does not recommend whether to report them or not.
- **IST** endorses that authors should include a statement in the manuscript mentioning that they obtained informed consent whenever the research involves human subjects. On the other side, the journal does not provide any instruction regarding anonymity and slightly touches the confidentiality issue.
- **TSE** does not make any recommendation regarding any of the three ethical issues.
- **TOSEM** tangentially covers the three ethical issues. However, there is no recommendation concerning whether and how to report such information in the paper.

A review of the author guidelines of these four software engineering journals indicates that they do not impose strong and detailed guidance on how the authors should report ethical issues like informed consent, anonymity, and confidentiality. Moreover, sometimes it is hard to find the instructions to the authors. For example, EMSE at least touches on all three ethical issues. However, parts of the recommendations are spread throughout the journal submission guidelines<sup>2</sup>, while the other parts appear on the Springer editorial policies<sup>3</sup>. Still, the latter has a general nature since it refers to all journals published by Springer. Another example is TOSEM, which does not mention any of the three ethical issues of its submission guidelines<sup>4</sup>. To find such kind of information, one has to access the ACM Code of Ethics and Professional Conduct<sup>5</sup>, and it also has a general nature. One must infer how to report ethical issues on papers by analysing a code of conduct to guide computing professionals behavior.

## 2.3. Related work

There are many relevant discussions in the computer science academic community about ethical issues of our profession. For instance, the various considerations on the ethics of advanced machine learning algorithms [11–13], or how software developers should be

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<sup>2</sup><https://bit.ly/3joV9YQ>

<sup>3</sup><https://www.springer.com/gp/editorial-policies>

<sup>4</sup><https://dl.acm.org/journal/tosem/author-guidelines>

<sup>5</sup><https://www.acm.org/code-of-ethics>

conscious about the impacts of systems they create and the way they behave as professionals [14–17].

Still, we do not see that level of urgency when considering ethical issues of empirical studies involving human subjects in software engineering. The results of our paper substantiate this claim, as well as other few related studies.

In 2002, Singer and Vinson [1] called attention to ethical issues that had been neglected in software engineering empirical studies. Based on a review of ethical codes of many research fields, the authors identified ethical issues related to software engineering empirical studies: informed consent, scientific value, beneficence, and confidentiality. They also illustrated those four issues with real empirical studies. In 2008, Singer and Vinson [18] expanded the first discussion, this time focusing on the role of Ethics Review Boards (ERB) and how to comply with them. They provide detailed information about how to plan and which documents are needed during an ERB review.

A recent literature review investigated ethical authorship issues on diverse research disciplines [19]. The author did not find any paper discussing ethical authorship issues in software engineering. In contrast, the author found 16 articles in research areas like Medical, Science and Engineering, Chemistry, Education, and Economics. The literature review does not cover ethical issues related to empirical studies in software engineering as our study does. However, it unveils more evidence that ethical issues have low priority in our research community. Few studies report or discuss ethical issues in the software engineering research field.

Software engineering research based on Mining Software Repositories (MSR) strategies has soared during the last decade. Although data collection and analysis in MSR studies are usually automated, Gold and Krinke [20] argue that such kind of research may involve human subjects, as repositories typically contain data about developers' interactions. In this context, they discuss the ethical implications of MSR research. From the viewpoint of the process used to ensure ethical software engineering research, Strandberg [21] proposed a checklist based on authoritative guidelines for interview studies involving industrial practitioners.

A subject even more rarely discussed is how inviting participants to software engineering surveys can pose relevant ethical issues. Baltes and Diehl [22] report their experience with different sampling strategies to conduct surveys. The authors highlight that researchers should be conscious that contacting software developers may harm them even when they do not answer the survey. Baltes and Diehl received the following comment by a developer they contacted asking to participate in one of their surveys *“I consider this problem now worse than spam since Google at least filters out spam for me. [...] [Y]ou send one, I get one per week – or more.”*

### 3. Research method

We used a mixed-methods approach – consisting of a literature review and a workshop – to understand 1) which ethical issues are reported in SE journal publications and 2) which ethical issues should be reported and the importance SE researchers place on reporting different ethical issues in their publications.

### 3.1. Research questions

**RQ1 To what extent, consent, confidentiality and anonymity are reported in software engineering journal publications?**

**Rationale:** Here we will describe reporting of research ethics in a sample of papers published in the four journals mentioned in Section 3.2.1. Mainly to understand to what extent and how authors discuss consent, confidentiality and anonymity.

**RQ2 Which ethical issues related to consent, confidentiality and anonymity should be reported in software engineering publications?**

**Rationale:** Here we will describe the importance of reporting consent, confidentiality and anonymity, and how they should be reported.

### 3.2. Literature review

We conducted a literature review to understand how software engineering (SE) researchers report research ethics in SE publications. We followed a systematic study selection and data extraction process. However, we did not perform the quality assessment of the included studies. In addition, our search is also limited to a few volumes in the selected journals. Thus, we do not refer to our review as a systematic literature review. We report the details of the literature review process in the sections below.

#### 3.2.1. Data collection

We selected four journals in software engineering, namely – The Empirical Journal in Software Engineering (EMSE), Information and Software Technology (IST), Transactions on Software Engineering (TSE), and Transactions on Software Engineering and Methodology (TOSEM). We selected these journals as they are among the top-ranked SE journals and are expected to reflect the best current reporting practices. We started our search from the volumes published in the summer of 2019 and continued screening previous volumes until we reached a sample of 100 papers (excluding editorials and letters) from each of the four journals. Table 1 provides the details of screening which includes the volumes, years and the number of papers reviewed in each journal.

