"I am always tired": Perceptions on Mental Health and Productivity Metrics

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Abstract. *This study aims to gather insights from tech and health professionals regarding their perceptions about twelve proposed metrics designed to measure mental health and productivity in software development. These professionals were surveyed to rate the usefulness and appropriateness of each proposed metric. The findings offer valuable insights into the factors that influence the perceived utility and likability of these metrics. By leveraging developers perceptions, we can develop more effective strategies to promote a healthier and more productive work environment in software development. Thus, this study paves the way for the implementation of more targeted interventions and best practices within the industry.*

1. Introduction

In the fast-paced world of software development, professionals often face high levels of pressure, characterized by long work hours, tight deadlines, and critical projects. These demands can significantly impact both the mental health and productivity of software developers. Understanding and improving these 2 critical aspects is essential for creating a sustainable and efficient working environment.

This study is part of an ongoing research project in which we surveyed 35 professionals regarding their perceptions about 12 proposed metrics and measurements in software development. We define metrics as the specific criteria used to evaluate mental health and productivity, while measurements refer to the methods or instruments employed to quantify these metrics. First, we develop a comprehensive catalog of mental health and productivity metrics for software development based on a literature review. This study seeks to explore the perceived usefulness and likability of these metrics, with the aim to refine and compile them into a catalog that promotes a healthy and productive work environment. We defined productivity as the quantity and quality of work produced in relation to the expected work [Melo et al. 2011, Melo et al. 2013] and mental health as the state of mental well-being that allows people to cope with their daily lives [Organization 2024]. Second, we create a refined survey structure that incorporates both existing and innovative metrics to assess mental health and productivity.

Our contributions include (1) a comprehensive *literature review* of existing metrics in mental health and productivity within software development; (2) a *metrics catalog* with detailed guidelines on their implementation and measurement; (3) a *metrics survey* gathering the perceptions from industry professionals on both existing and newly proposed metrics; and (4) a *replicable methodology* that can be used widely to validate other metrics and measurements.

The target audience for this study includes software development managers, and researchers in the fields of software engineering and occupational health. The proposed catalog of metrics serves as a foundational step toward developing comprehensive tools that not only

quantify productivity but also emphasize the role of mental health in sustaining high workplace performance. By applying these metrics, companies can gain valuable insights into their work practices and make informed decisions to enhance both individual and team outcomes.

2. Background and Related Works

In this section, we review 5 significant studies that have influenced our methodology and understanding of the factors affecting mental health and productivity in software development.

[Murphy-Hill et al. 2019] investigated software developers' productivity through a survey with 622 professionals from three companies. Their findings show the importance of non-technical factors such as job enthusiasm and useful feedback about job performance. The study highlights that while technical tools and code complexity are relevant, the most substantial impacts on productivity come from human and social factors within the development environment. In this context, [Khalid et al. 2022] conducted an analysis investigating the relationship between an organization's physical and psychological environment and employee mental satisfaction in the software industry. The study, conducted in Pakistan, identifies factors that affect employee satisfaction and loyalty to the organization, highlighting that a pleasant physical environment may not compensate for negative psychological factors such as biased rules. The findings from both studies reinforce the importance of considering both physical and psychological aspects in evaluating mental health and productivity in software development.

[Canedo and Santos 2019] conducted an empirical study to identify factors influencing software development productivity. They highlighted key factors such as experience, skills, motivation, team cohesion, and collaboration, which positively influence productivity. Conversely, factors like high turnover, complexity, and rework have negative impacts. The comprehensive categorization of productivity factors in this study has informed our approach to developing metrics and measurements that are multifaceted and address various aspects of the development process, from individual skills to organizational practices.

[Guerrero-Calvache and Hernández 2022] conducted a systematic mapping study that identified 63 factors contributing to team productivity in agile software development. Their research shows that productivity is a complex concept shaped by team collaboration, communication, and work quality. These factors guided us to understand the different dimensions of productivity in agile environments and shape our metrics accordingly.

[Melo et al. 2013] conducted case studies in 3 large Brazilian companies, identifying team member turnover, team design choices, and inter-team coordination as significant factors impacting agile team productivity. They emphasize that small teams and diversity boost productivity, while poor inter-team coordination and high turnover hinder it. This study's insights into team management guided us in developing measurements for agile settings.

These studies highlight the multifaceted nature of productivity in software development, emphasizing both technical and non-technical factors. Our research is grounded on these findings by proposing ways to measure these state-of-the-art metrics.

