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The Bad Side of HCI

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CCS Concepts: • **General and reference** → *General literature*; • **Human-centered computing** → **Empirical studies in HCI**.

Additional Key Words and Phrases: Bad Side of HCI, ACM, CHI, adverse effects, bias, challenges, concerns, social impact, societal impact, responsibility, ethical aspects

1 ABSTRACT

This study explores the negative effects of Human-Computer Interaction (HCI) technologies, focusing on ethical, social, psychological and environmental impacts. A significant research gap was identified, highlighting the lack of high-level studies on how the negative aspects of HCI are reported in academic literature. There are no comprehensive statistics from the Conference on Human Factors in Computing Systems (CHI) regarding the percentage of discussions focused on negative impacts, nor longitudinal analyses tracking these impacts over time. This study aims to close this gap by investigating the extent to which negative impacts of HCI technologies are addressed, exploring the coverage and depth of discussions and tracking changes over the years. By systematically analyzing selected papers published at the CHI conference, the research categorizes and evaluates the extent to which negative impacts are addressed. The study employs a detailed search query and manual PRISMA evaluation process to identify relevant papers, revealing that discussions on the negative aspects of HCI are underrepresented. Key findings indicate a significant focus on societal and psychological impacts, with less emphasis on environmental and ethical concerns. The results suggest a growing awareness of the negative impacts of HCI, particularly since 2018, but highlight a need for more comprehensive reporting and exploration in these areas. The study concludes that while the field of HCI advances, it is crucial to address its potential negative impacts to ensure responsible and beneficial technological development.

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2 INTRODUCTION

The interaction between humans and computers has consistently been subject to critical examination and questioning. With the progressive deployment of neural networks and the increasing integration of intelligent systems, the accompanying criticism has similarly intensified. Criticism evolves within society, both in its content and its expression. It is well-established that as societal acceptance of a concept increases, the associated criticism tends to decrease. This dynamic is equally prevalent in the scientific community, which functions as a constituent of society. This study tries to identify, describe, and categorize the nature of this criticism. It traces the evolution of critical perspectives towards Human Computer Interaction (HCI) over the years of research, describes thematic areas that are becoming increasingly relevant, and indicates emerging focal points. While the title “The Bad Side of HCI” is pleasantly brief and direct, the ontology of the term “bad” in this context necessitates decomposition into more precise, less complex terms. This approach can be described as a semantic divide-and-conquer strategy, wherein the complex and inherently vague term “bad” is segmented into multiple terms that yield a more concrete ontology for a less complex analysis of its components.
A significant portion of this study is dedicated to the human evaluation of papers identified through specific search parameters. For this purpose, we selected the comprehensive set of all papers ever published at the Conference on Human Factors in Computing Systems (CHI), analyzed them using an evolutionary refined search query, and conducted individual assessments of the resulting papers. The evaluation was performed manually, without the assistance of any algorithmic or computer-based systems.

3 STUDY DESIGN

The study is based on the definition of the "Bad Side of HCI" and the formulation of relevant research questions. We establish a clear research focus by deriving a hypothesis. We describe the methodology including the independent, dependent and control variables.
In the context of this paper we define the "bad side of HCI" as the undesirable negative impact of HCI research or technologies on various levels. The areas considered include ethical, social, psychological and environmental aspects. Negative impacts might include ethical dilemmas such as invasion of privacy and misuse of data, social impacts such as social isolation and reduced face-to-face interactions, psychological impacts such as cognitive overload and stress or environmental impacts such as environmental pollution or increased energy consumption.
The paper addresses a significant research gap by highlighting the lack of high-level studies on how the negative aspects of HCI are reported in academic literature. There are no comprehensive statistics from the CHI conference regarding the percentage of discussions focused on negative impacts. Additionally, there is an absence of longitudinal analyses across years to track how these negative impacts are reported over time.
We aim to close this gap by investigating the negative effects of HCI to find out to what extent the negative impact of HCI technologies is addressed in the academic literature, to explore the coverage and depth of discussions. Additionally, we seek to discover how the percentage of coverage on these negative impacts has changed over the past years. The intention is to promote a more responsible and thoughtful development and application of these technologies.

Therefore, the null hypthesis is tested against the alternative hypothesis:
Null Hypothesis (H0): Negative impacts of new technologies in HCI are well reported in the existing academic literature.
Alternative Hypothesis (H1): Negative impacts of new technologies in HCI are under reported in existing academic literature.