Table 1. Data collection description

Publisher	Journal	Volume	Year	No.
Springer	EMSE	V.23 I.6 to V.24 I.3	2018 (all issues)–Aug 2019	100
Elsevier	IST	V.103 to V.110	Nov 2018–Jun 2019	104
IEEE	TSE	V.43 I.11 to V45 I.7	Nov 2017–Jul 2019	105
ACM	TOSEM	V.24 I.4 to V.28 I.3	Aug 2015–Jul 2019	100
Total				409

#### 3.2.2. Study selection

Our objective was to include papers that employ humans in the study. Therefore we included papers that employ human subjects or involve collecting the information that can lead to identifying an individual or an organization. We excluded papers that do not collect

information from practitioners, such as methodological papers, systematic literature reviews and solution proposals. In addition, we excluded the studies that collect information that is publicly available (data from open source) and studies that do not involve human subjects or authors themselves are subjects. All four authors were involved in the review process. To ensure that we have the same interpretation of the inclusion criteria, we conducted a pilot study of 20 papers. All authors independently reviewed the title and abstracts of the papers to either include or exclude the papers. We conducted a kappa test to evaluate the agreement level. The average Cohen kappa for all raters for our pilot study was 0.88, which indicates a high agreement [23]. However, we still discussed the papers where at least one author had a different decision. We concluded that title and abstracts might not be sufficient to determine the inclusion of human subjects in the study design. Therefore we decided also to review the research questions and data collection methods when deciding to include or exclude the paper. Table 2 provides the total number of papers included from each journal.

Table 2. Number of papers included from each journal

Journals	Included Papers
EMSE	28
IST	21
TSE	33
TOSEM	23
Total	105
After full text reading	95

### 3.2.3. Data extraction

To facilitate the data extraction, we devised an extraction form. We conducted a pilot extraction study to review the relevance, completeness, and interpretation of the extraction items. All four authors extracted two papers, each resulting in data extraction from eight papers in the pilot extraction. As a result of the pilot extraction, we decided to remove some of the extraction items, such as extraction of research methods, as the data collection method was perceived to be more relevant for our study. Table 3 lists the extraction items. The first, third, and fourth authors extracted the data, and the second author reviewed the extraction.

Table 3. Data extraction form

Item	Description
Data collection Procedure	How was the data collected?
Data collector	Who collected the data?
Category of subjects	Who are the subjects – students and/or practitioners
Data description	What data is collected in the study?
Ethical issues (informed consent, confidentiality, and anonymity)	What was reported on ethical issues? (Verbatim from the paper)

### 3.2.4. Analysis

We conducted a mixed qualitative-quantitative analysis approach. For qualitative analysis, we performed inductive content analysis [24] to categorise the extracted information relevant to informed consent, confidentiality and anonymity. We chose this approach to look for new knowledge on the phenomena instead of relying on prior knowledge. We performed the analysis in the following steps:

1. Performing initial coding: For all the extracted data, we underlined all terms related to any of the three issues of informed consent, confidentiality, and anonymity. We doubled check whether the information provided for each category could also be relevant to another category.
2. Forming final codes: We grouped the initial codes to form the final codes iteratively based on the shared characteristics of the codes that could put them in the same group.
3. Forming categories: We overviewed the final codes and categorised them based on the patterns we found within the codes. We merged the categories into high-level when they could make sense.

For example, we extracted a text from a paper regarding confidentiality as “...*the data would remain with us, and the transcripts would not be published but only the research findings supported by the anonymous quote*”. We assigned an initial coding “publishing” to the statement, later converted to the final code “sharing.” Finally, we formed the category “reporting the sharing procedure” and assigned the statement to this category. For quantitative analysis, we used descriptive statistics and mainly used bar charts to visualise data quantitatively.

### 3.3. Workshop

We conducted a workshop study [25] to evaluate the importance of ethical issues from the perspective of software engineering researchers. The evaluation contributes to understanding what ethical issues researchers should report in software engineering publications.

The first and second authors organised the workshop study as a session of the SEthics 2021 (2nd International Workshop on Ethics in Software Engineering Research and Practice), co-located with ICSE 2021. SEthics2021 was virtual and used the ICSE Researchr platform. We conducted a survey and group discussions in the workshop to collect data. Surveys and group discussions are considered as suitable methods when evaluating artefacts (checklist in our study) based on people’s perspectives [26]. The workshop study session was organized for 40 minutes in the following four parts:

**1: Introduction** – At the beginning of the workshop, the first author provided the following information: an introduction to ethical issues applicable to software engineering (SE) research, journal publishers’ requirements to report ethical issues and a summary of our literature review results on the current state of reporting research ethics in SE publications.

**2: Survey** – We designed a questionnaire in the Mentimeter (<https://www.mentimeter.com/>). After the introduction, we asked participants to answer a survey on the importance of reporting ethical issues. The survey included the following question: How do you rank the importance of the ethical issues?

- IC1: Report the process of how the study purpose statement is communicated.
- IC2: Report the process of how the risks, and benefits are communicated to the participants. An explanation of any foreseeable risks or discomforts.



- IC3: Report how voluntariness is ensured. An explanation of the subject’s right to refuse without penalty.
- C1: Report how the analysis was conducted while protecting confidentiality.
- C2: Report how data is stored and used to ensure confidentiality.
- C3: Report how the data is shared to protect confidentiality.
- A1: Report how the data and subjects are anonymised.

The participants ranked the statements between 3 (Definitely will consider) to 1 (Would not consider) using sliders in Mentimeter. We provided a guide for the participants that defined and exemplified each statement to clarify the statements. The Ethical issues IC1–IC3 are relevant to informed consent, C1–C2 are about confidentiality and A1 is related to anonymity.

**3: Group discussion within the groups** – We created two breakout rooms: “reporting ethical details in manuscripts” or “skipping ethical details”. We asked the participants to join the breakout rooms that best represented their survey response. For example, if the participants primarily selected ratings close to 3, they should enter the breakout room: “reporting ethical details in manuscripts”. The first and second authors moderated each breakout room, responsible for facilitating, documenting, and summarising the discussions. The moderators took notes to collect the breakout room discussions. Taking notes allows unobtrusively collecting data in real-time [26]. Collecting data through field notes is prone to researcher bias [26]. To mitigate researcher bias, we shared the data collected in our notes with the participants, where they had an opportunity to confirm or suggest a reformulation.

**4: Final group discussions** – All participants from the breakout session joined the main session to share the discussions carried out in the breakout rooms. The first and second authors again shared the summarised statements of each group with all participants in the main session.