3. Methodology

3.1. Goals and Research Question

This study aims to explore the use and perception of traditional and proposed metrics for assessing mental health and productivity among professionals in the technology and health sectors. This involves examining the adoption and value of these metrics, highlighting their practical relevance and effectiveness in the dynamic software development environment.

We aim to address the following RQ: *What are technology and health professionals' perceptions on traditional and proposed metrics for assessing mental health and productivity?* To answer this research question (RQ), the study measures adherence to metrics across four categories: Individual Mental Health, Team Mental Health, Individual Productivity, and Team Productivity. We identify metrics with the highest adherences to guide future improvements and implementations. To perform our analysis and address the RQ, we designed an experimental survey that includes both technology and health professionals. While the metrics are primarily used in software development, the inclusion of health professionals ensures a well-rounded evaluation. Their mental health expertise is critical for validating these metrics and enhancing their application in assessing both mental health and productivity.

3.2. Study Phases

Figure 1 shows an overview of the study phases, which are detailed in the following sections.

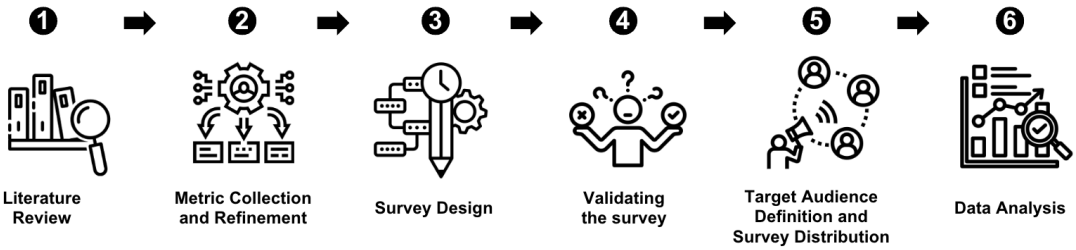

Figure 1. Study Development Phases

Phase 1: Literature Review. A comprehensive analysis of the existing literature was conducted to identify relevant metrics used to measure mental health and productivity in software development. This phase provided a foundation and context for the study, ensuring that selected metrics were grounded in existing research. The review included widely recognized metrics such as Lines of Code, Number of Commits, and Number of Resolved Issues.

However, the literature revealed significant shortcomings in these traditional metrics, particularly in their ability to effectively measure productivity and its correlation with mental health. These metrics, while straightforward, often fail to account for critical factors such as code quality and complexity, leading to an incomplete and potentially misleading assessment of productivity in software development [Mota et al. 2021, Canedo and Santos 2019, Guerrero-Calvache and Hernández 2022]. This gap in existing work highlighted the need for developing new, more comprehensive metrics and measurements that can better capture the nuances of software development productivity.

Recognizing these deficiencies in the literature was a key motivation for our study. It underscored the importance of creating new measurements that address these gaps, thereby providing a more accurate and holistic understanding of productivity in the context of software development. This literature review, therefore, not only provided a solid foundation but also drove the development of a catalog of metrics that are better aligned with the complex realities of the field [Canedo and Santos 2019, Guerrero-Calvache and Hernández 2022].

Phase 2: Metric Selection and Refinement. In this phase, we categorized the collected metrics into: Individual Mental Health, Team Mental Health, Individual Productivity, and Team Productivity. Initially, 4 specialists labeled the metrics, with some already pre-labeled on existing studies. We then grouped the metrics, removed duplicates, and ranked them by citation frequency. From this, we selected 3 metrics for each area, totaling twelve, to ensure a balanced

and comprehensive assessment across the different domains. Six proposed metrics are designed to provide fresh insight into the field and six traditional metrics are to better understand the proposed metrics' acceptance into the community in comparison to the traditional metrics. Three traditional metrics were kept unchanged from [Guerrero-Calvache and Hernández 2022, Canedo and Santos 2019], while the other three were modified with new measurement approaches or shifted to different categories. The final metrics were determined through a voting process, resulting in a set of 12 candidate metrics for the catalog available in Section 4.

Phase 3: Survey Design. A survey[1] was designed to gather opinions on proposed methods for measuring the selected metrics. We used Google Forms since studies often used it and several professionals are already familiar with the platform [Ferran et al. 2021]. The survey included 62 questions, divided into 17 sections: 35 closed questions to gather the background of the participants and quantitative data, and 27 open-ended questions to capture qualitative insights.