To test these hypotheses and investigate the negative effects of HCI, we employ a systematic approach, focusing on a comprehensive literature search, evaluation, and analysis of corresponding papers. We collect the data by developing a suitable search query to identify relevant literature and conducting a comprehensive search. We enter each paper systematically into a spreadsheet for thorough evaluation. This evaluation is characterized by a methodical and reproducible selection process, where we use specific criteria to filter out non-relevant papers and focus only on the studies most pertinent to our research questions. To enhance the overall analysis, we categorize studies according to specific topics. This thematic clustering is crucial for identifying patterns and gaining insights into the negative dimensions of HCI.

The effectiveness of literature research on the "Bad Side of HCI" is influenced by multiple variables, including independent, dependent, and control variables. Independent variables are those that are manipulated to observe their effect on the dependent variable. In this study, the independent variable is the adaptation of keywords used within the base query. Different combinations of terms such as “negative impact,” are employed to achieve various outcomes. The dependent variable measures the outcome of changes in the independent variable. In this context, the quantity and quality of papers are used. The quantity of papers refers to the number of available papers in the ACM Library. The quality of papers is manually evaluated based on their relevance. Relevance assesses whether a paper addresses the topic and research question, and to what extent it investigates the negative impact of HCI. Control variables act as constants throughout the research to ensure the comparability of results from variations in the independent variable. In this study, the base query and search engine serve as control variables. The base query, defined in Chapter 4.4, is the foundational search term used in all queries to maintain a consistent search base. All queries are conducted on the same search engines to ensure comparability between different queries.

4 RELATED WORK

Effective literature searching requires both the utilization of a search engine and the application of appropriate search terms embedded in a suitable search query. This search query ultimately determines the quality and the quantity of an output and therefore the results of a literature search. Initially, we planned to examine both the “ACM Digital Library” and “Google Scholar”; the first for its relevance within the scope of Human Computer Interaction (HCI) and the latter for its size and universal orientation. We later concluded that a more meaningful result could be achieved by focusing solely on the ACM Digital Library, as it is more specialized in HCI research.

4.1 Keyword Approach

As an initial step we had to identify specific introductory filters to bind our base query to certain areas of research. Regarding our initial focus, terms like "systematic review", "case study", or "empirical study" were pre-attached to our keywords to limit the outcome to specific types of scientific work.
Combined with a restriction to the field of HCI, both in abbreviation and fully written out, the initial concept of the query is as follows:

("systematic review" OR "case study" OR "empirical study") AND (("hci" OR "human computer interaction") AND ("*keyword 1*" OR "*keyword 2*" OR...)) AND NOT ("*exclusion 1*" OR "*exclusion 2*" OR...)

Formula 1: Logic of Base Query

In a following step and as a first basis, a set of meaningful terms had to be created, characterized by their ability to select research works that describe our focus. The initial keywords emerged from brainstorming sessions that included scanning various scientific papers in the field of Human Computer Interaction (HCI), which were considered important for forming a meaningful base query.
This approach leads, preceding the two words regarding the topic of the literature study itself, to the selection of essential keyword shown in Table 1:

Keywords
HCI
Human Computer Interaction
Error
Fault
Mistake
Failure
High-Risk
Incorrect
Ethic or Ethical
Side Effects or Undesirable Effect

Table 1. List of essential Keywords

4.2 Semantic Network

The keywords derived from multiple brainstorming sessions failed to provide a justifiable basis for constructing a query that would reliably identify relevant papers addressing “The Bad Side of HCI”.
Therefore a more non-heuristic approach involving the environment of a *WordNet* query centered around a selected keyword using *WordVis* was pursued. This process was repeated with various words to compile a set of relevant keywords. Figure 1 illustrates this with the word “Error” and its surrounding context as an

example. Words that were not likely to appear in a scientific context were sorted out.

Fig. 1. *WordVis* visualisation of the word "Error"

This approach yielded very good results and helped to establish a strong catalogue of search terms. The terms identified through the semantic network were in some cases supplemented with important word collocations and form the basis of the analysis presented in Table 2.

4.3 Specifying the Query

After several iterations, which included multiple brainstorming sessions, examinations, and discussions of increasingly relevant papers related to the topic "The Bad Side of HCI", we modified the base query. The logic of excluding terms was discarded, and henceforth only one keyword was investigated to quantify its relevance.

The resulting formula is as follows:

("systematic review" OR "case study" OR "empirical study") AND
(("hci" OR "human computer interaction") AND ("*keyword 1*"))

Formula 2: Base Query

Table 2 shows all search words found via the modified base query (see Formula 2), with a specific search term appended as a keyword to the base query, and the corresponding number of publications found in the search engines ACM Digital Library and Google Scholar.
The first line of the Table describes the base query without any additional concatenation, while the following lines each describe the base query expanded by the term in column one.