We informed the participants about the working group in advance in the program of the SEthics21 workshop published on the website. To ensure the confidentiality of the participants, we did not report the traceability of individual responses to participants. We ensured anonymity and confidentiality to mitigate social desirability bias. “Social desirability refers to the respondents’ tendency to admit to socially desirable traits and behaviors and to deny socially undesirable ones” [27]. We wanted the workshop participants to be honest, particularly if they disagreed with the need to report ethical aspects which could be considered sensitive in a workshop focused on ethics. Privacy (anonymity and confidentiality) can help in producing honest responses to sensitive questions [28]. Due to the pandemic, we conducted the workshop online. The sessions were recorded and uploaded to a streaming platform. We did not audio or video record the discussions of the working group; however, we recorded the summaries of the discussions. In our results, we report the recorded summaries word to word to avoid any misinterpretation. To ensure the validity of the concluded statements, we performed two real-time validations: within each breakout rooms and again in the main session, where participants validated the discussion summary.

#### 4. How ethical issues are reported in software engineering publications

This section answers RQ1 based on 95 included primary studies. We included only studies that employed human subjects directly. Practitioners were the most commonly employed subjects in the primary studies, followed by students. In some studies, both practitioners and

students were involved. A small portion of papers also involved end-users and researchers as subjects (see Figure 1 for details).

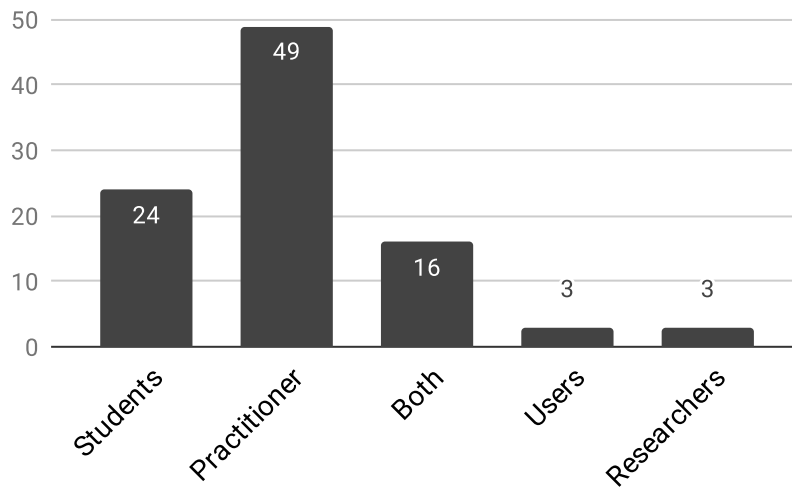


Figure 1. Number of papers in each subject category

#### 4.1. Overview of papers that reported ethical issues (49/95)

In our sample, the data was collected from subjects mostly by conducting experiments and through surveys and interviews as see in Figure 2. Most papers used a combination of two or more methods. In addition, papers reported using additional sources to collect data such as company documents, and data from crowdsourcing platform. In few papers, a tool was used to collect data. For example, a tool was installed on developers system to observe their activities. We categorized papers in the *other* category that did not report any specific data collection method, the studies were mostly exploratory. We did not find any significant relation among the papers reporting the three ethical issues and the data collection methods.

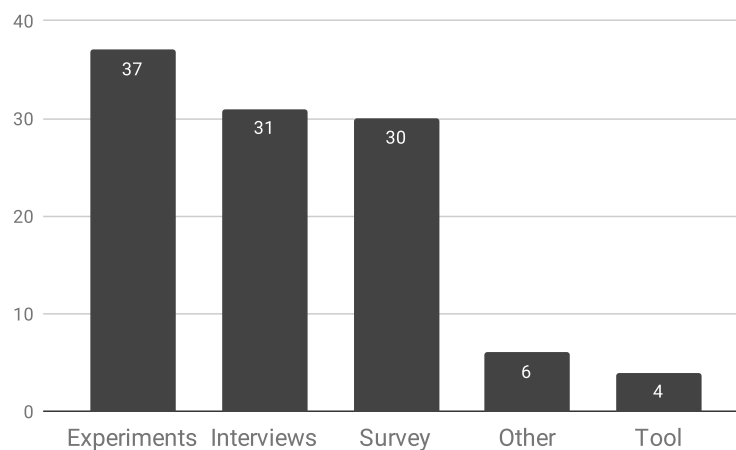


Figure 2. Methods used to collect data from subjects

From our sample of 95 papers, we found that around 50% (49 papers) considered at least one ethical issue in their study. Figure 3 shows the number of papers that report the different ethics issues. The number in round brackets (n) indicates the number of papers discussing only one ethical issue. As seen in Figure 3, not all ethical issues (informed consent, confidentiality and anonymity) are considered in all the 49 papers. Only six papers have discussed all three issues. Confidentiality and anonymity are more often mentioned together than any other combination of the three ethical issues. Although 50% of the papers in our sample report ethical issues, in most cases, however, only one issue is discussed. We provide details on what do researchers report on the ethical issues in Section 4.2.

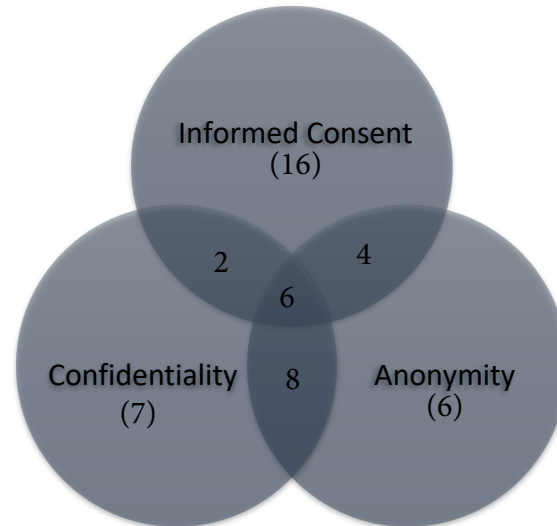


Figure 3. Number of papers discussing different ethical issues

We looked at how the researcher reported the three ethical issues. The papers that reported ethical issues reported different levels of detail. The next section provides details on what researchers report and how.