The first section of the survey aimed to inform participants about the research objectives and obtain their informed consent to participate. The second section provided definitions for mental health and productivity. The third section focused on the participant characterization, including a control question about their field of work (health, technology, or unrelated field[2]). The fourth section introduced an example metric (*Metric 0*), serving as a model to help participants understand the structure and content of the subsequent sections. The next 12 sections followed a consistent pattern applied to each metric under review: (1) metric definition; (2) proposed method to measure it, (3) question to rate their opinion on appropriateness of the proposed measurement method using a linear scale from 1 to 4 (very inappropriate to very appropriate); (4) suggestion request for alternative measurement methods in a discursive format; (5) question to the usefulness of the metric using the linear scale from 1 to 4 (very useless to very useful); and (6) we ask why they hold that opinion in a discursive format. This approach ensured systematic and uniform data collection, facilitating comparability and comprehensive analysis. After the 4 initial sections and the 12 standardized sections for metric evaluation, the final section of the survey was a thank you message, an option to provide an email for updates or future collaboration, and contact details for questions or suggestions.

Phase 4: Validating the Survey To ensure the reliability and clarity of our survey, we engaged in a thorough validation process of three iterative cycles of pilot testing. Each cycle involved conducting a pilot test with researchers who were external to our main study, collecting their feedback, and then refining the survey accordingly.

After each round of revisions, the updated survey was evaluated in subsequent pilot tests. We received specific feedback suggesting the addition of *Metric 0* as an example to guide respondents and clarify expectations. Additionally, we were advised to include definitions for technical terms related to the field of technology to avoid any confusion among participants. Both of these suggestions were incorporated into the survey. Following each phase of testing, we held brainstorming sessions with the research team to discuss the feedback comprehensively and implement necessary changes. This iterative process of testing, feedback, and revision continued through three cycles, with each participant spending approximately one hour on the survey. This rigorous validation ensured that the final survey was clear, comprehensive, and well-suited to meet the study's objectives.

Phase 5: Target Audience Definition and Survey Distribution. With the survey finalized,

[1]https://forms.gle/a4gBxwtWmCkUZqUb9

[2]If participants selected *"unrelated field"*, the survey would end due to the participant not being within our targeted work fields.

we sent the final version to our target audience, which consisted of professionals in the tech and health sectors. To reach this audience, we used LinkedIn by sharing the survey through flyers and private messages. Additionally, we expanded our distribution efforts by using platforms like WhatsApp and email to circulate the survey across various social networks.

Phase 6: Data Analysis. Data collected from the survey were analyzed using both quantitative and qualitative methods. Quantitative data from closed questions was analyzed and presented in tables and charts. The qualitative data from open-ended questions was coded and analyzed thematically to identify key insights and patterns.

4. Catalog

In this section, we introduce a catalog of metrics designed to measure mental health and productivity within the realm of software development. The catalog contains traditional and newly proposed metrics that are carefully defined and accompanied by a detailed method for its measurement. Our goal is to present these metrics in a way that they can be implemented and used by software managers, Human Resource professionals, and researchers to foster a healthier and more productive work environment.

The group of traditional metrics consists of: `Work Capacity`: team's ability to complete planned activities in terms of cost (development time) related to the deliveries made within the evaluated timeframe; `Turnover`: the rate at which employees leave a company and are replaced by new employees; `Absenteeism`: the frequency of absences in previously agreed commitments; `Missed Tasks`: percentage of tasks in progress that have not been updated in any way on any tracking board the company uses for more than 24 hours; `Number of Commits`: the total count of updates (commits) made to a code repository within a specified time span; `Number of Resolved Issues`: the total count of issues or bugs that have been fixed and closed in a project. These metrics often focus solely on quantitative aspects of productivity and do not capture the nuanced interaction between mental health and performance [Mota et al. 2021, Woods 2015]. Therefore, our catalog emphasizes six proposed metrics: `Self Vision`, `Team Vision`, `Work Vision`, `Quality of Social Interactions`, `Motivation` and `Work Environmental Conditions`.

4.1. Self Vision

Self Vision collects insights from individual team members about daily tasks completed, work quality, and overall performance. This metric focuses on self-assessment, allowing individuals to reflect on their own productivity and identify areas for improvement.

