The Employee as a Data Source: A Prospective View on Biosensor Technologies in the Workplace

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Abstract: This study explores the interpretation of the employee as a source of data and the emerging idea of the quantified workplace. It examines how employees perceive the future spread of biosensor technologies in the world of work, based on an online survey of 556 participants and an expert interview with futurist Dr. Árpád Rab. Results show that 61.5% of respondents considered it likely that biosensors will become widespread in workplaces within the next 20 years — significantly above the professional acceptance threshold. The findings suggest a growing openness among employees toward these technologies, which are expected to spread gradually and voluntarily, especially in safety-critical sectors. Their integration, however, will require transparent and ethical data practices to ensure trust in the future workplace.

Keywords: biosensors; human resource management; data protection; employee monitoring; quantified workplace;

1 Introduction

The emergence of new technologies has always evoked mixed emotions throughout human history: on the one hand, it inspires excitement and hope, while on the other, it raises uncertainty and concern about the consequences of change. Today, technological development permeates not only economic processes but every aspect of human life and work, creating an increasingly close relationship between humans and data. The appearance of biosensor technologies opens a new dimension in this relationship, as the human body itself becomes one of the most important sources of data collection and analysis. This transformation carries significant opportunities and challenges, especially in the world of work, where employee performance, health, and well-being can not only be observed but also measured, analyzed, and even predicted. At the same time, it raises the question of

how the employee can be interpreted as a source of data and what impact this perspective may have on the workplaces of the future.

The history of biosensors dates back to 1962, when Leyland C. Clark developed the concept of the enzyme electrode [1], [2]. The modern interpretation of the term is associated with Anthony P. F. Turner, who played a pivotal role in shaping the scientific concept of biosensors during his research at Cranfield University in the United Kingdom in the 1980s. According to Turner, a biosensor is an analytical device that combines a biological sensing element with a physicochemical transducer, enabling the performance of complex bioanalytical measurements [3].

Modern biosensors are complex systems that integrate a bioreceptor, transducer, electronic processing unit, and display, enabling the real-time digital measurement and visualization of biological signals [4]. In recent years, the technology has undergone rapid development, shifting from laboratory-based applications toward practical, human-centered uses. Systems that were once designed primarily for research purposes have now evolved into portable, multifunctional devices suitable for everyday life. According to international literature, biosensors increasingly influence not only healthcare but also organizational and decision-support processes [5], [6]. This trend has led to the emergence of the *quantified workplace* concept, in which data on employees' behavior, performance, and well-being become part of organizational decision-making. Moore, Piwek, and Roper [6] emphasize that such self-tracking systems may serve not only for productivity monitoring but also for supporting adaptive and learning processes that enhance employees' self-awareness, flexibility, and workplace well-being.

In recent years, the spread of wearable devices has been driven by the development of cheaper and miniaturized sensors as well as advances in mobile informatics. Their applications extend to monitoring physiological parameters (such as heart rate, body temperature, and respiration), biochemical signals (including sweat, tears, and saliva), as well as movement, ergonomics, and environmental factors [5]. Biosensors also offer new opportunities in the field of human resource management. Although the technology holds significant potential, its application in this area remains in an early stage. The introduction of workplace biosensors can enhance employee safety, enable objective monitoring of performance and health, and support overall well-being [7], [6]. Numerous wearable biosensors are already available for personal use, and they are expected to appear increasingly in workplace environments as well [8], [9]. These development trends foreshadow a future in which the employee becomes not only a participant in work processes but also a source of data through which organizations can make more precise, personalized, and predictive decisions—thus realizing the practical vision of the *quantified workplace*.

2 Methods

This study applied a mixed-methods research design, in which a targeted literature review was complemented by a quantitative online survey and a prospective, semi-structured expert interview with futurist Dr. Árpád Rab. The aim of the design was triangulation—that is, comparing statistical findings with future-oriented qualitative reflections in order to explore the concept of the "employee as a data source."

In the quantitative phase, responses from **n = 556 Hungarian employees** were analyzed (age range: 18–65 years; the majority held higher education degrees and worked in white-collar occupations). Data collection took place online, on a voluntary and anonymous basis, between December 2024 and March 2025. The questionnaire consisted of structured blocks containing 1–6 Likert-scale items, dichotomous questions, and open-ended items. Recruitment was conducted openly through online channels. Participants responded using a six-point Likert scale (1 = not at all likely, 6 = very likely). For analytical purposes, values 4–6 were defined as the category representing respondents who considered the widespread adoption of the technology to be likely.