#### 4.2. Details on ethical issues reported in software engineering publications

This section provides details on what and how much researchers report on ethical issues in the 49/95 studies. Figure 4 shows the overview of the reporting status. As seen in the figure, 28 papers discussed informed consent. However, out of 28 papers, nine papers did not discuss any details on the procedure for obtaining informed consent. The authors only mentioned that they obtained informed consent. We observed that most papers reported some details on how the authors ensured confidentiality. However, half of the papers did not report how authors achieved anonymity. Overall, 38 papers discuss details on addressing at least one ethical issue. Table 4 provides the list of the papers reporting details.

Table 4. List of papers that reported the procedure for addressing ethical issues

Paper ID	Title
ESE1	System requirements-OSS components: matching and mismatch resolution practices – an empirical study

Table 4 continued

Paper ID	Title
ESE12	Getting the most from map data structures in Android
ESE13	Older adults and hackathons: a qualitative study
ESE14	An empirical study on the impact of AspectJ on software evolvability
ESE21	Understanding the behaviour of hackers while performing attack tasks in a professional setting and in a public challenge
ESE25	An empirical study of architecting for continuous delivery and deployment
ESE26	Eye tracking analysis of computer program comprehension in programmers with dyslexia
ESE3	An industrial case study on the use of UML in software maintenance and its perceived benefits and hurdles
ESE4	Factors and actors leading to the adoption of a JavaScript framework
ESE8	Large-scale agile transformation at Ericsson: a case study
IST11	Exploratory testing: Do contextual factors influence software fault identification?
IST12	Impact of model notations on the productivity of domain modelling: An empirical study
IST14	The current state of software license renewals in the I.T. Industry
IST17	GuideGen: An approach for keeping requirements and acceptance tests aligned via automatically generated guidance
IST18	Quality requirements challenges in the context of large-scale distributed agile: An empirical study
IST5	An exploratory study of waste in software development organizations using agile or lean approaches: A multiple case study at 14 organizations
TOSEM16	Documenting Design-Pattern Instances: A Family of Experiments on Source-Code Comprehensibility
TOSEM17	Many-Objective Software Remodularization Using NSGA-III
TOSEM18	Software Change Contracts
TOSEM19	Platys: An Active Learning Framework for Place-Aware Application Development and Its Evaluation
TOSEM2	Status Quo in Requirements Engineering: A Theory and a Global Family of Surveys
TOSEM21	Mining Unit Tests for Discovery and Migration of Math APIs
TOSEM22	Code-Smell Detection as a Bilevel Problem
TOSEM23	On the Comprehension of Program Comprehension
TOSEM6	Fixing Faults in C and Java Source Code: Abbreviated vs. Full-Word Identifier Names
TOSEM9	Multi-Criteria Code Refactoring Using Search-Based Software Engineering: An Industrial Case Study
TSE1	makeSense: Simplifying the Integration of Wireless Sensor Networks into Business Processes
TSE14	Data Scientists in Software Teams: State of the Art and Challenges
TSE17	Coordination Challenges in Large-Scale Software Development: A Case Study of Planning Misalignment in Hybrid Settings
TSE18	Measuring Program Comprehension: A Large-Scale Field Study with Professionals
TSE2	Automatic Identification and Classification of Software Development Video Tutorial Fragments
TSE21	Towards Prioritizing Documentation Effort
TSE22	A Comparison of Program Comprehension Strategies by Blind and Sighted Programmers
TSE26	Understanding Diverse Usage Patterns from Large-Scale Appstore-Service Profiles
TSE3	The Good, the Bad and the Ugly: A Study of Security Decisions in a Cyber-Physical Systems Game
TSE6	Integrating Technical Debt Management and Software Quality Management Processes: A Normative Framework and Field Tests

Table 4 continued

Paper ID	Title
TSE7	Automated Refactoring of OCL Constraints with Search
TSE9	What Makes a Great Manager of Software Engineers?

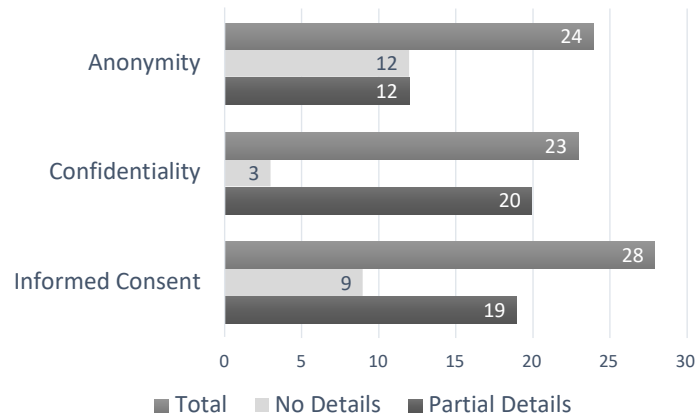


Figure 4. Overview of ethical issues reporting

The status of each paper reporting details on confidentiality, anonymity and informed consent is shown in Figure 5. As seen from Figure 3, six studies report all three ethical issues. However, out of the six, only three studies report details on how they addressed ethical issues, as seen in Figure 5. It is important to note that even though the studies (ESE4, ESE13, and TOSEM22) reported on all three ethical issues, they only report partial details. Most studies report details on at most one ethical issue. However, some of these studies have a rather detailed explanation of how they addressed the ethical issues. The level of details reported varies across the studies. We look at how researchers discuss each ethical issue in the primary studies.

#### 4.2.1. Informed consent

Full informed consent is important to ensure that the subjects understand the implications of participating in the study. As seen in Figure 4, 19 out of 28 papers discussed the details on obtaining informed consent. Most studies provided a link to the consent form from which we extracted the details. Figure 6 provides the details on informed consent reported in the 19 studies. As seen in Figure 6, among 19 studies that provided details on informed consent, study purpose and procedure is discussed more commonly (10 studies) in the consent forms, followed by benefit explanation (eight studies) and voluntariness (seven studies). However, most of the studies (12/19 papers) discuss only one ethical issue. ESE26 reports most details on obtaining informed consent; however, it does not discuss the risks to the subjects. Only one study, i.e., TOSEM16, discusses risk. The subjects can only be fully informed about the participation if they are fully aware of the potential risks and in related to the benefits gained from participation.