Search Term	# Results: ACM (in Base Query)	# Results: Google Scholar (in Base Query)
Base Query (see Formula 2)	14,152	19,000
Negative resarch:		
adverse effects	350	9,050
bias	3,199	18,000
challenges	7,609	18,100
drawback	907	15,900
error	4,489	18,000
failure	2,775	18,000
issues	9,231	18,600
limitations	6,908	18,100
negative results	151	2,680
User centered aspects:		
accessibility challenges	82	838
cognitive load	1,142	18,000
emotional impact	158	2,730
human error	312	9,060
human factors	5,837	17,600
inclusive design	262	4,990
usability issues	864	14,300
Specific challenges:		
adoption barriers	37	857
interaction complexity	47	368
Social aspects:		
access to technology (excl.)	58	3,420
cultural factors (excl.)	78	5,410
societal impact (excl.)	35	1,920
social implications (excl.)	56	4,280
social responsibiltiy (excl.)	43	6,810
Ethical and legal aspects:		
ethical considerations (excl.)	117	11,000
legal implications (excl.)	8	1,190
privacy concerns (excl.)	203	12,700
sustainability concerns (excl.)	45	469

Table 2. Quantitative Results of Base Query with a specific Keyword

Table 2 provides a comparative analysis of search results for various negative aspects related to HCI across ACM and Google Scholar. The purpose of this comparison is to clarify the general search query by adding

specific keywords and then analyzing the amount of search results in both platforms.
At first glance, it is clear that Google Scholar produces more search results than ACM for all the keywords. This difference likely originated from Google Scholar's search algorithm and broader scope, which includes a wider range of academic papers compared to ACMs. In terms of specific keywords, like "limitations", "challenges", "issues", "bias", "error", "ethical", "failure" and "human factors" shows a high frequency of results on both platforms. This could highlight them as critical or widely discussed keywords within the HCI community. Each of these keywords have over 2,000 hits in ACM and nearly 18,000 in Google Scholar. On the other hand, more specialized topics like "Adoption Barriers", "Sustainability Concerns" and "Social Impact" demonstrate relatively fewer results. This indicates that while they are recognized within the literature, they may not be as extensively studied or may represent newer areas of concern.

4.4 Searching the CHI

The Conference on Human Factors in Computing Systems (CHI) is the leading conference in the field of Human Computer Interaction (HCI). After extensive brainstorming sessions and multiple iterations of reviewing randomly selected papers, it has become evident that focusing exclusively on papers from the CHI would greatly benefit our research. By examining all papers ever published at CHI, we can obtain more significant results and clearly demonstrate the progression of CHI research over the years, regarding our research focus. The initial approach involved designing a base query using regular expressions (Regex) to cover all negative aspects related to HCI, applied across the entire ACM Digital Library and Google Scholar. After deciding to focus exclusively on papers from the CHI, we tested our initial query and found the results to be insufficiently specific. Consequently, we revised our base query approach to focus more on standard works in HCI to determine essential categories to include in our query. After examining a set of test results, we chose suitable keywords representing several general, broadly defined categories to capture papers aligning with our objectives. We actively decided against using sentiment analysis on a trained neural network, as it did not produce deterministic results and lacked a reliable training set that met our standards.
To avoid determining these essential categories ad hoc and to maintain a non-heuristic approach, we utilized standard works of Human Computer Interaction to determine the most significant categories for further usage. The main categories derived from several standard works, particularly those by Dix (e.g. [3]) and Preece (e.g. [5]), were: Social / Societal, Ethical, Psychological, and Environmental. After several iterations with a test set of randomly chosen papers and various negatively connoted keywords, we increasingly found that the adjective "negative" itself, in conjunction with the specific category and a separate additional noun also prefixed with the adjective "negative", yielded the best results. After additional iterations, "impact" yielded the most meaningful results and provided papers that were most suitable for further analysis.
Thus, the following query was developed, to be applied to all papers from all years of the CHI:

[All: "negative impact"] OR [All: "societal impact"] OR [All: "social impact"] OR
[All: "ethical impact"] OR [All: "psychological impact"] OR [All: "environmental impact"]

Formula 3: Final Search Query

The plausibility of the identified branches was investigated by examining the CHI subcommittees [1]. This revealed that the four established categories "social/societal", "ethical", "psychological" and "environmental"

are highly suitable for categorizing the papers under review, as they encompass a significant portion of the subcommittees. Furthermore, these categories were independently derived, ensuring their applicability and relevance.

