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Implementation of Ergonomics and Local Wisdom in Designing ErJo (Ergonomic Jojodog) as a Solution to the Sustainability of Squatting Work

Nana Rahdiana [1*], Afif Hakim [1], Amallia [1], Louwis Perdian Sahat Marihot [1], Tito Tri Aditya Anuraga [1], Nasirul Hajin [1], Putri Hutami Rahmadianti [1], Herni Herawati [1], Ida Raeni [1], Falahal Majid [2], Kezia Yanfahira Shafa [3], Rahmat Wiguna [4]

[1] Department of Industrial Engineering, Faculty of Engineering, Universitas Buana Perjuangan Karawang, Indonesia
[2] Department of Industrial Engineering, Faculty of Industrial Technology, Telkom University, Bandung, Indonesia
[3] Department of Industrial Engineering, Faculty of Science and Technology, UIN Sunan Kalijaga, Yogyakarta, Indonesia
[4] PT. Tri Jaya Teknik, East Karawang, Karawang, Indonesia
*Corresponding Author: nana.rahdiana@ubpkarawang.ac.id

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ABSTRACT

Background: This community service program was implemented to address musculoskeletal complaints among production workers who frequently adopted squatting postures, which imposed static loads on the lower back, knees, and calves, resulting in discomfort and reduced productivity.
Contribution: This study introduces ErJo (Ergonomic Jojodog), a culturally adaptive ergonomic innovation that integrates traditional sitting design with modern ergonomic principles to enhance worker comfort and foster cultural acceptance.
Method: A participatory ergonomics approach involving ten production workers was employed through design, testing, and evaluation stages. Musculoskeletal complaints were assessed using the Indonesian National Standard (SNI 9011:2021), complemented by field observations and semi-structured interviews.
Results: After two weeks of ErJo implementation, musculoskeletal complaints in the knees and calves decreased from 67% to 20%, while lower-back discomfort declined to 40%. Participants reported greater comfort, stability, and ease of movement, with the belt-equipped model achieving the highest usability score. This study demonstrates that integrating ergonomics with local wisdom enhances worker well-being and promotes sustainable occupational practices.
Conclusion: ErJo effectively reduced musculoskeletal complaints and improved work comfort in squatting tasks. This innovation supports

SDG 3 (good health and well-being) and SDG 8 (decent work and economic growth), with potential for broader application across similar manual occupations.

1. Introduction

Squatting postures are commonly observed across various occupational sectors in Indonesia, both in informal and formal workforces. In the informal sector, this posture frequently occurs during agricultural activities such as rice planting and weeding [1] and during domestic chores such as washing, ironing, and cooking [2]. It is also commonly found in mechanical workshops during motorcycle repair tasks [3]. In the formal sector, squatting is prevalent in manufacturing environments, particularly during welding, assembly, and maintenance activities that require access to low or confined spaces [4]. Culturally, squatting has long been regarded as a normal and acceptable practice in Indonesia. However, from an ergonomic perspective, this is not a neutral working posture because it imposes excessive stress on the knees, ankles, and lower limbs, which may lead to musculoskeletal disorders (MSDs) [5].

MSDs encompass a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, and peripheral nerves. Common disorders include tenosynovitis, bursitis, and osteoarthritis, while nonspecific symptoms such as myalgia and low back pain are also prevalent [6]. In recent years, researchers have increasingly focused on lower-extremity MSDs, particularly in the knees, ankles, and calves, owing to their strong association with the ergonomic risks of squatting and kneeling postures commonly observed among industrial workers [7], [8].

Several studies have confirmed that awkward postures, such as squatting, increase musculoskeletal load and reduce productivity [9], [10]. Maintaining such postures for extended periods elevates knee joint pressure, restricts lower limb circulation, and accelerates the risk of early onset osteoarthritis [11]. Repetitive strain on the hips and ankles, combined with hard or uneven surfaces and a lack of ergonomic facilities, exacerbates these problems [8]. Nevertheless, squatting remains culturally accepted and deeply embedded in everyday work routines, making it difficult to eliminate without practical and context-sensitive intervention.