The primary studies reported the following details on the procedure for obtaining informed consent:

**Study purpose and procedure:** The studies that mentioned that the study purpose and procedure were mainly to get honest and accurate responses from the subjects. The

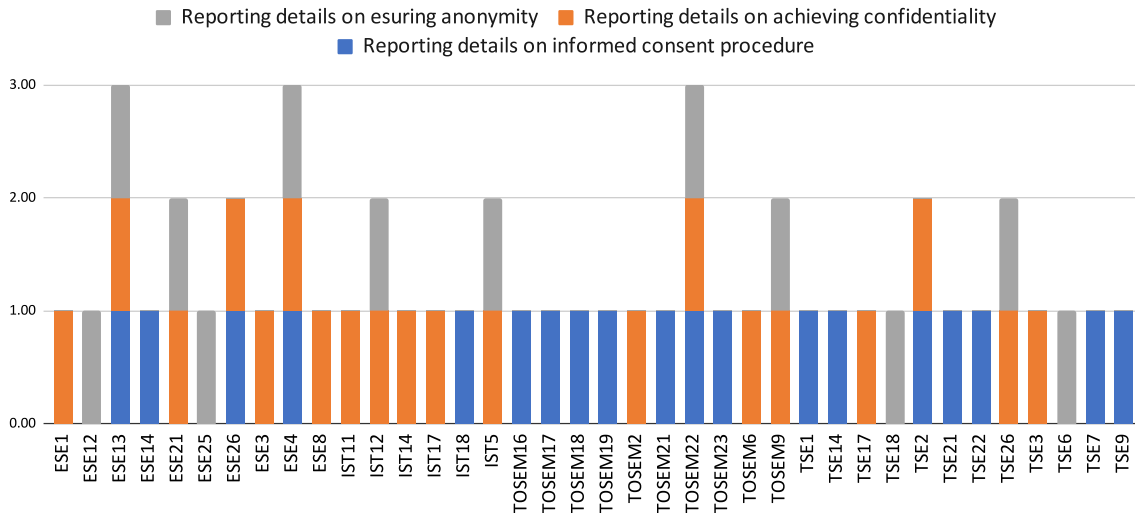


Figure 5. Papers reporting details on how ethical issues were addressed

authors communicated the study’s purpose and procedure at the beginning of the interview or sent an email before the interviews/experiment.

**Benefit:** Some studies with students as subjects mentioned benefits in terms of extra credit. In contrast, some studies mentioned monetary benefits ranging from \$100 to \$200 either to some or all subjects. One of the studies (ESE26) mentioned non-monetary benefits. They provided the importance of the topic and the benefit to the software engineering community at large.

**Voluntariness:** It is important to discuss voluntariness together with the benefit of participation. For example, some studies mentioned that the students were not obliged to participate in the study. However, the researchers offered the participating students extra credit. Such a benefit can compromise the voluntariness as there is a penalty (no extra credit) when not participating in the study. One study (TOSEM19) explicitly mentioned that nonparticipating students received an alternative task to earn extra credit. Therefore, it is important to report the procedure to ensure voluntariness without any penalty.

**Risks:** One study (TOSEM16) discusses the risk of the experiment results influencing the students’ grades. They reported that the study ensured that the experiment did not influence the grades.

Only one study (TOSEM16) in our sample discussed both risks and benefits (see Figure 6). However, the risks and benefits were discussed for master student subjects and not for other participants involved in the experiment (professionals and PHD students). The risks for students was the experiment influencing their grades which was mitigated by rewarding an extra point for all participants regardless of their performance.

#### 4.2.2. Confidentiality

In total, 23 papers reported confidentiality, of which three papers do not provide any details, just stated they assure confidentiality. Using the qualitative analysis, we understood that the remaining 20 papers report confidentiality at least in one of the following aspects:

- Storing and using data (12 studies),
- Analysing data (two studies),
- Sharing data (eight studies),

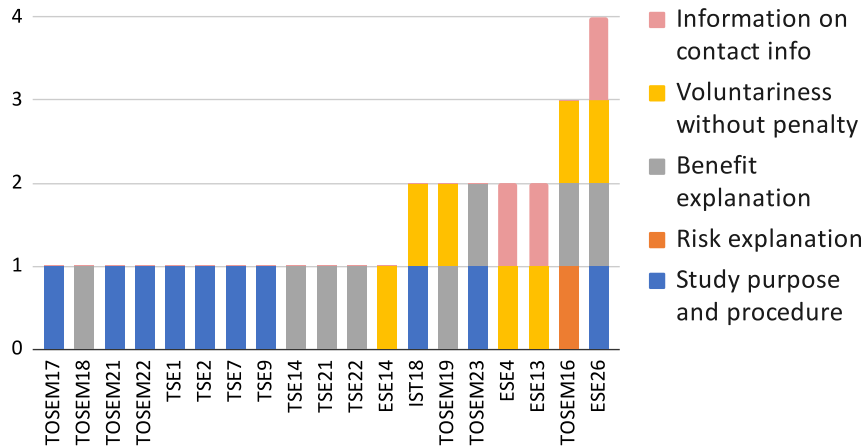


Figure 6. Studies reporting details on informed consent procedure

- Ethical approval (four studies),
- What data that is kept confidential (six studies).

As seen in Figure 7, only one paper, i.e., IST14, reported all confidentiality aspects, while most studies (14/20) address only one of the aspects. One study, i.e., ESE21, provides most details about confidentiality, however, it does not discuss the ethical issues of data analysis and approval.

The confidentiality details reported in the primary studies are as follows:

**Storing and using data:** Some studies reported the procedure on how authors collected and kept the private information confidential. Most of the papers that reported confidentiality have provided information on storing and using data (12/20). Researchers reported that they chose not to reveal information while storing and retrieving data. TSE26 reported using warehouse servers behind the company firewall to keep data confidential.