4.5 Defining Bad

It is often difficult to determine whether something is a negative aspect, as every reviewed paper lies in the scope of Human Computer Interaction (HCI), and any negative topic can also be part of a HCI paper. However, we aimed to highlight the prominent negative sides, specifically targeting the direct negative aspects of employed HCI techniques. The most challenging part is to distinguish whether negative aspects are only mentioned, or if a paper primarily focuses on a negative aspect that arises from the interaction between humans and computers, in any form.

For example, papers like "Dying, Death, and the Afterlife in Human-Computer Interaction: A Scoping Review" [2] do not fall into this category, even though they deal with topics that are obviously negatively connoted. However, this paper does not highlight a negative result of the interaction between humans and computers. Many papers that focus on improving established HCI systems describe the negative sides of HCI in terms of existing gaps or possibilities for improvement. These papers are not the focus of our investigation. We aim to specifically consider papers that primarily deal with the inherent negative sides of HCI.

5 SYSTEMATIC SEARCH

After the base search query was selected, a suitable approach for screening the relevant paper was chosen. In this case the "Prisma Flow Chart" is used. It follows three major steps: Identification, Screening and Inclusion of paper. The steps are described in detail below.

5.1 Prisma Flow Chart

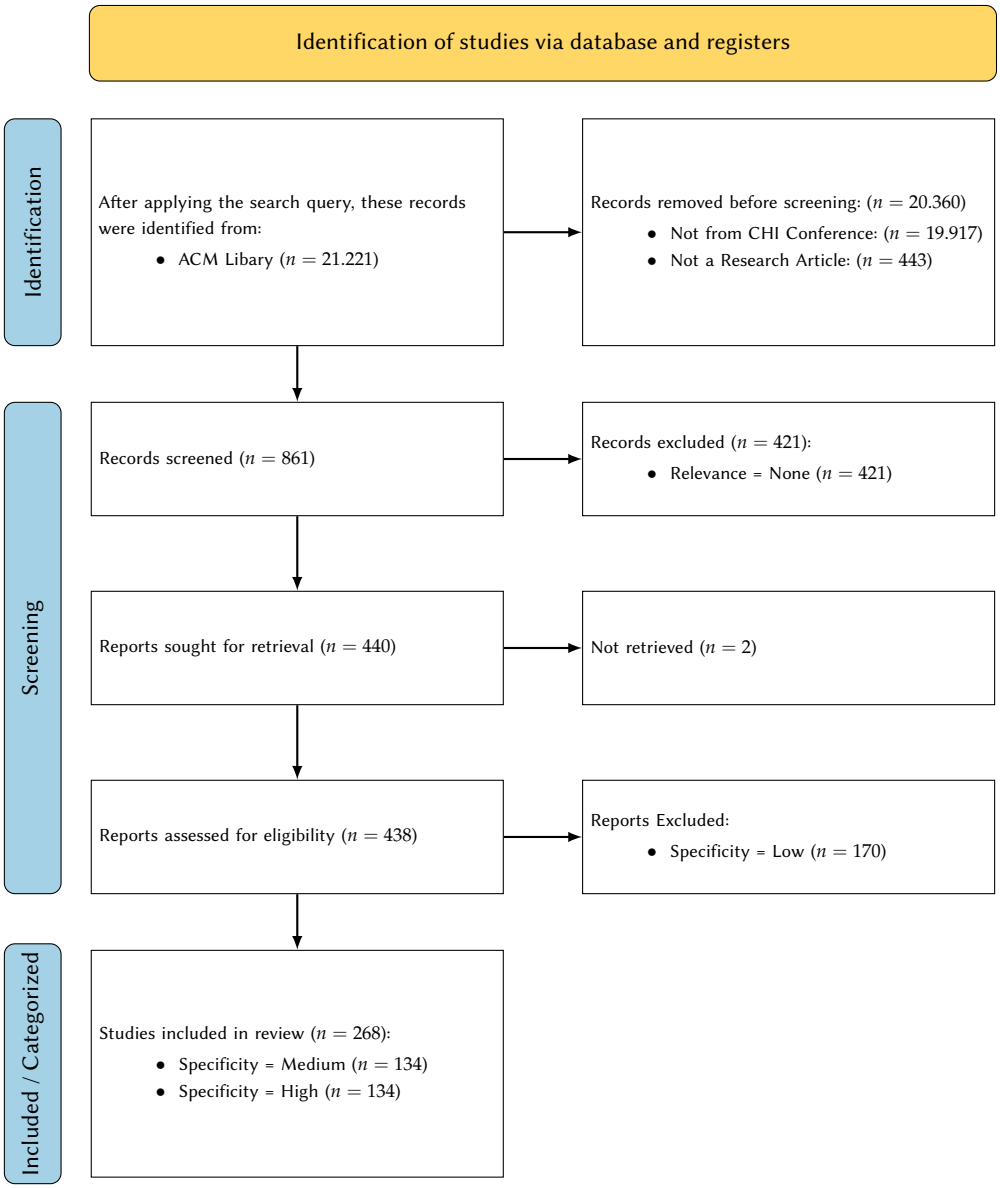


Fig. 2. PRISMA Flow Chart [4]

5.2 Identification

In our systematic search, we focused exclusively on the ACM Digital Library. This decision was made because Google Scholar yields an overwhelming number of results that are not limited to Human-Computer Interaction (HCI). By narrowing our scope to ACM, we ensure that our sources are more relevant and manageable.
First, all relevant paper from the ACM libary when applying the base query were recorded. Since the amount of 21.221 paper would exceed the possibilities of this paper, the identification was limited.
We concentrated specifically on papers from CHI conferences as mentioned in Chapter 4.4. The CHI conference is a prestigious venue where all submitted papers undergo a rigorous peer-review process. This ensures that the research we consider has been validated by experts in the field, thereby maintaining high standards of quality and relevance.
The selection of paper was further limited by focussing only on full research articles. In this way we can ensure that only full publications are used within our study and not shortened versions, abstracts or similar.

By focusing our search using these specific terms within the ACM Digital Library and CHI conference proceedings, we identified a total of 861 papers.

5.3 Screening

Each paper was reviewed by one reviewer with respect to the relevance and specificity of negative impact.
To ensure inter-rater reliability of the screening process, it is crucial for all reviewers to have a shared understanding of the evaluation criteria. This was done by having each reviewer independently screen the same set of ten research papers and by making sure that the relevance and impact of each paper are assessed consistently and accurately. Whenever discrepancies in the categorization occurred, the reviewers discussed these differences to further refine the understanding and application of the relevance