Previous ergonomic interventions have demonstrated that designs based on anthropometric data can effectively reduce MSDs and enhance comfort and efficiency [12]–[14]. However, despite numerous ergonomic studies, few have addressed how culturally embedded postures influence the sustainability of such interventions. In the context of Micro, Small, and Medium Enterprises (MSMEs), the adoption of ergonomic solutions often faces two primary barriers: (1) high production costs that limit accessibility and (2) inadequate alignment with local work habits and cultural norms, leading to low user acceptance [15]. Therefore, there

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is a critical need for adaptive and participatory approaches that integrate ergonomic design with sociocultural contexts to ensure long-term sustainability [16]–[18].

Several case studies have demonstrated that technically sound ergonomic solutions may fail when they neglect social and cultural contexts. As Imada and Robertson (1987) emphasized, ergonomic participation and design must align with local customs and community values [19]. For instance, work chairs for farmers or fishermen designed using international standards are often rejected because they conflict with traditional sitting habits and cultural practices of the users. In contrast, ergonomic designs that integrate elements of local wisdom tend to achieve higher user acceptance and sustainability.

In Sundanese culture, the jojodog, a small wooden stool approximately 20–30 cm high, represents a traditional seating device used for low-level activities such as cooking, pounding spices, and welcoming guests [20]. Drawing inspiration from this cultural artifact, the Ergonomic Jojodog (ErJo) was designed as a low ergonomic seat that merges modern ergonomic principles with cultural adaptation and local wisdom to enhance comfort, encourage user acceptance, and promote sustainable utilization in daily work practice. While preserving the familiar features of the traditional jojodog, the ErJo improves functionality through an adjustable height, optimized seating angles, and enhanced material stability. Its application has been shown to reduce pressure on the knees, hips, and ankles, thereby mitigating the musculoskeletal risks associated with prolonged squatting tasks.

Despite extensive ergonomic research on musculoskeletal risks, few studies have examined how cultural integration can enhance the adoption and sustainability of ergonomic interventions in industrial settings. This study addresses this gap by implementing ErJo, an ergonomic aid rooted in local wisdom, as a sustainable solution for employees performing frequent squatting tasks. This study aims to demonstrate how ergonomics can be contextually adapted to local practices, fostering both worker well-being and cultural continuity while supporting Sustainable Development Goals (SDGs) number 3 (good health and well-being) and number 8 (decent work and economic growth).

2. Methods

This Community Service (PKM) activity adopted a community-based design approach that emphasized the active participation of production personnel as primary users throughout all stages, from problem identification and design to solution implementation [21]. The community-based design framework aimed to incorporate extensive input from the user community to ensure that the outcomes genuinely reflected their real needs, daily work patterns, and contextual characteristics during the design process. This approach was selected because ergonomic interventions that focus solely on technical improvements often fail to achieve long-term adoption by workers. By actively engaging end users throughout each phase, the program aimed to ensure that the resulting innovation was not only technically sound, but also practically applicable, well-suited to existing work practices, and consistent with the surrounding cultural context.

Previous research has demonstrated the effectiveness of participatory ergonomics in various occupational settings. For instance, a study in the laminating and cutting sections of PT Primarindo Asia Infrastructure Tbk showed that engaging employees and occupational health experts in hazard identification and workstation redesign led to practical and implementable recommendations [22]. In the MSME sector, research in the leather slippers industry indicated that participatory workstation redesign combined with ergonomic education improved both comfort and productivity [23]. Similarly, a training-based intervention that integrated local wisdom in the Balinese handicraft sector not only reduced musculoskeletal complaints but also increased awareness of healthy work practices among artisans [24].

This PKM activity was conducted at PT Tri Jaya Teknik Karawang, a manufacturing company where several production processes still required employees to perform tasks in a squatting position, particularly during assembly and component repairs. The implementation lasted three months (May-July 2025), with a total of approximately 120 observation hours. The main participants were production operators who had previously been identified as experiencing musculoskeletal discomfort based on preliminary assessments. Ten individuals were actively engaged throughout all stages, from solution design and prototype testing to implementation evaluation. Their involvement was crucial to ensure that the developed innovation addressed actual workplace needs, remained compatible with prevailing work habits, and reflected the local cultural context.

The activity consisted of the following stages:

1. Problem identification

   This stage was informed by the findings of a previous study titled "Identification of Workers' Musculoskeletal Complaints Based on the Indonesian National Standard" conducted at PT Tri Jaya Teknik Karawang [5]. The study identified a high prevalence of musculoskeletal complaints, particularly in the lower back, knees, and calves, primarily attributed to prolonged squatting during work. These results provide a scientific basis and rationale for developing an ergonomic intervention through the design of a supportive work-aid device.