**Analysing data:** Only two studies, i.e., IST14 and TSE3, reported the procedure for

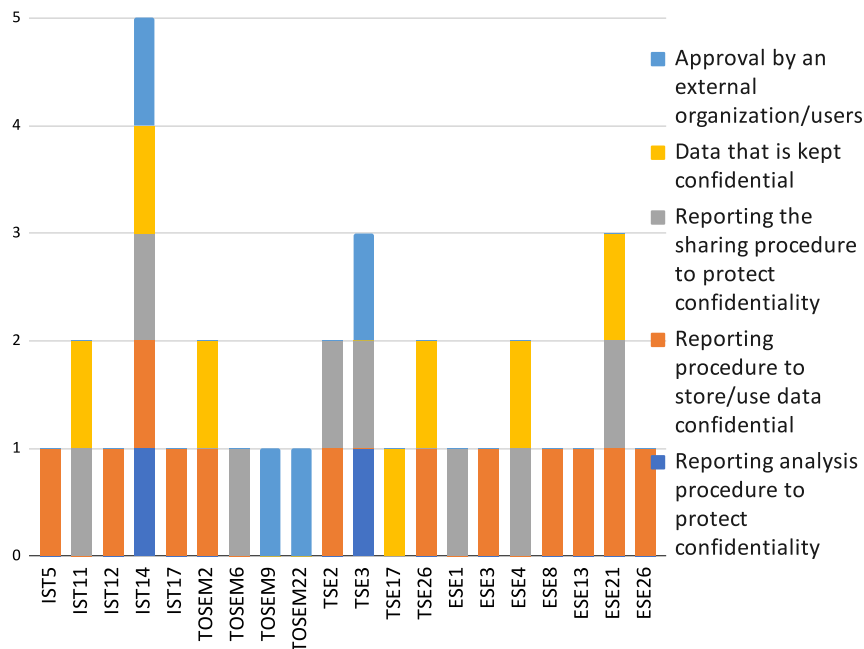


Figure 7. Studies reporting details on confidentiality

analyzing data confidential. The studies mainly cleaned the interview transcripts and recording statements to remove and destroy confidential information. One of the studies (IST14) also summarised content to ensure no confidential information is taken out of the organisation.

**Sharing data:** Some studies reported how the researchers protected and did not share the private data with other organisations or individuals. One of the common approaches used in the studies, for example, in ESE1, and TOSEM6, was aggregating answers/data before sharing to ensure confidentiality.

**Ethical approval:** Four studies, TOSEM9, TOSEM22, TSE3, IST14, reported that an Ethical committee reviewed the research project, design (e.g., questionnaire), and data to ensure their conformity with the ethical norms.

**Data that is kept confidential:** Some studies reported what data they did not disclose in the reports. Data such as companies' information (e.g., name, available hard-wares), faults and failures measurements are examples of the data that was kept confidential. Such information is valuable to provide transparency on how researchers ensured the confidentiality of subjects and projects.

#### 4.2.3. Anonymity

In total, 24 papers reported anonymity, in which only 12 described the procedure on how data and subjects are anonymised. ESE25 study reported anonymity for both of its research methods, questionnaire and interview. Three studies (i.e., TOSEM9, ESE13, ESE21) used more than one data collection method. TOSEM9 used questionnaire, experiment and case study research methods but reported anonymity only for its questionnaire. ESE13 conducted the study using observation, interview and questionnaire, and ESE21 recruited experiment and interview research methods. ESE13 and ESE21 reported anonymity for the whole research, when the participants registered for the study.

The studies anonymised the name of the subjects, firms, projects, and subjects' quotes. The studies followed different approaches to anonymise subjects and data. One study, i.e., ESE21, reported that participants chose a self-selected username to anonymise the subjects. ESE13 reported anonymising subjects using the group names (of younger adults) and the registration numbers (of older adults), but did not provide further details. The studies provided several reasoning for anonymising subjects and data. Social desirability bias (ESE25) and feeling of exposure (IST5) are two reasons the studies mentioned as threats that influence the participants' answers. Social desirability bias occurs when the participants adapt their responses to make the researchers happy. The studies anonymised the subject and data to mitigate these threats. Furthermore, the studies mentioned adhering to a non-disclosure agreement (TSE6) and security policies (TSE18) as two other reasons for anonymising subjects and data.

## 5. Checklist for reporting consent, confidentiality and anonymity in software engineering publications

This section answers RQ2 based on the literature review and workshop results. We discussed the literature review results and the checklist derived from the literature review in a workshop to understand the importance of reporting consent, confidentiality and anonymity.



The checklist we present here covers only ethical issues related to software engineering empirical studies that use human participants directly; in particular, it focuses on informed consent, anonymity and confidentiality. It is the first step towards developing recommendations for reporting ethical issues in publications. Researchers should also consider the overall ethical aspects when designing their studies and publishing their findings. Researchers could consider publishing a pre-study protocol that: 1) justifies the planned sample sizes and the choice of study design (e.g., subject allocation to control situations in experiments), 2) specifies the main hypotheses and analysis procedures to mitigate experimenter and/or researcher bias and 3) explains any blinding methods adopted to conceal design elements from participants, data collectors or analysts. Mechanisms to publish pre-study protocol already exist. For example, there is a Registered Reports Track in Empirical Software Engineering and Measurement (ESEM) in conjunction with EMSE journal, and preregistered papers in Transactions on Software Engineering and Methodology (TOSEM).

### 5.1. Importance of reporting consent, confidentiality and anonymity in software engineering publications

We conducted a workshop to investigate the importance of reporting consent, confidentiality and anonymity in software engineering publications. In total, 12 researchers participated in the workshop. The participants mainly were assistant professors, one full professor, one PhD student, and senior researchers from research institutes. All workshop participants answered the survey and participated in the group discussions. The active participants in the group discussions had co-authored at least one publication on ethics.

After the introduction to the workshop, individual participants rated the importance of the ethical issues through a survey as presented in Figure 8.