How to Measure? (i) Daily Surveys: Each team member rates their own productivity on a scale from 1 to 10. (*e.g., "On a scale of 1 to 10, how would you rate your productivity today?"*). (ii) Individual Perceived Productivity (IPP): The daily self-rating reflecting how productive a person feels they have been.

Purpose: This metric encourages individuals to regularly reflect on their work habits and effectiveness, while also providing a daily measure of perceived productivity that can be tracked over time to identify trends and areas needing attention. When compared with `Team Vision` (see Subsection 4.2), Self Vision can reveal discrepancies between self-perception and peer assessment, offering insights for both personal and team development.

4.2. Team Vision

Team Vision gathers insights from team members about their peers' contributions, collaboration, and overall performance. This metric helps in evaluating the collective assessment of each member's productivity by their peers.

How to Measure? Daily Surveys: (i) Each team member rates their peers' productivity on a scale from 1 to 10, using the same measure as the last metric (*e.g., "On a scale of 1 to 10, how would you rate the productivity of your peer today?"*). (ii) Team Perceived Productivity (TPP): The scores from these surveys are then averaged to calculate the TPP (see Equation 1). In Equation 1, S is the sum of the perceived productivity scores of team vision for each member and N is the number of team members.

$$TPP = S/N \tag{1}$$

Purpose: This metric provides a collective assessment of an individual's performance as perceived by their peers, and thus helps identify areas where individuals are excelling or need improvement based on team feedback. It encourages open communication and feedback among team members, fostering a collaborative work environment.

4.3. Work Vision

Work Vision compares IPP with the TPP of that individual. This metric highlights the alignment or discrepancies between self- and team assessment, providing valuable insights for improving both individual and team performance.

How to Measure? Weekly Percentage Calculation: Equation 2.

$$WorkVision = (IPP - TPP)10 \tag{2}$$

Purpose: This metric helps identify differences between how individuals perceive their own productivity and how their team perceives it, aiming for alignment between self-assessment and peer assessment. Work Vision highlights areas where self-perception may be misaligned with team feedback, providing opportunities for personal and professional growth.

4.4. Quality of Social Interactions (QSI)

The Quality of Social Interactions (QSI) metric evaluates how well team members communicate, collaborate, and support each other. This can be measured by using AI tools such as SentiStrength-SE [Islam and Zibran 2018] to classify messages from various platforms, such as instant messaging apps (Slack, Discord), project management tools (Jira, Trello), code repositories, and collaboration platforms (GitHub, GitLab), as neutral, positive, or negative.

How to Measure? (i) AI Classification: Use AI to classify text messages or voice messages exchanged via platforms as neutral, positive, or negative. (ii) Calculation: Focus on the interactions that express emotions. It's important to exclude neutral messages, so the focus remains on emotional interactions (see Equation 3). In Equation 3, TTN represents the total number of negative messages and TT denotes the total number of messages exchanged. The result is the percentage of negative interactions within a team's communication.

$$QSI = (TTN/TT)100 \tag{3}$$

Purpose: This metric evaluates team dynamics, by providing insights into the emotional quality of interactions within the team. It also helps identify potential issues in communication and collaboration that may affect team productivity and morale. QSI encourages positive interactions and support among team members.

4.5. Motivation

Motivation is a critical metric for understanding the mental health and productivity of software developers. It encompasses several key factors that influence an individual's drive and engagement in their work.

How to Measure? (i) QSI. (ii) Absenteeism Rate (AR): Track the percentage of last-minute rescheduling, poorly justified, or unjustified absences from previously agreed commitments. (iii) Percentage of Missed Tasks (PMT): Observe the percentage of tasks in progress that have not been updated in any way on any tracking board (e.g., Trello, Jira) for more than 24 hours.

Calculation results on the percentage of how motivated one feels. See Equation 4. Notice that although AR and the PMT are traditional metrics, they are included here as part of a holistic view of motivation as mental health, rather than solely focusing on productivity.

$$Motivation = 100 - ((QSI + AR + PMT)/3) \tag{4}$$

Purpose: This metric measures how motivated and engaged individuals are in their work. It also detects potential issues affecting motivation, such as poor social interactions, high absenteeism, and frequent missed tasks.

4.6. Work Environmental Conditions

Work Environmental Conditions assess the quality of the work environment from an ergonomic perspective, considering factors such as lighting, temperature, air quality, quietness, maintenance and cleanliness, physical safety, accessibility and mobility, comfort of work setup (*e.g.*, chair, desk), and quality of technological resources (*e.g.*, desktop, laptop).