2. Solution design (ErJo - Ergonomic Jojodog)

   The proposed solution was an ergonomic low stool called ErJo (Ergonomic Jojodog), inspired by the traditional jojodog used in Sundanese culture. The design preserved the familiar form of the stool to ensure user acceptance while incorporating modern ergonomic principles, such as adjustable height, optimized seat angle, and the use of sturdier and more comfortable materials to support long-term use.

3. Prototype development

   Based on the finalized design, ErJo prototypes were produced using cost-efficient and durable materials. Each unit was internally tested to ensure structural stability, user comfort, and ergonomic compliance before being deployed for field evaluation by the target users.

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4. Socialization and training

   Before the implementation stage, the participants attended an orientation session that explained the purpose of the intervention and the expected benefits of using ErJo. The session also provided brief training on correct usage techniques, fundamental ergonomic principles, postural variation, and simple stretching routines designed to minimize muscle fatigue during extended work activities.

5. Implementation testing

   ErJo was used during daily operations over a two-week trial period. Throughout this phase, field observations and semi-structured interviews were conducted to capture participants' experiences, with particular attention to comfort, usability, and challenges encountered during use.

Quantitative data were analyzed descriptively using pre- and post-intervention SNI 9011:2021 scores, while qualitative feedback was thematically summarized to capture participants' perceptions, comfort, and sociocultural acceptance of ErJo implementation. The main evaluation instrument, the Indonesian National Standard (SNI) 9011:2021, provides standardized guidelines for assessing ergonomic risk factors in the workplace [25]. This tool was selected for its strong contextual relevance to Indonesian work settings and its capacity to objectively represent the distribution and intensity of musculoskeletal disorders.

Ethical considerations. All participants were fully informed of the study's objectives and the voluntary nature of their involvement. Written informed consent was obtained prior to data collection, ensuring compliance with the ethical principles of community-based participatory research.

3. Results and Discussion

As a local wisdom–based ergonomic innovation, the Community Service (PkM) team developed ErJo (Ergonomic Jojodog) by adapting the traditional low jojodog stool, a seating concept deeply rooted in Sundanese culture. The design aimed to minimize static loads resulting from prolonged squatting postures, which are still commonly practiced by production employees at PT Tri Jaya Teknik in Karawang. Through a participatory design process involving active dialogue and iterative feedback from participants, two ErJo prototype models were developed successfully in Figure 1. This collaborative approach ensured that the final design was ergonomically functional, socially acceptable, and culturally aligned with local work habits.

ErJo was constructed using lightweight, durable, and readily available materials in the local market. The main body was made of Styrofoam with a density of 30 kg/m^3, molded into a cylindrical shape measuring 20 cm in height and 30 cm in diameter. The top surface is padded with a polyurethane (PU) foam sheet to enhance sitting comfort, and the exterior is covered with canvas fabric to improve durability and resistance to tearing. From a design perspective, two variants of the ErJo were developed, differentiated by the type of fastening strap to accommodate varying user preferences and task requirements:

1. The harness-belt model provides greater stability during use.
2. Simple belt model, which offers higher practicality and ease of wearing.

As part of its product identity, ErJo features a simple yet meaningful logo that serves as a visual symbol and a representation of the underlying values of this innovation. The circular logo, dominated by black and white, prominently displays the word "ErJo", an abbreviation of Ergonomic Jojodog, accompanied by the phrase "Since 2025," marking the year of its development. A minimalist design approach was deliberately adopted to enhance recognizability and user acceptance, particularly among those directly engaged in its use. Beyond serving as a visual identifier, the logo symbolizes ErJo's identity as a culturally grounded ergonomic innovation designed for sustainability and broader adaptation.

Figure 1. Two ErJo prototype design models

The field trial of ErJo was conducted in the finishing section, with ten participants who frequently adopted squatting postures, especially during painting and accessory installation activities. Among them, two were assigned to use the ErJo regularly over a two-week period, under direct field observation. A comparison of the working postures with and without the device is presented in Figure 2. Overall, the participants provided positive feedback, reporting that the ErJo effectively reduced fatigue and discomfort in the lower back, knees, and calves, which are the areas most affected by prolonged squatting. Between the two prototype variants, users expressed a preference for the simple belt model owing to its practicality, ease of use, and comfort during squatting, standing, and transitional movements. The representative postures while using the ErJo are illustrated in Figure 3.