The prospective component of the study examined societal perceptions regarding the future spread of biosensor technologies. The key question was the following: *"In your opinion, how likely is it that biosensor devices will become widely used in two thirds of workplaces within the next 20 years?"*

The aim of the hypothesis testing was to determine whether the level of societal perception reaches the minimum threshold for professional acceptance. The empirical foundation for this benchmark was provided by a study published in Human Factors, which surveyed 952 Occupational Safety and Health (OSH) professionals. According to the results, 53.5% of respondents supported, and an additional 27.3% indicated conditional openness ("might be interested") toward the workplace use of wearable sensors [10]. As this study represents one of the largest peer-reviewed empirical sources on workplace acceptance of wearable technologies, the present research adopted $p_0 = 0.535$ as a professionally grounded threshold.

Accordingly, the hypothesis tested in this study was formulated as follows:

H_0: Less than 53.5% of respondents consider it likely (values 4–6) that biosensor technologies will become widespread—present in at least two-thirds of workplaces—within the next 20 years.
H_1: At least 53.5% of respondents consider it likely (values 4–6) that biosensor technologies will become widespread—present in at least two-thirds of workplaces—within the next 20 years.

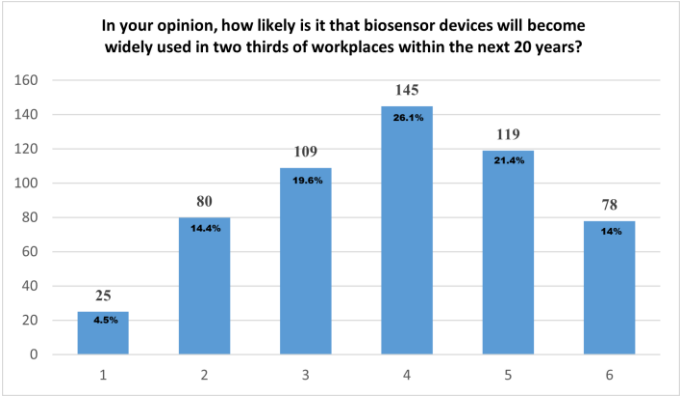
The combined interpretation of the quantitative and qualitative results provided methodological triangulation, that is, the integrated understanding of statistical

attitudes and futurist reflections. This integration reinforces the prospective, future-oriented approach of the research.

3 Results

This study forms part of an ongoing multi-stage research project examining the social, ethical, and safety-science implications of workplace applications of biosensor technologies. The analysis presented here constitutes the prospective component of the project and explores the extent to which respondents consider the widespread adoption of biosensor devices likely over the next twenty years. The survey question examined in this analysis was as follows: *"In your opinion, how likely is it that biosensor devices will become widely used in two thirds of workplaces within the next 20 years?"*

Based on the analysis of 556 responses (see Figure 1), the distribution showed a moderately balanced pattern on the six-point Likert scale—where value 1 indicated "not at all likely" and value 6 indicated "very likely." The frequency of responses was as follows: value 1: 25 responses (4.5%), value 2: 80 responses (14.4%), value 3: 109 responses (19.6%), value 4: 145 responses (26.1%), value 5: 119 responses (21.4%), and value 6: 78 responses (14.0%). When aggregating response categories 4–6—which represent perceptions of the technology's spread as "likely" or "very likely"—61.5% of participants indicated that they consider it at least somewhat likely that biosensor technologies will become widespread in two-thirds of workplaces within the next 20 years.



8. Figure
Perceived Future Adoption of Biosensors

The threshold value of **53.5%** was derived from previously published empirical findings from one of the largest peer-reviewed studies on workplace acceptance of

wearable technologies. As this benchmark was already discussed in the Methods section, it is referenced here only briefly to contextualize the hypothesis test.

The relationship between age and the 20-year outlook showed virtually no meaningful association, and the mean values across age groups differed only minimally. A similar pattern emerged when comparing generations: Generation Z (mean = 3.87), Generation Y/Millennials (mean = 3.85), and Generation X (mean = 3.90) expressed nearly identical future expectations. Although the Baby Boomer group showed a higher mean score (4.60), this difference cannot be considered reliable due to the very small subsample size (n = 5). Gender-based differences were also modest: men reported a slightly higher average score (4.02) than women (3.83), although both groups were predominantly positioned in the positive range of the scale. Regarding educational attainment, respondents with secondary education (mean = 4.08) and those holding a scientific degree (mean = 4.25) were somewhat more optimistic compared to respondents with higher education degrees (mean = 3.74); however, these differences should be interpreted cautiously due to the smaller subgroup sizes.