criteria. Therefore, ten papers were chosen and each team member independently reviewed the papers and categorized the relevance of the negative impacts according to the predefined levels. The team convened to discuss their individual assessments and resolve any discrepancies. This discussion was aimed at refining the understanding and application of the relevance criteria. Through iterative discussions and feedback, the team reached a consensus on the categorization of each paper, ensuring a shared understanding and consistent application of the criteria. This method aimed to minimize bias stemming from individual differences in assessments, thereby enhancing the reliability of the results.

To systematically evaluate the relevance and specificity of the papers, they are categorized based on the extent to which they address the negative impact of HCI. These categories are defined as follows:

- **High Relevance**: Papers that address the negative impact of HCI comprehensively throughout the entire paper. These papers provide an in-depth analysis and substantial evidence on how HCI affects various aspects negatively.
- **Medium Relevance**: Papers that discuss the negative impact of HCI in one section or across several sentences. They are not as extensive as high relevance papers, but still contribute significant insights into the negative aspects of HCI.

- **Low Relevance**: Papers that mention the negative impact of HCI briefly. These mentions lack a detailed examination or evidence. Often found within the Discussion part of a paper.
- **None**: Papers that do not address the negative impact of HCI within the context of the study, but focus on other aspects of HCI without considering its negative implications.

Within the rating of the ten initial papers, we realised that a clear cut has to be defined which paper count as relevant for the Inclusion/Categorization step. Naturally, all papers that do not get a "None" rating would possibly be considered. In our case the "Low" rating was often applied when a paper only mentioned the desired topic in a few short sentences. Often these sentences could be found with the "Discussion" or "Limitations" section of a paper. Mostly those papers only mentioned that possible negative impacts could occur based on their findings, but they haven't investigated on those assumptions. It felt more like the authors wanted to make sure to mention those concerns but not really to elaborate on their thoughts.
Based on this trend, we decided to only include the "High" and "Medium" Rating within the Inclusion / Categorization step. In this way we can ensure that only papers that mainly focus on those negative impacts of HCI are kept for the Analysis of the results.

5.4 Inclusion / Categorization

In addition to categorizing the relevance of the papers based on the extent to which they address negative impacts, we enhanced the Inclusion step by classifying the specific types of negative impacts. In the screening process we noticed that some paper may fit into multiple categories. To ensure that no information would be lost, we included two category columns to also capture the relation between different categories. The available categories (based on the described finding process in Chapter 4.4) are:

- Social/Societal
- Ethical
- Environmental
- Psychological
- Other

If a paper addressed negative impacts that did not fit into any of the predefined categories, we added a note to the spreadsheet, suggesting a possible new category.