Quantitative measurements revealed a reduction in musculoskeletal complaints in several body regions, particularly the lower back, knees, and calves. Before the intervention, most participants reported moderate to high levels of discomfort in these areas; however, after two weeks of using the ErJo, both the frequency and intensity of symptoms decreased noticeably. In addition to these physical improvements, social acceptance is a significant outcome. Participants described the ErJo design, resembling the traditional jojodog stool, as familiar and culturally aligned, facilitating its acceptance and integration into daily work routines. Several users also reported greater comfort while performing prolonged tasks. Overall, these findings underscore the significance of integrating local wisdom into ergonomic design to promote

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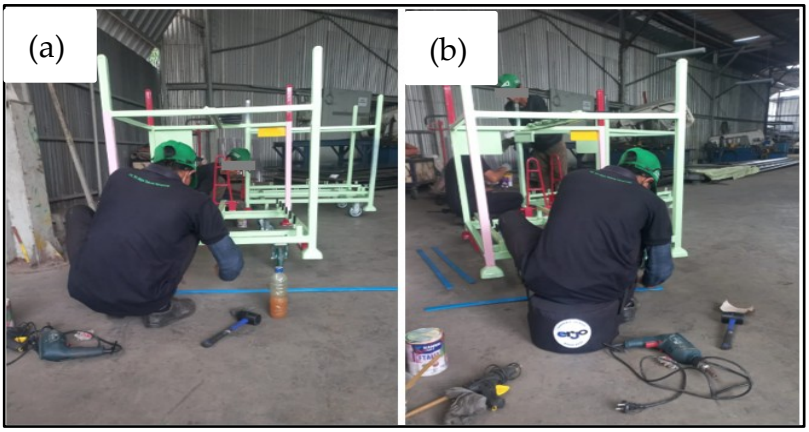
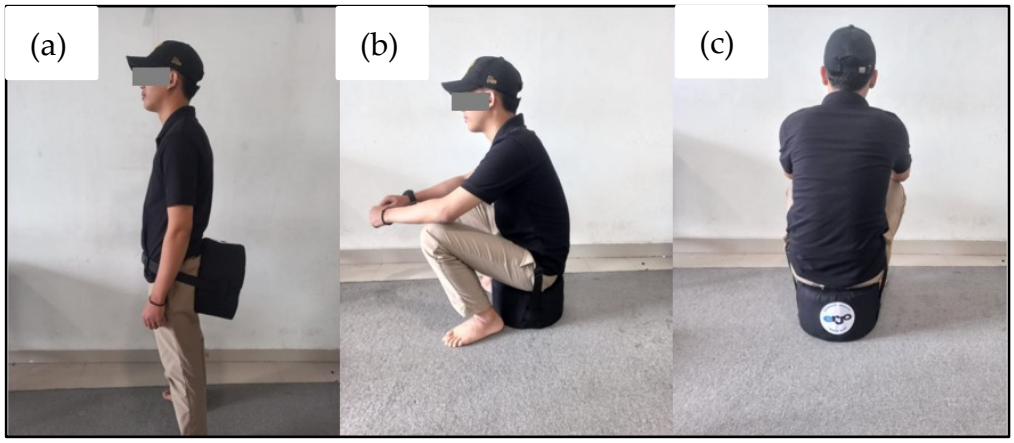
sustainability, strengthen user acceptance, and foster long-term behavioral adaptation in the workplace.



(a). Before using ErJo (b). after using ErJo

Figure 2. Worker posture



(a). Standing posture view (b). Side-sitting view (c). Rear sitting view

Figure 3. ErJo usage position

The evaluation of musculoskeletal complaints was performed after a two-week period of ErJo use, as shown in Figure 4. Quantitative assessments using the SNI 9011:2021 instrument indicated a significant reduction in musculoskeletal discomfort following the intervention. The most notable decreases were observed in the knee, lower back, and calf muscles. Prior to implementation, approximately 67% of employees reported moderate-to-high discomfort in the knees and calves; this figure declined to 20% after using ErJo. Discomfort in the lower back also decreased, although to a lesser extent, likely because of residual forward-bending postures during specific tasks. These findings confirm the positive impact of the ErJo in alleviating musculoskeletal strain associated with prolonged squatting. A summary of the pre- and post-intervention results is presented in Table 1.