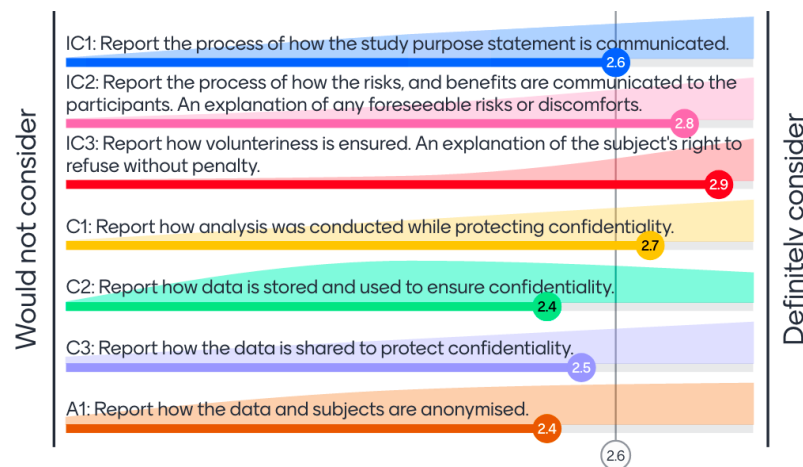


Figure 8. Importance of ethical issues

The ratings were in the range of  $2.6 \pm 0.3$ , meaning that the participants considered the ethical issues important. Overall, the participants perceived informed consent reporting slightly more important than other ethical issues. Within informed consent, the voluntariness aspect was rated highest, which has implications for scientific values. Voluntary participation could increase the accountability and trust of the results.

After the survey, we conducted group discussions. The participants were put in two separate Zoom breakout rooms based on their agreement level. As mentioned in Section 3.3,

we named the two breakout rooms as: “reporting ethical details in manuscripts” or “skipping ethical details”.

There were only two participants in the “skipping ethical details” zoom room. We summarised the discussion as follows:

- There is no concrete answer to whether researchers should include or skip ethical details in a research publication.
- Depending on the research topics, the researchers should be able to decide the ethical details to report.
- Research ethics value might be too limiting when the researchers discuss a lot of details on the procedure to address ethical issues. It is not important to report everything for the sake of reporting without adding any value to the report.

So, in conclusion, they mentioned that *“there is no clear no to reporting ethical details; the researcher should choose important details for reporting.”*

The second group, with 10 participants. We summarised the discussion in “reporting ethical details in manuscripts” breakout room as follows:

- Reporting ethical details are important, e.g., for reviewers of articles to get insight into how the researchers deal with the ethical issues, or for healthcare articles to improve the research reliability.
- Providing a supplementary ethical document attached to a paper, depending on the program committee’s permission and confirmation.
- Software engineering committee should research and prepare guidelines for reporting ethical details.
- Not only the ethical rules and regulations should be a matter, but also the rationale behind considering them.

The session was concluded with the message that *“we all think that reporting ethical issues is important, but we are questioning ourselves how much of it should be reported in practice.”* We believe our checklist will help in deciding what and how much details on ethical issues should be reported.

## **5.2. Checklist for authors and reviewers on reporting consent, confidentiality and anonymity in software engineering publications**

We aggregated details on reported consent, confidentiality and anonymity and created a consolidated list as shown in Table 5. Table 5 contains attributes of informed consent, confidentiality and anonymity that researchers can report to strengthen the validity of the results. When applicable, the researchers can refer to the documentation they may have used to get ethical boards’ approval or to communicate to the subjects, such as consent forms. The checklist includes a description and the importance of reporting consent, confidentiality and anonymity. In addition, we provide examples from the studies that have reported the ethical issues. The checklist is not prescriptive; instead, the researchers should identify the potential risks to the subjects based on the study objectives and decide which attributes they should report to strengthen the results. In addition, the researchers should also report the potential risks to justify the measures taken to address ethical issues.

Table 5. Checklist for reporting the process for obtaining informed consent, achieving confidentiality and anonymity

ID	Attribute	Description of the ethical issue	Example
IC1	Report the process of how the study purpose statement is communicated. For example, how the participants were made aware of what the study involves, its purpose, procedures to be followed, and the likely duration of the subject's participation.	Participants may feel that they are not only being observed but also being evaluated. Hence, the purpose should be clear and the participation duration should be clear so that participants can assess the needed effort and avoid inconveniences such as boredom, frustration, and wasting of time.	IST18 – The interviewer started each interview by explaining the objective of the research to the participants and the importance of giving accurate and honest answers to the validity and reliability of the research.
IC2	Report the process of how the risks and benefits are communicated to the participants. An explanation of any foreseeable benefits and risks or discomforts to subjects.	The risks and benefits of participation should be clear so that true results are obtained. For example, students should be made aware of the impact participation will have on their grades, if any. Different risks include psychological, social, economic, legal, and physical risks. Students and practitioners should know the benefits of participating in the research study. In addition, it is important to discuss the balance of risks and benefits to the subjects.	TOSEM16 – The participants were not evaluated on the results achieved in the experiments. All students... were equally rewarded with one extra point in the exam grade, regardless of their actual performance.
IC3	Report how voluntariness is ensured. An explanation of the subject's right to refuse without penalty.	The participation should be voluntary and free from coercion. For example, students should be able to refuse participation without having any impact on their grades. When students are given credits for study participation, an alternative task should be provided when the students do not want to participate in the study	TOSEM19 – Participation in the study was not mandatory. Nonparticipants were offered an alternative task to earn points equivalent to what they would earn by participating in the study.
C1	Report how analysis was conducted while protecting confidentiality.	Participants should be ensured that their private information is protected and researchers do not reveal the information during data analysis.	IST14 – The responses of the participants were literally transcribed, allowing the destruction of the original material, on the same day of the interviews; in addition, all identifying remarks were perpetually removed and destroyed to protect all the participants.

Table 5 continued

ID	Attribute	Description of the ethical issue	Example
C2	Report how data is stored and used to ensure confidentiality	Participants should be ensured that their private information is kept confidential and researchers have chosen proper storage to record data and do not reveal the information while storing or retrieving.	TSE26 – All raw data collected for this study are kept within the data warehouse servers, which are placed behind the company firewall. Furthermore, The dataset includes only the aggregated statistics for the users covered by our study period. No actual users can be traced at all.
C3	Report how the data is shared to protect confidentiality	Participants should be ensured that their private information is protected and researchers do not share the private information with other organizations and individuals while reporting the research findings.	ESE21 – For confidentiality reasons on the industrial use cases, programs could not be shared among different companies and each hacker team only attacked the program owned by the corresponding company.
C4	Report what data is kept confidential.	Participants should ensure that their private information is protected by understanding which corresponding info the researcher hide and reveal during research analysis and reporting.	IST11 – Access to the Firm’s fault data and employees was offered provided that liability issues were considered by not further disclosing the company name or the magnitude of the fault numbers.
A1	Report how the data and subjects are anonymised when needed	Participants should be ensured that their identity and personally identifiable information is publicly kept unknown	ESE12 – All questions were optional, and the survey was anonymous to encourage developers to participate.