6 RESULTS

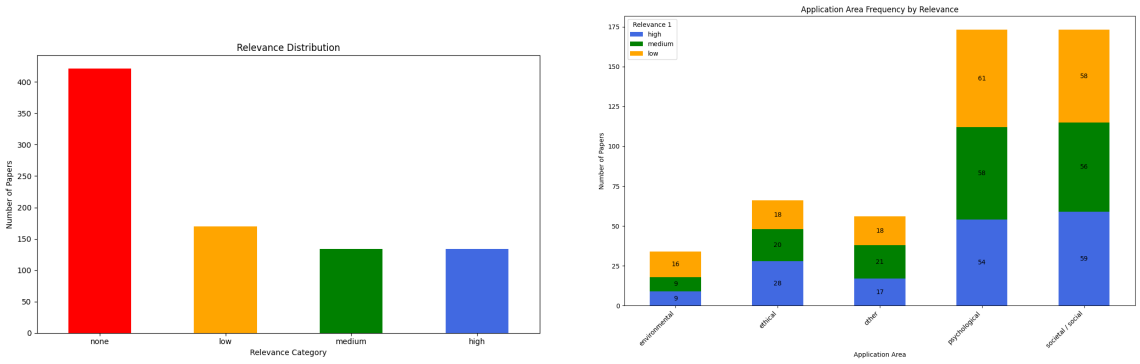
The results section provides an analysis of the reviewed papers from the ACM digital library.

6.1 Application Area and Relevance Distribution

The plots below provide an overview of the distribution of papers across various application areas and their respective relevance classifications.

In plot 3a it can be seen that the majority of the papers, over 400, have no relevance to negative impacts, as indicated by the 'none' bar. The 'low' relevance classification follows with fewer than 200 papers, while 'medium' and 'high' relevance classifications have a relatively similar number of papers, both slightly below 150.

Figure 3b illustrates the distribution of papers across different application areas (environmental, ethical, psychological, societal/social and other) categorized by relevance (high, medium, low, none). It is noticeable that most papers were categorized as societal/social and psychological, with a significant portion classified as medium to low relevance. In comparison to this, environmental, ethical and other areas have fewer papers, indicating these might be less explored or considered less relevant.



(a) Relevance Distribution

(b) Application Area Frequency by Relevance

Fig. 3. Comparison of Relevance Distribution and Application Area Frequency

6.2 Word Cloud of Free Comments for "other" Application Area

In the review process, reviewers could write free comments for the "other" Application Area. Given the substantial volume of comments, we performed preprocessing and filtering to generate a word cloud, which helps to visualize potential application areas apart from the predefined categories. The word cloud in Figure 4 reveals that terms like "privacy", "health", "experience", and "emotional" are prominent, indicating these are concerns in HCI research.

Fig. 4. Word Cloud of Free Comments for "Other" Application Area

6.3 Number of High/Medium Relevance Papers per Year

In further analysis, we limited our focus on high and medium relevance papers as these categories represent the most impactful and significant research in the field of Human-Computer Interaction (HCI), while papers classified with 'low' only scrap the surface of negative impacts. Figure 5 tracks the publication trend of high and medium relevance papers over the years. There is a noticeable increase in publication that address negative impacts from 2018 onwards.

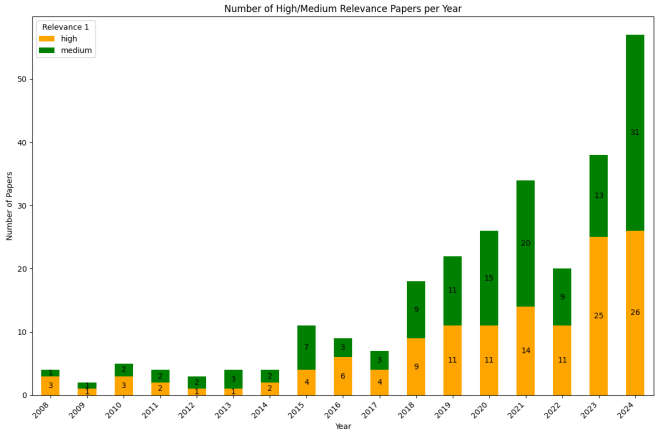


Fig. 5. Number of High/Medium Relevance Papers per Year

6.4 Ratio of High/Medium Papers to All Publications per Year

Figure 6 shows the ratio of high and medium relevance papers to the total number of published research papers at the ACM CHI conference for each year. The total number of published research papers per year was determined by performing empty search queries restricted to each CHI conference and filtering to display

only research articles.