How to Measure? Feedback Checklist: Create a checklist that includes all relevant factors that the company judges relevant for assessing work environment quality.

The calculation determines the percentage representing the quality of the work environment based on the feedback provided. Where UIC is the total number of unchecked items on the checklist, and TIC is the total number of items on the checklist (see Equation 5).

$$WorkEnvironmentalConditions = (UIC/TIC)100 \tag{5}$$

Purpose: This metric evaluates the ergonomic quality of the work environment, ensuring it meets the standards for health and comfort, identifies specific areas of the work environment that need improvement, and contributes to the overall well-being and productivity of employees by ensuring a supportive work environment.

5. Study Results

Our survey collected responses from 7 professionals in the health sector and 24 professionals in the tech sector. The majority of participants are professionals, possessing one to 3 years of experience in hybrid roles within the private sector. Additionally, over 50% are employed by companies with fewer than one hundred employees. Among all participants, only 7 indicated that their productivity or mental health has been measured or rewarded in their workplace.

5.1. What are technology and health professionals' perceptions on traditional and proposed metrics for assessing mental health and productivity?

As detailed in Section 4, we categorized the 12 metrics into 2 groups, aiming to distinguish between metrics found in our literature review (*i.e.* traditional metrics) and proposed metrics.

Table 1. Average Likeability of Traditional and Proposed Metrics

	Traditional Metrics						Proposed Metrics					
Field	Work Capacity	Turnover	Missed Tasks	Absenteeism	Number of Commits	Number of Resolved Issues	Self Vision	Team Vision	Work Vision	QSI	Motivation	Work Environmental Conditions
Health	3.29	**3.14**	3.43	2.86	**2.83**	3.00	2.43	2.71	3.00	**3.14**	**3.57**	**3.71**
Tech	3.08	**3.04**	2.88	3.00	**2.13**	2.70	2.88	2.92	2.96	**3.00**	**3.21**	**3.21**

As illustrated in Table 1, we identified `Work Environment Conditions` (3.71) as the most favored by health professionals and both `Motivation` (3.21) and `Work Environment Conditions` (3.21) as the most favored by tech professionals.

Conversely, `Number of Commits`, a traditional metric, was rated the lowest, mostly by tech professionals. This aligns with findings from our literature review, suggesting a flaw in this metric's perceived relevance to productivity by professionals [Oliveira et al. 2020]. Tech professionals, who are more familiar with this concept, had an average rating of 2.13, compared to 2.86 from health professionals. This disparity may indicate that those with deeper insight into the tech field are more critical of this metric, recognizing its limitations.

P01 noted *"Sometimes, an individual might be working intensely on a project and forget to commit changes, making the number of commits an unreliable indicator of productivity"*, P04 mentioned *"An individual might make several insignificant commits to appear productive"*. P21 also pointed out that *"Measuring the number of commits can indicate activity and contribution frequency, but it does not account for the quality or relevance of changes"*.

These responses from tech professionals underscore the limitations of using the number of commits as a sole metric and emphasize the need for more comprehensive and context-aware measures that consider the quality, complexity, and overall impact of the work being done.