The results confirmed that the use of ErJo effectively reduced the static loads on the lower body. In line with previous studies, Choobineh (2004) demonstrated that ergonomic workstation redesign can significantly reduce physical strain [12]. Similarly, Das (2021) in India and Sukapto (2024) in Indonesia emphasized that participatory ergonomic interventions are

highly effective in minimizing musculoskeletal risks [26], [27]. Moreover, the present findings reinforce the importance of culturally adapted ergonomic solutions, where the integration of local design elements contributes not only to physical comfort but also to behavioral sustainability.

Figure 4. Musculoskeletal complaint evaluation process using SNI 9011:2021

Table 1. Summary of pre–post evaluation results of musculoskeletal complaints using ErJo (SNI 9011:2021)

Body Part	Before Using ErJo	After Using ErJo	Decreased (%)
Lower back	67%	40%	-27%
Knees	67%	20%	-47%
Calves	67%	20%	-47%
Hips	33%	30%	-3%
Feet	33%	20%	-13%

Beyond its physical effectiveness, cultural congruence plays a pivotal role in sustaining user acceptance. The familiarity of the jojodog-inspired design fostered user trust, emotional connection, and a sense of ownership, supporting Helander's (2005) concept of cultural ergonomics as a determinant of sustainable intervention adoption [28]. Conversely, interventions that disregard the local cultural context often fail to achieve long-term engagement and usability.

From a reflective standpoint, this study provides insights into how local wisdom rooted in community traditions can be systematically embedded into ergonomic innovation. Such integration can be replicated in other industry contexts, particularly where workers' daily practices and postures are influenced by cultural norms, such as traditional craftsmanship, agriculture, and home-based industries. Thus, the ErJo model offers a transferable framework for developing culturally sensitive ergonomic interventions in diverse work environments.

This study extends participatory ergonomics by demonstrating how local wisdom enhances user adoption, acceptance, and long-term sustainability of design innovations in the workplace [29], [30]. From a practical perspective, this study shows that ergonomic innovations grounded in cultural values can be effectively implemented within micro, small,

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and medium-sized enterprises (MSMEs), where financial constraints are common but social cohesion remains strong. Policymakers and practitioners should promote participatory ergonomic programs that integrate sociocultural dimensions into occupational health and safety strategies.

Overall, this community service initiative demonstrates that integrating ergonomic principles with culture-based approaches can produce solutions that are technically effective, socially inclusive, affordable and sustainable. The ErJo innovation directly contributes to the achievement of the Sustainable Development Goals (SDGs), particularly Goal 3 (good health and well-being) and Goal 8 (decent work and economic growth) [31]. Improvements in workplace facilities and working postures implemented through the ErJo project have created safer, healthier, and more productive working conditions for workers. Furthermore, this study enriches participatory ergonomics practice by demonstrating how integrating local wisdom can enhance user acceptance and ensure the sustainability of ergonomic interventions.

4. Conclusion

This study exemplifies how ergonomic research can be translated into culturally embedded, practice-oriented innovations through the development of Ergonomic Jojodog (ErJo). The implementation of ErJo demonstrated a significant reduction in musculoskeletal complaints, particularly in the knees and calves, as measured using Indonesian National Standard (SNI) 9011:2021. Beyond its physical function as an assistive device, the ErJo provided an adaptive solution aligned with workers' cultural familiarity and habitual postures, resulting in greater acceptance and usability in daily work activities. From a broader perspective, the ErJo innovation advances ergonomics by incorporating cultural dimensions into the design process. This integration bridges traditional knowledge with modern ergonomic principles, emphasizing the significance of sociocultural adaptation in ensuring the long-term sustainability of ergonomic interventions. Practically, ErJo supports the achievement of the Sustainable Development Goals (SDGs), particularly Goal 3 (good health and well-being) and Goal 8 (decent work and economic growth), by promoting safer, healthier, and more productive working environments in small- and medium-scale industries.

Future research should explore the adaptation of the ErJo model across occupational sectors characterized by prolonged squatting, such as agriculture, fisheries, and informal home-based industries. Future studies should quantitatively assess long-term physiological impacts and evaluate the cross-sectoral adaptability of culturally embedded ergonomic tools. Long-term evaluations involving biomechanical assessments, postural analysis, and behavioral adaptation studies are recommended to reinforce empirical validation. Ultimately, the ErJo model illustrates how ergonomics informed by cultural context can foster inclusive innovation, align cultural identity with workplace sustainability, and offer a replicable framework for culturally responsive ergonomic design.

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