The ratio seems to remain relatively low at a peak of 0.05 of all papers focusing on negative impacts, but this may be biased by the search query not including all relevant results. Not only is the amount of relevant publications rising, Figure 6 also indicates a rising ratio to all published research articles at CHI each year, particularly since 2018. This suggests that negative impacts are a growing concern in the field of HCI.

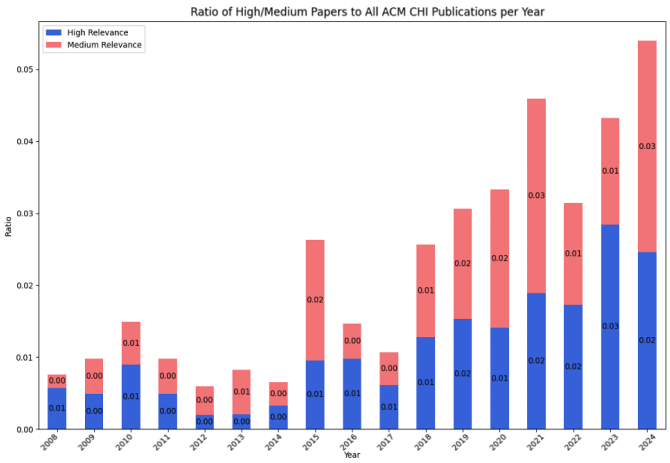


Fig. 6. Ratio of High/Medium Papers to All Publications per Year

6.5 Keyword Frequency

Table 3 lists the most common keywords across all reviewed papers. The high occurrences of "social media", "ethics" and "privacy" indicate that those are critical topics in the discourse around the negative impacts of technology. The presence of terms like "artificial intelligence" and "machine learning" can indicate a growing interest in implications of these technologies, but may also be related to a high amount of research in these areas.

Keyword	Occurrences
social media	17
ethics	15
privacy	14
virtual reality	13
sustainability	13
artificial intelligence	11
trust	8
gender	8
augmented reality	8
machine learning	8

Table 3. Keyword Occurrences in HCI Research

6.6 Confusion Matrix of Combined Application Areas and Relevance

The confusion matrix in Figure 7 presents the distribution of papers across combined application areas and their relevance categories. Notably, the combination of psychological and societal/social areas shows a high concentration of both medium relevance (15) and high relevance (13) papers, indicating a significant research focus at this intersection. This suggests that the negative impacts of technology on psychological well-being and societal interactions are critical areas of concern in HCI research. Other combinations, such as ethical and psychological, as well as ethical and societal/social, show considerable numbers of high relevance papers (7 and 6, respectively), further emphasizing the importance of ethical considerations in technology's impact on psychological and social domains. Lastly, combinations involving environmental factors, such as environmental and ethical, have fewer papers, indicating less emphasis in these areas.