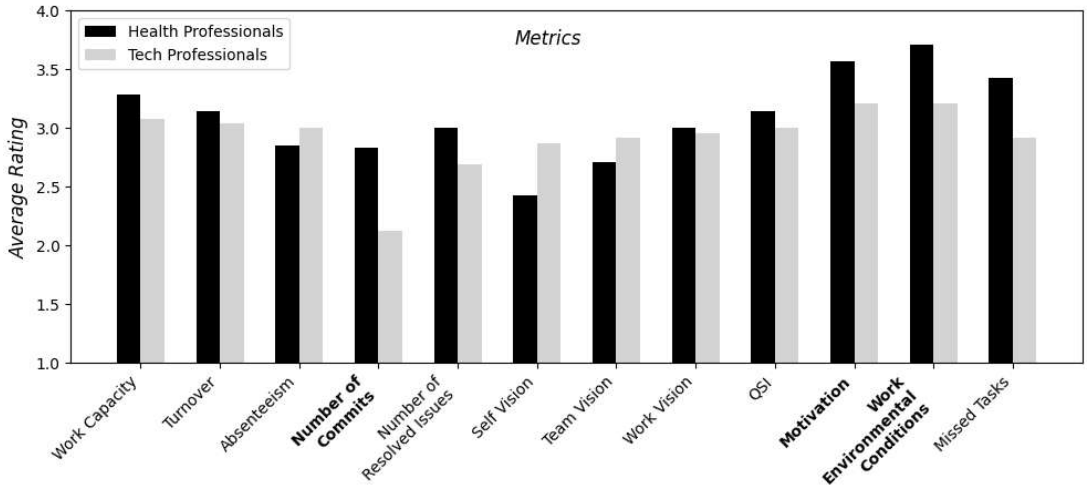

Figure 2. Average Ratings by Metric: Health vs. Tech Professionals

Further analysis in Figure 2 indicates that metrics such as `QSI` and `Motivation` received high ratings, suggesting a growing recognition of the importance of social factors and intrinsic motivation in workplace assessments from both fields. P21 said *"The quality of social interactions can significantly impact team dynamics and overall productivity. Positive interactions foster a supportive environment, enhancing both morale and efficiency."* and also noted that *"Measuring the QSI is crucial as it directly affects collaboration and team cohesion"*.

Additionally, `Work Environmental Conditions'` remarkable ratings indicate a consensus that physical workspace and conditions significantly contribute to better mental health and increased productivity. As P01 noted, *"Work environment conditions can totally impact the team's mental health, considering safety, comfort, ease, and accessibility. If someone works long hours in an uncomfortable place, with poor technology, accessibility, and being hot, they won't concentrate as much and may become stressed"*. P03 emphasized, *"I believe understanding the influence of the work environment on individuals makes total sense. An organized and calm work environment tends to increase productivity"*. Additionally, P21 pointed

out, *"The quality of the work environment can significantly impact employees' productivity and well-being"*. These insights highlight the critical role of a well-maintained and supportive physical workspace in fostering a productive and mentally healthy work environment, underscoring the strong approval and success of this metric among professionals.

In summary, the strong disapproval of `Number of Commits`, especially by those familiar with its limitations, points to the need for more nuanced and qualitative measures of productivity. The consensus around the importance of work environment conditions further underscores the shift towards metrics that better capture the holistic nature of workplace productivity and well-being, reflecting the evolving priorities in both professional fields.

5.2. Threats to validity

One significant concern is the limited sample size, which may not fully capture the diversity of opinions from tech and health professionals. To mitigate this bias, we reached professionals in the tech and health field with expertise in people management. Another concern is related to the definitions and interpretations of the metrics used in the survey, which can vary among participants, potentially affecting the validity of the results. We provided clear definitions and explanations for each metric to ensure consistent understanding among participants, as revised in Section 3.2. However, there may still be variations in individual interpretations that could impact the findings.

By acknowledging these threats to validity and taking steps to mitigate them, we aim to enhance the credibility and reliability of our findings. Future research should address these threats to validity to provide a more comprehensive understanding of the effectiveness of mental health and productivity metrics in the workplace.

6. Conclusions

There is a need in the literature to balance traditional productivity metrics with those that also account for mental health. Metrics like `Team Vision` and `Work Environmental Conditions` were well rated, indicating their potential as valuable metrics in fostering a supportive and productive work environment.

As shown in Figure 2, tech and health professionals showed differing attitudes toward traditional metrics like `Number of Commits`, likely due to their distinct areas of expertise. Tech professionals, being more familiar with metrics related to commits and issues, were more critical of these measures, whereas health professionals placed greater emphasis on mental health indicators such as `Motivation` and `Work Environmental Conditions`. In reflecting on these experiences shared by participants, a quote resonated deeply, *"I am always tired! I don't have a lot of quality time for myself, and it affects my productivity."* (P15). This statement highlights the persistent fatigue in software development, underscoring the need to address mental health and well-being in the profession.

To enhance the relevance and acceptance of workplace metrics, it is crucial for organizations to integrate employee feedback into the development of these metrics. This approach ensures that the selected metrics resonate with the workforce, thereby increasing their effectiveness and acceptance.

Overall, our study highlights the growing recognition of metrics that integrate social and environmental factors, offering a more holistic approach to balancing productivity with mental health. Moving forward, we plan to test these metrics in an industrial case study, utilizing longitudinal studies to track employee well-being and organizational success over time.

This approach will enable us to assess the long-term impact of these metrics, providing valuable insights that can advance the field and contribute to the development of a healthier, more productive work environment in software development.

Acknowledgements

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