## 6. Discussion

A survey published in 2001 by Hall and Flynn [29], with heads of 44 computer science departments in the UK, indicates that software engineering researchers have little regard for ethical issues when conducting studies with human participants. Only 36% think that monitoring ethical considerations is very important. Hall and Flynn’s survey [29] was published 20 years ago. Our workshop study shows that researchers are more enthusiastic about reporting ethical issues. However, our literature review results show that the software engineering community still pays little attention to ethical issues when reporting empirical studies.

It is important to justify ensuring confidentiality and anonymity, as one of the workshop participants mentioned. Researchers should also consider the interactions of ethical aspects with other scientific issues, such as open, transparent research practices (traceability and reproducibility). To make the research reproducible, it is important that all relevant information – such as methodological details on what and how data was collected and analyzed – should be reported. However, the study subjects’ anonymity concerns should

also be considered by withholding the information sensitive to the subjects, such as their identities. There seems to be a tradeoff between reporting all versus withholding or anonymizing some parts of the information considered sensitive by the study subjects. However, to replicate a study, the secondary data users may not need all information as long as all necessary methodological details are transparently reported. Thus, we think it is possible to address both concerns by balancing the need to report all necessary methodological details and withholding/anonymizing sensitive data. In addition, the specific context of the study may also result in a different set of tradeoffs depending on, for example, the type of research being reported. Even when researchers do not report details that can identify individuals, they can choose to keep the links between the data and subjects internally if needed for follow-up studies. Confidentiality mechanisms need to be proportionate to possible risks. Researchers need to be aware that they cannot adopt blanket solutions for all studies involving human subjects.

### 6.1. Comparing the results of the literature review and workshop

**Informed Consent:** The literature review results show that in the few papers (19/95) that provided some details about informed consent, the most commonly mentioned informed consent aspect was study purpose and procedure. The other two aspects – voluntariness and benefits explanation – were discussed in even less number of studies. The survey respondents, on the other hand, rated all three aspects worth considering to report in their papers. IC3 (Voluntariness) received the participants' highest ranking (2.9/3.0). Voluntariness, however, is covered only in a handful of papers in our sample. Likewise, the risk and benefits explanation also received a high rating from participants – however, that too is not discussed in many papers in our sample. Overall, the survey participants rated all informed consent aspects worth considering for reporting. However, the data from the literature review indicates that these aspects are practically not reported by a majority of the studies in our sample.

**Confidentiality:** In our sample of papers included in the literature review, only a limited number of papers (20/95) reported some details about confidentiality. The most commonly reported aspect (12/20) is about data storage and usage, followed by how data is shared (8/20). The survey respondents considered all aspects worth considering for reporting. However, the survey ratings for confidentiality related aspects are lower than informed consent ratings.

**Anonymity:** Anonymity related details was reported in only 12 studies in our sample of studies. In the case of the survey, overall, the participants did rate anonymity as something that should be considered for reporting. However, it received a relatively lower rating as compared to other issues. Half (12/24) of the papers in our sample that reported anonymity did not share any details on how was it done. The authors thought it enough to just report that anonymity is addressed without providing any further details.

### 6.2. Threats to validity

We used a combination of methods – literature review and a workshop – to investigate reporting of ethical issues in SE research. Our study may still have a few limitations. We use Petersen and Genzel's [30] classification to discuss the threats to the validity of the data collection and analysis phases of our study.

**Descriptive validity** is concerned with those threats that may happen due to problems in the data collection phase of a study, which may eventually distort the accurate description of the truth. With regards to the literature review, all authors first piloted the data extraction form on a sample of papers. The results of the piloting process were discussed in a joint meeting to ensure that all authors have a shared understanding of the data extraction form and process. The questionnaire of the survey was designed jointly by the first two authors, who were both involved in collecting the data at the workshop.

**Interpretive validity** is concerned with those threats, such as researchers' bias, that may lead to inaccurate conclusions. To avoid any issues in drawing conclusions, the first two authors jointly performed the analysis, including the coding. Furthermore, the results were presented and discussed in a joint meeting involving all four authors.

**Generalizability** is concerned about the extent to which the results are applicable to those that are not part of the study. In case of the literature review, our sample is quite small and therefore is not representative of the entire SE literature. Moreover, the results obtained on the reports of ethical considerations in the literature review (and therefore the checklist) are limited to the types of studies found (that is, primarily experiments, interviews and surveys, as see in Figure 2). In addition, we review journal publications only as they provide specific guidelines (see Section 2.2). The results may differ if we consider conference publications as well. Our aim was not to achieve generalizability, but rather to observe how ethical issues are reported in a sample of recent journal articles published at top SE journals. The sample gives an idea about the state of research practice on reporting ethical issues in SE research – that even most of the recent articles in this sample at top quality journals do not report necessary ethical issues appropriately. The workshop participants are also limited in number. In addition, as the participants were attending a workshop on ethics in SE, they were likely more positive towards reporting ethical issues. We think further evaluation of the checklist, involving more SE researchers, is needed in future.

## 7. Conclusions and future work

Our literature review results based on 95 primary studies indicate limited reporting of consent, anonymity and confidentiality issues in SE publications. The studies included in our sample mostly discussed the process of obtaining informed consent. However, this was limited to informing the subjects on the study purpose and procedure in most cases. We identified different aspects of confidentiality reporting. Most studies discuss the details of storing and using data to maintain confidentiality. Half of the studies that mentioned anonymity did not provide information on how they anonymised.

In the workshop, the participants rated the procedure to: obtain voluntariness, communicate risks and benefits, and analyse to preserve confidentiality as the top three ethical issues to report. However, in our literature review, we observe that the risks of participation and the analysis process to preserve confidentiality were the least discussed aspects.

Finally, we propose a checklist that SE researchers can use to identify the ethical issues related to informed consent, confidentiality and anonymity applicable to their study and consider when reporting their findings.

The proposed checklist is only based on selected empirical software engineering literature. In the future, we plan to compare it with related works from other disciplines (e.g., [31, 32]) as well and see how can we further improve it.

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