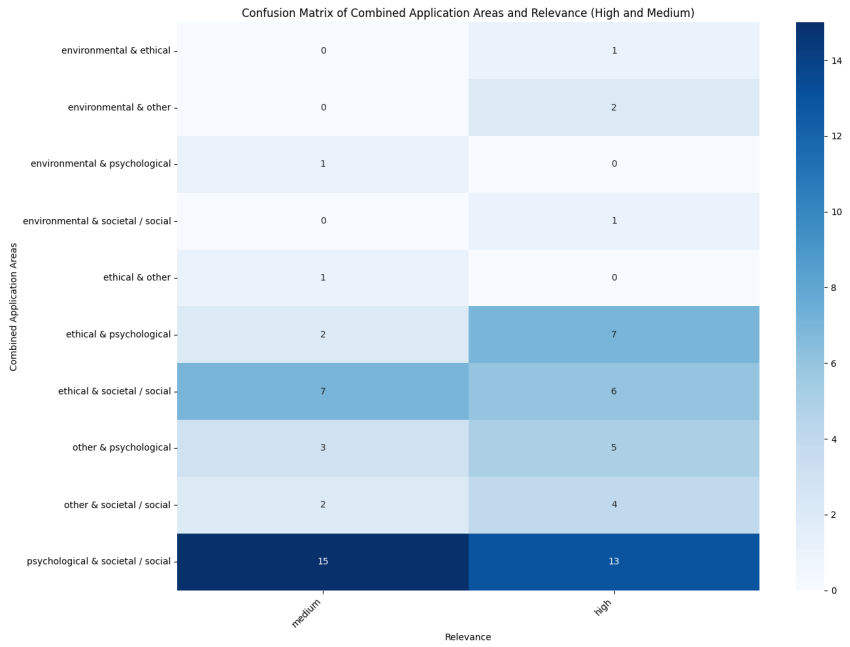


Fig. 7. Confusion Matrix of Combined Application Areas and Relevance

6.7 Distribution of Papers by Application Area

Figure 8 shows the overall distribution of papers by application area, with the high and medium relevance. Societal/social and psychological areas dominate, each constituting 34.3% of the total papers, followed by ethical (13.1%), other (11.6%), and environmental (6.7%). This distribution underscores the emphasis on societal and psychological impacts in HCI research.

Fig. 8. Distribution of Papers by Application Area

6.8 Hypothesis Testing

The results from the above analyses provide a clear indication of the current state of research in HCI. While there is a notable increase in publication classified as high and medium relevance in recent years, particularly from 2018 onwards, the overall ratio of these papers to the total number of publications remains relatively low. This trend suggests that although awareness and concern about the negative impacts of technology are growing, these issues still represent a smaller fraction of the total HCI research output. Furthermore, the keyword frequency analysis and the confusion matrix of combined application areas highlight critical topics and intersections that are receiving attention. However, the emphasis on certain areas like societal/social and psychological impacts, with relatively fewer papers on environmental and ethical issues, points to potential gaps in the literature.

Therefore, the null hypothesis is tested against the alternative hypothesis:
Null Hypothesis (H0): Negative impacts of new technologies in HCI are well reported in the existing academic literature.
Alternative Hypothesis (H1): Negative impacts of new technologies in HCI are underreported in existing academic literature.

Based on these, the null hypothesis (H0) can be rejected in favor of the alternative hypothesis (H1). The negative impacts of new technologies in HCI appear to be underreported in existing academic literature, indicating a need for further research and exploration in this domain.

7 LIMITATIONS AND FUTURE WORK

In this chapter, we address the limitations of this study and suggest possible ways for future research to close these gaps.

One limitation of this study is the scope of the literature review, which is restricted to papers accessible through the ACM library and the selected search query. This might not capture all relevant studies, as some important works might use different terminology, leading to potential gaps in the query and research and thus introducing a bias. Moreover, manually evaluating the quality of papers can introduce subjectivity, which could also bias the assessment since different reviewers might interpret relevance and quality in varying ways even after conducting an inter-rater reliability test. Furthermore, relying only on academic literature may also overlook significant negative impacts reported in non-academic sources, such as industry reports, news articles, or user testimonials. Another limitation of the study's methodology is its dependence on available literature to assess the positive and negative impacts of HCI. The full extent of these impacts remains unknown because not all unintended or undesired negative effects are reported or documented in academic or public sources. This results in a potentially skewed understanding of the negative impacts of HCI.

Future work could address these limitations by expanding the search scope to include a broader range of search engines, search queries, and non-academic sources, thus capturing a more comprehensive view of the negative impacts of HCI. Additionally, automated tools could be used for evaluating the relevance and categorizing the papers to reduce subjectivity and improve the consistency of the literature review.

8 CONCLUSION

The literature review of the "Bad Side of HCI" has shown a gap in the existing academic literature regarding the negative impacts of technology in HCI. Despite the increasing volume of research papers addressing HCI, as well as a rising ratio of research papers addressing negative impacts, the proportion remains relatively low. This indicates a critical need for more exploration and reporting on the potential downsides of HCI technologies.

Our study systematically reviewed a substantial body of literature, employing methods to ensure the relevance and quality of the papers examined. The rejection of the null hypothesis in favor of the alternative hypothesis confirms that the negative impacts of HCI technologies are indeed underreported in the existing literature.

The analysis revealed that while societal and psychological impacts are frequently discussed, there is a notable lack of emphasis on environmental and ethical concerns. This result suggests that some areas are underrepresented and require further attention.

Future research should aim to broaden the scope of incorporating diverse sources and perspectives to capture a more view of HCI's impacts. Expanding the search to include non-academic sources and employing automated tools for paper evaluation can help mitigate the limitations identified in this study. By doing so, new researcher can be more thoughtful on developing new technologies, while ensuring that their benefits do not come at the expense.

In conclusion, while the field of HCI continues to advance rapidly, it is important that everyone that is involved with technologies to remain attentive about its potential negative impacts. Proactively addressing these concerns will ensure positive impact on society.

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