For clarity, the hypothesis tested in this study is restated here:

H_0: Fewer than 53.5% of respondents consider it likely (values 4–6) that biosensor technologies will become widespread—present in at least two-thirds of workplaces—within the next 20 years.
H_1: At least 53.5% of respondents consider it likely (values 4–6) that biosensor technologies will become widespread—present in at least two-thirds of workplaces—within the next 20 years.

The observed proportion of 61.5% was significantly higher than the threshold value of $p_0 = 0.535$, allowing the null hypothesis to be rejected and thereby supporting the alternative hypothesis. A one-sample proportion test was applied to determine whether the observed proportion differed from the expected value derived from the literature. The results indicate that the majority of respondents already consider the widespread adoption of biosensor technologies in the workplace to be realistic, suggesting a strengthening of technological trust and a shift in attitudes toward acceptance. Overall, the findings reflect a form of cautious optimism: most respondents believe that biosensor systems will naturally become integrated into the world of work over the coming decades, provided that their implementation occurs under transparent, voluntary, and ethically sound conditions.

In light of the qualitative findings, futurist Dr. Árpád Rab emphasized that the development of biosensor technologies may fundamentally reshape the relationship between humans and work in the coming decades, as the employee can be interpreted as a source of data. Such data may enable organizations to monitor safety, performance, and well-being in an increasingly data-driven manner. According to Rab, the spread of biosensors is likely to be gradual and predominantly voluntary, emerging first in industries where health and safety are

critical—such as healthcare, chemical manufacturing, or air-traffic control. The success of these technologies, however, will depend on transparent data management and ethical implementation. Employee acceptance requires that individual benefits—such as preventing overload, stress, or risky physiological states—are tangible, and that introduction occurs through voluntary, pilot programs. Artificial intelligence is expected to play a key role in this process by contextualizing the collected data and transforming it into decision support. As the technology becomes increasingly "invisible," its integration into everyday work routines will deepen, while human data itself becomes one of the most valuable resources in work organization.

4 Discussion

The quantitative and qualitative findings both indicate that the social acceptance and workplace adaptation potential of biosensor technologies are gradually strengthening. A majority of respondents consider it realistic that these devices could become present in a significant proportion of workplaces within the next 20 years, signaling growing technological trust and a forward-looking openness to innovation. The expert interview reinforces this pattern, suggesting that the introduction of biosensor systems in the coming decades will be shaped less by technological limitations and more by social and ethical considerations. Trust, transparent data management, and voluntary, well-communicated implementation will remain the key conditions for successful adoption.

These results can also be interpreted in a broader context, as the role of data in the world of work has fundamentally shifted: in the digital economy, data has become a central resource for organizational decision-making and competitiveness, and the notion of the employee as a "source of data" has gained increasing prominence. The prospective findings—consistent with international trends—suggest that societal attitudes are evolving favorably toward the future use of biosensor technologies. The methodological triangulation, integrating survey data with futures-oriented expert insights, further indicates that the societal prerequisites for technological diffusion are already partly in place, although the ultimate success of implementation will continue to depend on trust and ethical data governance.

5 Conclusion

The findings of this study indicate that the future spread of biosensor technologies in the workplace is not solely a technological development, but one that raises strategic, organizational, and human considerations as well. The future employee is entering a work environment in which biosensors and other advanced technologies become deeply embedded in everyday processes, shaping how work

is monitored, supported, and experienced. This evolution represents more than a trend: it signals a transformative shift in workplace dynamics, consistent with the broader changes described by Chappuis and Rizzo, who highlight how technology-driven environments redefine the nature and design of work itself [11]. As biosensor integration accelerates, the responsibility placed on HR professionals, policymakers, and organizational leaders also increases. Ensuring that data is used in ways that protect and enhance human well-being—rather than diminish it—will be essential for maintaining trust and legitimacy.

In the workplaces of the future, the interpretation and use of data will depend not only on technological capacity but equally on human factors such as transparency, voluntariness, and ethical data governance. Biosensor systems have the potential to elevate decision-making, safety, and well-being to a new level, but their success will hinge on whether organizations can introduce them in ways that are perceived as fair, beneficial, and respectful. Ultimately, the key question is not whether employees become sources of data—this transformation is already underway—but how organizations can create value from such data without compromising human dignity, trust, or transparency.

Acknowledgement

I would like to express my sincere gratitude to Dr. Csaba Otti for his professional mentorship and to Dr. Árpád Rab for the time he devoted to me.

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